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CHANGES IN THE NEED FOR RESEARCH AND EXTENSION EVALUATION INFORMATION

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There is little question that we are facing an increasing number of requests for more and more information on the payoff to public outlays for research. At every turn, there is another policy group, budget makers, symposium, or "futures" of world food study wanting more information on research and extension (R&E) cost-benefits or rates-of-return than we are presently capable of providing. This certainly indicates that something is happening in this environment in which R&E evaluation is carried out. We must assume that it is not simply idle curiosity that is causing this apparent awakening to something to which many have been devoting their attention for years.

It would seem useful to briefly consider the overall environment within which R&E evaluation is to be made and used. To do this, I would like to consider three topics: the trends and factors that are indicating a need for more and better R&E evaluation information, the roles and requirements of R&E evaluation information, and some thoughts on the challenge to those who will continue to develop R&E evaluation information.

An Assessment of the R&E Evaluation Environment

To meet these increasing requirements for R&E evaluation information, we need to spend some time in assessing what these information needs are, what it is in the R&E evaluation environment that is creating that need and, in fact, what the environment is. Else, we may continue to generate figures about payoff in greater and greater quantities and only assume that this is the information that those who want the information actually need. It is not just the quantity of R&E evaluation information but the particular nature and content that is important.

We have probably assumed the R&E evaluation environment to be a relatively homogeneous entity in which needs for R&E evaluation information are quite singular in characteristic. This may simply reflect our preoccupation to date with R&E evaluation methodology. Unfortunately, the R&E evaluation environment is a most complex array of interlocking factors which precludes such simplistic assumptions.

In general, the R&E evaluation environment is the composite agricultural and food industry, the policymaking and resource allocation bodies and processes, the totality of the public and private agricultural and food research enterprise, and the R&E evaluation community itself, including its performers, organizations, disciplines, models, methodology, data and more. This is an austere array of areas that should influence what we decide to do in R&E evaluation efforts and how we do it. It is my contention that it would benefit us to consider these areas of the environment for the more significant changes that are occurring in this complex environment and the effect these may have on what we should be giving primary attention to in the development of R&E evaluation information.

Three broad areas of change in our environment are having substantial influence on the need for and characteristics of R&E evaluation information. These are (1) trends in agricultural production and related areas, (2) fundamental changes in the socioeconomic environment, and (3) changes in the agricultural research community itself.

Trends in Agricultural Production

The concerns about trends in agricultural production are well known as are their conjectured impacts. I need not dwell on these. The general population suddenly became aware of a "limits-to-growth" possibility during the food crises of the early 1970s. However, even the less emotional of concerned individuals point to the drop in the rate of increase of agricultural production from 24% during the 1950s to 11% in the 1960s {1}, a decline which continued during the 1970s, as indicating some need for concern about the potential of agriculture to meet future food requirements.

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Certainly, many explanations are given for this decline. The source of the cause seems to lie largely outside of agriculture. Not the least of these are the changes in social goals which emphasize environmental quality and food safety and health factors, both of which impact negatively on the quantity of agricultural production. Another explanation involves changing patterns of resource quality, availability and cost--climate and weather patterns becoming less favorable, resources becoming more costly as supplies dwindle or as international political relationships change, and the continuing high rate of inflation. Other explanations point to a stabilized level of R&E funding that in real terms hasn't increased since the mid-1960s, the research that is done being more costly and the problems investigated being increasingly more complex. Yet, there is real and documented concern that agricultural production is indeed reaching the biological limits of existing knowledge in several areas and that substantial shifts in research emphasis are needed {2,3,4}.

There are obviously many questions to be answered in these trends related to the fundamental issues of "What is it feasible to do?" and "What is it relevant to do?" It is important to know what are the sources of the reduced rate of growth of agricultural production, which of these do we reflect in our goal structure, which in our "pricing" structure, which are indeed limitations to growth and, consequently, which can we do something about...and what?

Trends in Socioeconomic Factors

Two basic types of changes can be mentioned here--those in or impacting on key economic resources (natural resources, factor inputs, energy, climate and weather, inflation, etc.) and those representing changes in societal goals (environmental quality, nutrition and food safety, and many more). These are not independent influences but highly interlocking in how they affect agriculture and the channels through which the effect operates.

The array of economic related factors is substantial. In the area of natural resources, we are experiencing increasing competition from non-agricultural sources for land, and it is seldom over the poorer producing land. Increasingly, marginal or previously nonproductive land (desert) is being brought into production, and we are experiencing an increasing incidence of unstable soil conditions which affects geographical areas other than the source. Climate and weather conditions have moved into a period of extremes where drought, floods, heat, and cold are alternately experienced, whereas our high producing crop varieties were developed during an extended period of favorable conditions. Water availability and quality is increasingly becoming a more important factor in production decisions as water tables drop, requiring ever deeper wells and as saline problems become increasingly more widespread. Changes in energy sources and requirements are paramount considerations as oil prices quadrupled, changing patterns of energy use, requiring new ways of running our agricultural plant to get around deficiencies and high cost, patterning whole farming systems around this one resource, and finding ways to counteract devastation of lands from energy extraction activities (strip mining). Double-digit inflation followed by an expected sustained rate of at least 6-8% has continuing traumatic effects throughout domestic factor and international commodity markets. One could also discuss at some length the economic effects associated with changing size and scale of farm and marketing organizations and affiliated institutional structures.

The story is little different with respect to changing social goals and institutions. The changes that have occurred in the last decade represent an interesting period in our history. We have seen the impetus of social goals change basically from one concerned with "survival" to one concerned with "consumption." The historical concern with growth in GNP has been replaced with verbiage on "zero growth" and a preoccupation with "quality of life" and "equity." The effect of this has been felt in such areas as more stringent regulations on environmental quality, on food labeling and additives, and food safety. It is also reflected in pressures to preserve "proper" balances between personal income and food prices among others, and the impact of many technology changes in agriculture on rural families, farm-to-city migration, availability of opportunities, technologies, and markets for city-employed farmers and for marginal subsistence farm operators and a number of other similar goals.

The foregoing obviously presents a perplexing array of factors to be simultaneously considered by public policymakers and research administrators. They must contend with wholly different patterns of resource emphasis than the traditional ones. Many of these require substantial shifts in emphasis and consequently frequently run head on into established positions and interests. They face very hard questions like how much of the resources should go into production increasing research versus "defensive" types of research--a problem faced by public as well as private research organizations. Certainly the old resource allocation equations have many new variables in them.

Trends in Agricultural Research

The science system as a whole has been involved in a strange paradox in recent years. On the one hand, it has been the object of almost unrequited overconfidence in its capacity

to solve society's problems while on the other hand there has been an overwhelming distrust of its products and to some extent even its motives. One can note the impact of this in several trends in the agricultural research system. A second interesting occurrence specific to agriculture has been the large number of studies of the agricultural research community--15 major studies and conferences at last count {5,6}. Yet another major one is now underway in the Congressional Office of Technology Assessment. This is surely indicative that something out of the ordinary is happening to which we should be responsive in our R&E evaluation efforts.

With respect to the research activity itself, we note that research is increasingly conducted within a "systems" context that is multidisciplinary and multivalued, such as research on crop growth models or pest management systems. There has been a gradual shift away from basic research to applied research to provide faster payoffs. Agricultural research is becoming involved in new areas of research or increasing efforts in areas previously underemphasized by traditional research organizations. These include energy as a separate area of inquiry, new food sources and production methods, human nutrition, economic uses of plant and animal (and human) waste, information as a substitute for depleting capital availability and others.

The organization of agriculture is also undergoing some significant changes. There has been a sudden opening up of what the Mayers referred to as "the island empire" {7} through an increasing emphasis on the roles and responsibility of private sector research as well as greater emphasis on extramural research in federal research programs and on various grants programs. There has been almost a dogged insistence on programmatic-oriented devices that assure a coordinated strategy among all participants in the research process. Congress and the executive have become more involved in determining what research is and is not to be done, aided in no little measure by advisory bodies relatively new to the area of agriculture. Other significant changes in research organizations include the separating out of functional areas like nutrition, energy, and pollution as separate research entities, increases in scale of facilities to support high cost research equipment, and a tendency to specialization of research areas of inquiry reflected in the establishment of centers. Certainly, the rapid growth and capabilities of the international research centers and their capabilities should not be omitted for their impact on R&E evaluation endeavors.

In considering changes in funding of agricultural research, it is the lack of change that is the most disturbing. Through glut or shortage, the USDA's research budget has remained at about 2% of the federal total R&D outlays since the early 1950s. In real terms, it is at the same level as in 1964. In any measure, it has trailed by a wide margin increases in research funding for HHS, NSF, EPA, and NSF, our major competitors. Significantly, funding for "biological" research has declined in the USDA since 1970 while increasing markedly for HHS and somewhat for both NSF and EPA {8}. Further, while the Food and Agricultural Act of 1977 designated substantial new charges to the agricultural R&E community, it provided no additional funding to carry them out.

A most significant trend from the standpoint of evaluation efforts is a widespread pressure throughout the federal and even many state bureaucracies for more accountability in our resource allocation processes. Unfortunately, the trend isn't policy oriented; it is management oriented. Under this influence, great importance is placed on coordination and control mechanisms and documented evidence of past successes are not quite as important as visible indications that we have been "neat" in our research management processes. Certainly, the federal-state-private system fails according to this criterion. The emphasis is not so much on providing cost-benefit figures for research as it is to have well-organized management structures and planning processes to develop the cost-benefit measures.

Finally, there has been a pervasive change in attitudes regarding the appropriateness of funding methods. Historically, we have lived with formula or institutional funding for both state and federal research organizations. Almost overnight, widespread pressures have surfaced to move away from institutional or formula funding to grant , contract, and privately financed research. In part, this reflects the growing uncertainty about the "island empire's" ability to respond fully to national needs; in part, it reflects the interest of non-traditional agricultural research organizations to share in the formula funding "pot." Irregardless, the change in attitude indicates a growing pressure that is shifting research organization, planning, and funding away from a resource orientation more toward a program orientation.

Again, the kinds of trends observed here present a difficult set of variables for policymakers, research planners, and resource allocators in agriculture to cope with. Significantly, the kinds of decisions faced require more information than simply rates-of-return to research for a commodity area. There is a broader array of questions including who performs the research, when, where, and how to fit the pieces into a single research strategy. These are not simple, singular issues to handle.

Trends in the R&E Evaluation Environment

As a first step in making sense out of the foregoing, it may be noted that there is a rational trend to what is happening at the present time. There is a structure of change that reflects where we are in the evolution of planning and decision philosophies in agriculture. That is, if one looks back in a very general way at the context within which allocation decisions have been viewed, formulated, and analyzed, there seems to emerge several general stages of development. Up to the 1920s and 1930s research and research organization and planning seemed to be largely concerned with "discovery," trying to unravel the basic mysteries of nature. Somewhere around the 1920s we began placing more emphasis on the "control" of nature in terms of production knowhow, improved management of our environment, and more effective flow or distribution of products and commodities. Somewhere up to the end of the decade of the 1950s or early 1960s, the emphasis in selecting research was on "efficiency"--how to get more for less. This period tended to encourage relatively specific research topics locked into a single field or discipline. In the early part of the 1960s, there was a shift in attitude associated with environmental and equity concerns and later associated with the youth revolution that seemed to question the "relevance" of the research being done. Fields of research that were new to agriculture emerged. Later in the decade and extending on into the 1970s we entered the age of "systems" in which it was recognized that "problems" could not be studied independently but that sometimes very complicated interrelationships had to be reflected in our problem definition and analysis. However, research was still largely carried out within the context of traditional areas of investigation. In the latter part of the decade we have almost been propelled into a fourth planning philosophy, that is referred to as the "holistic" perspective, or the age of "comprehensive analysis" as one calls it. This age is characterized by the totality of interrelationships and, equally significant, the tenuousness of solutions. We now concentrate on developing continuing processes for change rather than seeking discrete answers or one-time solutions. I emphasize the fact that at no time have we relinquished any previous stage completely, but rather adopted yet a new one on top of the old.

There are several significant features of this evolution that are relevant to R&E evaluation considerations. First, in the earlier stages, research was predominantly centered about separate, individual investigations and discoveries relating to single disciplines and characterized by the Heidelberg and Vienna schools of philosophy. In later stages, group, team, multidiscipline organizations and approaches to research have become increasingly more important and commonplace. However, in all stages and at all times it has been the nature of the information demanded that was the determining factor in research organization and planning.

A second major factor is that when research organizations and institutions get out of phase with the prevailing stage of research information philosophy, things happen. Usually, there is reorganization of some sort which is nearly always induced from outside the existing organization. What is happening now in the federal-state system is no different than has happened before. What is different is that changes have been coming faster and faster, one heaped on top of another. This does not provide much chance for one to adjust perspectives to a new situation and develop workable relationships with the new situation before another is begun.

The third factor is that the social sector and the science community are beginning to converge with respect to policy and planning structures, information development processes, and, most importantly, in basic "relevance" and "appropriateness" philosophies. Evidence of this has shown up in several areas of our society. However, this does not mean they will or can completely converge. The pluralism/elitism paradox that we face in our increasingly more complex social and technical environment will assure that we continue to ebb and flow between what it is feasible to do and what it is relevant to do. Conflict between the two will continue because we cannot have consensus of goals nor perfect information.

Information relative to research becomes a key issue in all this. The goals of our pluralistic society and the technology of our elitist science community are no longer as independent as they once were. Increasingly, policy and resource allocation decisions are being made within "frameworks" that implicitly relate means to ends, that indicate negative by-products, that reflect strategies for most effectively achieving ends over time and by the appropriate performers. The primary implication to us is the need for a perspective attuned to these conceptual frameworks and the development of information determined by and aimed at the needs of these conceptual frameworks.

The Roles and Characteristics of R&E Evaluation Information

As a general rule, we do tend to view R&E evaluation figures as somewhat homogeneous entities, although variable in quality, which are equally applicable to almost any decision situation. It is true that any rate-of-return or benefit-cost ratio can be an input into almost any decisionmaking situation, but it is not true that they are uniformly applicable. Decision situations are simply too heterogeneous in their

information needs. The data in some cases are actually more than is required, while in other cases they are inadequate.

R&E evaluation information used in decision situations varies in several respects, one being the purpose for which it is intended. However, there are several important dimensions to information. I would describe the quality of information as consisting of the dimensions of "identification" (whether or not all relevant factors have been included), "precision" (whether or not the data sources and analytical methods adequately measure the influence of these factors), and "reliability" (whether or not the user of the information generated has confidence in it). These dimensions do vary in relative importance among decision situations. There are other significant dimensions. Two of these, "timeliness" and "cost," relate directly to the three basic dimensions. In most decison situations with which I am acquainted, one or the other or both of the latter become the primary limiting dimension with identification and precision carried to a level consistent with these limitations. R&E evaluation information that is very precise but takes too much time to develop is less useful than timely information that is not very precise at all.

Roles, Characteristics, and Use

With this as a base of discussion, I would like to concentrate on three broad roles of R&E evaluation information--education, policymaking, and resource allocation--and the characteristics or dimensions associated with each.

"Education" may not be the most appropriate term for the first role considered but it does best describe what I consider to be the most relevant function in this role. R&E evaluation information applicable to this role has the primary function of making us more knowledgeable about the R&E environment. It is, in effect, foundation or base knowledge. The information is applicable to everyone who makes policy or allocates resources or studies these areas. The principal sources of this R&E information have been the ex post analyses which measure the tracks previous research have left on our economy.

The "policymaking" role for R&E evaluation information is the most difficult one to describe. This may be why we have relied so heavily in the past on information in the education role to satisfy the information needs in this area. First of all, the situation relating to policymaking is inherently conflict oriented; if conflict is not present then one probably isn't dealing with the making of policy. This implies the comparison of people's basic values as well as of facts. Second, R&E evaluation data is never the full range of information involved, societal values and various types of impacts being of relatively equal or greater importance. In fact, the interchange between values and impacts are usually the information areas of primary interest. Hence, the whole process, while logical, is not rational in the context of expert analysis being rational. Other key requirements are that R&E evaluation information must relate to or be imbedded in a specific decisionmaking framework and that it enunciate alternatives, the latter point being inherent in any conflict situation.

There are two key features of information in the role of "resource allocation," timeliness and specificity of information needs. Most allocation decisions are made on relatively short time lines, some on none at all. Once again, education information is particularly important to provide a foundation for timely decisions. However, nearly all allocation decisions require relatively specific information about alternatives; aggregate measures of R&E evaluation are only useful in very general terms and are never completely adequate. Other needs for R&E evaluation information include alternative strategies for getting research done, including program areas, public-private participation and alternative approaches.

How effective has R&E evaluation information been in each of these decision roles? Without some "real time" observations and recording of information use or even an explicit study of use, response to this question must be based on impressions. These are my impressions.

In the role of educating users of R&E evaluation information, we have probably achieved our singular success. The studies to date and the resulting information have been good and they have been useful. However, most recent success has been more applicable to the international research environment, where much of the study has been conducted, than to the domestic. The international environment is certainly easier to study than the domestic. It is at a less developed state than that in the United States and, consequently, is less fraught with significant complexities. How transferable the knowledge we learn from the international studies is to the domestic situation is conjectural. Insofar as I know, no study of this issue has been conducted.

In the role of policymaking, I would submit that R&E evaluation information has had little direct effect. As background or foundation information as in the context above, R&E evaluation information has provided at least a base for consideration of policy, in the sense that it prevents the filtering out of certain alternatives that "experts" might consider to be, rationally, the better options. However, in most of the policymaking situations I have

observed, information of a type other than rates-of-return or benefit-cost ratios has been relied on. For whatever reasons, economic returns information is not considered useful or adequate relative to other information.

Much the same is true for resource allocation decisions. R&E evaluation information has not entered directly in the consideration of program or budget development decisions with which I have been associated at the federal or state levels. With the advent of Zero-Based Budgeting, attention has been given to the development of R&E evaluation information...but after the allocation decisions have already been made. The decisions made by OMB relative to the department's budget submission does not appear to reflect the extensive rates-of-return information developed for them under the auspices of ESCOP. Neither did those of the House Agricultural Committee.

R&E Evaluation Information Requirements

As the characteristics of the roles for R&E evaluation information vary, so also do the requirements for their development. For the educational role we obviously need more of the same studies that have been produced since the mid 1960s, as long as new information is being produced. Herein lies the challenge. The same type of study approaches that were used to analyze the United States system, once the major methods were applied, were generally transferred to application in the international environment. Further significant gains in knowledge about the United States research environment have been relatively limited. New methodology, variables, or data are going to have to be forthcoming to provide the continuing gains in understanding of this complex R&E environment. We do need some innovative efforts.

Requirements for the policymaking role are more substantial. To make my point here, I refer to a framework enunciated by Wright {9} in discussing the informational structure of policymaking. He points out that there are three components to policymaking, namely (1) the policymaking decision itself, (2) "intermediate" knowledge, and (3) the contribution of expert knowledge. The main point is that experts make contributions to policymaking activities that are meaningful within their conceptualization of the policymaking situation. In most cases, this usually consists of a partial analysis of the total decision situation. Someone else must then further analyze the contributions of experts, by means of a more complete analytical framework, to produce what Wright calls intermediate knowledge. It is on the basis of this intermediate knowledge and not that of the experts directly that policymakers base their decisions. If R&E evaluation experts want to or expect to have impact on policies, then their analysis needs to reflect the characteristics of this intermediate knowledge framework more effectively, even if only a partial analysis is intended. Else, two things are apt to happen--the "translation" or interpretation of our expert knowledge is made by someone who is less competent to make such an interpretation, or the information is simply considered interesting, possibly impressive, but not all that relevant.

The needs for R&E evaluation information in the resource allocation role have even more specific needs for detail. Again, the principal features of this role are that it is almost a unique selection among alternatives, in a relatively short timeframe, and probably never to be repeated again in exactly the same form. Hence, the role requires an information orientation, not an analytical one, as the primary driving force for identifying relevant variables, selecting appropriate analytical methodology, acceptance of data quality, etc. That is, one must start with the decision and work backwards. Traditionally, this perspective has required someone other than the discipline oriented expert. A second requirement is that the whole effort be future oriented, how ever much the analysis is based on past studies and data. The R&E evaluation effort is not inherently to predict but to help anticipate based on the best information available. Finally, the R&E evaluation information effort must be scaled to time and cost requirements that are appropriate to the decision being made; identification, precision, and factors that would contribute to statistical reliability are nearly residual attributes to these primary concerns.

"Delivery System" Requirements

An important area of consideration related to R&E evaluation information is the nature of the existing "delivery systems," that is, the linkages between the R&E evaluation information suppliers and those who need the information. The adequacy of this linkage is particularly important since it determines how well requirements in information characteristics are communicated from users to suppliers.

One must conclude that these linkages are not currently entirely adequate to provide effective communication from users to suppliers about the specific nature of information needed, from suppliers to users about what information is available, what it means and what it implies, or to provide an adequate environment within which potential users of R&E evaluation information can become more knowledgeable and more adept in its use.

Linkages for educational purposes may be considered generally adequate with one exception.

There are no organizational structures or mechanisms for helping decisionmakers to interpret the information provided and to "educate" them in its use and relevance as we educate our students in the use of economic principles and data. This may be the most significant fault of all. We inform but we do not change their decisionmaking behavior.

Beyond this, both for policy and resource allocation use, linkages between suppliers and users of R&E evaluation information are nonexistent, loose, or at best, ad hoc. Part of this stems from the fact that policy issues are not generally raised by policymakers but gradually evolve in public rhetoric and become manifest in studies designed and conducted by organizational units disassociated with the policymakers as such. There are exceptions to this but they are relatively few. The important point is that during design phases, there are few established linkages between performers and policymakers to obtain interactions from intended users with respect to users' interests in the specific content of the policy being studied, specification of issues, or the appropriate composition of "shadow prices."

Within the Department of Agriculture and the state agricultural experiment stations, with which I am most familiar, linkages generally are no more than a charge to a study group to go out and do a study without actual involvement at any subsequent point on the part of the policymakers. Most policy-oriented R&E evaluation studies are conceived and conducted within the ESCS or departments of agricultural economics. Much the same is true in the executive, where OMB and now OSTP are delegated to conduct special policy studies. The OSTP probably comes the closest to providing performer-policymaker linkages mainly through the composition of the study groups. One can see a glimmer of hope in the organization of SEA in which an Evaluation and Impact Analysis Staff works closely with administration of that organization. This coupled with the national and regional planning and priority setting groups dictated by Title XIV provides the basic mechanism for this linkage of which I am concerned. The closer the IR-6 Research Committee can associate itself with these planning groups in an operational sense, the more effective this linkage will work. We certainly can hope.

Some Thoughts On the Future of Research Evaluation

The foregoing only touches on the range of factors that shape the policy and resource allocation decisions that are being made today and which indicate the type of R&E evaluation information that is needed. But, there is a challenge to us in the foregoing. In our R&E evaluation efforts, we do tend to think of agricultural and related research as a relatively homogeneous activity that turns out its products (new knowledge) in an environment that is, if not sterile of complicating factors, certainly "least squares." Yet, we expect our products to be used in a decidedly untidy environment. We surely are at a sufficiently advanced stage in the growth and development of our R&E evaluation methods that we can take time to rethink our posture about this R&E evaluation environment, to consider what it needs, how what we have already done fits into these needs, and how we can assign the task among ourselves according to abilities to best get the job done. It will take some hard soul searching for some of us, including a reassessment of our primary motivations and the appropriateness of our reward system in our discipline and professional circles and a real assessment of the impact of the rational structure of our economic theories on what we do and how we do it.

The informational environment associated with research administration and policymaking is getting increasingly more complex. The science we deal with is more sophisticated now than in the past, meaning that the margins we can work with have increasingly less room to tolerate error and wrong decisions are more costly. There are more factors to be considered in making our judgments about the right thing to do, and these decisions are more interlocking. Further, there is almost negligible time between such decisions and the first felt impacts of those decisions. Decisions must be made more quickly, more precisely, and be more reliable--reliable in the sense that what results from that decision most often corresponds with our expectations about that result.

This has two important implications to advisors of these policy and resource allocation decision processes. First, greater emphasis must be placed on the analytical frameworks in which measures of research impact are used to produce the intermediate knowledge to which Wright refers. Data generation and analysis schemes must be tied closely to these frameworks to permit better identification and specification of variables and an improved feedback to experts about the relevance of what they are providing. Second, experts will need to focus even more than in the past on educating policy and decisionmakers, not about methodologies and appropriateness of data provided, but about the significance of factors and relationships those data reveal. Unfortunately, substantial decisions will still tend to be made on the spur of the moment. The most appropriate information at those moments is not tables and graphs but that knowledge tucked in the back of a policy or decisionmaker's mind.

One of the most encouraging signs to me is that the bureaucracy is beginning to build into the research performing organizations themselves the function of handling research evaluation information. The principal benefits come in being able to tie various decentralized and highly disjointed efforts together to provide the intermediate knowledge linkage previously described. Whether this is occurring because administrators and policymakers are becoming more sophisticated in their decision processes or are acting more out of desperation to the complexity of information requirements described above is not really important. With the right people in the staff groups and on the various planning committees, the job will get done.

At the same time, I would offer a precaution. The close association with scientists that I have experienced over the past few years has given me a changed perspective of the research administration process. It has resulted in an awareness of the fact that we do need to be "opportunistic." We do not dare to overload the research system with so much information on measures of research benefits and costs, especially in light of the increasing management orientation that prevails, that we stifle opportunism as a working philosophy. Science always has been and will always be a highly creative process. Breakthroughs that can cause discontinuities in our measures of gain in productivity cannot be anticipated or indexed. The purpose of our exercises must be attuned to the role of helping to anticipate the future and the options open to resource allocators. It is not the drafting of rigid blueprints. Our methods and techniques and our expectations regarding their use as reflected in how we present the results of our analysis must be designed to this end.

With respect to methodology of measuring research benefits, the ex post analysis school and the ex ante analysis school have generally been going their own ways, often with some rancor between them. In the future, it will not be a question of the one or the other; the results of both types of analysis are and will continue to be needed. The one can provide the basic understanding of research and technology processes as well as base line estimates of gains. The other can provide forward looking estimates of gain in the context of highly judgmental circumstances and at considerably less aggregated levels. Also, as statistical estimation is being improved by the hybridization of Fisherian statistics and Baysian statistics, so also will resource allocation and policymaking information be improved by the hybridization of ex post and ex ante analysis methodologies.

Finally, I believe there is an ultimate challenge which the community of researchers who conduct R&E evaluation studies must face. It would be very easy to continue doing essentially the same sorts of studies, based on the same sorts of approaches and methodologies as we have in the past, using the current groundswell of concern to support these efforts, yet largely disregarding the relative degree of relevance of these efforts to actual information needs. The challenge is to step back and critically evaluate what is being done, to question whether past approaches are as relevant as they once were (a hypothesis not a conclusion), to consider that we might even need to change our whole approach to measuring the product of research. Do we only keep pecking away at interesting, possibly important, issues related to our understanding of the research and technology adoption processes, or do we also commit ourselves to helping anticipate as best we can the future of research-related challenges and then try to guide the system in what we anticipate to be the most effective direction? I don't believe both of these approaches can be accommodated as a single goal. Certainly, the one is much more comfortable, but the second is more useful and productive in the long run.

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