

## Executive Summary

The global population in 2050 will be about 9 billion, with most of the increase between now and then taking place in developing countries. To feed the world in 2050 and beyond, we will need to intensify agricultural production. Many observers consider that intensification will cause unacceptable harm to the environment, perhaps undercutting the ecosystems that support agriculture. CRP5 challenges this perspective and examines how we can intensify agriculture while protecting the environment and lifting millions of farm families out of poverty.

To achieve the vision of sustainable intensification, we must redouble our efforts to increase agricultural productivity, while protecting the environment we must conduct new and integrative research on agricultural and ecosystem interactions. Consequently the objective of Water, Land and Ecosystems is:

*To learn how to intensify farming activities, expand agricultural areas and restore degraded lands, while using natural resources wisely and minimizing harmful impacts on supporting ecosystems.*

### Conceptual framework

CRP5 is based around a conceptual framework that examines how changes in external drivers affect production systems and how management responses in production systems in turn impact ecosystem services and the broader environment. We aim to determine how these changes will impact natural resources at basin and landscape scales, how to measure changes in critical ecosystem services and how to use this information to improve land and water policy decisions and management responses.

If changes in key processes (e.g. water flow, erosion rates and vegetation) can be observed and measured at basin and landscape scales, we can use that information to provide policy advice and further adjust management practices. Given that management practices may act independently, we need also to determine the cumulative impacts of management practices at landscape and basin levels through modeling and mapping. Hence CRP5 will be supported by a strong foundation of analysis and information.

We view the relationships involving drivers and responses of the production system and its underpinning natural resources through a nested, spatial approach. At the broadest level we focus on major regions. Where possible, we will develop knowledge of broader agroecological zones (e.g. international public goods on nutrient cycling, soil fertility and water scarcity). By working at the basin level, we can quantify water flows and uses, and thus examine upstream-downstream environmental changes and socioeconomic trade-offs. We will use basic tools of water accounting and new approaches to monitoring land health, to quantify the impacts of agriculture on the environment, and vice versa.

## **Strategic Research Portfolios**

Within the broad topic of Water, Land and Ecosystems, we have identified five Strategic Research Portfolios (SRPs). These are Irrigated Systems, Rainfed Systems, Resource Reuse and Recovery, River Basins and Information Systems. They encompass irrigated and rainfed agricultural systems, in which improved policy and management practices will have to be implemented if we are to sustainably intensify agriculture. Resource Reuse and Recovery focuses on the pressing need to improve the recovery and reuse of water and nutrients in agriculture while at the same time limiting environmental pollution. We use landscape and river-basin perspectives to understand how changes imposed by external drivers and management practices will affect ecosystem services at broader scales. The SRP on the development of better information systems is vital to support science-based policy development and its implementation as well as improved natural resources management practices.

In addition to the five SRPs, we have established two cross-cutting themes that will influence and enhance our research: 1) Ecosystem Services, and 2) Institutions and Governance. Within each SRP we will promote ecosystem resilience and minimize negative impacts on ecosystem services. We will seek to enhance, and increase the value placed upon, ecosystem services. In doing so, we will work to improve resilience and provide farmers and pastoralists with production systems that are better adapted to environmental change.

With regard to institutions and governance, we will examine measures for building capacity and enhancing policy and institutional effectiveness across the SRPs. Throughout the program, gender and equity considerations will be emphasized in project planning, targeting of potential beneficiaries, and communication strategies.

## **Regional setting**

We will work initially in eight regions that are centered on large river basins:

<b>Region</b>	<b>Basin</b>
Southeast Asia	Mekong
South Asia	Indus and Ganges
Central Asia	Amu Darya and Syr Darya
Middle East	Tigris and Euphrates
West Africa	Volta and Niger
East Africa	Nile
Southern Africa	Limpopo and Zambezi
Latin America	Andes basins

Each basin contains a mixture of agro-ecological zones, urban and rural landscapes, and social, economic and political entities. In each, the natural resource base supporting agriculture and livelihoods is under stress. During the first five years of the CRP we will focus our research around key ‘problem sets.’ These contain a mixture of regional, basin-specific, global and methodological issues. The precise nature of problem sets is specific to research sites, but cross-regional parallels and similarities are not uncommon.

Our initial estimates suggest that at least 300 million people can benefit from the outcomes of CRP5 during the next 10 to 20 years. Additionally the work on the *Resource Recovery and Reuse* and *Rainfed Systems* SRPs may help another 200 million poor people, including some in urban communities.

### **Integration of CRP5 with other CRPs**

Whereas other CRPs will conduct research at the commodity, field and farm levels, CRP5 researchers will work primarily at larger scales (landscapes and basins), with an emphasis on interventions that influence the environment and natural resources. However, to predict the consequences of actions and interventions we will also examine interactions – and describe the implications – at the plot and farm levels, to predict the consequences of actions and interventions, thus enabling us to describe the implications of our results at the landscape and basin scales.

CRP5 researchers have a unique opportunity to integrate research at basin and landscape scales, and to investigate the spatial consequences of the site-specific work undertaken in CRP1 (Integrated Agricultural Systems) and CRP3 (Wheat, Maize and Rice). The nested strategy adopted in our conceptual framework facilitates this approach. We will work in locations where other CRPs are conducting crop and field management trials that have implications for research questions at the basin and landscape scales. For example, drought-tolerant crop varieties may have beneficial impacts on the hydrological cycle. Conservation tillage can increase groundwater recharge while reducing runoff and erosion. Improved water management in rainfed settings may increase crop production but reduce water flow in wetlands and streams, thus affecting biodiversity. To improve long-term analysis, we will work with researchers in other CRPs to select sentinel monitoring sites.

We will also focus on improving the understanding of hydrological and land degradation processes in key basins with a view to better modeling water flow and guiding sustainable land management strategies. Such work will be linked with the climate change analysis in CRP7 (Climate Change, Agriculture and Food Security). We will work with CRP2 (Policies, Institutions, and Markets to Strengthen Assets and Agricultural Incomes for the Poor) with respect to the policy changes needed to achieve better water and land governance.

### **Success through collaboration**

By crafting new partnerships and enhancing existing relationships, CRP5 researchers will strengthen links with universities, national research institutes and global organizations. The program's partnership strategy recognizes the different roles of 'core research partners,' 'implementing partners' and 'influencing and outreach partners.' We will develop new partnerships with private-sector entities as we examine opportunities for businesses to provide agricultural and environmental services.

### **Box ES.1. Key problem sets for each Strategic Research Portfolio**

#### ***Irrigated Systems SRP***

- Finally unlocking Africa's irrigation promise
- Revitalizing public irrigation systems in Asia
- Managing groundwater overexploitation in India through the energy–irrigation nexus
- Revving up the 'Ganges Water Machine' through intensive groundwater use for livelihoods and environmental benefits
- Managing salt–water balance in Indus and Central Asian irrigation systems

#### ***Rainfed Systems SRP***

- Recapitalizing African soils and reducing land degradation
- Revitalizing productivity on responsive soils
- Using agro-biodiversity to sustain agricultural production
- Reducing risk by ensuring water access for pastoralists
- Reducing risk by providing farmers with supplemental irrigation

#### ***Resource Recovery and Reuse SRP***

- Creating wealth from waste
- A grey revolution in wastewater management

#### ***Basins SRP***

- Payment for Environmental Services (PES) as a water management tool: Andes group of basins
- Water storage to reduce regional drought risk: Volta–Niger
- Integrating environmental water allocations and climate change impacts with water resources development: Ganges–Indus
- Harmonizing the water–energy–environment nexus in the Mekong Basin
- Managing water resources to reduce poverty and improve wetland management in the upstream Nile
- Solutions for transboundary water management hotspots in transition economies: Aral Sea basins

#### ***Information Systems SRP***

- Monitoring longer-term spatial and temporal change in agroecosystems
- Harnessing water and land information to improve management

### **Implementation of CRP5**

The International Water Management Institute (IWMI) will be the lead center for CRP5, which will have an advisory steering committee that will focus on scientific strategy, partnerships and impact. The program will have a management committee under the leadership of the program director and comprise a monitoring and evaluation specialist, SRP leaders and Working Group leaders.

In the first six months we will develop annual work plans with milestones and deliverables, and analyze the expected benefits of the work. Subsequently, a prioritization process led by the program steering committee will advise management and the lead center on program strategy and funding allocations across SRPs. To ensure that the program's benefits are realized, an

innovative marketing, communication and knowledge management strategy will be a feature of all activities.

CRP5's gender and poverty strategy will ensure that its outcomes target not only to the poor in general, but also women farmers. A conference on gender will be held in the inception phase to ensure that projects will incorporate key local and regional gender issues.

Considerable emphasis will be given to building the capacity of key target groups, including policymakers and land and water managers, to capitalize on the availability of better information. We will conduct tailored workshops to educate NARES staff about key issues, technical methodologies and uptake strategies. IWMI and the International Rice Research Institute (IRRI) already are planning an agricultural water management training course that will be rolled out across CRP5 and CRP3.3 (Global Rice Science Partnership).

The program will have a strong focus on communicating its findings to users via different strategies targeted at farmers and policymakers. We will emphasize monitoring and evaluation of impacts, as well as our delivery process.

The three-year budget (2011–13) is estimated at US\$246 million. This considers 2010 actual expenditures and allows a modest average annual increase of 6.8%. The sums of first-year funding for each of the SRPs are influenced significantly by existing restricted funding. However, prioritization processes may change this distribution in later years. More than one quarter (29%) of first-year funding will go to partners, with an increasing proportion of new funding earmarked for partnerships. The Food and Agriculture Organization of the United Nations (FAO) has offered to provide in-kind support, valued at US\$33 million over the three years.

Finally, as we conduct the research of CRP5, we will generate policy recommendations for increasing agricultural productivity, improving NRM and enhancing food security. We will work with uptake specialists to ensure that our recommendations are considered by public officials and others responsible for managing agricultural and natural resources and enhancing livelihoods in developing countries. Our success in conducting good science and policy analysis will contribute to achieving several changes we hope to see in the world by 2020 (Box ES.2).

**Box ES.2. Looking back from 2020**

Consistent with the vision that motivates our work, we look forward to seeing the following potential outcomes in 2020:

- The pace of aquifer decline in the Western Indo-Gangetic plains is slowing, while previously untapped water resources in the eastern plains are enabling 8 million farm households to secure alternative livelihood activities. CRP5 researchers and their national partners are continuing to model the groundwater hydrology and explore alternative livelihood options.
- Irrigation has been made possible for 12 million households in sub-Saharan Africa. CRP5 agronomists and hydrologists joined forces with economists to develop the scientific and policy recommendations that enabled successful irrigation interventions. Our research has inspired irrigation development in 14 countries including Burkina Faso, Niger and Zimbabwe.
- We have provided scientific and policy support for the expansion of irrigation in South Sudan. CRP5 researchers determined the best ways to develop irrigation potential, while minimizing harm to flora and fauna in large wetland areas adjacent to irrigated farmland. An estimated 8 million households in South Sudan are food secure as a result.
- We have reduced the vulnerability and improved the incomes of 17 million smallholder households in rainfed and pastoral areas of sub-Saharan Africa and South Asia. We achieved this by improving access to fertilizer while minimizing financial risk in the face of unpredictable rains, and promoting agriculture that supports rather than degrades ecosystem services. CRP5 agronomists developed the crop, fertilizer and sustainable land management recommendations, while economists crafted the risk-reducing safety net programs taken up by donor organizations.
- We have enhanced the livelihoods of 9 million households in peri-urban areas (i.e. at the edges of cities and towns) of Asia and Africa by developing safe ways to use polluted water for irrigation. An estimated 48 million consumers face less risk of illness, and healthier farmers are using nutrients recovered from wastewater.
- We have resolved the longstanding issue of competition between food and energy for land and water. Government subsidies for producing biofuels have largely been eliminated, and markets reward farmers for producing moderate amounts from non-food plants. CRP5 research on the implications of biofuel programs catalyzed changes in policy that have lowered food prices for 1 billion residents of low- and middle-income countries.
- We have slowed the pace of and increased the benefits provided by hydropower development in the Mekong Basin. With national partners and ministry officials, CRP5 scientists developed innovative protocols for protecting the environment and enhancing the livelihoods of smallholder families in hydropower watersheds throughout Cambodia, Laos and Vietnam. CRP5 economists developed measures for slowing the rate of growth in energy demands while maintaining vigorous economic development. An estimated 45 million urban and rural residents in the Mekong Basin benefit from lower energy prices.