A. Summary

1. **Title**: The Rice-Wheat Consortium for the Indo-Gangetic Plains: An Ecoregional Partnership in South Asia

2. **Duration**: The Rice-Wheat Consortium (RWC) has existed as an Ecoregional Program of the CGIAR since 1994. Before that date, however, some features of the RWC were present in a special project funded by the Asian Development Bank, and in a set of informal collaborative arrangements among CIMMYT, IRRI and national research systems of South Asia.

3. **Objectives**: The RWC was convened in response to growing concerns about the sustainability of rice-wheat systems in the Indo-Gangetic Plains. These systems are fundamental to food security, incomes and employment to hundreds of millions of rural and urban poor in South Asia. The objectives of the RWC are to help improve livelihoods and eliminate poverty through more productive and sustainable agroecosystems based on the rice-wheat rotation, and to conserve natural resources (soil, water, fuel, and agroecosystem diversity) devoted to these systems.

To meet this goal, the RWC facilitates integrated research to solve rice-wheat system problems, and helps Consortium partners improve their capacity to address them. Research focuses on four major themes: tillage and crop establishment; integrated nutrient management; integrated water management; and system ecology and integrated pest management. Other related themes – crop improvement, socioeconomics and policy, farmer participatory research, and GIS and project information systems – cut across and link the four main themes.

4. **Activities**: To meet its objectives, the RWC:
   - Provides a forum for regional and international scientists to interact on ways to increase and sustain farm productivity in RWC countries.
   - Minimizes duplication of research across sites by developing expertise at individual sites for specific topics and devising region-wide workplans.
   - Helps focus and coordinate the development and training of national scientists at international centers and research institutes.
   - Encourages sharing and closer interaction among scientists on common research issues and methodologies.
   - Introduces a systems perspective and multi-disciplinary approach to research.
   - Promotes farmer participatory research methods.
   - Encourages the use of new information technology—geographic information systems, modeling, farm management systems, project management information systems, etc.
   - Supports members’ efforts to obtain external funding for research and to communicate major concerns and results to multiple audiences.

5. **Area**: Natural Resources Management

6. **Region**: Asia – Pacific

B. Stakeholders

1. **Beneficiaries**: The principle beneficiaries of the RWC are the hundreds of millions of rural poor living on the approximately 12m ha of land devoted to rice-wheat systems in the Indo-Gangetic Plains. These systems stretch from the Pakistan Punjab, through the Indian Punjab, Haryana, Uttar Pradesh, the Indian and Nepal terai, through Bihar and West Bengal, and into
Bangladesh. Other beneficiaries include the landless rural poor, who rely on rice-wheat farming systems for employment, and poor rural and urban consumers, who benefit by having less expensive, more reliable food supplies. Finally, it should be recognized that RWC members are also beneficiaries, as they improve their capacity to identify and solve productivity and sustainability problems.

2. Research partners:
   - *Consortium full members.* These include four national systems (Bangladesh, India, Nepal and Pakistan) and five international centers (CIMMYT as convening center, IRRI, IWMI, CIP, ICRISAT). Within each national system, several agencies typically participate.
   - *Consortium associate members.* At present only the national system of China fits this category, but others (e.g., Iran) are seeking associate membership.
   - *ARI collaborators.* Several advanced research institutes collaborate in RWC activities, among them Cornell University; University of Melbourne; Institute for Arable Crops Research, Rothamsted; CABI International; International Agriculture Center, Wageningen.
   - *Private sector and NGO collaborators.* At the site level, there is a host of NGOs and private sector entities collaborating in farmer experimentation on small-scale implements.
   - *Farmer collaborators.* Farmer experimentation by village groups is a key part of the RWC.

3. Donors and budgets: On RWC financial matters, it is important to distinguish between the RWC Facilitation Unit, and research conducted by RWC members and collaborators. The Facilitation Unit is centrally funded by RWC donors. In contrast, collaborating research institutions must for the most part obtain their own funds, whether through special projects or from internal resources.

At present, financial support for the Facilitation Unit comes from the Netherlands and the CGIAR Finance Committee. This latter source is temporary, so at present the Facilitation Unit is not financially sustainable. Research support comes from: core unrestricted funds from CGIAR Centers; internal funds of national systems; NATP loan funds from the World Bank to India; AREP WB funds in Bangladesh and Nepal; ACIAR project funds supporting U Melbourne; USAID Soils CRSP funds supporting Cornell; DFID CRF project funds supporting IACR Rothamsted, CABI International, and CIMMYT; IFAD funds supporting IRRI; and Asian Development Bank funds supporting ICRISAT. A major project has been proposed for ADB funding to foster greater collaboration among International Centers at the site level, with some Facilitation Unit support.

The Facilitation Unit annual budget is on the order of $400,000 per year. The whole RWC budget as described above has not been calculated, but would easily reach several million US dollars annually – most of it from internal resources of national systems and international centers.

C. Results and Impacts

There have been four kinds of results and impacts from the RWC:
1. better understanding of rice-wheat system problems;
2. new technologies that address these problems;
3. impacts on farming communities as new technologies take hold; and
4. improved capacity among collaborating institutions to undertake systems research.

**Better understanding of problems:** RWC research has found that resource degradation in rice-wheat systems takes many forms: loss of soil organic matter; mining of soil nutrients; build-up of
weeds, diseases and pests; salinity and sodicity; falling groundwater tables (in some areas) and rising groundwater tables/ waterlogging (in other areas). In addition, there are problems that reduce system productivity, e.g., delayed crop sowing and inefficient use of water or fertilizers. Many of these problems are interrelated. Soil degradation and system ecology problems tend to be concentrated in areas where farmers practice continuous rice-wheat rotations. Low nutrient and water use efficiency is associated with delayed crop establishment, in turn driven by inappropriate tillage practices. Excessive pumping from wells leads to declining water tables in some areas, while in others inadequate drainage leads to waterlogging and salinity.

New technologies

Tillage and establishment: Timely sowing and good plant stands are crucial for rice-wheat system productivity. Delays in sowing wheat after rice can reduce yields as much as 1.5% per day, while reducing the efficiency of fertilizer and water. RWC scientists have developed and tested various conservation tillage technologies that result in timely sowing, lower production costs, increased productivity, and enhanced soil quality. These new tillage options also open up “space” (time, labor and land) for farmers to experiment with more diverse systems. Work has also started on the rice establishment phase and the effect on total system productivity. Results show that by not puddling rice soils, the next wheat crop does better when established without tillage.

Surface seeding of wheat onto unplowed, wet soil before harvesting rice has worked well in heavy, poorly drained soils. The technique is particularly relevant to farmers with small land holdings and who have limited or no power sources. In the 1997-98 wheat season, farmers in Nepal were hampered in planting wheat by continued rain. Farmers using surface seeding were able to get their crop planted on time and harvested 4 tons of grain per hectare, but farmers who used traditional methods were unable to plant a crop.

Reduced tillage sowing using a seed drill locally manufactured in India and Pakistan has significantly reduced production costs, enhanced yields, and generated enthusiasm among farmers in extensive on-farm tests during the past three years. This year more than 20,000 hectares of wheat were planted on farmers’ fields using the drills, about half each in Pakistan and India. Observations by farmers and scientists include: equal or better yields; fewer weeds; less irrigation water needed for the first irrigation; less leaching of nutrients; reduced fuel use.

The two-wheel hand tractor, another reduced tillage option, sows wheat into standing rice stubble. Developed in China, the tractor rotovates the soil ahead of the drill. Field trials in Nepal, Bangladesh, and Eastern India have yielded encouraging results. Two-wheel tractors can also be used to power other implements – pumps, threshers, reapers, winnowing fans, and trailers.

Rice transplanting and dry seeded rice. In South Asia, transplanting is the predominant method and involves raising seedlings and transplanting them into puddled soil. Puddling destroys soil physical properties and is increasingly expensive as real rural wages increase. Direct sowing has system benefits and is becoming increasingly attractive. Broadcasting of rice seedlings, a system common in China, reduces the drudgery of transplanting.

Integrated pest management: To minimize the use of chemicals, the RWC has developed integrated control measures for pests, weeds, and diseases in rice-wheat systems. Planting wheat in beds facilitates mechanical weeding and provides good control without the use of herbicides. Crop diversification with sunflower, sugarcane and other crops helps reduce losses to weeds. Stemborers survive in rice crop residue, but zero tillage practices actually help reduce this problem because rice stubble harbors beneficial insects that help control stemborers.
Integrated nutrient management: Long-term experiments on continuous rice-wheat rotations in India and Nepal show evidence of a depletion and imbalance in soil nutrients, including micronutrients, and a general reduction in soil organic matter, all or some of which appear linked to stagnating or lower yields. On-farm research to develop site-specific nutrient management (SSNM) has focused on 1) crop nutrient requirements based on an economically efficient yield target; 2) estimation of potential soil supply of N, P and K; and 3) plant N status during critical periods of rice growth. On average across fields and two consecutive seasons, yield gains from SSNM were about 10%, but can be as large as 15-20%. In extensive experiments, use of the chlorophyll meter has been shown to allow a 20-25% reduction in fertilizer applications without affecting rice yields. The technique permits an estimation of leaf nitrogen content at specific stages in plant growth by measuring leaf greenness. In this way, it gives farmers an idea of when to apply fertilizer and how much is needed. Simple color charts are being introduced to help farmers better target fertilizer applications. Soil organic matter dynamics are being studied and monitored in fields with new tillage options, rotations and crop technical innovations.

Regional salt and water balances: The demands for water from the rice-wheat system exceed that available from rain, canal and groundwater sources. In some areas, farmers use saline/sodic water that can damage the soil. RWC scientists are initiating research to assess long-term regional hydrologic salt and water balances as influenced by existing and alternate management practices; and as driven by policies (e.g., pricing, common property management). Scientists are using crop growth simulation and risk programming models to evaluate risk-efficient water-use strategies at the district level. Initial results suggest that improved water and energy pricing policies could reduce water use by 25%.

An ecoregional approach to natural resource management: Scientists from IRRI, CIMMYT, and several participating countries are developing tools for land-use planning via a systems research network called SysNet. Their “toolkit” includes simulation and optimization models, and geographic information systems. Alternative land-use scenarios are analyzed to assess development potential and opportunities, as well as trade-offs among agricultural activities and economic and environmental goals, for defined region.

Impacts on farming communities: To date, the most obvious impacts of RWC research on farming communities is through the work on tillage and crop establishment. Through system interactions, however, these impacts potentially affect nutrient management, varietal selection, crop rotations and system diversification, water management, and basin-level water resource quantity and quality. In Bangladesh, small-scale mechanization is creating a revolution in crop production. More than 200 thousand hand tractors are used by farmers in this country today compared to hardly any at the beginning of the decade. This is speeding up operations, reducing costs and resulting in higher productivity and input efficiency. Similar gains are expected in Nepal as more sets of equipment become accessible to farmers. The next step is local manufacture of the reduced tillage/ direct seeding implement and other accessories. Similarly, in the western part of the Indo-Gangetic Plains, rice-wheat area sown with zero till drills has increased from virtually nothing to around 10,000 ha each in Pakistan and India. Given private sector interest in zero drill manufacture and maintenance, this may be merely the start of a tillage and establishment revolution in rice-wheat systems throughout the Indo-Gangetic Plains.

Impacts on collaborating institutions: Probably the most important achievement of the RWC so far is the establishment of regional and national systems for research collaboration, combined with the introduction of new research methods, perspectives and information management tools. This has taken time but has resulted in national programs having more confidence in the
Consortium and seeing it as a bonus and help to their own research programs. The various discussions and meetings held by the Consortium and the exposure of national scientists to new ideas in these meetings has had an influence on the thinking on how to improve research efficiency in national programs. For example, the RWC experience influenced the design and development of the World Bank NATP loan project in India.

D. Partnership

There are two levels of organization for the Consortium: the national system level (including the site level) and the regional level.

**Regional level:** A multi-tier system is used at the regional level. A *Regional Steering Committee* (RSC) provides policy guidance and serves as a governing board through its annual meetings. This RSC is comprised of the Directors General of the four participating national research systems, along with the Directors General of CIMMYT and IRRI, and a representative of the donor support group. The RWC Facilitator serves as Member Secretary to the RSC. A *Regional Technical Coordination Committee* (RTCC) meets twice a year to plan and monitor RWC activities. The RTCC is composed of senior technical personnel from participating organizations. Finally, an internationally recruited scientist serves as RWC Facilitator and heads the *Facilitation Unit*, which provides support, leadership and coordination for many RWC activities. The Facilitation Unit is housed in the CIMMYT office in New Delhi, India.

**National level:** In member countries, a multi-tier system is also used. A *National Steering Committee* (NSC), composed of senior managers, guides activities and improves linkages among agencies within that country. A *National Technical Committee* (NTC) reviews research plans. Finally, *Site Committees* with a Site Coordinator conduct site-level planning and coordination, implement the research plans, and develop synergies between the different discipline and commodity partners working at the site.

Research targets site-specific national and regional sustainability problems. National systems identify and prioritize problems and suggest potential RWC interventions and research sites. A *National Rice-Wheat Coordinator* designated by each country monitors the national program, allocates research tasks, and shares information and resources across national institutions. Rice, wheat and other commodity programs are linked to provide a systems perspective in research at the site level. Multidisciplinary research efforts that address system-level biological and socioeconomic problems are encouraged and supported. The National Technical Coordination Committee and National Steering Committee are responsible for overall program management.

**An example of collaboration: Project Management Information Systems:** The Consortium is promoting the use of new research tools to increase the efficiency of agricultural research. One of these is the use of electronic media for handling project management information. The Consortium and member national programs all require an efficient electronic system for handling various aspects of research management. The number of projects being implemented and data generated are growing daily and are not easily monitored by manual means. Needs include:

1. Systems that facilitate project management: budgets, expenditures, staff performance, research progress, and project information (management emphasis);
2. Systems that track research outputs: who has conducted/ is conducting what kind of research, where, with what result, nationally, regionally and globally (technical emphasis);
3. Systems that manage and use spatially referenced information (GIS emphasis).
The Regional Steering Committee (RSC) encouraged the Facilitation Unit to identify consultants from the International Agricultural Center, Wageningen, to develop and implement these systems. The RWC system, at the advice of the RSC, will draw on the system developed for National Agricultural Technology Project (NATP) of ICAR, India. Two scientists from India visited IAC during August 99 to finalize the data base structure, input forms and output reports. The beta version is being completed and was demonstrated in September 1999. India is willing to share this information for the benefit of the other partners.

Other RWC activities

- Use of web pages to publicize research information and outputs. The Consortium already has a web page at [http://www.cgiar.org/rwc](http://www.cgiar.org/rwc). The Consortium has helped the NATP project in India and the AREP project in Nepal and Bangladesh to develop their web pages and will similarly assist other Consortium members.
- With the help of CIMMYT and Texas A&M in the USA, digital atlases will be developed that take available spatial data and convert them into a form useful to national scientists. This simple output will help scientists look at their regions more holistically and analyze the possibilities of scaling up new technology to areas of similarity.
- The Consortium promotes publication of quality research information. It does this by publishing important research results in a Consortium research series. To date seven papers have been prepared and five are already circulated.

TAC Review Findings

In a recent review of Ecoregional Programs within the CGIAR, the RWC was listed as one of the two best such Programs in the CGIAR system. Some highlights include:

- The effectiveness of collaboration within the RWC (“The RWC is clearly a NARS-driven initiative with the Centers having roles largely defined by the Consortium”).
- Commitment of stakeholders to the RWC (“In the case of the RWC, there is clearly a strong commitment to it at the highest level of leadership in the three national systems with whom the Panel had discussions. The enthusiasm of the participating researchers and extension specialists was also very evident.”)
- The role of the RWC in raising awareness in South Asia of the benefits of a whole system perspective in agricultural research and of the importance of integrating NRM research with production research.
- The effectiveness of the RWC in fostering the use of new research tools (e.g., participatory research) by national scientists.
- The success of the RWC in identifying new tillage options that increase production while conserving soil resources and saving on fuel, tractor costs, water, and fertilizer.
- The influence of the RWC on World Bank NATP funding for national research systems.
- The participation of beneficiaries and stakeholders in the definition of research priorities.
- The important role of the RWC in fostering communication among scientists and in fostering improved research planning and implementation.

E. Conclusion

Future Directions

The RSC and RTCC discussed future directions for the Consortium. A number of issues have been flagged and some of these are listed below. By implementing some of these suggestions it is hoped that the RWC will become stronger and play a vital role in enabling national programs to meet the complex challenges facing them for food production in the coming years.
1. Increase the capacity of national scientists to use modern systems research tools.
2. Implement with national scientists the “scaling up” and information dissemination activities needed to make research results widely available.
3. Integrate crop improvement products, and social science and economic analysis, more effectively into RWC activities.
4. Further existing work on water management, crop diversification and system ecology.
5. Put a higher profile and emphasis on site level activities. Review present setups and programs. Revisit and update system diagnosis.
6. Do a better job of site characterization and definition to enable better scaling up and dissemination of results to areas of similarity.
7. Look at the possibility of dividing the Indo-Gangetic Plains into more homogeneous water basins. The IGP is not uniform and differences exist within this large eco-region.
8. Improve site-level, cross-thematic research to better explore interactions within the system.
9. Develop a best bet package of technology at each site that can be tested in farmers’ fields using participatory approaches.
10. Promote more participatory approaches at the site level including all stakeholders present in the command areas. Clarify the role of each partner in the process.
11. Improve the visibility of the Consortium and its achievements to secure more sustainable funding.
12. Revise the strategic visions document of the Consortium.

For the national systems in the region to continue to keep pace with food demands in the next 20 years, efforts are needed to strengthen linkages between all stakeholders involved in food production. The Rice-Wheat Consortium provides a forum for this to happen and promotes synergism between different groups. Only by working together can food security be attained.