

Consultative Group on International Agricultural Research

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Agenda Item 12

Action Plan to Follow up on UNCED
Report of the CGIAR Task Force

As agreed at the 1993 Mid-Term Meeting a small Task Force was appointed further to develop further a paper outlining a response by the CGIAR to UNCED. This paper is attached.

The Task Force recommendations suggest a CGIAR response built around four major themes.

- Improvement Management and Productivity of Marginal Soils
- Genetic resources
- Human resources
- An Agroecological database/GIS initiative

To provide a mechanism for mobilizing incremental funding for these initiatives the Paper proposes that a UNEP Trust Fund be created and that proposals for CGIAR Center implemented research programs to be financed through this Fund be reviewed by a UNEP Steering Committee with strong CGIAR representation.

At ICW the Group is invited to react, both on the substance of the proposal and suggested institutional arrangements.

Attachment

Distribution

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Revision:

The Document of September 28, 1993 included duplicated text on pages 11-18.

TASK FORCE REPORT

CGIAR RESPONSE TO UNCED'S AGENDA 21

**PREPARED FOR CGIAR INTERNATIONAL CENTRES WEEK
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INTRODUCTION

When world leaders agreed on Agenda 21 at the UNCED meeting in Rio de Janeiro in June 1992, they also requested the international research community to consider specific contributions that it could make towards implementing Agenda 21. (Chapter 14.29 "International institutions, such as FAO and IFAD, international agricultural research centres, such as CGIAR, and regional centres should diagnose the world's major agro-ecosystems, their extension, ecological and socio-economic characteristics, their susceptibility to deterioration and their production potential. This could form the basis for technology development and exchange for regional research collaboration.") Based on Agenda 21 three international conventions regulating government activities are emerging: on biodiversity, climate change and desertification. Governments, both rich and poor, require scientific input to realise the ambitions of the 27 Principles of the Rio Declaration, Agenda 21 and the conventions.

CGIAR is one of the World's largest international research systems. Governments therefore expect the CGIAR to respond specifically to Agenda 21, in addition to maintaining and developing its traditional agricultural research agenda. Many, if not most, of the activities currently undertaken by the individual agricultural research centres (IARCs) relate closely to many of the wide-ranging list of development initiatives requested by Agenda 21. Through a series of studies on priorities and strategies and on ecoregional mechanisms the CGIAR is responding to increased awareness of the need for sustainable agricultural development. This work is well in hand. But the CGIAR is expected also to respond to other Agenda 21 environmental issues where its system expertise is relevant for achieving sustainable development.

OBJECTIVE

The objective of this paper is to suggest how the CGIAR, in addition to its general awareness of Agenda 21 principles in its work with agricultural research, can specifically respond to Agenda 21 (and the associated conventions) in a transparent and focused mode by initiating and participating in four global initiatives in fields where it has strengths and comparative advantages. The four initiatives assume separate and additional financing, beyond traditional CGIAR financing mechanisms. As the CGIAR gains experience in research on agro-environmental issues, further initiatives may be launched and find funding from donors anxious to secure wise use of land in the spirit of Agenda 21.

This paper suggests:

- that the CGIAR should respond forcefully to Agenda 21 calls for more environmental concern in research, by launching a Global Marginal Soils Initiative - we believe this should be the main thrust of CGIAR's response to Agenda 21;
- furthermore that the CGIAR should respond to Agenda 21 calls for further research in biodiversity, by extending its traditional role in ex situ conservation of mandate crops to stronger in situ conservation, and extend its interests into the genetic resources of livestock and fish, through a Global Genetic Resources Initiative;
- that the CGIAR should meet the Agenda 21 challenge on human and institutional capacity building by utilizing and extending its traditional roles in support of capacity building in developing countries by a Global Human Resources Initiative;
- that the CGIAR joins with the United Nations Environment Programme (UNEP)/Global Resources Information Data Base (GRID) system to provide an initiative on geographical information systems (GIS) and minimal global data sets for agro-ecological research (Agro-ecological data base / GIS.)

The present paper is based on previous reports to the CGIAR (at ICW92: "A CGIAR Response to UNCED Agenda 21 Recommendations" by the CGIAR Secretariat; and at MTM93: "Report by the Working Group on Possible Follow-up Action for the CGIAR on UNCED Agenda 21"), and the suggestions and guidelines laid down by the MTM93 in its deliberations on this issue. Readers are referred to the two earlier papers for specific references to Agenda 21 chapters and sections for the proposed initiatives.

Agenda 21 has 3 most relevant items to the CGIAR:

1. Poverty alleviation
2. Increased agricultural production
3. Environmental protection

The agricultural research community is aware that much environmental damage occurs in land under agriculture. The suggestion is therefore that in relation to Agenda 21 the CGIAR should profile itself as an effective entity contributing towards fulfilling ambitions of Agenda 21 within these 3 fields.

At MTM93 participants drew attention to the basic role played by soils in the quest to achieve sustainable agricultural development. Although important for much work done by the international agricultural research centres (IARCs) a sharper focus on some of the difficult soils issues was seen by many as a most important contribution towards wise use of land. IARCs have considerable soils expertise directly or indirectly that could interact fruitfully with activities of programmes and institutions also outside the CG system (e.g. IBSRAM). There is a growing awareness of the role played by soil factors, particularly for the poorest sections of the agricultural communities of the world with limited access to external inputs. But also for more intensive production systems the reliance on amelioration of soil conditions through external inputs must be revisited, with increased environmental concerns and changing economics. The Task Force wishes to stress that the important and ongoing CGIAR research efforts to maintain and increase the productivity of better lands are central to the CGIAR; the proposals forwarded by this Task Force are additional to this well-established CGIAR work.

Similarly MTM93 endorsed that an important part of preserving global biodiversity is the preservation of the genetic resources of domesticated plants, animals and fish, and their close wild relatives. The IARCs already play major roles in ex situ conservation of plant germplasm. There is a growing awareness that in situ conservation will become increasingly important, but the operational mechanisms whereby this can be achieved are still poorly known. This is an obvious field for research, where the IARCs in close collaboration with the national agricultural research systems (NARS) may contribute significantly. MTM93 therefore suggested that in situ conservation and use of genetic resources could be emphasized as a CGIAR contribution towards Agenda 21.

The relation between the CGIAR and its IARCs with NARS has been in focus throughout the existence of the CG, and is an important issue in the current remodelling of the CGIAR. Human resources development is a crucial tool in strengthening the NARS, and a significant proportion of the overall CGIAR budget is used towards this end. The key role played by universities in developing countries as places of training, is often overlooked. With the widening scope of sustainable use of natural resources on which primary production is based, the universities - with their more broadly based social and natural science platforms - could

benefit greatly through support that will link them more closely with their own NARS, and with the IARCs of the CGIAR system. At MTM93 a limited emphasis on this aspect of human resources development was suggested.

At ICW92 notice was given by IARCs of an initiative aimed at making relevant global environmental data bases available for the IARC through cooperation with UNEP's GRID system. Such data bases, and their processing within geographical information systems, could be of significant importance for the IARCs in their implementation of ecoregional initiatives. They could also be of use for NARS and for other national and international institutions. During the work of this Task Force it became clear that this initiative, which has attracted considerable donor attention, could form a useful part of a CGIAR Agenda 21 response. It is therefore added to the original list of initiatives presented at MTM93.

The four Global Initiatives suggested for the CGIAR in response to UNCED's Agenda 21 are:

The Marginal Soils Initiative
 The Genetic Resources Initiative
 The Human Resources Initiative
 The Agro-Ecological Data Base / GIS Initiative.

THE MARGINAL SOILS INITIATIVE

Soils play a central role in global environmental sustainability. Soils are central processing units of the Earth's environment and farmers are the custodians of the bulk of the Earth's most fertile soil resources. The composition of rain water (and other sources of water, e.g. surface water, sewage) changes upon infiltration in the soil and interaction with the soil at all levels. Solar energy and CO₂ from the air and nutrients from the soil are converted into plant products that feed animals and humans. Soils also filter and render harmless many toxic wastes and play a major role in regulating gas fluxes by serving either as a source or a sink of carbon. The soil is essential for the production of food, feed, fibers and fuel, and the home for many living organisms. The soil plays an essential role in determining the quality of the terrestrial and many aquatic environments.

Soil management issues figure prominently in six major chapters of Agenda 21, although they are also highlighted in several more. The six Agenda 21 chapters are:-

Protecting the atmosphere (Chapter 9).
 Managing land sustainability (Chapter 10).
 Combatting deforestation (Chapter 11).
 Combatting desertification and drought (Chapter 12).
 Sustainable mountain development (Chapter 13).
 Sustainable agriculture and rural development (Chapter 14).

THE CHANGING SOIL PARADIGM

Soil science is about one hundred and fifty years old. Major advances have been made in understanding the basic chemical, physical and biological processes involved as well the properties, taxonomy and geographical distribution of principal soil groups around the world. Most of the technologies developed on the basis of such understanding have focused on intensive agricultural systems on fertile lands where the working paradigm for years has been: overcome soil constraints through irrigation, drainage, tillage and application of fertilizers and amendments in order to meet the plants' requirements. This strategy is responsible to a very considerable extent for the sustained increases in world food production both in developed and developing countries. Increased food production, however, has led to many environmental problems: e.g. changes in ground water levels and contamination with salt, nitrates, phosphates and pesticides. There are problems in managing the good soils in a sustainable manner.

Even less is known about how to sustainably manage marginal soils. These are soils with severe constraints for agriculture and forestry, e.g. affected by drought, aluminium toxicity, low nutrient reserves, high phosphorus fixation, stoniness, limited water holding capacity, low adsorption capacities or being on steep slopes. Throughout history, people have settled more densely in the fertile lands. During the last decades population increases have led to widespread migration towards marginal lands in the tropical forests, hillsides and semi-arid areas. In some areas not much new fertile land is available for agriculture. The intensive use of purchased inputs (fertilizers, irrigation) is less feasible in more marginal areas either because the cost: benefit ratios are unattractive or because of socio-economic constraints in the farming communities. Soil science research to tackle these problems is much more recent. A second paradigm has emerged: "rely more on biological mechanisms by adapting germplasm to adverse soil conditions and water stress, maximize nutrient cycling to minimise external inputs and increase the efficiency of their use".

CGIAR SYSTEM INVOLVEMENT

The CGIAR system has made important contributions in both paradigm directions; some but by no means all of them are listed below as examples:

- Basic understanding of the fertility dynamics of flooded soils (IRRI).
- Comparison of land clearing systems, post-clearing soil dynamics and minimum tillage in subhumid forests (IITA).
- Selecting and breeding germplasm for tolerance to acid soils, aluminium toxicity, salinity and drought (CIAT, IITA, CIMMYT, IRRI, ICRISAT, others).
- Managing the physical constraints of shrink-swell vertisols (ICRISAT, ILCA).

- Low-input upland rice-pasture rotation systems for acid savannahs (CIAT).
- Contour leguminous hedges and vegetative filter strips for erosion control and nitrogen enhancement in steep hillsides (ICRAF, IRRI).
- Understanding methane emission processes from rice fields (IRRI).
- Dynamics of nitrogen and phosphorus in dry land soils (ICRISAT, ICARDA). Major advances have also come from institutions outside the CGIAR centres, with much intellectual leadership in tropical soil science. Examples of these are FAO/UNESCO world soil map and later the GLASOD exercise (ISRIC/UNEP) and agroecological zoning (FAO); ISRIC on soil data bases; SMSS in soil taxonomy, ORSTOM in pedology, CIRAD in tropical soil fertility, NIFTAL in rhizobium technology, TROPISOILS in the management of oxisols and ultisols, IFDC on fertilizer sources, marketing and use, TSBF in tropical soil biology and organic matter management, IBSRAM in networks and management of black vertisols. Several national agricultural research systems (NARS) have also made major advances in soils research, particularly in Brazil, India and Malaysia.

LAND MANAGEMENT ISSUES

We propose that the CGIAR system offers to initiate and participate in soil and water research efforts in terms of main Agenda 21 issues. The six major Agenda 21 ambitions previously mentioned form three major land management strategies:

- Attaining sustainable management of marginal lands subject to deforestation, erosion on steep slopes and desertification (Chapters 9, 11, 12, 13).
- Reclaiming degraded lands that are consequences of the above processes (Chapters 11, 12, 13).
- Maintaining the productivity of intensive systems while minimising environmental contamination (Chapters 10, 14).

Attaining sustainable management in marginal lands involves major research thrusts in 1) developing sound alternatives to slash and burn agriculture in the forest margins, 2) developing productive systems that arrest soil erosion on steep lands and mountainous regions, and 3) developing sustainable land management strategies near the desert margins involving both cropping and pastoral components.

Reclaiming degraded lands that are the end products of tropical deforestation involves complex strategies e.g. for vast areas of degraded forest fallows in Africa and throughout the humid tropics, the Imperata grasslands in Southeast Asia, the degraded pastures in the

Amazon and overgrazed rangelands in the semi-arid tropics. Reclamation of eroded steep lands is possible in many cases, but not where the topsoil is virtually gone. Since desertification is often a reversible process, the opportunities for large-scale reclamation are present with innovative approaches.

Prime, fertile irrigated land is often degraded by soil compaction due to excessive tillage, salinization due to poor irrigation management, nutrient imbalances due to poor fertilizer management and in some cases contamination of heavy metals by sewage sludge applications or other forms of pollution. Maintaining the productivity of these intensive systems is an essential issue for world food sustainability. Although these problems occur throughout the developing world, research on the marginal lands and reclamation of degraded lands are generic enough to be of international scope. The Task Force therefore recommends the CGIAR system and its collaborators to focus on the first two broad land management issues in their response to Agenda 21. The CGIAR addresses intensive systems through its well-established research agendas.

FROM LAND MANAGEMENT ISSUES TO RESEARCH PRIORITIES

One overriding theme for research emerges from the two land management issues: effective nutrient management. The old paradigm "overcome soil constraints through external inputs (e.g. the additions of fertilizers and amendments) to meet plant nutrient demands" is not applicable in most marginal lands. We must consider the basic principles of nutrient cycling in natural plant communities. But, agricultural systems differ from natural systems in one fundamental aspect: there is a net removal of nutrients from the site with crop harvests. This does not happen in natural systems where the losses due to leaching, volatilization or erosion are small enough to be compensated for by additions from atmospheric deposition or the weathering of primary soil minerals.

One basic principle of sustainability is to return back to the system the nutrients taken away, in order to maintain an adequate nutrient capital in the soils savings account. Agriculture should live off the interest but since large amounts of nutrients are often removed by crop harvests, the capital should be replenished. Major losses of nutrient capital occur when soil erosion and runoff surpass tolerable levels. Furthermore, savings can be made if plant demands are less. Hence another key point is the use of germplasm of certain plants that - other aspects being equal - require less inputs because they tolerate soil constraints.

SUGGESTED RESEARCH APPROACH

The Task Force suggests the following research approach be offered by the CGIAR system and its collaborators as an integrated strategy aimed at increasing and stabilising yields in marginal lands and reclaiming adjacent degraded lands. This approach consists of ten main components, none of which are not new but have seldom been put together as a package.

1. Participatory Analysis

Diagnostic studies should be done on the farm and policy levels focusing on issues that prevent soil fertility maintenance or improvement. This involves both socio-economic and biophysical constraints.

Traditionally, most participatory diagnostic and monitoring exercises have focused on socio-economic and cultural aspects of households and farming communities. Activities must be strengthened by making them joint undertakings with soil scientists, agronomists or foresters.

Better management of marginal and degraded soils will depend largely on improvements in the policy arena. Ex-ante analysis of policy constraints is necessary. Secure land tenure and accessibility to credit are major prerequisites to improved soil management. Few farmers are willing to invest additional efforts in soil erosion control or in purchased inputs if the land tenure is not secured. Accessibility to credit and markets is seldom adequate in marginal areas. Indigenous people and women are often particularly constrained by policies and practices. Understanding constraints as perceived by the farmers regarding land tenure security, knowledge on returns to fertilizers not to maximize production but to maintain productivity, availability of credit, access to markets and procurable suitable fertilizers are essential for the generation of proper promotional policies.

It is often claimed that farmers cannot afford the use of fertilizers in marginal areas. The policy environment must be examined because it is highly unlikely that biological processes alone will raise crop yields much beyond the subsistence level. In many cases, the wrong fertilizer blend is imported. The question is no longer what is the optimum application rate but how little fertilizer is enough for improved food security.

2. Improving Germplasm for Soil Constraint Tolerance.

Selection and/or breeding of germplasm aimed at increasing plant tolerance to specific soil constraints is one of the most effective components on how to manage marginal soils. The use of earlier maturing varieties may help escape late season severe drought stress and offset the need for irrigation. The use of acid-tolerant species or varieties may eliminate the need of lime to neutralise aluminium toxicity. Other this being equal (e.g. size of crop harvested) germplasm that utilises phosphorus more efficiently will require lower phosphorus inputs. Plants tolerant to low salinity levels will reduce the need for high quality irrigation water and drainage. The maximum use of legumes in a farming system may reduce or eliminate the need for nitrogen fertilizers. Since many of the candidate systems involve some sort of agroforestry intervention, selection and breeding of annual crop germplasm for tolerance to shade and for more aggressive root systems should also be undertaken. Maize and upland rice varieties bred for agroforestry combinations are badly needed. Breeding for soil acidity tolerance in maize, wheat, sorghum and rice has been conducted by several CGIAR centres

and soil acidity tolerance has been a selection criterion for sweet potato, pasture grasses and legumes as well as some multipurpose tree species. The selection or breeding for soil constraint tolerances must be accompanied by other necessary agronomic characteristics such as yield potential, grain quality and tolerance to the prevailing pest and diseases.

The CGIAR can contribute to such germplasm improvement work. It is strategic and multidisciplinary in nature as it involves breeders, soil scientists and plant physiologists and pathologists.

3. Matching Plant Requirements with Soil and other Constraints

Most soil maps provide limited practical quantitative information to farmers and agronomists. This can be overcome by translating soil mapping units into soil parameters in thematic maps at scales sufficiently large to be of practical use. Thematic maps should clearly outline soil constraints such as aluminium toxicity, high phosphorus fixation capacity, salinity hazards, erosion risk, along with socio-economic constraints such as undefined land tenure, high transportation costs for inputs and marketable produce, and areas outside the reach of credit or other service schemes. Many countries are making major efforts in "land zoning", using soil surveys and other data to define geographically the different types of agricultural systems possible. Thematic maps such as the ones proposed here, with interpretations appropriate to the second paradigm, could substantially strengthen these important zoning efforts. Species and varieties of annual crops, pasture accessions and tree provenances should be classified as to their critical levels of tolerance to adverse soil factors, e.g. deficiencies in available phosphorus levels, percent aluminium saturation and salinity levels. A quantitative assessment of such tolerances can be matched to the soil constraint maps produced by geographical information systems (GIS). Germplasm known to be tolerant to specific soil stresses should be described at the variety or accession level unless the entire species exhibits such tolerances. Such work should be done using a uniform protocol system wide.

4. Measuring and Interpreting Differently

According to the first paradigm, soil tests are the primary tools for identifying nutrient requirements and serve as the basis for fertilizer recommendations. Such recommendations are traditionally made at the point where marginal revenues equals marginal costs. They worked well, but sometimes resulted in tremendous fertility build ups in intensively cultivated soils, e.g. in the ultisols of south-eastern United States which were originally acid and infertile, but are now neutral and extremely fertile, and the naturally fertile mollisols of Europe which are more fertile than ever before. This resulted as a consequence of using substantial amounts of capital to apply fertilizers to relatively limited areas of land.

In marginal areas of the tropics, the opposite is the case: there is a net mining of soil nutrients primarily via crop harvest removal, loss of organic matter and reduced biological activity which have rendered even initially fertile soils (e.g. many alfisols in Africa) depleted

and extremely deficient in nitrogen and phosphorus. This resulted as a consequence of not applying any fertilizer to extensive areas of land.

A realistic approach could be based on nutrient cycling and strategic additions of both inorganic and organic nutrient sources. Suitable methodologies must be developed, particularly for nitrogen, phosphorus and carbon to maintain fertility and not necessarily to increase it. Research protocols should also be different. The traditional paradigm, although challenged over the last two decades but is still alive, calls for making sure that all nutrients other than the one being investigated are not limiting. This is normally accomplished by "blanket applications" of lime and fertilizers. In the second paradigm, we are interested in the minimum amount of external nutrients necessary to apply. Therefore, the levels of other soil properties should remain as they are.

Interpretations should also be done differently. Instead of using marginal analysis to equate marginal cost to marginal benefits which provide unnecessary build-ups of nutrients in the soil based on the assumption on unlimited availability of capital, the approach to be used is to maximize the yield response per unit of applied nutrient and maintaining fertility taking into consideration the limited availability of capital.

5. Nutrient Budgeting and Cycling

An analysis of nutrients input and outputs in different production systems provides an agro-ecological perspective. For example, research on dairy cattle farms in the Netherlands has shown large annual positive balances of N,P and K, while in smallholder farms in Western Kenya there are negative balances.

In such calculations, the soil itself is treated as a black box. Research on nutrient budgets should overcome this limitation. The second paradigm, however, calls for revisiting total nutrient budgets, actually not only soil but soil + plant. Total carbon, nitrogen or phosphorus contents must be split into functional pools, and the fluxes between them realistically assessed. CGIAR centres should contribute to this development at key strategic research sites in the agro-ecosystems where they are working.

How can we manipulate a system to maximize nutrient cycling? Input and output data from nutrient budgets are essential components. Some processes have received little research attention; one example is nutrient pumping by roots of trees or cover crops from subsoil depths beyond the reach of the roots of annual crops. Others are so well known that they can be readily quantified and modelled.

The strategic input approach also changes the importance of well known soil processes. Keeping the soil acid while growing an aluminium-tolerant crop enhances the rate of dissolution of phosphate rock (but at certain pHs fixation also occurs). Calcium and magnesium leaching in oxisols increases basic cations in the subsoil which sometimes promotes deeper root development, and more tolerance to periodic droughts.

The second paradigm implies that both organic and inorganic nutrient inputs should be used together, rather than one versus the other. There is little knowledge whether such combinations enhance nutrient cycling effectiveness. The role of the grazing animals in nutrient cycling is often very positive. Beef cattle recycle about 80 percent of the nitrogen, phosphorus and potassium they ingest. Also well-managed pastures do increase soil faunal activities and soil organic matter contents. Overgrazing may have negative effects.

Existing nutrient cycle models vary between those based on organic farming (favoured by some ecologists) to those based purely on inorganic farming (favoured by some agronomists). There is an obvious need to integrate both approaches and include the major interactions between organic and inorganic pools.

The strategic application of expensive external inputs, e.g. inorganic fertilizer, to supplement inputs from organic sources must be evaluated both from the agronomic, economic and ecological viewpoints.

6. Biological Erosion Control

Nutrient budgeting studies in the steep lands of Rwanda show that about half of the negative nitrogen and phosphorus balance is due to water erosion losses. Controlling erosion and runoff, is therefore also an integral component of increasing nutrient use efficiency and a centerpiece of the second paradigm. The basic principle of erosion control is extremely simple conceptually: keep the soil covered with a plant canopy the year around. Crop rotations, green manures, intercropping and managed fallows are ways to achieve that objective. In areas with a pronounced dry season, this is often impossible to do, particularly right before the onset of the rainy season when high intensity storms frequently occur.

Contour terrace construction and maintenance is not always feasible in marginal areas, unless intensive systems such as irrigated rice or horticultural production are to be installed. Where land and socio-economic conditions allow, contour terrace construction has been demonstrated to give significant benefits. In other areas attention should be given to the use of biological controls to erosion such as the contour leguminous fodder hedges that ICRAF is working with in the African Highlands, the vegetative filter strips that IRRI has incorporated in Southern Philippines and the promotion of vetiver grass strips in World Bank projects. A major by-product of such practices is natural terrace formation after a few years, facilitating other management practices.

7. Enhancing Soil Biodiversity

Below-ground fungi, bacteria and animals are important components of global biodiversity. Soil degradation results in decreases in species diversity and in microbial biomass. Such decreases hinder effective nutrient cycling and degrade soil structure. Little is known, except for biological nitrogen fixation by rhizobia and frankia, about how to practically manipulate soil organisms for the benefit of humankind. There is preliminary evidence that the

manipulation of termites and earthworms can dramatically increase the nitrogen and phosphorus mineralization in humid tropical soils, but such research has been done at a very insufficient scale. Practical use of mycorrhiza remains to be developed. Soil crusting and surface sealing are particularly bewildering constraints in sandy alfisols of the Sahel and other semiarid areas, reducing workability and water infiltration. CABO's work and TROPISOILS researchers in Niger have shown that scattering dead branches and leaf litter promotes "biological tillage" by soil fauna which partially overcomes this problem. In all marginal ecosystems, the potential for promoting "biological tillage" by termites and earthworms remains to be researched at a sufficient appropriate scale.

CGIAR centers should pay increasing attention to enhancing and utilizing soil biodiversity. CGIAR is well poised to exploit the variations in germplasm in their ability to enhance these important soil biological processes. E.g. CIP has data that show wide differences among forage sweet potatoes' capability to benefit from associative N-fixation.

8. Protecting the Atmosphere Through Better Soil Management

The soil can act both as a source or as a sink of carbon. Decomposition of soil organic carbon by the aerobic or anaerobic respiration of micro-organisms yields carbon dioxide and/or methane. It is now well understood that soils of the tropics are not intrinsically different in organic matter contents from soils of the temperate regions. The carbon stored in soils is nearly three times that in the above-ground biomass and approximately double that of the atmosphere. There is little quantitative data about the amounts of soil carbon lost to the atmosphere as a result of deforestation or about the amounts of carbon that can be sequestered by soils during the reclamation of degraded lands by fallow re growth, agroforestry or reforestation. Part of the problem is that we normally consider soil carbon a black box. The more recalcitrant or passive pools are likely also to play a significant role in carbon dynamics. But more attention should be given to the labile pools.

About 30 percent of the current CO₂ emissions to the atmosphere are caused by soil organic carbon decomposition. This proportion is expected to increase as emissions from fossil fuels become progressively under control. Much of the methane also comes from anaerobic decomposition of soil organic carbon. The bulk of nitrous oxides emissions is due to denitrification of nitrates added to the soil as fertilizer or produced during the mineralization of soil organic nitrogen.

Changes in the albedo at the desert margins are likely to affect water vapor content of the atmosphere. A permanent vegetative cover will produce a darker albedo than the bare soil surface in the semiarid regions. At the desert margins, this difference may be large enough to affect positively atmospheric vapor pressure.

CGIAR centers focusing on natural resource management should establish long term plots that can be used to quantify the changes in the emissions of these greenhouse gases as we

attempt to prevent the degradation of marginal systems in the tropical forests, hillsides and desert margins.

9. Water harvesting

Arable agriculture, improved pastures and tree establishment projects are difficult to sustain in marginal drylands. Yet indigenous techniques (some poorly known outside their centers of origin) and modern techniques exist whereby run-off from occasional high-intensity rainfall may be slowed down or concentrated on more limited areas to provide for additional soil moisture. Such water harvesting structures may also be useful in erosion control, and to provide limited amounts of water to ponds or recharge basins for use as drinking water for humans and livestock or small-scale irrigation (e.g. for horticultural crops). Care should be taken to avoid health problems associated with water sources.

CGIAR centers should assemble experimental evidence on the efficiencies of alternative structures in varying environments, and facilitate widely the transfer of knowledge of water harvesting technologies. Possible environmental impacts of diverting water through water harvesting methods must also be considered.

This component also includes a variety of approaches in support of community management of upper watersheds, also in humid and sub-humid areas. Seasonal water availability, flooding propensities and irrigation infrastructure are strongly influenced by upper watershed management.

Also included are techniques (mostly indigenous) for catching dew and cloud moisture in desert areas of Pacific South America, Atlantic Southern Africa, and in some other places.

10. Policy Design and Implementation

The previous 9 research components are primarily technological ones, although the specific research is based on the ex-ante analysis of farmer constraints and the policy environment. Policy dialogues with national and local governmental and non-governmental institutions must take place simultaneously to assure that the necessary policy changes are considered and implemented. Policy research issues such as strengthening institutions, fertilizer formulation and marketing, land tenure, crop residue management regulation and facilitating "biological" terraces (based on e.g. grasses, small bushes) are likely to be part of the agenda. Without appropriate policies and institutions, the technological improvements are likely to fail.

CONTRIBUTION TO AGENDA 21

Although each of the above 9 research components is important, the entire package taken as a whole is a necessary but not sufficient condition to achieve the environmental and sustainability objectives of Agenda 21. The package is necessary because without a

world-wide research approach to achieve sustainability in the marginal lands currently being encroached and to reclaim degraded lands, the needed policies and technologies would not be adequately developed. It is not sufficient because soils is just one component of sustainability and other disciplines play equally important roles. Also the CGIAR system is limited to research and research-related training, and the outcomes must be incorporated into development projects. There is also an obvious synergism between this soils initiative and the biodiversity initiative. Any contribution to mitigate tropical deforestation and promote sustainable mountain development will reduce encroachment into habitats that harbor the bulk of our world's plant and animal diversity.

GENETIC RESOURCES INITIATIVE

EX SITU and IN SITU CONSERVATION

Genetic resources have always been central to CGIAR activities, particularly for crops, to a lesser extent also for livestock. Indeed, many major IARC successes can be traced to creative use of plant genetic resources. The CGIAR plays a leading role in the ex situ conservation of plant genetic resources, and exercises a global responsibility for long-term conservation for its mandate crops. IARCs have a clear competitive advantage in ex situ plant genetic conservation, and have also significant in situ conservation capabilities. The CGIAR centers intend to continue to play a leading role internationally in the ex situ conservation of the gene pools of their mandate crops, and the preservation of livestock and fish genetic material.

At the same time IARCs recognize the need to expand their activities to include in situ conservation, on farms and in the context of their actual farming systems, and in the wild for wild relatives, and also for livestock and freshwater fish. The Convention on Biological Diversity recognizes that nations are key players in genetic resources activities. Many of the countries ratifying the Convention still lack the infrastructure and capacity needed for this, and are unable to adequately conserve and use their genetic resources.

The development of improved, more productive yet sustainable farming systems will depend on local communities and researchers having access to a wide range of genetically diverse samples of diverse plant and animal and fish species. Land races, local varieties and provenances have important roles to play, together with those developed through the efforts of breeders. Local varieties are likely to prove of particular value, being well adapted to the target environment and having quality and other characteristics that are preferred by local communities. Efforts are needed to conserve such local varieties, to characterize and evaluate them and to make them available for direct use and for breeding. Conservation strategies need to be developed that take into account local and national circumstances, and that use both ex situ and in situ methods as appropriate.

MANDATE CROPS, ORPHAN CROPS, TREES, LIVESTOCK, FISH AND OTHER GENETIC RESOURCES

The CGIAR covers many of the world's most important food, forage, and tree species. There is also considerable CGIAR activity in cattle genetics and for selected fish species (e.g. tilapia and carp). However, there is a large number of other species that are not covered by the CGIAR and which are extremely important in local or regional agricultural systems. International support for these species is often absent. The capacity of NARS to support conservation and development of local varieties, and locally important species is often absent. Research on the management of genetic resources must also take into account the genetic diversity of species that are outside cultivation and domestication. These include species which are of actual or potential use in forestry and agroforestry systems, forages, wild relatives of crops and animals and fish, medicinal plants and species that are important for maintaining the integrity of ecosystems.

OBJECTIVES OF THE INITIATIVE

One objective of the initiative is to ensure the effective conservation of local crop varieties and tree provenances, livestock and selected fish species, and wild relatives of these, through increased emphasis on in situ conservation methods to complement existing ex situ conservation efforts.

A second objective is to enable NARS, NGOs and farming communities to play more active roles in identifying, conserving and using local genetic material in the local context.

CGIAR SYSTEM INVOLVEMENT

Through their mandate crops, forest and agroforestry trees and livestock/fish mandates most IARCs have already evolved systems for genetic resources management of selected commodities, with particular emphasis on ex situ crop conservation. Some IARCs have become increasingly involved in situ conservation, and are exploring this for their mandate commodities. Gene banks have the double objectives of conserving and facilitating the use of genetic resources. Gene bank conservation will continue to play a central role in the area of agricultural research. The CGIAR must now extend its role to include those of livestock and fish, and to include a major effort for forest tree species which so far has achieved little attention. For fish we suggest that the efforts are limited to species of importance to tropical fish farming.

SUGGESTED RESEARCH APPROACHES

The Task Force suggests that the CGIAR and its collaborators develop one component in this initiative:

- exploring methods for effective in situ germplasm management.

1. Methods for in situ germplasm management

In situ conservation in nature reserves is the normal strategy for conservation of wild species. For semi-wild species which depend on certain cultural landscapes and for landraces which depend on a traditional seed supply system, it is less clear how in situ conservation could be achieved. Although two approaches have been suggested (the museum approach and the breeding approach), neither have been subjected to large-scale experimentation in the context of developing countries. Thus neither their efficiencies nor social acceptability nor costs have been adequately explored.

Crops, including trees, differ in their biology and the role they play in alternative farming systems. Wild relatives, or wild species that are important in the maintenance of local farming systems may require other methodologies for in situ conservation. Whilst the CGIAR has some expertise in genetic conservation of important breeds of cattle (e.g. schistosomiasis resistance in cattle in ILCA and ILRAD) and species of fish (e.g. Tilapia in ICLARM), much remains in the development of widely applicable in situ conservation methods.

We envisage that this initiative will establish an arsenal of in situ methods for essential and important genetic resources, including their actual modes of operation in farming communities. Non-governmental organizations are likely to play important roles in these tasks.

This initiative must be closely associated with existing ex situ work in IARCs and the close cooperation with NARS and with FAO. The evaluation, characterization and documentation of existing ex situ germplasm are important features of the planning of in situ management. In situ management must therefore be closely related to ex situ (genebank) activities for plants (crops and trees), animals and fish.

HUMAN RESOURCES INITIATIVE

People are central to the process of agricultural development. It is people that evaluate their own needs and priorities in the fields, people that give advice in how these needs can best be met, people that research on how improvements can be made and people who decide on the overall policies. The TAC/CDC Report on Ecoregional Approaches to International Research for Sustainable Agriculture stressed the importance of participatory processes at the community level, among institutions and between scientists and policy makers. Human resource development recognizes the central role of people and focuses on developing the capacity of both individuals and the links between them and other partners in the process of agricultural development, possibly requiring alternative mechanisms from those now in use within the CGIAR system.

In recognition of this, TAC has given priority to human resource development. TAC Priority (IX) is presented in Expansion of the CGIAR System, "Strengthen institutions and human resources in national research systems to accelerate the identification, generation, adaptation and utilization of technological innovations."

The Task Force suggests that the CGIAR system should use its growing expertise in natural resources management, also arising from agro-ecological initiatives, to support universities in developing countries in curriculum development and with teaching material, for undergraduate and graduate courses in management of natural resources and sustainable agriculture. Since the NARS recruit many of their staff members from universities, the Task Force suggests that modernization of university teaching activities is essential for human resources development for the 21st century.

Several universities in CGIAR donor countries now offer limited support within this field to a few selected developing countries universities through twinning or similar arrangements. The Task Force believes that these limited activities can be greatly strengthened through active involvement of IARCs, whose human resources development sections and publication and information facilities have proven records of efficiency in training and information dissemination.

We further believe that closer educational cooperation between IARCs and local universities in developing countries may open up for wider cooperation in research in the future. Greater involvement of universities in donor countries may also strengthen the IARCs in their efforts to incorporate sustainability issues more closely in their traditional agricultural research.

We see a potential for encouraging local universities to relate more closely to non-governmental organizations through training programmes for NGO staff. NGOs are likely to play increasingly important roles in the setting of future research agendas, and in knowledge transfer, also to groups not always reached by official extension systems, e.g. poor farmers, women, indigenous people. The Keystone Dialogue on Plant Genetic Resources, and co-operative efforts between CIFOR, ICRAF and IUCN are examples of novel approaches. CGIAR support to local universities in developing countries to offer facilities to NGOs for training in management of natural resources.

We consider one activity under this initiative:

- support to universities in developing countries for education in management of natural resources and sustainable agriculture.

1. Support to universities

IARCs will be encouraged to develop curricula and teaching material for universities in developing countries, within the fields of management of natural resources and sustainable agriculture. IARCs will be encouraged to cooperate to develop courses aimed at relevant

agro-ecosystem, and to cooperate closely with universities both in recipient and donor countries for this initiative. Liaison with UNEP and UNESCO initiatives is essential.

Products of this initiatives will be proposals for curricula at B.Sc. and M.Sc. levels, and for individual courses aimed at representatives from non-governmental organizations. Furthermore the Task Force believes the IARCs could play a major role in making books and other teaching material available at low cost to participating universities.

Linked to this initiative we see opportunities for developing post-graduation (post-M.Sc.; post-doc) activities whereby young scientists can get opportunities to practice their acquired skills. IARCs could play important roles in linkages between universities in developing countries and in the industrialized world.

AGRO-ECOLOGICAL DATA BASE / GIS INITIATIVE

INTRODUCTION

The remodelling of the CGIAR system currently underway puts increased emphasis on ecoregional approaches. The IARCs have a growing need for data relating to the physical, biological and social environments of their research domains. Environmental data bases, coupled to the use of computer-based geographical information systems (GIS), offer useful tools for this, and have been successfully employed by some IARCs (e.g. CIAT, IRRI, ICRISAT, CIMMYT). However, the construction and maintenance of high-quality data bases, the need to achieve data consistency within the CG system, and the desire to communicate through standard interfaces to institutions outside the CG system, are major tasks.

A separate initiative on close cooperation between CGIAR and UNEP's GRID system is at an advanced stage, with indications of donor support. A number of IARCs and UNEP have played major roles in the development of this initiative. The initiative, in its original form, is described in Appendix 1.

The objective of this initiative is ensure that high quality minimal data sets on environmental (including socio-economic) variables are available for IARCs and other interested users. Furthermore that an efficient distribution mechanism of the data will be in place, and that there are training facilities for the use of these data through geographical information systems (GIS).

ACTIVITY

The Task Force recommends that this initiative be included as part of CGIAR's response to Agenda 21, and be organized as an initiative under the proposed organizational structure.

INSTITUTIONAL APPROACH

The Task Force has considered alternative modes of implementing the proposed initiatives, also bearing in mind that the 4th initiative (The Agro-ecological Data Base/GIS) is further advanced than the others. The Task Force has been particularly anxious to ensure that CGIAR's response to Agenda 21 does not detract from the basic mandate of the CGIAR system in its efforts for agricultural research. At the same time the opportunities offered by Agenda 21 for application of agricultural knowledge for wise and sustainable use of the environment must not be overlooked, neither by the centers nor by the environmentally conscious countries that support and benefit from CGIAR efforts.

The Task Force is well aware that most, if not all, CGIAR activities can be allocated to one or more of the 40 chapters of Agenda 21. The CGIAR system will do well to portray its traditional and general activities within the framework of Agenda 21, the Rio Declaration, and the conventions on climate change, biodiversity and desertification arising from UNCED. IARCs have put much emphasis on natural resources management and sustainable development in their Medium Term Plans before ICW93. But the reduced CGIAR funding received during the last few years has resulted in the IARCs having a greater research management capacity than their present research portfolio. The four initiatives proposed by the Task Force in this report go beyond regular CGIAR activities in an effort to utilize existing CGIAR capability for other aspects of Agenda 21. For this new and additional funding is required, most likely from sources and donor government budget posts that are not earmarked "CGIAR" or "international agricultural research", e.g. from environmental budgets. This is also to ensure that contributions to IARCs for the four initiatives are not linked to, and possibly deducted from, regular economic support to the CGIAR, whether core or complementary.

Whilst ideally the Task Force would have encouraged the four initiatives to be considered within the traditional framework of CGIAR activities, and subject to the same well-established funding mechanisms, we are doubtful whether this is realistic in the present financial climate.

As an alternative the Task Force therefore recommends that the initiatives be formed for financing under the framework of a single United Nations Environment Programme Trust Fund (with its rules and regulations - see Appendix 2, which contains a draft with further details). Donors may contribute to the UNEP Trust Fund, also by earmarking their contributions to specified initiatives. It is assumed that the wording of the Trust Fund will name CGIAR institutes as the main recipients of the funds donated, but will also open up for close collaboration with non-CGIAR institutions. The wording of the Trust Fund must allow further agro-ecological initiatives to be added to the ones already proposed.

As part of the operation of a UNEP Trust Fund the Task Force recommends that a common Steering Committee be formed for all initiatives, and that the CGIAR be requested to forward candidates for at least half of the members of this Steering Committee. As the Marginal Soils Initiative is the largest, the Task Force has considered whether a separate steering committee is warranted for this, also to incorporate other soils and land management initiatives currently discussed (e.g. IBSRAM/IFDC/FAO initiatives). On balance the Task Force feels that a common steering committee can adjust and incorporate a larger soils initiative, and forge effective links to other initiatives.

The Task Force further recommends that UNEP be invited to make available a position for a full-time Facilitator for the operation of the initiatives, for an initial period of two years. UNEP will seek the advice of the CGIAR Secretariat for candidates for this position, and provide the Facilitator with suitable means to exercise her/his duties.

The Task Force further recommends that donors to the CGIAR be encouraged to make contributions available to the proposed Trust Fund for the Agro-ecological initiatives, and that these funds be additional to contributions made to the traditional research activities of the CGIAR. In particular The Task Force would invite the World Bank to participate actively in the four initiatives through the Trust Fund through consideration of matching funds. For the success of the suggested approach contributions made to a center from the Trust Fund for the specified four initiatives should not be subject to balancing fund mechanisms as with traditional CGIAR activities. The notion of additionality for this Agenda 21 initiative could then be lost. The Trust Fund Steering Committee is expected to invite CGIAR to forward detailed project proposals for the implementation of the four initiatives and to recommend the funding of such proposals through the appropriate channels. The Trust Fund itself is likely to be a major source of funds, but the Steering Committee should also encourage the involvement of other financial sources, e.g. the Global Environment Facility, and assist in the formulation of project proposals that may attract such support.

FURTHER ACTION

The Task Force suggests that donors at ICW93, the CGIAR Secretariat and TAC review the proposals, together with the Board of Directors General, with the aim of launching CGIAR's Response to Agenda 21 by 1 January 1994.

APPENDIX 1

The Agro-ecological data base - GIS initiative in the form of "Project Proposal for Use of Geographic Information Systems in Agricultural Research Management"

APPENDIX 2

Terms of Reference for a UNEP Trust Fund

PROJECT PROPOSAL

for

USE OF GEOGRAPHIC INFORMATION SYSTEMS IN AGRICULTURAL RESEARCH
MANAGEMENT

1. OVERVIEW

This project will involve UNEP/GRID and its co-operating centres, and the Institutes supported by the Consultative Group for International Agricultural Research. The activities proposed will take place over three years (33 months).

This proposal seeks donated funds of US\$ 1.2 million; in addition "in-kind" contributions are anticipated from UNEP/GRID and the International Agricultural Research Centres. There is a commitment in principle from these organisations.

The proposed workplan indicates initial planning of activities in a number of areas and would include verification and quantification of commitments from the various organisations.

It has been indicated that several donors may look favourably upon this proposal and that a UNEP Trust Fund may be an appropriate mechanism to manage the funds. With that in mind the proposal is drafted along the lines of a UNEP project document. The establishment of such a Trust Fund and negotiation with multiple participants will take time. Thus, this material is intended as a starting point for discussion with representatives of Norway with the intent of initiating action as soon as possible.

2. INTRODUCTION

2.1 Organisations Involved

The Global Resource Information Database (GRID) Programme of the United Nations Environment Programme (UNEP) was established in 1985 and now operates in three main areas - provision and management of environmental data; assisting in implementation of decision support applications; and supporting extension and training in Geographic Information System (GIS) technology. This technology and that of Image Processing (IP) are employed extensively by UNEP/GRID. GRID works through a growing system of co-operating centres including GRID-Arendal, a Norwegian Centre established in 1989.

There are now 18 International Agricultural Research Centres (IARCs) supported by the Consultative Group for International Agricultural Research (CGIAR). The CGIAR has its own secretariat and a Technical Advisory Committee (TAC) which provides advice to the whole system regarding overall planning, budgeting and management. The Centres operate with National Agricultural Research Centres (NARCs) and through governmental and non-

governmental extension services work towards transfer of sustainable agricultural technologies to the farmer.

2.2 Background

There has been increasing interest in the use of GIS within the IARCs. The proceedings of the Rome workshop on Agricultural Environments, organised by the CGIAR and the Food and Agriculture Organisation (FAO) in 1986, defined their advantages at that time and since then. GIS technology has developed and now meets many of the requirements detailed in that meeting.

In January 1991, after informal discussions between the IARCs, the Rockefeller Foundation (RF), the Centre for Resource and Environmental Studies (CRES), United Nations Environment Program (UNEP), and the Technical Advisory Committee (TAC) of the CGIAR, UNEP hosted a workshop in Nairobi to consider the use of intelligent GIS within the IARCs for decision support, with emphasis on improved agricultural productivity in Africa. The intent was to update the conclusions of the Rome workshop in view of the data and technologies now available, but giving emphasis to Africa. Attendees were from the Centres, other international agencies and external institutions who have expertise in the development and implementation of GIS technology, and in its applications to agricultural research and development. The major recommendation from that workshop was that the IARCs, UNEP, other institutes and concerned donors work together to ensure that environmental data and data management technology are being generated and used in a co-ordinated fashion throughout the CG system.

As a follow-up, GRID commissioned a consultancy in late 1991 to look further in to the information needs of the Centres. In that, contacts were established with the IARCs, a review conducted of their GIS capabilities and of planned and ongoing GIS projects.

The lack of available digital data sets was identified as the major impediment to the efficient implementation of applications of the technology and specific recommendations were made for this to be addressed through co-operative efforts between the CGIAR, GRID and appropriate outside agencies. Recommendations were also made to facilitate the exchange of expertise and experience among CG institutes and co-operating agencies.

To address these issues, GRID, with support from the Norwegian Ministries of Environment and Foreign Affairs, organised a technical workshop held in Arendal in September 1992.

Representatives from 11 Centres, from GRID offices and external experts attended. The meeting involved identification of the data sets commonly required, development of ideas for their acquisition, compilation and distribution, and consideration of how these tasks might be undertaken. It was agreed that additional resources be sought for these activities to ensure that Centres' priorities are kept to the forefront and that the momentum developed over the past two years is maintained.

Activities within GRID and IARCs complement each other. GRID views the Centres as high quality research "customers" with whom co-operation to meet their needs will aid further development of GRID capability and data sets. The results for the CGIAR will be the evolution of a powerful tool for enhancing and integrating their activities, and those of external agencies.

3 OBJECTIVES AND ACHIEVEMENT INDICATORS

3.1 Objectives

3.1.1 Long-term objectives

1. To effectively integrate natural resource and socio-economic information for improved agricultural research management for sustainable development at the international, regional and national levels.
2. To establish effective long-term linkages between the CGIAR system and UNEP in furthering sustainable agricultural developments.
3. To improve transfer of appropriate land management technologies which incorporate GIS and other information analysis technologies, from IARCs to National Agricultural Research Centres.
4. To harmonise research activities, technology and information management throughout the CG system.
5. To enhance the free exchange of data and information for agricultural sustainable development among world-wide users through the GRID system.

3.1.2 Short-term objectives

1. Identification of spatial data sets of prime interest to the IARCs; and cataloguing of data set sources.
2. Preparation of proposals for data and data set acquisition and development, including determination of quality standards.
3. Assembly of consistent high quality environmental and socio-economic data sets of prime interest to CG centres.
4. Strengthening the ability of the CGIAR and individual Centres to use GIS technology and expertise to incorporate environmental and socio-economic data into their research planning and execution.
5. Providing for the easy access and distribution of such data sets to all IARCs through the UNEP/GRID world-wide network.
6. Development of methodologies for the manipulation, analysis and quality assurance of priority environmental data sets, and their integration into IARCs' research and applications programmes.

3.2 Achievement Indicators

The objectives will be achieved through the establishment of clear interfaces for provision and distribution of data between the existing two networks of IARCs and GRID Centres, and through demonstration of the use of such data.

These may be quantified through:

- the number of data sets made available to the IARCs through GRID (target 5)
- the number of IARCs requesting data sets from GRID (target 10)
- the number of IARC projects using such data sets in research and execution (target 10)

4 OUTPUTS, FOLLOW-UP ACTIVITIES, INPUTS AND ASSUMPTIONS

4.1 Outputs

Project outputs comprise:

- available high quality natural resource and socio-economic data sets at global, regional, national and project levels
- an effective functional distribution mechanism for such data sets.
- documented methods and technologies for the production and quality assurance of such data sets,
- staff in IARCs trained and experienced in the effective utilisation of GIS technology for sustainable agriculture.
- dissemination of advances in GIS utilisation for agricultural research in published journals and reports.
- use of integrated data sets for planning and execution of research for sustainable agricultural development.

4.2 Use of outputs

The individual CG Centres will be the primary users of the data sets for research planning and execution, and for extrapolation of findings. The Centres will also be using GIS technology to carry out these functions more effectively. The CGIAR's Technical Advisory Committee will use the data sets and technology in strategic planning.

In the longer term, they will be of use to NARS, national planning agencies, and national decision makers in national and regional planning. Although targeted to meet CG Centres' priority needs, the data sets will be of general use to other clients of GRID (governments, intergovernmental organisations, etc.) for rational and sustainable natural resource management, and to UNEP itself in support of strategic environmental research.

The strengthened network linkages between GRID and the CG centres will be used to transfer data, experience, and expertise, to the benefit of both organisations. Within the Centres themselves, the improved practical implementation of information management tools, such as GIS will be used to make more efficient and effective use of internal resources.

4.3 Follow-up action

Follow-up actions will be integral to the project activities and will involve:

- assessing the degree to which the compilation and distribution of the identified data sets meet the Centres' needs.
- initiating modifications where required.
- identifying emerging requirements for new data sets, preparing proposals for the Steering Committee (see 5.1.) and initiating collection and compilation when accepted.
- evaluating the use of GIS technology in the CG centres and developing plans for incorporation of evolving technology where appropriate.

4.4 Activities

A series of overlapping phased steps are to be undertaken as follows.

4.4.1 Implement project plans for compilation, review and distribution of each of the priority data sets identified below.

Base Data:

Base data such as roads, rivers and settlements, are important to use in building other data sets. The best available source for global coverage is the recently issued Digital Chart of the World. For CG purposes this needs:

- review of the organisation of the data with the objective of designing and implementing mechanisms for dissemination of subsets in a manageable form, and
- review of the content and quality of layers and geographic areas (those identified as CG priorities) and reconciliation/consolidation with data which exist in Centras, often at higher resolution.

Climate Data:

The overall approach is to acquire all available data, raw and processed, in digital form. Recommended stages are:

- compilation of an inventory of available data, both digital and paper records,
- consolidation of existing CG holdings, and
- from the results of the above, identification of priority areas for digitising efforts.

Population Data:

The need for population data is a priority for the CGIAR. A global base layer of administrative boundaries, to the tertiary level, would provide the spatial basis for this. This would be compiled through consolidation of existing data held by CG Centres and GRID, with such data sets as DCW. The population data obtained from national and international agencies would be tied to these spatial units. The question of updating both the tabular and spatial components is one of major importance.

Soils Data:

The reissued FAO 1:5 million digital Soil Map of the World can be used to meet strategic CGIAR requirements. Any larger scale needs cannot be met by a single source currently or in the near future. Similarly there appears no single source for uniform point data.

On-going work in agencies such as FAO and ISRIC will be monitored to ensure that any data sets developed can be easily available to the CGIAR and to keep the Institutes abreast of developments.

Other Data sets:

It is expected that requirements for other data sets, e.g. agricultural statistics, health and nutrition indicators, will be more fully defined during the course of the project.

4.4.2 Define requirements and mechanisms for the transfer of data sets from GRID to IARCs and between IARCs; set up mechanisms to serve these needs, building on existing GRID facilities.

The current GRID distribution facilities and procedures will be used as a basis for distribution to IARCs of both existing data sets held by GRID and for those compiled in the activities outlined above (4.4.1). They will also serve, though with modifications anticipated, to index and distribute data sets currently held in the Centres themselves. Development work will be undertaken to establish procedures to ensure that user feedback from the Centres is solicited and channelled (where appropriate) to update and improve the quality of the data sets held.

4.4.3 Ensure that formal and informal training efforts are in place for IARC management and staff in GIS technology and its application to sustainable agricultural development.

This may be done in conjunction with external agencies who have specialised expertise and through arrangements with vendors (see 4.4.5 below).

4.4.4 Develop methodologies and implement pilot projects to demonstrate the utility and efficacy of the use of the data sets, in conjunction with the use of GIS technology for research and planning purposes in the CG centres. Criteria for the selection of such pilot projects will be developed and Centres asked to make proposals indicating goals, requirements and evaluation criteria.

The applications chosen will be funded, to some extent from this project e.g. a GIS analyst supplied, a specific data set compiled, etc. Upon completion, a review will be undertaken to assess the role of GIS technology and the use of the digital data.

4.4.5 Facilitate and encourage technology transfer among Centres and GRID nodes, GIS vendors and external institutions with suitable expertise through formal and informal secondments, meetings, and workshops, and undertaking co-operative projects.

4.4.6 Develop technology transfer mechanisms to enable NARS to benefit from the data sets and GIS technology in use in the IARCs and in GRID. This is planned in the latter-most months of the project although related low-level activity in data set compilation and pilot projects involving NARS is anticipated throughout the project lifetime.

4.5 Workplan

A bar chart of the activities is given in Appendix I.

4.6 Inputs

Funding for the project will be utilised primarily for personnel costs, both for staff positions and for consultant services. Human resources will also be provided by in-kind contributions from GRID and the IARCs.

IARC and GRID hardware and software facilities will be used, through in-kind contribution, as needed and agreed between the parties, with provision being made to acquire only a minimal amount of additional equipment to reinforce existing capabilities.

Expert input will be sought to review data content, to participate in meetings directed towards specific problems and to deliver contractual services as appropriate.

4.7 Assumptions

National and international agencies (such as FAO, WMO, UNEP, WCMC) will cooperate in making data available for extraction and distribution.

IARCs will have the needed infrastructure (trained personnel, equipment) and resources to support GIS in the longer term.

The GRID network, expertise and technology will be available to the IARCs.

The IARCs will be active partners in data set compilation, development, exchange and review.

The IARCs will facilitate the exchange of personnel, expertise and experience related to GIS, through flexible and creative arrangements.

5. INSTITUTIONAL FRAMEWORK, EVALUATION AND BUDGET

5.1 Institutional framework

A Steering Committee will be established to give overall direction to this project. The committee will comprise, at a minimum, representatives of the CGIAR, GRID and contributing agencies. It will provide the forum for consideration and approval of the activities (i.e. detailed tasks and sub projects) to be undertaken and the associated expenditures. GRID will have the responsibility for the overall implementation and will therefore co-ordinate all operational efforts. It is anticipated that the bulk of the work will be carried out in GRID, through any of their Facilities or co-operating centres, or through external institutions with suitable expertise, as appropriate.

To provide on-going co-ordination, an information systems professional will act as Project Manager, reporting to the Steering Committee and the Director of GRID. The Project Manager will work closely with the Director of GRID and liaise between IARCs and GRID offices to ensure effective communication and technology exchange between all parties; will provide high level advice on GIS technology; suggest arrangements for appropriate expert groups and task forces; and co-ordinate evaluation of the project at appropriate intervals.

5.2 Evaluation

The Steering Committee will provide the first level of project evaluation. It will receive reports on plans versus actual achievements on an annual basis.

During the course of the project the Committee will also call upon expert opinion to:

- review progress in choosing and assembling priority data sets and adjust priorities if necessary,
- evaluate the contribution of GRID to these particular activities and suggest necessary modifications to GRID working procedures in that regard,
- review the suitability for transfer of data sets and associated GIS technology to NARS.

In the latter part of the project, an external review will be commissioned to be undertaken by one or more persons experienced in the use of GIS and similar technology in international agencies.

This review will evaluate:

- to what extent GIS technology has improved research effectiveness and decision making in the CG Centres.
- what mechanisms have evolved to ensure the long term co-ordination and sharing of common data sets,
- to what extent technology transfer has taken place between the Centres themselves, between GRID and the Centres and between the Centres and the NARC'S.

The results of the review will be used by the Steering Committee as a basis for recommending any required actions and infrastructure to ensure continued return on investment from this project.

5.3 Budget

WORKPLAN

(Note that the time-line shows the project commencing in April 1993. That is an arbitrary choice and activities remain relative to any actual start date.)

	1993		1994		1993
	A	H	J	J	A
	S	O	N	D	J
	F	H	A	H	J
	J	A	S	O	M
	J	S	O	M	J
DATASETS (Coapilation, Review & Update)					
Base Data	P	X	X	X	-----
Clients Data			P	X	-----
Population	P	X	X	X	-----
Soils Data	P				-----
Other Datasets					XXXXXXXX-----
DISTRIBUTION MECHANISMS					
Compiled Datasets			X	X	-----
Centre Datasets			X	X	-----
PROJECTS					
Selection			X		
Implementation			X	X	X
Review			X	X	X
STEERING COMMITTEE MTGS					
	X		X		X
COORDINATION WITH CENTRES/ERID					
SHOPS					
			X		X
TECHNOLOGY TRANSFER WITH NARS					
EVALUATION					
					X

P = Preparatory/Planning activities
 X = Intensive activity
 - = Ongoing Class intensive efforts

BUDGET

	w/m	\$	w/m	\$	w/m	\$	Total
10 PROJECT PERSONNEL COMPONENT							
1100 Project personnel	9	60,000	12	80,000	12	80,000	220,000
1101 Database mgr/analyst	9	45,000	12	60,000	12	60,000	165,000
1199 Total		105,000		140,000		140,000	385,000
1200 Consultants							
1220 Unspecified	15	120,000	12	100,000	10	82,000	302,000
1299 Total		120,000		100,000		82,000	302,000
1300 Administrative support							
1301 Admin. assistant	3	9,000	2	6,000	2	6,000	21,000
1302 Digitising technician	6	20,000	6	20,000	6	20,000	60,000
1399 Total		29,000		26,000		26,000	81,000
1999 Personnel total		254,000		266,000		248,000	768,000
20 Subcontracts component							
2100 Subcontracts							
2101 Data acquisition		10,000		10,000			20,000
2102 Methodology Development		30,000		30,000		30,000	90,000
2103 Dataset Review		30,000		20,000		10,000	60,000
2199 Subcontracts total		70,000		60,000		40,000	170,000
30 Training component							
3300 Meeting/conference							
3301 Meetings		75,000		75,000		75,000	225,000
3399 Training total		75,000		75,000		75,000	225,000
40 Equipment component							
4200 Non-expendable							
4201 Computer equipment		20,000		40,000		15,000	75,000
4202 Misc. software				10,000		5,000	15,000
4299 Equipment total		20,000		50,000		20,000	90,000

TERMS OF REFERENCE
FOR THE ADMINISTRATION OF A TECHNICAL CO-OPERATION TRUST FUND
TO ASSIST THE INTERNATIONAL AGRICULTURAL RESEARCH CENTRES
(IARC) OF THE CONSULTATIVE GROUP ON INTERNATIONAL
AGRICULTURAL RESEARCH (CGLAR) IN CARRYING OUT AGRO-
ENVIRONMENTAL RESEARCH AND TRAINING IN THE FRAMEWORK OF
THE RESPONSE TO AGENDA 21

1. The UNEP Governing Council decision 17/19 of 21 May 1993 encouraged UNEP, *inter-alia*, to continue to compile, disseminate and catalyze the further development of successful desertification control project designs and implementation methodologies, including model land-use and socio-economic development programmes for marginal drylands.
2. Decision 17/21 requested the UNEP Executive Director to strengthen the existing links between UNEP and relevant centres of excellence;
3. Decision 17/37 requested UNEP Executive Director to implement Agenda 21 in accordance with its relevant provisions and the mandate of UNEP, taking into consideration the specific needs and conditions of each region;
4. UNEP Governing Council decision 15/14 reaffirmed that the Clearing-house mechanism is an essential aspect of the coordinating and catalytic role of the United Nations Environment Programme, and called for a focus, in particular, on activities which enable, *inter-alia*, developing countries:
 - a) to formulate and initiate programmes and activities for dealing with their most serious environmental problems;
 - b) to formulate and participate in action plans for the common management of ecosystems and critical environmental problems at the national, regional and global levels.
5. Decision 14/6 of 17 June 1987 called on Governments and other donors to make additional financial resources available through the Clearing-house mechanism to strengthen the capacity of developing countries. It further decided that the Clearing-house should focus its efforts on strengthening the capacity of developing countries to promote sustainable development by supporting policy planning and institution building, enabling the developing countries to give adequate priority to environmental considerations, and that it should, *inter-alia*, support a limited number of programmes of regional significance.
6. The Trust Fund is established in accordance with the rules of the United Nations, financial rules of the Environment Fund, the relevant provisions of the Secretary-General's bulletin ST/SGB/188, Administrative Instruction ST/AI/285, and the authority to establish Trust Funds delegated to the Executive Director of The United Nations Environment Programme in accordance with paragraph 11 of ST/SGB/188 and Article V of the General Procedures governing the Operations of the Environment Fund of the United Nations Environment Programme.

7. The Trust Fund will be maintained by the Executive Director to receive and account for contributions pledged by various governments and donors and to make an account for disbursements in accordance with the United Nations Regulations and Rules.
8. The Trust Fund will be used to administer the funds provided by donors and aimed at assisting the International Agricultural Research Centers (IARCs) supported by the Consultative Group of International Agricultural Research (CGIAR) in carrying out agro-environmental research and training. Programmes to be implemented under the Trust Fund shall be agreed upon within broad areas of activities by UNEP, the Donors and the CGIAR.
9. UNEP may draw on the sums deposited as required to meet the cost of the activities of the Trust Fund in line with requirements as agreed with Donors and the CGIAR.
10. The payment to the Trust Fund shall be deposited in convertible currency into UNEP Trust Fund Account No. 015-002756, Chemical Bank, United Nations Office, New York, NY, 10017.
11. The schedule of payment to the Trust Fund shall be jointly agreed through an exchange of letters between UNEP and Donors.
12. All contributions received into the Trust Fund and not immediately required for the financing of project activities shall be invested at the discretion of the United Nations and income earned shall be credited to the Trust Fund.
13. The UNEP Executive Director shall administer the Trust Fund in accordance with the financial regulations, rules and directions of the United Nations. Personnel engaged for the purpose of the Trust Fund shall be recruited and administered in accordance with the provisions of such regulations, rules, and directives.
14. Should the funds paid into the Trust Fund by Donors including interest credited to the Trust Fund in accordance with paragraph 9 above, exceed the amount spent by UNEP on activities financed from the Trust Fund, the surplus amount shall be dealt with as agreed between UNEP and the donors by exchange of letters upon settlement of all outstanding obligations and upon presentation of the final statement of account.
15. In accordance with the United Nations rules UNEP shall deduct from the income of the Trust Fund an administrative support charge of 13 per cent of the expenditures charged to the Trust Fund in respect of activities financed under the Trust Fund.
16. Annual accounts of the Trust Fund shall be prepared and audited in accordance with normal United Nations procedures and will be sent to Donors as soon as the annual financial report is available.
17. UNEP shall submit to donors a yearly report on the progress of project activities initiated under the Trust Fund.