

Assessing the Benefits of ARS R&D within an Economic Framework
March 10-11, 2008
Workshop Report

Katherine Smith, ERS Administrator, opened the workshop by pointing out that public research should have value to the public, but that in most cases increasing the quality of research evaluation required increasing the resources available to conducting the evaluation. Following this, the objectives of the research project and of the workshop were reviewed.

Day 1, Session 1: Approaches to Research Evaluation

Keith Fuglie, ERS, Chair

Presenters: Rosalie Ruegg, TIA Consulting.
Evaluation Tools for Public R&D Investments
Barry Bozeman, University of Georgia.
The Social Implications of Public Science Policy: Public Value Mapping
George Norton, Virginia Tech.
An Overview of Economic Evaluation of Agricultural Research

Rosalie Ruegg opened the workshop by providing an extensive summary and characterization of evaluation tools for public R&D investments. Two major purposes of research evaluation are to guide program management and strategy, and to provide means for accountability. Multiple research evaluation methods exist to answer different stakeholder questions, to provide alternative perspectives, to provide multiple lines of evidence, and to meet both program management and accountability requirements. The presentation showed that to develop an evaluation strategy, it is important to focus the evaluation questions and select the appropriate tools by determining who needs to know what and when.

Barry Bozeman was scheduled to give the next presentation, but unfortunately was unable to attend because of illness. In his prepared presentation he argued that neo-classical economic models have difficulty with public goods, non-substitutable goods, and goods oriented to future generations. He proposed the concepts of “public values” and “public failure.” Public values are “fundamental secular values which provide the normative consensus about the rights and prerogatives to which citizens should be entitled and about the principles on which governments and policies should be based.” Public failure occurs when “*neither* the market *nor* the public sector provides goods and services required to achieve public values.”

George Norton summarized the two major approaches to economic evaluation of R&D, econometric and economic surplus analysis, as well as some of the important issues in economic evaluation: multiple research objectives, the fact that research investments are long term, the level of aggregation of the analysis, the necessity to isolate what would have happened without the research, and the question of retrospective vs. prospective economic evaluation. Norton concluded that aggregate economic impacts of agricultural research can help justify the overall budget; it is not feasible to quantify impacts of all projects, but it is useful to have examples of the benefits of specific projects; portfolio analysis should be kept simple because of the difficulty

in disaggregating benefits across projects; and economic principles can help guide portfolio selection even if impacts are not all quantified.

Day 1, Session 2: Inside and Outside Views of ARS Research

Keith Fuglie, ERS, Chair

Presenters: Caird Rexroad, ARS.
Overview of ARS, with Special Attention to National Program Assessment.
Rick Welsh, Clarkson University.
Choice of Research Priorities by Public and Private Sector Scientists and Research Administrators

Caird Rexroad, ARS Associate Administrator, outlined the five year cycle of program planning, program research, and program evaluation for National Programs within ARS. Input into ARS program planning and evaluation comes from the executive branch and other Federal agencies; customers, partners, and stakeholders; Congress; agency scientists and managers, and the scientific community. Dr. Rexroad said that economic impact assessment should be an integral part of program management, both *a priori* to aid resource allocation decisions and *ex post* as part of accountability.

Rick Welsh presented joint research with Leland Glenna (PSU) comparing survey results from a non-statistical sample of ARS research managers and scientists (based on the ARS case studies from the project) with a previous statistical sample of university scientists cooperating with industry scientists on agricultural biotechnology research. They found that ARS scientists are similar in many ways to university scientists, with both of these two groups tending to focus on contributions to scientific theory and on academic publishing. However, ARS scientists characterized their work as being somewhat more applied than did university scientists, and ARS scientists are closer to industry scientists in valuing marketability of a product.

Day 1, Session 3: Case studies of ARS Research

Dale Bucks, ARS, Chair

Presenters: John King, ERS.
ARS Research on Water Quality and Watersheds
Kelly Day Rubenstein, ERS.
The ARS Nutrient Data Laboratory Research
Paul Heisey, ERS.
ARS Research on Bovine Quantitative Genetics and Genomics

John King opened the session of three case studies by ERS economists on ARS research programs. ARS water research combines several elements important for economic analysis: the “market failure” paradigm, resulting from problems in water quantity markets and the fact that water quality is essentially a non-market good; and the “mission paradigm,” particularly in support of other USDA and Federal agencies that enhance the natural resource base and the

environment. ARS research on biophysical models of water quality provide counterfactual scenarios, an important basis for estimating economic effects. Evaluation of ARS research requires an understanding of environmental policy, but double-counting of benefits can plausibly result when multiple actors, including ARS researchers, make indispensable contributions towards an improvement in environmental quality. Narrow economic studies of specific regions or environmental benefits are feasible, but difficulty in obtaining reliable market information and the need for multi-disciplinary research makes these studies difficult to generalize and unlikely to account for all benefits of ARS research.

Kelly Day Rubenstein identified the National Nutrient Database for Standard Reference (SR) as the key output of the ARS Nutrient Data Laboratory. The SR is used in many areas: medical research; nutritional research; technological research, particularly concerning sampling and data quality; public policy formulation; support of regulatory requirements; nutrition-related education; food surveys; and secondary, often proprietary databases. The National Food and Nutrient Analysis Program (NFNAP) was developed to implement appropriate sampling strategies, define and direct analytical approaches, and evaluate the quality of data. From its inception, NFNAP has been guided by a rigorous peer review process. NFNAP has resulted in significant improvements and improved statistical power for the food composition data in the SR. However, most of the economic benefits from the NDL research are difficult to quantify because they are nonmarket and attribution is difficult. And other quantitative analyses to measure research benefits would also be difficult to apply.

Paul Heisey outlined “ARS Research on Bovine Quantitative Genetics and Genomics.” Many actors, both public and private, produce and use research in beef and dairy quantitative genetics and genomics. The public sector is a substantial investor in this research area, USDA has made important inputs into the genetic improvement of beef and dairy cattle, and ARS has taken a leadership role in the development of bovine genomics and transgenics. Many users of ARS technology in bovine quantitative genetics and genomics would find it difficult to obtain this technology from alternative sources. They cite the complexity and completeness of ARS data, ARS’ ability to apply systems approaches, ARS’ ability to integrate new research with older findings, the high quality of DNA data from ARS, and the availability of ARS data given intellectual property constraints on other sources. However this does not answer broader questions of whether ARS covers all areas where it might have a research advantage, or whether ARS does research in areas where other institutions might have an advantage. A number of different options for both retrospective and prospective economic evaluation are possible in this research area. They include:

- Retrospective studies of all beef or dairy genetic improvement research, regardless of provider;
- A prospective study of one application of bovine genomics based on the time and cost savings of sire evaluations using DNA data instead of conventional progeny tests;
- A prospective study of the relative economic weights to be given to reproductive/lifetime efficiency criteria relative to production trait criteria.

Day 1, Session 4: Panel on Economic Evaluation within the Context of Federal Research
Dale Bucks, ARS, Chair

Panelists: Gary Anderson, NIST
Rosalie Ruegg, TIA Consulting
Sharon Drumm, ARS

Gary Anderson noted that NIST develops standard reference materials for calibration and sponsors the development of research tools. Prospective, strategic planning studies often calculate the cost of not having critical infratechnologies; retrospective studies usually take the form of cost-benefit analysis. Because NIST examines technologies in a very broad range of industries, it uses prospective studies to identify the most beneficial areas to allocate resources. Rosalie Ruegg contended that including economic and social measures was important throughout the research cycle, for meeting both program management and accountability goals. She suggested economic analysis should be done only for programs with specific economic goals; evaluating nonmarket benefits can be difficult or controversial. Economic analysis should take into account additionality (with/without analysis); the distinction between social and private benefits; the different timing of costs and benefits; interdependence among projects; and risk and uncertainty. Sharon Drumm reviewed the ARS program planning cycle and the sources of input into planning and priority setting. She listed the different performance measures used by ARS in the context of specific management goals being addressed, noting that evaluation might have implications for assessing individual scientist performance and communication of ARS results to the public. She raised the key issue of institutionalizing economic analysis within this process, and indicated a need for integrated, multiple-use data and indicators.

Day 1 – Discussion

Workshop participants raised a number of issues in their responses to individual sessions, during the panel discussion, and during the general discussion at the end of the day. Some highlights centered on the following questions:

- How to start economic evaluation within a research organization
 - Who pays for the evaluation?
 - Need for scientists and economists to find a common language
 - Possibility of starting with prospective analyses to identify research gaps
 - Then moving to more retrospective studies, beginning with highly successful programs that would encourage participation in economic evaluation by research managers and scientists, despite the charge of “cherry-picking”
- Issues in the conduct of economic evaluation of research
 - Appropriate scale for the analysis
 - Potential use of retrospective, econometric studies to sort out contributions of different research performers
 - Limits of quantification
 - More fundamental research

- Importance of the political process, as well as economic criteria, in setting and evaluating the research agenda
- Danger of defining research goals in such a way that they structure research towards easily identifiable outcomes

Day 2, Session 1: Evaluation of Agricultural Research at the Sub-Sector Level in Australia

David Schimmelpfennig, ERS, Chair

Speaker: John Mullen, New South Wales (Australia) Department of Primary Industries

John Mullen leads a group of economists who conduct economic evaluation activities of research programs in the NSW DPI. His presentation reiterated two of the major reasons for performing economic evaluation—accountability and priority setting—and added a third, capacity building: developing scientists’ capacity to think more clearly about what can be achieved with a given budget, what drives adoption, what would happen both ‘with’ and ‘without’ the research, and who benefits from the research. Mullen gave examples of economic evaluations conducted by the Australian Council for International Agricultural Research (ACIAR) and by the NSW DPI. He presented an approach to *ex ante* Rapid Impact Appraisal (RIA), along with criteria to determine high and low priority projects using RIA. He outlined principles for the appropriate level of disaggregation in research evaluation. He also suggested that establishing an “evaluation culture” within a research organization is difficult, and presented some “do’s” and “don’ts” for creating such a culture; not as prescriptions, but as suggestions:

- “Do start by picking some winners.”
- “Perhaps start in areas where investment decisions are imminent.”
- “Do involve the scientists as co-authors.”
- “Do help scientists understand benefit-cost analysis and how economists view the role of government.”
- “Do set up opportunities for peer review of key assumptions.”
- “Don’t adopt a Big Brother approach.”
- “Don’t set up an evaluation unit.”

Day 2, Session 2: Panel on Evaluation of Public Sector Research—Can it Be Disaggregated?

David Schimmelpfennig, ERS, Chair

Panelists: George Norton , Virginia Tech
 Andy Toole, Rutgers University
 Keith Fuglie, ERS

This panel addressed the assessment issue of choice of scale: how demonstrable benefits might change when moving from an aggregate level towards a project level. George Norton considered whether an evaluation of individual projects within a program would be consistent with an evaluation of the entire program as a whole. He concluded disaggregation was possible for non-interrelated projects, but that groups of interrelated projects have meaningful interactions, such

as complementarity or cumulative improvement. Consideration of these relationships and their probabilities of success or failure adds significant complexity to evaluation. He also suggested that it was easier to disaggregate for retrospective than for prospective assessments. Andy Toole said the three big challenges for economic evaluation were the history and organization of public research agencies, the need for devoting time and money to evaluation, and the extreme heterogeneity of ARS research programs. Among other things, he proposed research mapping exercises to link project outputs into economically meaningful groupings. He suggested a focus on primary user groups, and gave his analysis of NIH extramural R&D as an example of how mapping was combined with retrospective economic analysis. Keith Fuglie presented the experience of the International Potato Center (CIP) with the economic evaluation of research. Initially, economic input into CIP's research planning was limited, and the Center did not face a strong budget constraint. As both factors changed, the center undertook both *ex ante* analyses of the research portfolio and *ex post* case studies of technologies actually being adopted. They found the aggregate impact from adopted technologies justified CIP's research investment, but it was 20 years after the founding of the center before benefits really took off. CIP also used re-evaluation of underperforming projects to make mid-course corrections, or in some cases devolution of these projects.

Day 2 – Discussion of Australian Case and Panel on Aggregation of Evaluation

The discussions following these two sessions (as opposed to the final discussion and reports by breakout groups, outlined below) raised a number of issues:

- Maintaining cooperation between scientists and economists if economic evaluations are less favorable
- Not only the dollar cost (some suggested spending 1-2% of the research budget on economic evaluation) but the time commitments necessary to do good quality evaluations, retrospective or prospective, and align the analysis with program planning cycles
- Complementarity of peer review and economic analysis
- The issue of attributing research outcomes to research performers or research funders was raised—could be either, as long as the analyst was clear about the questions asked

Day 2 – Breakout Groups

In the final workshop sessions, participants were divided into two breakout groups and asked to address the following three questions:

1. What are the opportunities for institutionalized evaluation and reporting of public agricultural research?
2. What are the best approaches for assessing the economic and social benefits of public agricultural research at the component or program level?
3. What are the comments and suggestions for completing this initial project?

Participants identified some of the issues that they felt were most important for implementation of evaluation at ARS. Their responses were reported back to the entire group and used to generate additional discussion and preliminary findings of the workshop.

Discussion about opportunities for economic evaluation of ARS research programs included the following comments:

- Evaluation should emphasize program management (choice of future research projects and allocation of resources) rather than assessment (performance of past projects). ARS has more latitude to select appropriate evaluation methods for management, and is more likely to gain cooperation and goodwill towards the effort from scientists and program leaders.
- Most participants agreed that evaluation initiatives should build on existing efforts rather than start from scratch. For instance, ARS participants felt that the 5-year program cycle took a lot of effort to create, and is working adequately in most respects. ARS conducts other activities that can be used to inform economic evaluation.
- Participants felt that one or more pilot projects would be the best way to begin, noting that subsequent evaluations might require very different analysis.
- It was hoped that the evaluation would feed up to a systems-level evaluation, but such an evaluation was beyond the current budget and goals for evaluation activities.
- Sharpening the questions that evaluation should answer is an important early step.

As the groups discussed best approaches for implementing evaluation at ARS, participants made the following comments:

- New evaluation activities could be incorporated into the five year planning cycle currently in use at ARS. Incorporating evaluation activities (possibly at the project level) into retrospective assessments was mentioned most often. However, this raised concerns about timing (whether adequate time elapses to properly assess benefits) and panel composition. Longer term retrospective assessments (10-15 years) might be more suitable.
- There is a need to identify who is going to perform this assessment. An in-house “champion” could lead the effort, but partner agencies and organizations might be required to assist or carry out analysis.
- Initial selections for pilot evaluation should have economic benefits that are relatively easy to identify, to gain experience with economic evaluation.
- Where programs have results that are hard to evaluate in economic terms, a promising approach is to describe qualitative benefits of research, then estimate physical effects of research, and only then attach an economic value to the physical effects. This has the advantages of beginning with ARS core competencies and improving the robustness of the evaluation,
- A diverse toolbox of analytical approaches may be necessary, so it might be helpful to choose programs that require a different set of evaluation tools.

Results and Findings

The workshop presented the research of a community of practitioners with experience in economic evaluation of research and development. The speakers drew on evaluation experience in U.S. agriculture, but also from a variety of other industries, institutional settings, and countries. Their presentations set out the most important issues and concepts in economic evaluation of R&D, highlighting a wide array of analytical approaches and tools necessary to address these different situations.

In the three case studies of ARS research program components, the team found that the ARS research in each component has public goods aspects. In each case study, the project team found that ARS provides research that would not be provided at all, or would be more incomplete or costlier, were stakeholders to attempt to acquire the research outputs from alternative suppliers. A major role played by ARS is in the gathering and analysis of data with broader geographical scope (very often national coverage) or longer temporal coverage than would be provided by other sources.

ARS National Program staff brought their own experiences in managing and assessing benefits of R&D to the workshop. They were able to interpret their experience in terms of the concepts described in this framework. The breakout discussions towards the end of the workshop had extensive participation, and showed integration of the concepts as participants used them to identify issues and next steps for economic evaluation of ARS research.

The workshop was successful in focusing the discussion and creating a common vocabulary and array of concepts. In addition, the dialog between ARS National Program leadership and economic evaluation practitioners introduced potential partners who may help carry out new evaluation initiatives.