SDR/TAC:IAR/01/23A Rev.3
iSC Working Document

CONSULTATIVE GROUP ON INTERNATIONAL AGRICULTURAL RESEARCH

Interim SCIENCE COUNCIL

Water and the CGIAR:
A Discussion Paper

iSC SECRETARIAT

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

October 2002

TABLE OF CONTENTS

WATER AND THE CGIAR: A Discussion Paper[1]

1. Introduction: Purpose and Scope

This paper has been prepared with three objectives in mind; first, to inform CGIAR stakeholders of the current state of water in the context of CGIAR activities and of the needs, challenges and opportunities for water research in the CGIAR. A second objective is to identify the most relevant issues and goals to be pursued in research by the CGIAR, given the complexity of water problems, the probable future scenarios, and the comparative advantages of CGIAR Centres. Finally, a vision for the future and the elements of a research agenda on water for the CGIAR, including possible roles of the various Centres in this area, are presented. The overall aim of the paper is to facilitate discussions towards the formulation of a common strategy for water research in the context of CGIAR's comparative advantage and the evolving CGIAR framework for integrated natural resources management.[2]

This effort is justified by the perception that water scarcity worldwide will be a problem of increasing importance in the 21st Century and could affect directly the main objectives of the CGIAR, namely, poverty alleviation and sustainable food security. Failure to resolve the many conflicts related to water in the past, from local to international, indicates that renewed and well coordinated Systemwide research efforts will be needed to ensure adequate water supplies, healthy aquatic ecosystems and efficient use of water. These are but a few of the many goals encompassing the rational management of water resources in the future.

The paper presents first an introductory section on water management principles to delineate a framework of the water problem and to outline the role of management in achieving an efficient use of a scarce resource such as water. This is followed by a brief outline of the world water situation and of probable future scenarios. A section on major water issues, problems and opportunities in research, particularly in the context of CGIAR activities, is then presented, followed by the section on the vision for research in water management in the CGIAR.

---

[1] Discussion working paper prepared by Elias Fereres and Amir Kassam. An earlier draft version of the paper was discussed at TAC 81 in September 2001 at CIFOR. A revised draft of the paper was distributed for comments to all CGIAR Centres. Their comments were incorporated in the subsequent draft which was discussed at iSC/TAC 82 in April 2002 at CIP. This final draft incorporates comments from iSC/TAC 82. The review comments from the Centres are gratefully acknowledged. Special appreciation is expressed to Hans Gregersen, John Vercoe, Klaas Jan Beck, Adel El-Beltagy, William Dar, Bekele Shiferaw, Don Pedon, David Molden, Ken Fischer, Ruth Mienzen-Dick and Jacob Kijne for their input.

[2] See: (a) TAC (2001a) Evolution of NRM Concepts and activities in the CGIAR. Paper presented at the Workshop on Integrated Natural Resources Management for Sustainable Agriculture, Forestry and Fisheries, 28-31 August 2001, CIAT, Cali, Columbia. SDR/TAC:IAR/01/18, TAC Secretariat, Rome. (b) TAC (2001b) NRM Research in the CGIAR: A Framework for Programme Design and Evaluation. SDR/TAC:IAR/01/24 Rev.1, TAC Secretariat, Rome.

2. Managing Water as a Renewable Resource

2.1 Main Features of the Hydrologic Cycle in relation to Water Management

Freshwater is a very small fraction of all water in the Earth. There are about 100,000 km^3/yr of precipitation of which 60 % evaporates to the atmosphere. Only less than a quarter of the remaining 40,000 km^3 is accessible to man for diversion to various uses.

The urban, industrial, agricultural, and environmental sectors all use water diverted from surface and groundwater sources and storage facilities. Agriculture is the primary user of diverted water; two thirds of all diversions are used for irrigation worldwide. Rainfall in excess of that infiltrating the soil runs off to watercourses and eventually, to the oceans. On land, water evaporates from plant and soil surfaces, driven by solar radiation. Evaporated water condenses to fall as rain elsewhere, closing the hydrologic cycle.

In any watershed, incoming water in the form of rain or irrigation must be balanced by evaporation from soils (E) and transpiration (T) from plants (termed evapotranspiration, ET) plus that moving out as runoff, deep percolation and the stored soil water. It is possible to quantify a water balance at many scales, from an individual field, to a farm, a hydrologic basin or a region, up to the global scale.

Water that evaporates from a watershed is considered a loss or consumption, while water running off can be recovered downstream and may not be lost to the system. Thus, there are consumptive and non-consumptive uses of water. Water applied as irrigation may be used consumptively in the ET process, while the network and runoff losses may be recovered downstream and used by others.

Water used within a basin is not always consumed in that basin and can be used several times before it leaves the basin. Water conservation efforts may or may not lead to net water savings depending on whether the water saved is part of the recoverable or the unrecoverable losses.

Every time water is used, its solute load increases as of course does the chance of it picking up contaminants; the result is a deterioration of water quality. Such deterioration has many and diverse impacts, from human health to ecosystem services, and it directly affects the availability of water supply for many uses.

2.2 Management of Water for Agriculture and the Environment

Crop plants loose large amounts of water, keeping less than one percent of what they transport from the soil to the atmosphere during their life cycle. Crop consumptive use is met by stored soil water from rainfall and/or irrigation.

When soil water supply is insufficient to meet the evaporative demand, crops undergo water stress and their production levels are usually reduced. Irrigation is aimed at avoiding water stress in periods of insufficient rainfall, although often the irrigation supply is insufficient to fully meet the crop demand.

Effective water management in rainfed and irrigated agriculture has very similar goals: maximizing the use of stored soil water and at minimizing losses to runoff and percolation. There is no reason to isolate rainfed from irrigated agriculture, since in many agricultural systems a continuum exists from rainfed to limited to full irrigation supply.

Lack of control of runoff and percolation losses in agriculture leads to a major source of non-point pollution that negatively affects the environment. While some losses may be unavoidable, effective water management is the primary tool to minimize pollution from agricultural systems. Therefore, environmental impacts of agriculture are directly tied to water management.

Irrigated agriculture is often seen as a water source for alternative uses, given the large proportion of the diverted water that is used for irrigation. Irrigated agriculture can play an important role in mitigating water scarcity if integrative, coordinated approaches to water management are pursued at the basin and regional levels.

Water plays a critical role in supporting environmental services and, therefore, environmental water use should not be considered in isolation from other uses, including agriculture. There is insufficient information on environmental needs and on the functioning of many aquatic ecosystems, in particular those that have been altered by intensive water development. This is one reason why environmental demands have been a source of conflict among water users.

Management of these competing demands is also constrained by the absence of governance systems that allow for equitable sharing of the benefits of water use, whether this be for agriculture or maintenance of ecosystem benefits. Such governance systems need to be developed and provided with accurate information on the nature and distribution of the benefits of different forms of water use.

A number of new approaches in water and watershed management are directly relevant to the effective and efficient management of water resources for agriculture, environment, domestic consumption and industrial uses. Unless realistic options for significant importation of water exist, management of water resources at the watershed level and in an integrated fashion becomes a necessity, since there are competing uses for water as it flows through watersheds or catchments and river basins. Watershed management becomes one way to focus integrated natural resources management, when water is the main scarce resource of concern. The key to effective watershed management is development of institutional mechanisms that allow the different stakeholders in a watershed or catchment to effectively work together towards some common goals and targets. Thus, institutional issues become key in effective water management.

3. The World Water Situation

There is general agreement that population increase and economic growth, coupled with mounting awareness of the wider benefits that people obtain from water dependent ecosystems, are subjecting existing freshwater resources to considerable pressures today, and there is no question that the demands for this resource will increase significantly in the future. Thus, there is a generalized perception that water scarcity will be a major problem worldwide as we progress into the twenty-first century and that inadequate and uncertain supplies will be the norm rather than the exception in the future. The water scarcity problem has many dimensions. While there is physical scarcity in some countries and regions, there is also economic scarcity in many others, where lack of financial resources limit access to sufficient amounts of high-quality water. While statistics vary, there is evidence that in many developing countries, sections of the population do not have access to safe running water, which is essential for a healthy life and perhaps the most basic food of all.

In the past, society responded to water scarcity by developing new supplies. That is not possible in many cases today, as the economic and environmental costs of new water developments exceed either the value of the new resource or the investment capacity of those demanding more resources. The alternative to new developments is conservation of existing resources for which a new conservation ethic is needed in all sectors of society. Agriculture as the primary user of diverted water is under close scrutiny. The combination of high water demands and apparent lack of control makes this sector particularly vulnerable to criticism, and the first to be looked at for conservation and redistribution of water in situations of scarcity. In fact, reallocation of water from agriculture to other sectors has already started in many areas, in particular as urban development continues at an accelerated rate and is expected to increase in the future. However, the role that irrigation plays in sustaining world food production may place a limit to the release of water from the agricultural sector. Opinions vary on the future water demands of the various sectors which no doubt will be an increasing source of conflict as competition for the scarce resource increases. Attempts to resolve these conflicts will need to recognise that the benefits of the different scenarios and their outcomes will vary greatly depending on the reliance of poor rural households upon water dependent ecosystems for flood recession agriculture, fisheries, livestock, and other products, and upon the capacity of water development projects to yield sustained increases in agricultural and industrial production that can improve the economic options of the poor.

Pressures on water resources have generated responses of diverse nature. A notable development has been the recent emergence of many international organizations and fora to facilitate discussions, exchanges of information and of viewpoints on many aspects of water. One important organization is the World Water Council, responsible for the organization of the World Water Forum (the most recent event took place in The Hague in 2000 and the next one will take place in Japan in 2003). The Global Water Partnership plays a key role in implementing the visions at the World Water Forums. There are many other organizations at the regional and even global levels, with similar objectives of disseminating ideas and creating awareness on critical issues. The environment created by these organizations will certainly contribute to the resolution of many water conflicts but in itself, is insufficient to solve most water problems. Most water issues have local and site-specific features that cannot be ignored; thus, general policies must be tailored to specific situations. Much remains to be done to translate broad visions into effective actions at the appropriate levels.

4. Issues and Challenges in Water Research

From the research viewpoint, these are exciting times. For too long, research on water issues has been disjointed, based on traditional disciplinary sciences without crossing boundaries, largely focused on short-term issues, and lacking coordination and cooperation among potential partners. Surface waters were treated separately from ground waters; water quality, independently from water quantity and each sector of users (i.e., agriculture) was ignorant of all the others. This approach to research often led, not surprisingly, to inadequate policies that were not well suited to solve the problems addressed.

A consequence of the research approach described above is that progress in some disciplines has been lagging behind relative to others, and in some cases, they have been largely ignored in much of the research on water issues. It is now evident that research in the social sciences has not contributed sufficiently to the development of new knowledge in the water area, and that the progress made in the biophysical and engineering sciences, have not been matched by that made in social sciences research. Yet, it has been evident for some time that science and technology are just two components of the solution to most water problems, and that the economic, social, institutional, and cultural aspects of water are essential determinants of its use and management. Insufficient research on water institutions is a particularly critical issue, given that in many cases, institutions are obsolete or even non-existent.

Improving the efficiency of water use in all sectors is a major challenge now and in the future, given the scope for improvement that exists; however, such a goal can only be addressed properly when the underlying basis of water use patterns, both consumptive and non-consumptive, is fully researched and characterized. What are the controls and the factors influencing water use? What responses should be expected to changes in supply and demand? How dependent is food production from natural ecosystems on different levels of water flow? It would be particularly critical to know the responses of the different sectors to extreme events such as droughts. Of all sectors, knowledge of factors determining the consumptive use in the agricultural sector is perhaps the most advanced, although much remains to be uncovered, while very little is known of the basic processes underlying environmental water use.

One critical problem worldwide is the lack of reliable hydrologic data, either because of lack of monitoring programs or because many of the programs designed in the past for field data collection have deteriorated. Causes of that deterioration include lack of funding for long-term monitoring programs, diversification of government agencies with overlapping functions and gaps, and the decline in prestige for field activities of routine nature. One result of the inadequate data collection programs is the unreliability and uncertainty of water supplies caused by the lack of precision in hydrologic forecasting. The problem is particularly critical in the developing countries where the absence of data even prevents hydrologic forecasting and rational water resources planning. (The key question here is – what data do we need to be able to make better decisions).

The last decades have seen a decline in the quality of water due to anthropogenic activities. Surface water quality deteriorated first but now, evidence of the lowering of groundwater quality is becoming apparent in many parts of the world. We need a better understanding of the physical, chemical and biological processes that determine the long-term changes in water quality, particularly in groundwater, which is expected to be an increasingly important source of supply in the future. Thus, there is also an urgent need for developing new strategies for efficient groundwater recharge in different watersheds. Much progress has been made in recent years in the development of simulation models of contaminant transport in soils and water but more efforts are needed in producing means for preventing pollution, in assessing the capacity of environments for processing contaminants, and in predicting impacts of water quality changes at the ecosystem level.

In most environments, the use of water follows a continuum from the initial efforts in water development to the competing demands for an increasingly scarce resource. Solutions to the water crisis require multidimensional approaches including supply augmentation, demand management and enabling policy and institutional options. The exact combination of strategies will differ among locations and regions, as most water problems have many site-specific features. Research aimed at identifying what interventions will likely have the greatest relevance under varying biophysical, socioeconomic and cultural conditions, will be critical in focusing the correct solutions to water problems.

Many more research challenges could be listed but regardless of the problem tackled, what is most important is to approach it with the correct framework and focus. It is time to consider simultaneously water quantity and quality; to analyse jointly surface and groundwater; to bring into the analysis at the start, all the social, environmental, and health components that are relevant to the problem under consideration. To summarize, it would be hard to find an area of research where multidisciplinary approaches would be more effective that they can be in the area of water.

5. Research on water in the CGIAR

In the present climate, what are the major water issues relevant to CGIAR goals? The CGIAR has certain comparative advantages in carrying work in water at the various scales, from the farm up to global, that should be offered to the international community. Actually, recent initiatives at the global scale by IWMI highlight the potential of the CGIAR to act as a focal point in some critical issues. Renewed efforts in water research are now undergoing in most, if not all of the other 15 CGIAR Centres. While other international organizations are very active in many international initiatives, the CGIAR is one of the few that could contribute much needed research information in many world areas. The CGIAR must focus more on water in relation to the plight of the poor in particular. There is a need to increase the adaptive capacity of the poor to adapt to, and to manage the water supply and quality constraints. This could be achieved by focusing at the community level and by developing inexpensive, easy to use monitoring tools that would alert the communities of forthcoming problems and provide them with means to take remedial action. This action is often needed long before there is any hope of changes in policy and other macro-level interventions. The fundamental issue of water as a food requires that attention be given to the quantity and quality of water available for domestic use in poor households and communities. Health issues associated with domestic supply and with irrigation management have been important research themes in the CGIAR and demand increasing attention.

In the future, CGIAR Centres could effectively participate and even coordinate interdisciplinary research on water together with many stakeholders at the national and regional levels. Given the current composition, activities and comparative advantages of the

CGIAR, it is proposed that research on water management should focus on the following four broad general areas:

1. Improving the efficiency of water use in agriculture, via increased water productivity;
2. Management of watersheds for multiple functions;
3. Management of aquatic ecosystems, in particular those with boundaries with terrestrial ecosystems;
4. Policy and institutional aspects of water management.

The first area concentrates most of the current efforts on water-related research of several CGIAR Centres and deserves the highest priority because of its direct links with one of the two main objectives of the CGIAR, namely that of sustainable food security. The other three areas have been addressed in the recent past and are emerging as important areas of research for some Centres. In addition, the water Challenge Program uses basins as key units for research development within the program. The CGIAR also has an ongoing, cross centre dialogue on integrated natural resources management. This initiative focuses on several of the four priority areas listed above.

What follows is a justification of the research needs and opportunities as well as some initial ideas for the development of a specific research agenda on each area. As the aim of water management research is to address water constraints and issues in an integrated manner, the four areas cannot be treated in isolation from each other. Instead of listing a fifth area for achieving integration, we refer readers to TAC's views on INRM (see foot note 2).

5.1 Improving the Efficiency of Water Use in Agriculture

Large amounts of water evaporate through crop plants, normally several hundred kg of water per kg of biomass produced; however, the supply of water to agricultural systems is even much more than what ends up consumed in crop transpiration. In some rainfed systems, only 5% of the rainfall or less is consumed as transpiration (T). In irrigated systems, some 30% of the water input are considered normal as transpirational losses. There are, therefore, substantial opportunities to increase the proportion of water that is used consumptively in agricultural systems, thus improving the efficiency of water use. Such opportunities are very diverse and occur at multiple scales, from plot to farm to watershed and region and at the biological, environmental, and management levels.

As stated above, not all water used in agriculture is lost to the system but can be recovered, at least in part, and reused. Thus, efforts to improve the efficiency of water use may or may not lead to net water savings, depending on whether the water saved is part of the recoverable or the unrecoverable losses. It is therefore important to make such distinction, for which two general ratios are useful in expressing the efficiency of water use for biological production:

Water Use Efficiency (WUE) = Water consumptively used in ET/Water input; and,

Water Productivity (WP) = Yield[3] / Water consumptively used in ET.

[3] Water productivity can be quantified on the basis of biological output or economic return.

Improving WUE by reducing the water input into the plot or the farm may or may not result in an overall improvement for the reasons stated above. Also, some of the influencing factors are related to the physical infrastructures of water delivery and management. As discussed below, research in the CGIAR for improving WUE in agriculture should have a very strong institutional and social component.

The improvement of WP by increasing yield and/or reducing ET, always results in a reduction of agricultural water requirements. This is the reason why David Seckler correctly focused some years ago on improving WP as a fundamental research goal of IWMI. Actually, all the yield improvement research carried out by the CGIAR has made an important contribution to the global increase in agricultural WP experienced over the last decades. In contrast, very little progress has been made in reducing ET, the denominator in the WP ratio.

The challenges and opportunities for future research in improving WP can be discussed around three system components: the **biological** (crop), the **environmental**, and the **management** component. Obviously, it is through synergies among such components that progress in increasing WP has been and will be made.

In the **biological** area, genetic improvement of WP has already been achieved as part of the yield gains effort, particularly in the irrigated systems, and more will be possible as effective demand for biological products continue to improve, allowing farmers to increase yields. Specific breeding programs aimed at improving WP, in rainfed systems, have not been nearly as successful except in the relatively favourable rainfed production systems. Primary reasons in the unfavourable rainfed systems have been the multiplicity of crop responses to drought and the large variability of drought-prone environments. Notwithstanding such difficulties that make short-term progress in drought adaptation a very uncertain proposition, biotechnology offers new possibilities that, combined with the expertise that several CGIAR Centres have in crop adaptation and performance in adverse environments, should open an important avenue for research in the medium term. As an example, one important goal would be to aim at yield stability in low rainfall years in marginal environments in an attempt to produce cultivars that would avoid the catastrophic impact of severe droughts but continue to provide bumper yields in average and good rainfall years. Another important medium-term research objective of producing a C4-type rice, if achieved, would increase significantly the WP of this major irrigated crop.

The major reason why it has been so difficult to reduce ET is that it is primarily dependent on the evaporative demand of the **environment**. That characteristic cannot be changed easily, but there are opportunities for WP improvement in the temperate zones and in cooler mid and higher altitude tropics and subtropics if crops could be raised when the evaporative demand is lowest; i.e., in winter. However, the primary way to reduce total ET is by growing a crop that has lower water requirements because of its shorter growth cycle. Here, crop choice, environment and management (by selecting optimal planting dates) interact and new research could produce excellent results if modelling is combined with experiments to offer the best strategies that maximize WP and income. As it is the T portion of ET, which determines biological performance, increasing T through rapid or continuous ground cover can lead to higher WP.

There are important effects of the environment in WP. WP in the summer of the arid zones is several times lower than in the winter of mild climates and inside greenhouses. Such differences, together with the opportunities that protected cultivation techniques such as plastic tunnels and unheated greenhouses offer for high WP and high economic returns for small farms, points out at the need for the CGIAR to get involved in horticultural research where appropriate.

The major opportunities that exists today in improving WP and that demand priority efforts reside within the **management** component. Inadequate management is the primary cause of the low WP that exists today in rainfed and irrigated systems. There are also challenges in the biophysical area related to maximizing WP under limited or deficit irrigation. It is very likely that many irrigated areas will not have full supplies in the future and will be forced to use limited supplies in an optimal fashion. Actually, large irrigated areas exist today that were under-designed for political reasons and suffer chronic restrictions in water supply. Research at optimizing a limited amount of water has been carried out in the past, but the new tools of spatial analysis and simulation modelling have much to add to the development of effective tools for advising irrigators in optimal scheduling methods. One other major challenge in rainfed but also, irrigated systems, is the need to maximize the potential for stored soil water in the crop root zone. Water conservation measures that increase the fraction of rainfall that ends up in transpiration need to be developed and tailored to each major system. The major advances in the improvement of WP until now have been achieved by yield increases through improved crop husbandry. A primary issue in this regard is the study of the interactions between soil fertility, plant nutrition and water management, from the plant up to the basin level.

While many of the opportunities discussed above have been partly researched, a major gap exists in most agricultural systems between what is known to increase WP and what is actually applied. This is primarily because there has been little or no involvement of social scientists in the research and extension efforts. Here lies a great opportunity for the CGIAR to link several actors and disciplines in agricultural water management research in the major water-limited agricultural systems of developing countries.

Traditionally, water productivity concepts have been applied mainly to crop production. There is no reason why water productivity concepts could not be defined for application to other uses of water for biological production, e.g., livestock or aquaculture. Demand for milk and meat is expected to double over the next 20 years. This demand needs to be factored into future assessments of water use and productivity. Water productivity in livestock production systems must be characterized in all of its dimensions. In addition further consideration needs to be given to developing a broader approach to water productivity, one that can take account of the different uses of water within the basin. This should in particular integrate food production from aquatic ecosystems.

5.2 Management of Watersheds for Multiple Functions

The CGIAR works in areas where the environment has many functions and provides multiple services for the rural population. Most of those services depend on the correct management of watersheds, which in turn depends on having an understanding of the relationships among watershed components. To develop management strategies, the components, structure and function of the watershed must be known. For the CGIAR Centres working at the watershed, catchment (or whole river basin) level, it is essential to understand the hydrology of the area under study. Hydrologic studies should preferably be conducted at the watershed level rather than following arbitrary geographical boundaries. Such studies at the basin level can form the basis for further analysis at higher scales, such as regional or even global levels, where assessments on water resources and demands are important issues where the CGIAR can make a contribution.

Watershed management will always be carried out by multiple stakeholders at the local level, with more or less public and government participation. The role of the CGIAR in this area is as one of the partners in a multidisciplinary team in the research-to-development continuum, being in charge of tasks placed at the more strategic research levels. In this theme, hydrologic issues must be addressed in the context of human interventions, as property rights, collective action and stakeholders participation play key roles in effective watershed management. Also, as livestock and wildlife play a significant role in watershed and basin hydrology, research efforts on their impact in many ecosystems are needed.

The CGIAR should be in the cutting edge of new approaches based on ITC technologies, such as remote sensing and GIS, to incorporate them into the research related to integrated watershed management, carried out cooperatively with other stakeholders. As an indicative agenda, research in the CGIAR under this topic should primarily focus on:

(a) Development and tests of simulation models at the watershed level; and
(b) Assist in the development of benchmark sites and of new methods for risk assessment and risk management with respect to water supply and use in basins.
(c) Institutional and policy research related to designing optimum institutional arrangements for effective watershed management;

5.3 Management of Aquatic Ecosystems, in particular those with Boundaries with Terrestrial Ecosystems

Research in environmental issues related to water has been largely neglected relative to research in other sectors. As an example, at present it is not known with any degree of accuracy what the water requirements are for many, if not most, of the aquatic environments. In some of the environments in which the CGIAR works, the aquatic environments have boundaries with terrestrial environments, and very complex relationships exist between the two ecosystems that are mostly unknown. It is obvious that knowledge of the hydrologic regime would be essential for the understanding of the role of water in those environments. Other important aspects such as the preservation of biodiversity or the assessment of the fate of contaminants in these ecosystems are but two examples of the urgent need to invest more resources in this area.

An agenda for research in this area would have numerous topics, including the following:

(a) Characterization of the functioning of the aquatic ecosystems where the CGIAR works.
(b) Development of simulation models with hydrologic, biological and geochemical components to elucidate the behaviour of such ecosystems and to propose strategies for improved management.
(c) Relationships between water quantity, quality and the provision of services by aquatic ecosystems.

In addressing these topics particular attention should be given to the fish production of aquatic ecosystems. These sustain important capture fisheries in most developing countries and are the principal source of animal protein to many millions of people.

Finally, it must be emphasized that, particularly in the last three areas described in section 5.2, 5.3 and 5.4, it could not be conceived that a research programme could be conducted by the CGIAR without crossing disciplines and even institutions, with broad participation of a wide range of stakeholders, and with a multiple national/international partnerships.

5.4 Policy and Institutional Aspects of Water Management

The urgent need for renewed research on water policy and institutions has been mentioned above as one critical area requiring enhancing research related to water in the social sciences. The CGIAR has the potential to make significant contributions in this area for two reasons; it can freely exchange information and compare features of institutions in the various areas, and it can act as a more objective advisor when policy and management research is carried out on institutional development and change. In general, very little is known about the reasons for the adoption gaps that are so common in agricultural water management. The assumption that new technologies will be picked up spontaneously by farmers is incorrect, and insufficient attention has been paid to the dissemination of appropriate technologies. New knowledge on the different user-organized water institutions must be developed to remove a critical constraint in many areas where innovative water institutions could make the most important contribution to improved water management. There are multiple aspects integrating biophysical and socio-economic issues that could be covered in this area of research and, given the limited resources, priority should be given to in-depth assessments of the benefits of the research prior to launching the projects.

In the specific area of water and forests, policy decisions are often based on insufficient scientific evidence on the interactions between forests and water issues. Thus, there is a need for further characterization of the causal relationships that form the basis for the policy interventions that will ensure the delivery of expected water services by forests.

Given that many important social science research issues have not been investigated sufficiently, work in this area could explore broad areas of water economics, law, anthropology and other social sciences. In the specific area of water institutions, the research agenda should address:

(a) Innovative institutions that would deal effectively with new problems such as equitable groundwater and waste water management.
(b) Comparative studies of institutions, exploring the cultural, ethical, and religious features of the different entities.
(c) The roles of prices, markets and regulations in improving water management
(d) New methods for enhancing stakeholder participation in institutions and in defining water policies.

6. Concluding Remarks

This discussion working paper provided a basis to initiate a debate in TAC/iSC and with the CGIAR Centres and other stakeholders within and outside the CGIAR regarding the role of the CGIAR in the water sector, the elements of an overall common CGIAR strategy for water management research, and CGIAR's scientific advocacy role in the international arena.

Sustainable food security is inextricably linked with sustainable water security. Progress in achieving improvements in food and water security would depend on integrated NRM approaches for improving water productivity for food, livelihoods and environment. This paper has highlighted some of the key problems and opportunities the CGIAR must address through a coherent Systemwide strategy to achieve sustainable and balanced progress.

This revised document serve as a framework delineating a common CGIAR strategy for water management research and advocacy. The iSC is pleased that the proponents of the Challenge Programme on Water and Food found this framework useful in designing the Programme.

The paper is being shared with CGIAR stakeholders with the iSC Chair's report for information and comments.