Impact pathway analysis for research planning: The case of aquatic resources research in the WorldFish Center

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Abstract

In line with its mandate of poverty reduction and sustainable development, the WorldFish Center is orienting its research towards high impact scientific activity. Identifying such activities is the task of prospective impact assessment, in turn based on impact pathway analysis. The paper describes a framework for analyzing benefits from aquatic resources research, the relevant research categories, pathways to impact by category, and indicators along each pathway that can be estimated in order to quantify probable research impact.

Introduction

Science-based innovation has been the key element in the long-term elevation of living standards worldwide. However, the transmission channels by which such innovations eventually deliver benefits to the poor and the environment are complex. As development-oriented research requires an intentional strategy to focus on high-impact activities and approaches, understanding such channels becomes an essential element in research design.

The WorldFish Center is in the process of integrating the analysis of impact pathways into its research planning. Impact pathway analysis within the WorldFish Center is conducted within an impact assessment cycle, which is conceptually divided into three stages (Ahmed, Dey and Williams 1999). The first is the planning stage, in which impact is prospectively evaluated to identify research priorities; next is the monitoring and evaluation stage; last is the stage of retrospective impact assessment which attempts to observe and measure actual impact. WorldFish impact studies span all these stages (Dey and Gardiner 2000).

The current initiative within WorldFish is focused on prospective assessment, structured in terms of an analysis of pathways to research impact. This initiative is a relatively novel one in agricultural research, as impact assessment has mainly been conducted retrospectively or *ex post* (Evenson and Gollin 2003; Adato and Meinzen-Dick 2003). This paper discusses the methods and tools for conducting such an analysis.

Impact Pathway Analysis at the WorldFish Center

Impact pathway analysis was the focus of workshop sessions during the 2002 WorldFish Center Science Week. Case studies for impact pathway analysis were presented at the output and project level. The analyses incorporated the following elements: statement of the actual research output, statement of the desired final impact, and identification of outcome as well as dissemination strategy. The analysis of impact pathways was extended during the 2003 Science Week to encompass the major categories of WorldFish research. The focus of the final workshop sessions was the identification of impact indicators for use in research priority setting.

Impact Pathways and Indicators

Impact pathway analysis identifies causal links by which research achieves its intended benefits. It is helpful to researchers and research planners as it requires them to 'form hypotheses about the route from research-specific activities to development impacts, to define the changes at each stage, to describe the linking processes, and to identify indicators to measure both content and process' (Springer-Heinze et al. 2003).

Impact pathway analysis is particularly useful in view of the new perspective on impact, which conceptualizes technical change in agriculture as a complex process involving feedback loops, and interactions between social, cultural and biophysical systems. This contrasts with the traditional characterization of agricultural research as involving a linear chain from output to impact, with minimal engagement between remote parts of the chain, i.e. researchers and final beneficiaries (Douthwaite et al. 2003).

Within this paper, impact pathway analysis is applied mainly to quantify prospective impact. At key stages in the pathway, measurable outcomes, corresponding to impact indicators, can be identified and estimated. In general, the indicators will take the form of a measure of *potential impact* at the research-output stage, as well as potential scope of impact or the *extrapolation domain.* These are then adjusted by the *performance gaps* associated with socioeconomic behavior and biophysical constraints. The specific processes and indicators along the pathway will depend on the nature of the research and type of system affected.

The Impact of Research on Aquatic Resources

We first analyze how benefit flows from aquatic resources (Figure 1), as the background for analyzing the impact of aquatic resources research. Benefits are generated through human activity as structured by institutional arrangements, such as markets. *Economic* benefits are obtained through the production of fish; these benefits are distributed across the various social sectors, e.g., between producers and consumers, and between poor and non-poor. *Environmental* benefits meanwhile are generated by a wide range of ecosystem services and are diffused across all users of aquatic resources, e.g., waste disposal by rivers and lakes, coastal protection from coral reefs, maintenance of biodiversity, etc. Human activities can affect these ecosystem services, e.g., environmental damage (a form of "externality") may occur as a by-product of production and other human activities.

Production activities, in turn, can be classified into fish farming and capture fishery. Fish farming is conducted on *divisible* resource systems, i.e. farms, ponds, cages, etc., for which rights-to-use are defined and enforced at an individual level. However capture fishery is conducted on *common pool* resources which support natural stocks from which tangible commodities can be harvested, but for which subdivision of the total stock or the supporting system into the exclusive use of specific harvesters is infeasible (Ostrom, Gardner and Walker 1994). Accordingly, farming decisions are largely independent, whereas individual fishing effort affects the catch of other fishers. However as this collective effect is largely unrecognized by individuals, the usual problem that arises for fisheries is overextraction of the resource stock.

Based on the foregoing, three major research categories may be distinguished. Research on *technology* affects production relations in divisible resource systems. Adoption of the research output is mainly the decision of the individual user (e.g., the farmer). Research on *natural resource management* provides information to institutions that deal with the problems of environmental damage and overextraction of common pool resources. Finally, *policy research* provides information for policymakers and other actors in the policy environment. For example, trade policies affect the behavior of markets, land-use policies shape choices and regulations on the use of land and water; and zoning laws affect the spatial distribution of fishing activity.

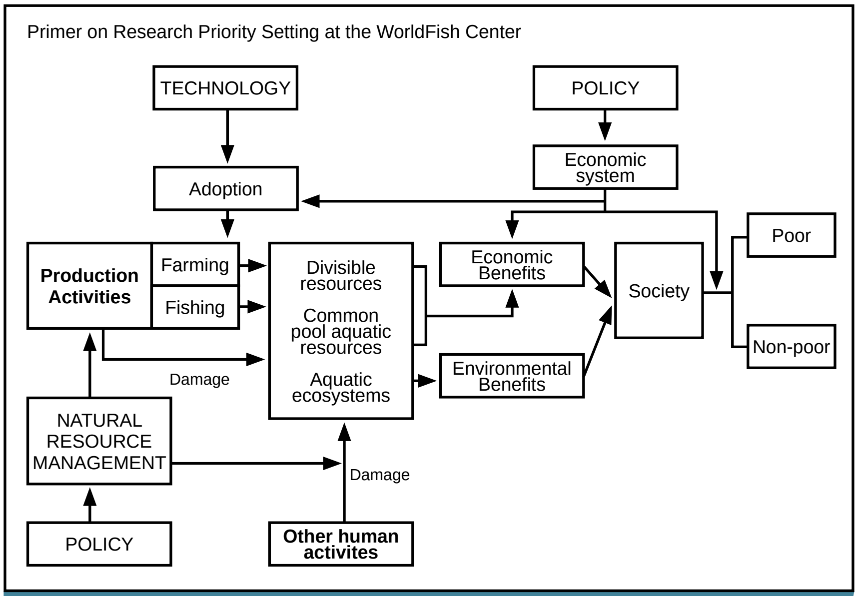

Figure 1. Framework for describing benefits from aquatic resources.

Impact Pathways by Research Category[1]

Research on technology

The impact pathway and indicators for technology research are straightforward (Figure 2). The research output takes the form of a production innovation, e.g., a genetically improved fish type, a device or production practice. The innovation then undergoes an on-farm validation phase, following which it may be released for dissemination by impact intermediaries (e.g., the government extension system). Fish farmers then adopt the technology, which leads to productivity changes. Through markets, this will affect consumers, producers, and linked suppliers and traders through their consumption and earnings. The reverse arrows represent feedback effects.

For potential impact, the indicator may be the increase in yield (at similar cost), or decrease in cost (at similar yield), change

[1] The impact pathway analysis in this section relies extensively on the outputs of the 2003 WorldFish Science Week Mini-Workshop on Impact Pathways, with sessions chaired by Alphis Ponniah, Johann Bell and Mahfuzuddin Ahmed.

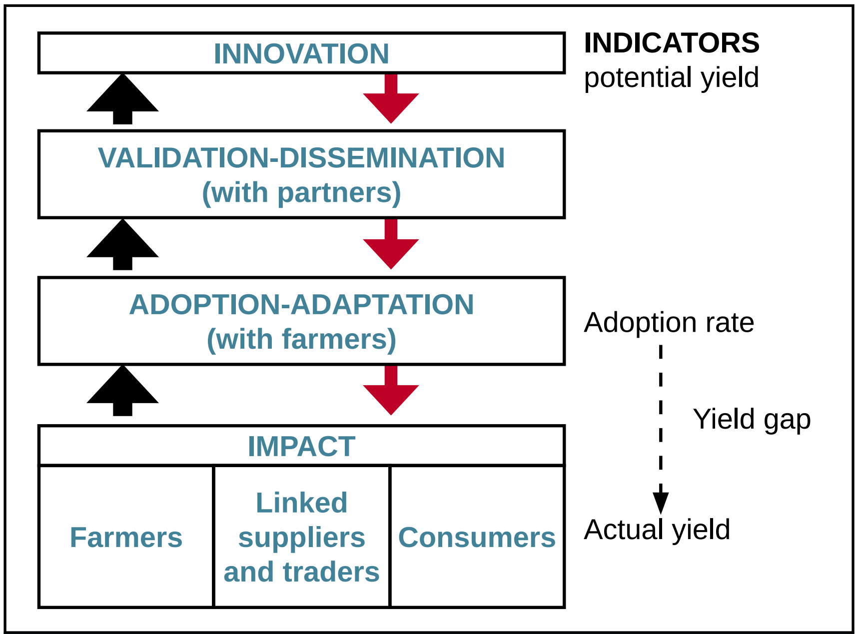

Figure 2. Impact pathway for technology research.

in quality (for similar yield and cost), or even reduced variability of output (i.e. production risk). Once the technology is disseminated and adopted, impact can be measured at the field level. Evidence on production technology adoption in agriculture points to a gap between potential yield (the research benchmark) and farm-level yield (the actual impact), hence the potential impact needs to be adjusted downwards by a "yield gap".

Upon adoption, production-side benefits take the form of higher profit and increased activity for vertically linked sectors (e.g., input suppliers, farm traders, etc.) For consumers, widespread diffusion of the technology may lead to aggregate increases in consumption, better quality and lower price. The economic gains will then be distributed between poor and non-poor.

The impact of technology encompasses more than economic changes. The environmental consequences should also be evaluated, e.g., genetically improved shrimp may stimulate expansion of brackish water aquaculture and hasten mangrove destruction. Moreover, for some research activities (i.e. participatory research) part of the impact takes the form of changes in attitudes, knowledge and capacities of the adopters. Such intangibles, though omitted in conventional economic analysis, should nevertheless be recognized in evaluating technical change.[2]

Research on natural resource management

Management interventions for aquatic resources may involve restrictions on the magnitude of fishing effort; regulations on the way fishing activity is conducted to reduce environmental damage; and other regulations on human activities to attenuate environmental damage, for example, the protection of mangroves to reduce sedimentation of coral reefs; and finally, efforts at restoring destroyed habitats or restocking depleted fisheries, e.g., construction of artificial reefs.

Implementing these interventions however faces serious information constraints. Often the status or vulnerability of a particular fish stock or aquatic ecosystem is unclear; moreover, its role in livelihoods or the economy may also be in doubt, weakening the imperative for immediate and decisive action. Furthermore, the causal relations may also be vague or poorly established, whether in terms of the impact of human activity, or the likely outcomes of various management options.

Research assists management by assessing the status and values of the aquatic resources, and by identifying the likely impacts of human activity or management actions. Its impact pathway may be traced as in Figure 3. Research output may take the form of management recommendations, or more broadly, decision support for management action. As with the case of technology, natural resource management research needs to undergo a trial phase (i.e. piloting) to validate or modify its output. The influence of research impacts on intermediaries (National Aquatic Research and Extension Systems or NARES, fishers' organizations, etc.) is spread by dissemination activities, capacity building, and advocacy.

Adoption (conditional on the policy environment) leads to specific actions such as effort restrictions and regulations. At this stage of the pathway, it becomes feasible to identify indicators such as reduction in fishing effort, new regulations introduced, area of artificial coral reef constructed, etc. All of these require adjustments for performance gaps based on implementation problems and biophysical constraints. Impact may be measured in terms of economic and environmental benefits. Note the left-side arrows connecting all the rows, denoting the pervasiveness of feedback in the entire process from research to final impact.

[2] Some innovations, such as integrated farming systems or sustainable agricultural practices, aim at institutional and ecosystem-level benefits and are often classified under "natural resource management". Due to the nature of the farm production system however such interventions are classified in this paper under the technology category.

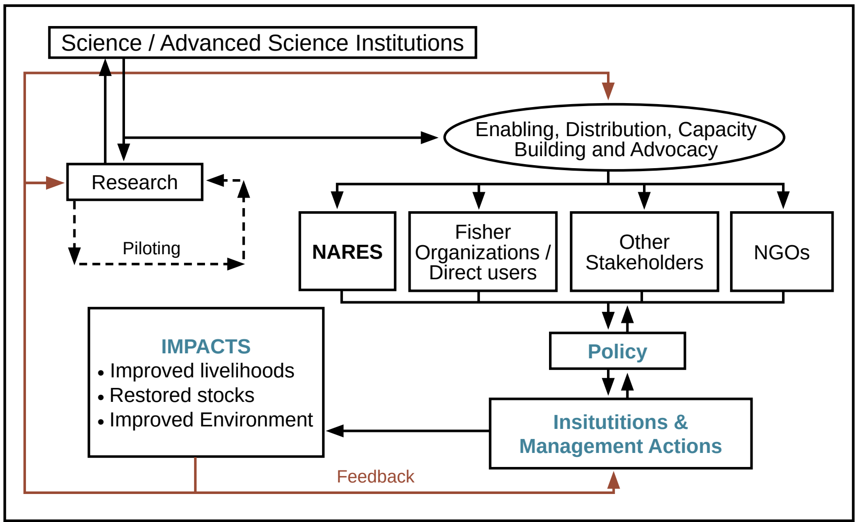

Figure 3. Impact pathway for research on natural resources management.

In practice, little work has been done on determining research impact for the management of aquatic resources. This mirrors the shortage of impact assessment for research on natural resources management in general (Pingali 2001). Impact pathway analysis suggests that impact indicators be identified and estimated for a with- and without-research scenario. Adjustment for these estimates must be made for performance gaps, e.g., enforcement failures and ecological constraints, as well as for lags in adoption by governments and user associations.

For management aimed at mitigating environmental damage, indicators related to ecosystem health and biodiversity may be used. For management aimed at over-extraction, performance may be gauged relative to a norm, or "reference point" (Garcia and Staples 2000). Frequently maximum sustainable yield or maximum long term yield should be used as a basis to gauge how successful management action has been in restoring the long-term viability of natural stocks.

Research on policy

The impact pathway for policy research resembles that for resource management research (Figure 4). Analysis and recommendations from policy research influence various actors such as governments and development agencies. Influence could be manifested by changes in policy choices, program implementation, institutional design or organizational capacity. In turn, these changes may affect socioeconomic and environmental conditions through price and income changes, increased resource stocks, as well as expanded resource access and employment opportunities. These in turn lead to changes in purchasing power and consumption at the household level, which may benefit households, both poor and non-poor.

The identification of indicators along the impact pathway is a major challenge for policy research (even more so than natural resource management research). Lower down in the pathway one can identify economic indices and trends as measures of impact. Further up the pathway, indicators for "influence" (applicable more or less to each of the intermediaries) may include: budget allocation to the fish sector (or to specific initiatives within this sector), citations in publications or official plans, partnerships formed, endorsements, etc. One can use these indicators as a basis for estimating the openness or favorability of the policy environment (measured by some suitable index) to the recommendations and implications of policy research.

Concluding Remarks

The framework for prospective impact assessment discussed in the foregoing consists of a categorization of aquatic resources research, a delineation of impact pathways by category, and identification of a broad set of indicators

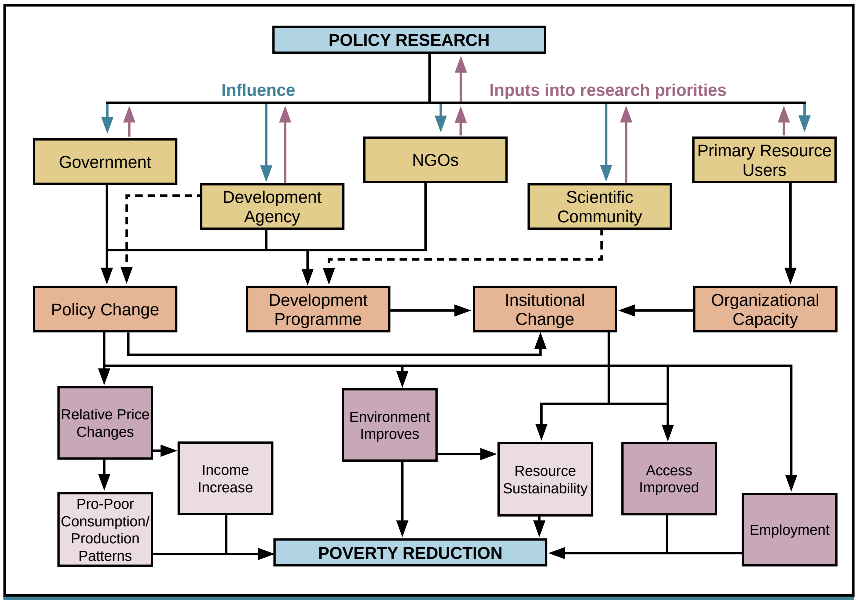

Figure 4. Impact pathway for policy research.

for major nodes along the pathways. For research planning, the indicators will have to be estimated beforehand by expert judgment, or by using retrospective impact studies of similar research in the past, or both. Reliance on subjective judgment does have its problems, but as it is unavoidable, the framework presented can at least provide a common model for the estimation of these indicators. A rigorous attempt at quantification would, hopefully, pay off in terms of increasing the likelihood that research planning would indeed identify the appropriate priority areas for high-impact research.

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