Photo: Hamish John Appleby (IWMI)

Irrigation and water management research in CGIAR: what do we know of the impacts?[1]

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Key messages

- While CGIAR has invested an estimated US$800 million (nominal, not constant dollars) in irrigation and water management research over the past 25 years, it has substantially underinvested in economic, social and environmental impact assessments (IAs) of this work.
- Only about 14 cases (out of 25) qualified as IAs of uptake, outcomes, and impacts of irrigation and water management research.
- There is no definitive answer to the question on overall influence, outcomes, and impacts of CGIAR water management research since 1991. There is too much missing data to make credible claims, even as there is some evidence of positive impacts by individual projects/programs on broader scientific literature, policy and research agendas, and food security/incomes of farmers.
- None of the CGIAR water management IAs refers explicitly to the contribution of research to SLOs, and none clearly measures impacts on poverty, equity, gender or ecosystems. Two (2) of the 14 IAs reviewed document environmental impacts. The review reinforces good practices for IAs of policy and NRM research, e.g. planning for IAs from the earliest stage of research and attribution analysis.
- Newer IA-related challenges have come up in the context of the changing CGIAR. For instance, given the shift in focus from single-dimensional innovations to agro-ecological systems research involving multiple stakeholders, planning for IAs and methodological innovation is even more critical.
- A number of promising candidates for future IAs emerge, including large-scale irrigation systems work in Asia, IWMI's policy research program in India, the Irrigated Rice Research Consortium's and Inland Valley Consortium's work, rainwater harvesting and supplemental irrigation.

Background

A significant proportion of CGIAR research investment has been spent on policy and natural resource management (NRM). However, compared with other areas of research e.g., crop germplasm improvement (CGI), there appear to be relatively

1 This brief is based on the study: Merrey, D.J. 2015. An Evaluation of CGIAR Centers' Impact Assessment Work on Irrigation and Water Management Research. Rome, Italy, Standing Panel on Impact Assessment (SPIA), CGIAR Independent Science and Partnership Council (ISPC). 83 pp.

few impact assessments (IAs) in this domain. To fill this gap, one of the activities of the Standing Panel on Impact Assessment (SPIA)-coordinated *Strengthening Impact Assessment in the CGIAR (SIAC)* program targets assessments of these presumably 'under-evaluated areas' of CGIAR research, including irrigation and water management, agroforestry and policy and social sciences.

This brief summarizes the findings and recommendations of a critical review of IAs of *CGIAR irrigation and water management research.* Critical reviews such as this one are intended to be the first step in encouraging new IAs of the under-evaluated topic in question, as well as to provide inputs on improving the quality of IAs.

Scope of the review

SPIA commissioned Doug Merrey to review all IAs of CGIAR irrigation and water management research (hereafter, water management research) completed after 1991 to:

- estimate total CGIAR investment in water management research since 1991
- review existing economic, social and environmental IAs of CGIAR research on water management
- summarize the impacts documented by the more reliable IA studies
- pinpoint areas requiring attention for future adoption and IA studies.

How were IA cases for the review identified?

In addition to SPIA's IA work, all Centers and CRPs were asked to provide a list of relevant IAs. Thirty-two (32) IA studies were identified, many represented by multiple publications or reports. Most existing water management interventions are not the products of CGIAR research; they have multiple and usually obscure origins. Studies that were not assessments of CGIAR research leading to the development and uptake of the technologies were rejected.

Overall, only about fourteen (14) IA cases[2] qualified as assessments of the uptake, outcomes and impacts of irrigation and water management *research* (Table 1). Given that water management research is considered to be primarily about policies and institutions, it is surprising to note that technology innovation (8) and management practice (10) cases outnumber policy or institutional innovation cases (6) in the full set of IA studies.

Investment in water management research

The study focuses on the period since IWMI joined CGIAR in 1991. A rough estimate of total investment by donors in this research domain since the Center was established in 1984 is US$800 million (nominal, not constant dollars). A more detailed costing by Center and program gave US$665 million (nominal, not constant dollars), but this is likely to be an underestimate.

Box 1. What constitutes irrigation and water management?

For the purposes of this review, 'irrigation and water management' was initially taken to mean technologies and practices that bring water to the root zone of crops through rainwater harvesting or supplementary or full irrigation, as well as policies, institutions, practices and technologies that relate to water management. Watershed management was excluded since this is an entire domain in itself. As the study progressed, this definition proved too narrow and was broadened reflecting the broadening of focus at Centers such as IWMI and IFPRI.

Hence, IA cases in this review range from the traditional research area of "irrigation management" to the broader "water management" domain that includes hydro-economic modeling of river basin management, and integrated water resources management in river basins. Basic technological research is also reflected in IAs reviewed, such as zero tillage wheat in the rice-wheat systems of South Asia, use of a broad bed maker in vertisol soils in Ethiopia, and aerobic rice technology.

2 The 32 studies submitted by the Centers were classified into 25 cases, of which 14 cases were classified as research IAs. There is some overlap i.e. some cases are both policy/innovation and technology, while others are none of the three (classified as project or program). The cases include IAs conducted on research by the International Water Management Institute (IWMI) – the lead CGIAR Research Center engaged in water management research, and its Challenge Program on Water and Food; the International Food Policy Research Institute (IFPRI); the International Maize and Wheat Improvement Center (CIMMYT); the International Livestock Research Institute (ILRI); the International Rice Research Institute (IRRI); and WorldFish. The International Center for Agricultural Research in the Dry Areas (ICARDA) and International Crops Research Institute for Semi-Arid Tropics (ICRISAT) have long-standing programs on irrigation and water management, but have not done IAs of these programs. Africa Rice has a significant agro-ecological program in West Africa with a focus on this domain but, similar to ICARDA and ICRISAT, no research IAs have been carried out. The International Center for Tropical Agriculture (CIAT) also confirmed that it has not carried out IAs of its water management research.

Difficulties in estimating total investment in water management research stem from:

- absence of data in some Centers, given that financial information is not maintained using this category;
- differences in what costs to include, e.g. some Centers include extension costs and in-kind partner contributions, and others do not;
- funding flows among Centers and possible double-counting of the Challenge Program on Water and Food (CPWF) funds.

specific innovations (zero tillage, aerobic rice, alternate wetting and drying), there are few credible methodologically rigorous *economic IAs* of water management *research*, and none of the *environmental* or *social impacts* of this research.

A second conclusion is that there is no definitive answer to the question on overall influence, outcomes and impacts of water management research in CGIAR since 1991. There is too much missing data to make credible overall claims; however, there is some evidence that: (a) individual projects or programs have had positive impacts on food security,

Table 1. Water management *research* IA cases

CGIAR Centers/Programs, projects and countries
1. IWMI - Irrigation Management Transfer (IMT), multiple countries including Sri Lanka, Nepal, and Central Asia
2. IWMI - IMT Action Research Project, Pakistan, 1995-2000
3. IWMI – reform of groundwater governance through reform of electricity supply, Gujarat, India
4. IWMI – improvements in environmental quality due to changes in sluice gate operations, Bac Lieu Province, Vietnam (Mekong Delta)
5. IWMI – soil remediation (addition of bentonite clay) to improve water and nutrient holding capacity, northeast Thailand
6. IWMI – malaria control through environmental and irrigation management, Sri Lanka
7. IFPRI – 'Water Resource Allocation: Productivity and Environmental Impacts' (1994-2010), a program evaluation around three themes (global modeling, river basin hydro-economic modeling, institutions)
8. CPWF – System of Temperate and Tropical Aerobic Rice (STAR), IRRI's project in China, India, Lao PDR, Thailand, and Philippines
9. CPWF – water and land management at interface of fresh and saline water environments, Mekong Delta
10. CPWF – Sustaining Collective Action Linking Economic and Ecological Scales in Upper Watersheds (SCALES), CIAT's project in the Colombian Andes
11. CPWF - Models for Implementing Multiple-Use Water Supply Systems for Enhanced Land and Water Productivity, Rural Livelihoods and Gender Equity (MUS), IWMI's work in Colombia, South Africa, Thailand and Zimbabwe
12. Rice Wheat Consortium (RWC) – Zero Tillage (ZT) in rice-wheat zone, South Asia
13. Irrigated Rice Research Consortium (IRRC) – aerobic rice and alternative wetting and drying (AWD), meta-analyses for multiple Asian countries
14. ILRI – Broad Bed Maker (BBM) plow, Ethiopia

Impacts of CGIAR water management research and investment in IAs

One major conclusion of the study is that CGIAR has seriously underinvested in both *ex-ante* and *ex-post* economic, social and environmental impact assessments of its research on irrigation and water management. This applies across the CGIAR system, with only a few exceptions. For instance, total investment in CPWF was US$120 million over ten years, with 50-70 projects in Phase 1. IAs were commissioned on only four of these projects. Only two of these analysed the entire project – these were *ex-ante* return on investment analysis; there were no ex-post IAs in Phase 1.

While this study identified (and reviewed) a number of credible assessments of impacts of

incomes and livelihoods of millions of Asian farmers (e.g. the Rice Wheat Consortium and Irrigated Rice Research Consortium); (b) work done at IWMI and IFPRI on institutions and policies have contributed significantly to the scientific literature, and in the case of IWMI, influenced government policy on electricity for pumping groundwater in one Indian state; and, (c) CPWF may have had substantial influence on policy and research agendas.

A number of weaknesses and gaps in the IAs of CGIAR water management research were identified. While there is a *paucity of assessments of aggregate impacts* – the contribution of research to CGIAR SLOs, and clear measurement of impacts on poverty, equity, ecosystems or gender – there is also a *lack of attention to disaggregated impacts*,

Box 2. Challenge Program on Water and Food (CPWF), 2003-2013

IWMI was the implementing Center for this program that ran in two phases: Phase I was between 2003 and 2008/09, and Phase II between 2009 and 2013.

Only after many of the projects began in Phase I did CPWF start developing its theories of change, adopting the use of impact pathways in project management as well as M&E functions. A 'Participatory Impact Pathway Analysis (PIPA)' methodology was developed and included an outcomes logic model and an impact logic model. An attempt was made to retrofit projects using these tools, but projects varied considerably in their adoption of these tools. As Phase I neared completion, CPWF adopted the 'Most Significant Change (MSC)' technique to document complex change processes.

Impact assessments were done on four (4) of the over 50 projects that constituted CPWF Phase I: namely, aerobic rice, interface between fresh and saline water environments, SCALES and MUS project. No follow-up or new IAs were commissioned in Phase II. The four IA cases used a combination of tools (MSC, benefit-cost analysis, Extrapolation Domain Analysis (EDA), social network analysis etc.) in their assessment of the processes by which the projects contributed to desirable outcomes and impacts. Evidence suggests that two of these projects, aerobic rice (STAR) and MUS, have possibly contributed to achieving substantial food security or poverty reduction, and are clear IPGs. The project on managing the fresh-saline water interface is a possible IPG with potential for impacts, but it is unclear if SCALES is an IPG.

Even as CPWF emphasized learning from projects, it underinvested in collecting data on outcomes and impacts (even the 4 IAs commissioned did not conduct primary data collection). But CPWF does offer important tools, guidance, and evidence on how to design complex programs, involving multiple partners to achieve outcomes (and potentially impacts).

i.e. differential impacts on various categories of farmers, consumers, larger landscape and agro-ecological systems, etc. This is particularly important in the context of a recent shift in CGIAR's research towards a systems-based approach as distinct from one based on single dimensional innovations. Water management is now understood to be an integral part of complex agro-ecological or river basin systems, rather than a single isolated resource.

Relatedly, water management research in the CGIAR falls in the environment and natural resource management domain, and CGIAR would like to be able to claim positive environmental impacts in addition to social impacts. *Only two of the 14 IAs reviewed document environmental impacts:* the impact of the Rice-Wheat Consortium's zero-tillage intervention on groundwater and greenhouse gas emissions, and IWMI's work in the Mekong Delta (gate operations) on flora and fauna. Finally, a majority of the credible water management research IAs measure the impacts of technologies, management practices or packages thereof. The three cases that attempt to evaluate outcomes and influence of water management *policy research* do not go far enough.

Challenges in IAs of water management research

Methodologies for assessing the impact and economic value of research-based technologies such as improved crop varieties have existed for some time now, and the methods of such evaluations continues to improve (de Janvry et al. 2011). Impact assessments find a much higher rate of return on basic technology research investments compared with policy and NRM, leading some to argue that CGIAR should rebalance its research portfolio by reducing policy and NRM research (Renkow and Byerlee 2010, also refer Raitzer and Ryan 2008 and Walker et al. 2010). These judgements may be premature because of the complexity of IAs in policy and NRM domains, and the limitations of traditional IA tools.

The IA cases examined point to a strong need for innovation in impact assessment methodologies, and the use of more rigorous counterfactual[3] frameworks. Other findings included the lack of *ex-ante* IAs and underinvestment in collecting data for monitoring/assessing progress towards outcomes and impacts that may enable future IAs, the lack of information on impact pathways, a failure to clearly delineate the

3 What would have happened in the absence of research.
4 Unless the innovation examined is the only significant output of the program – in the case of Rice Wheat Consortium and Zero Tillage (ZT) IA, this is unclear. The Irrigated Rice Research Consortium's multi-dimensional ex-ante analysis is one good example of a program-level analysis.

roles and value added of other partners in research work, and the narrow focus on assessing impacts of specific innovations and not the entire program[4].

Credible evaluations of returns on investments in true IPG policy and NRM research are very rare, particularly because it is difficult to attribute SLO-level impacts to specific research outputs. Attribution is complicated by multiple impact pathways and the long time lag between research and impacts. Since much of CGIAR water management research is consumed by other researchers, CGIAR should consider distinguishing between research that contributes to basic scientific understanding (which can be evaluated using normal science procedures like peer review to assess influence), and research that is aimed at achieving specific outcomes and impacts (requiring rigorous assessment of impacts and returns on investment). Because impacts of policy and NRM research may play out over decades, it also raises questions on the appropriate point at which one should measure the impacts, and compare research benefits to costs. These considerations need to be weighed against the potential donor demand for benefit-cost studies such as those for CGI, and evidence of impacts at system-level. At the same time, CGIAR needs to be cognizant of the perverse incentives that such demand can create – for instance, Centers may focus their research on easy-to-assess innovations rather than complex social-economic-policy issues of which IA is relatively more challenging.

Overall, the review makes a case for better documentation of adoption of research-based water management technologies and the returns on research investment; improving impact assessment and benefit-cost analytical methodologies for policy and NRM research; and conducting more meta-analyses of research programs such as those done for IFPRI or IRRC.

Box 3. Irrigated Rice Research Consortium (IRRC)

IRRC was a 15-year eco-regional program that aimed to facilitate identification, development, dissemination and adoption of NRM technologies (direct seeded rice, integrated pest and rodent management, aerobic rice, alternative wetting and drying [AWD] etc.) suitable for rice-based ecosystems in Asia.

A meta-analysis of IRRC was completed in 2013, relying on existing documents and data, including IA studies. A number of recommendations for improving IA quality were made, including examining heterogeneity of impacts, tracking adoption rigorously, and building the evidence on environmental impacts. Attribution was also complicated because of the long history of research on AWD and aerobic rice preceding IRRC.

Rejesus, Martin, and Gypmantasiri (2013) find overall returns on IRRC research investment to be highly positive, and the highest returns to investments were from AWD (on the other hand, returns on aerobic rice are lower and even negative in the Philippines). Poverty impacts were assessed using a case study approach, and the authors found that incomes improved but not enough to raise people above the poverty line.

Despite these shortcomings, IRRC IAs are especially useful as a model for designing future program IAs. IRRC invested in good *ex-ante* multi-dimensional analysis of the program, as well as lessons learned, the outcomes and impacts achieved to date and those likely to be achieved in the near future.

Potential approaches to address IA challenges

One of the objectives of this study was to identify approaches likely to support robust impact assessments of water management research in the future. A central principle to emerge was the importance of planning ahead, so that research programs and projects are designed from the outset with impact assessments in mind.

Developing a credible theory of change and impact pathways, and a plan to monitor processes, lessons, outputs, outcomes, and impacts (*ex-ante* and as they occur) will increase the potential to assess impacts and returns at a future date. Where possible, the anticipated outputs should be explicitly linked to the System Level Outcomes – all CGIAR research is expected to contribute to achieving one or more of these outcomes. Relatedly, the review urges more environmental impact assessments of water management research, especially critical since water management is considered an environmental intervention.

While the need for methodological innovation applies across policy and NRM domains, more effective qualitative as well as quantitative methodologies need to be developed and widely used if CGIAR is to demonstrate the value added of policy-oriented water management research


Photo: Hamish John Appleby (IWMI)

investments. A final recommendation is a partnership between CGIAR impact assessment scientists and IA specialists from advanced institutions so as to identify, develop, test and disseminate more effective impact assessment methodologies.

Promising innovations and programs for IA in water management research

In identifying programs and projects whose impacts/influence should be assessed, the study pinpoints the special importance of targeting IWMI to understand the value added, contributions, outcomes and impacts of its work. IWMI likely accounts for at least 60% of total CGIAR irrigation and water management research investment over the last 25 years. Five high priority candidates for evaluation are the *Comprehensive Assessment of Water Management in Agriculture (CA)* program, *IWMI-TATA water policy research program in India, regional programs* in Central Asia and Africa, *Asian large-scale irrigation* systems work, as well as the *AgWater Solutions Project*. Other potential candidates include the work on river basin modeling, waste water reuse for irrigation (resource recovery and reuse), and sustainable agriculture in wetlands.

Given the *ex-ante* and short-term *ex-post* work that has occurred at the Rice Wheat Consortium and IRRC on *zero tillage (ZT), alternate wetting and drying (AWD)*, and *aerobic rice*, these are excellent candidates for a comprehensive *ex-post* IA. The review strongly urges a comprehensive *ex-post* IA for the *Inland Valley Consortium (IVC)* in West Africa, since it appears that no IA has ever been conducted on impacts or returns on the investment of this long-running program.

Other water management research areas where evaluation is lacking, despite significant research investment, are the *rainwater harvesting* and *supplementary irrigation* work by ICARDA, ICRISAT, ICRAF, and to a lesser extent, CIAT. There is also scope for a full follow-up *ex-post* IA of the WorldFish-led *Integrated Agriculture-Aquaculture (IAA)* work in Asia and Africa. And finally, CPWF remains a major candidate for social, economic, and environmental impact assessment, the returns on research investment, and lessons from implementing a large-scale, partnership-based eco-regional research program.

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