

**Evaluating public and private seed industries:
Technical constraints, practical considerations, and institutional realities**

by

Michael Morris, R.P. Singh, and Suresh Pal*

December 15, 1994

Prepared for the workshop on "Integration of research evaluation efforts of ICRISAT with national agricultural research services (NARSs) and other international agricultural research centers (IARCs)," Hyderabad, India, December 14-16, 1994.

* Michael Morris is with the Economics Program, International Maize and Wheat Improvement Center (CIMMYT), Bangkok; R.P. Singh and Suresh Pal are with the Division of Agricultural Economics, Indian Agricultural Research Institute (IARI), New Delhi. The views expressed in this paper are those of the authors and do not represent official policy of CIMMYT or IARI.

1. Introduction

Since 1992, researchers from the IARI Division of Agricultural Economics and from the CIMMYT Economics Program have been engaged in a collaborative study of the Indian maize seed industry.¹ Using the IARI-CIMMYT study as a point of departure, this paper discusses technical constraints, practical considerations, and institutional realities which can influence research evaluation and impact assessment efforts. In short, it is a paper about the challenges involved in doing a particular type of research, not a paper designed to lay out a conceptual framework or to present empirical results. Our thesis is that although research evaluation and impacts assessment studies can generate useful information, researchers charged with carrying out such studies face a number of obstacles which can limit the scope of inquiry, complicate data collection activities, and potentially jeopardize their professional relationships.

2. Background of the study

The maize sector in India has undergone dramatic changes in recent years. One of the most significant developments has been the rapid growth of the private seed industry. Private seed companies have sprung up in many important maize-producing states and today offer farmers a wide range of materials, not only proprietary hybrids developed by their own breeding programs, but also improved open-pollinated varieties (OPVs) and hybrids originally developed by the public sector. Private companies have captured a significant share of the national market for maize seed, and all signs point to continuing expansion of this market share in the future.

The rise of the private seed industry has important implications for the state and university breeding programs charged with developing improved germplasm, as well as for the government and parastatal seed corporations responsible for delivering this improved germplasm to farmers in the form of seed. Formerly, leaders of these public-sector institutions could plan research and development activities secure in the knowledge that they enjoyed a virtual monopoly over the development and dissemination of improved maize germplasm. This facilitated the implementation of policies designed to meet the needs of a wide range of potential end users and made it possible to strike a balance between efficiency goals best achieved by serving the needs of commercial maize growers and equity goals best achieved by addressing the needs of small-scale, semi-subsistence farmers. Now, however, the rise of the private seed industry has changed matters. Motivated by the quest for profits, private companies are aggressively targeting potentially lucrative commercial markets in important maize-growing states, such as Andhra Pradesh, Bihar, Karnataka, and Maharashtra; at the same time, they are largely ignoring marginal areas of low commercial potential. Their presence has muddied the

¹ Throughout this paper, the term *seed industry* is used in a broad sense to include research, seed production, and seed marketing activities.

waters and complicated the challenge facing research administrators and government policy makers.

The emergence of a powerful private seed industry has forced leaders of the Indian national maize program to review their strategy and tactics.² Despite an outstanding record of achievement by public-sector breeders, there is some danger that increasing competition between public breeding programs and private seed companies will lead to a wasteful duplication of effort. Research policy makers therefore need better to understand the relative strengths and weaknesses of the public and private seed industries in order to ensure that future technology development efforts carried out in the public sector complement those carried out in the private sector, rather than compete.

The growing strength of the private maize seed industry also has implications for international research efforts. In India as elsewhere, CIMMYT until recently provided support mainly to public institutions, a strategy which made sense as long as private companies were not very active in developing technologies suitable for the poor farmers that are a priority for CIMMYT. However, in recent years private companies have demonstrated considerable success in promoting hybrids, not only among the large-scale commercial growers who have been their traditional customers, but increasingly among small-scale semi-subsistence farmers who are beginning to adopt hybrids for the first time. The success of the private seed companies has raised the question whether CIMMYT should pursue closer links with the private sector, since strengthening public breeding programs and strengthening private seed companies represent alternative ways of achieving the ultimate goal of delivering superior germplasm to small-scale producers. In the interest of maximizing the use of its own germplasm, CIMMYT thus needs better to understand the performance of the public and private seed industries.

3. Research design considerations

During the initial planning stages of the study, we identified several different research objectives. In reviewing the conceptual tools available to examine these objectives, in listing the types of data required to carry out the analysis, and in considering the nature of the expected results, it became clear that our efforts to evaluate the performance of the public and private maize seed industries would be influenced by three factors:

- (a) *technical constraints* limiting the number of conceptual tools available to identify and measure research inputs and outputs;
- (b) *practical considerations* affecting the feasibility of collecting the required data; and
- (c) *institutional realities* surrounding the political sensitivity of the expected results.

² The national maize research program includes 27 separate programs located throughout India. Their activities are coordinated by the Directorate of Maize Research, IARI, whose offices are in New Delhi.

(a) Technical constraints

In order to evaluate the performance of the public and private maize seed industries, we knew we would have to identify, measure, and assign economic values to research inputs and outputs. Conceptually speaking, the inputs side posed relatively few problems: maize research involves scientists, research facilities, and materials, all of which can be identified, measured, and costed out (at least in theory). The outputs side was more problematic, however. Some more tangible products of research were fairly easy to identify and measure (e.g. improved OPVs and hybrids), but others were not (e.g., recommendations for improved crop management practices, policy information). This problem is hardly peculiar to India. Few efforts have been made to evaluate research programs whose main output is information (e.g., crop management research, social science research); most published studies involving commodity research have focused on breeding.

In the absence of a widely-accepted conceptual framework for identifying, measuring, and valuing the more intangible products of commodity research, we decided to focus on breeding activities. However, restricting the focus in this way did not completely solve our problem. Although the products of maize breeding research (improved OPVs and hybrids) are fairly easy to identify when they are initially released, they can be extremely difficult to track after they reach the field level. Since maize is an open-pollinating crop, individual plants frequently cross with other plants in the same field or even in nearby fields. Over time, a single stand planted with genetically pure seed can end up including a wide range of materials related to varying degrees to the original source material. The genetic composition of subsequent generations becomes increasingly diverse, until at some point the plants no longer resemble the original source materials and cannot be considered improved. For purposes of impacts assessment, a clear-cut criterion is needed to distinguish between improved and unimproved materials. Unfortunately, no such criterion exists, because even genetically “pure” materials contain some degree of contamination (even grains from the same ear can differ in their genetic composition). In order to measure research impacts, it is therefore necessary to resort to arbitrary criteria. For example, in our study the area planted to improved materials has been defined to include the area planted to hybrids using seed purchased in the same year, as well as the area planted to improved OPVs using seed purchased within the previous three years.

b) Practical considerations

One important objective of our study was to develop a database on public and private investment in maize research. Conceptually, this seemed like a fairly straightforward objective requiring the collection of information on numbers of maize researchers working in the public and private sectors, researchers' salaries and support costs, costs of establishing and maintaining research facilities, etc. Unfortunately, much of this information proved very difficult to come by. Salaries of individual researchers are considered confidential, and we were often made to feel uncomfortable when we asked about them directly. Levels of public-sector investment in research are rarely monitored

closely, and research managers frequently were unwilling to undertake the exhaustive review of their books necessary to generate detailed, disaggregated accounts. Levels of private sector investment in research evidently were known with greater accuracy, but seed company representatives were rarely willing to provide us with this information.

Another important objective of our study was to assemble information on the impacts of maize breeding research. This required estimation of two key parameters: the area planted to improved OPVs and hybrids, and the yield gains attributable to the use of improved materials. Once again, while the two parameters seemed conceptually straightforward, collecting the data presented enormous practical difficulties. Because of their importance in this and other studies of interest to the participants in this workshop, it seems worthwhile to discuss these two parameters in some detail.

Probably the single largest problem confounding the evaluation of maize breeding research is the lack of consistent and reliable estimates of the area planted to improved OPVs and hybrids. For purposes of generating official statistics, the area planted to improved materials is usually estimated based on reports submitted by local agricultural officials, sometimes cross-checked against reported seed sales (which presumes some knowledge about average seeding rates and seed replacement rates). However, these approaches are not always accurate, because local agricultural officials rarely carry out regular, systematic surveys, and because data on seed sales are frequently unreliable. Another approach (used by CIMMYT in its global maize impacts study) is to request that knowledgeable maize scientists “guesstimate” the area planted to improved materials -- the assumption being that maize scientists are more likely than anyone else to have an accurate idea of what is going on in farmers’ fields. Unfortunately, when such “guesstimates” have been cross-checked with actual seed sales data, often they have been found to be high. Thus there is a need for regular and consistent reporting of the areas planted to specific OPVs and hybrids. Periodic farm level surveys provide intermittent snapshot views from which varietal diffusion patterns can sometimes be interpolated, but periodic surveys are not sufficient. Accurate data on varietal diffusion patterns can best come from regular monitoring of seed sales data, verified using information obtained from annual surveys carried out in important production zones. Information on the area planted to improved materials is particularly difficult to obtain in the case of OPVs, since farmers typically plant seed of OPVs for a number of years before replacing seed stocks with fresh purchases of commercial seed. In addition to producing seed for their own use, farmers who plant improved OPVs may also provide seed to their neighbors, leading to additional changes in the area planted to improved materials which are not easily tracked via seed sales data. The fact that OPVs gradually become contaminated through outcrossing with other varieties only compounds the problem of devising accurate area estimates, since what farmers identify as a specific improved OPV may include a range of materials related to varying degrees to the same original improved source material.

The second key parameter which is extremely difficult to estimate in practice is the yield advantage offered by improved OPVs and hybrids over materials currently being grown by farmers. Although maize breeders routinely conduct varietal trials to determine yield

differences between improved materials and local checks, results from conventional varietal evaluation trials usually cannot be used to calculate research benefits because they do not reflect farmers' management practices. Conducted under tightly controlled experimental conditions which typically involve recommended management practices and levels of inputs, conventional varietal evaluation trials almost invariably overstate the *absolute* yield advantage conferred by improved materials when they are grown using the less-than-optimal levels of management typically provided by farmers. Although the *relative* yield advantage achieved in conventional varietal evaluation trials may provide a more reasonable approximation of the yield gains likely to be achieved in farmers' fields, even the assumption of the same relative increase in yield may not hold when the crop is subject to extreme moisture and/or temperature stress. Thus, if the yield advantage of improved materials is to be estimated realistically, breeders will have to be much more systematic about including farmer managed on-farm trials in the evaluation process.

c) Institutional realities

In addition to being shaped by technical constraints and practical considerations, the objectives of the study were influenced by another factor -- the knowledge that our efforts to evaluate seed industry performance could potentially jeopardize our professional relationships with other researchers and with colleagues working for private seed companies. This point warrants further elaboration, because it highlights how research evaluation and impact assessment work differs from other types of research normally carried out by social scientists working in NARSs and IARCs.

Like most research evaluation studies, ours was originally conceived as one whose results could benefit a number of interest groups. Potential beneficiaries were highlighted in project documentation:

- The Indian national maize program was expected to benefit from having the level of public investment in maize research documented and the products of public maize breeding programs clearly identified. This information would help research administrators identify areas of greatest potential payoff and rationalize maize breeding activities, contributing to improved performance in the future.
- CIMMYT was expected to benefit from having the use of its germplasm in public and private OPVs and hybrids clearly identified. This information would help research administrators to identify areas of likely future impact, which in turn would allow breeding strategies to be fine-tuned.
- Private seed companies were expected to benefit from an improved understanding of the organization and performance of the maize seed industry. Also, private seed companies were expected to benefit to the extent that the results of the study enabled public breeding programs to increase the flow of useful breeding materials.

- Maize growers were expected to benefit to the extent that the performance of the overall seed industry improved.

While it is true that these interest groups all stood potentially to benefit from the results of the study, less frequently mentioned was the fact that they also stood to lose should the study's findings have proved unfavorable:

- The Indian national maize program might be negatively affected if the study were to conclude that current levels of investment in maize research simply are not justified relative to the amount of economic benefits generated.
- CIMMYT might be negatively affected if the study were to conclude that CIMMYT germplasm is little used by public and private breeding programs in India.
- Private maize seed companies might feel threatened by the results of the study for at least three reasons. First, companies which rely heavily on public materials might not want this information made public, since it would be difficult to sell their hybrids as "original" proprietary hybrids justifying higher prices. Second, companies which use materials poached from competitors would hardly want this information publicized, since this might elicit demands for compensation. Third, many private companies might not want their sales volumes to be publicized, since this information could attract the attention of government tax collectors.
- Maize growers might be adversely affected if the study were to conclude that there has been significant over-investment in maize research, leading to cutbacks in research investment and a decreased flow of improved germplasm.

As the two lists make clear, research evaluation and impacts assessment studies are a double-edged sword. On the one hand, they offer the possibility of confirming that investments in research have had positive impacts and have generated attractive returns -- results which can be cited by leaders of public research programs in seeking additional funding, and/or by seed company representatives in lobbying for more favorable government policies. On the other hand, at the same time such studies risk exposing the fact that breeding programs may not have had significant impacts and may not have generated attractive returns, or the fact that private companies are generating excessive profits or are otherwise behaving in socially undesirable ways -- results which could lead to reductions in research funding and/or the introduction of stricter regulatory policies.

Because the results of research evaluation studies are potentially threatening to certain interest groups, those who undertake such studies often find themselves in a difficult position. Rarely are they viewed as ordinary scientists engaged in normal research. Instead, they tend to be seen as performing some sort of performance evaluation exercise

or regulatory function.³ This double-edged quality makes research evaluation studies fundamentally different from other types of research, a reality which needs to be recognized by management. Because of the potentially disruptive effects, at some IARCs research evaluation and impacts assessment activities have been assigned to specialized monitoring and evaluation units attached to an administrative unit, such as the Director General's office, rather than to a regular research division.

4. Data collection experiences

Given the double-edged nature of research evaluation work, it is perhaps not surprising that data collection activities can turn out to be quite challenging. In our study, many respondents were quick to provide information which they believed would reflect favorably on their own activities or unfavorably on the activities of perceived competitors, but they tended to suppress information which would have given the opposite impression. In some instances, respondents very clearly attempted to mislead us by providing false information. This section of the paper briefly reviews our data collection activities and identifies several types of information which proved to be particularly sensitive.

Official published statistics were obtained from government publications. Additional non-published data on the activities of public agencies and parastatal corporations involved in seed production and distribution were requested directly from these organizations. Procuring unpublished data proved to be time-consuming, often requiring repeated requests made through letters, telephone calls, and/or personal visits. Although the IARI researchers were able to speed the process a bit by exploiting personal contacts, on the whole progress was slow. In some cases, the problem was simply that the requested data were not readily available and had to be compiled by the concerned agencies. In other cases, the data were apparently available, but for one reason or another they could not be provided. This was a bit surprising, considering that the information should have been a matter of public record.

Information about the level of public investment in maize research, as well as information about the products of public breeding programs, was collected through the use of a questionnaire distributed to 27 public maize breeding programs located throughout India. These questionnaires were distributed along with a cover letter from the director of the national maize program. The questionnaires requested information about each program's level of investment in research activities, as well as a list of the improved OPVs and hybrids developed since 1960. The initial response to this survey was disappointing, as

³ Given the suspicion that research evaluation work naturally arouses, it is unfortunate that in commodity research institutes, such work is usually carried out by social scientists. With the status of social scientists already marginal, their involvement in research evaluation activities has the potential to erect further barriers between disciplines.

few of the questionnaires were returned by the specified deadline. Most of those which were returned on time were incomplete and had to be returned to the respondents for additional information. Eventually, after several reminder letters had been sent out, all of the questionnaires were filled out and returned. Although it is difficult to know for certain, the slow response on the part of many public breeding program leaders apparently came about because some of the requested information was not readily available and required considerable time and effort to compile. Many of the public program leaders initially ignored the questionnaire, apparently in the hope that they would hear nothing further; only when reminded of the questionnaire by the director of the national maize program did they feel compelled to respond.

The problems we encountered in collecting information from leaders of public breeding programs illustrate the importance of involving NARS researchers in this type of study. With little or no personal interest in the outcome, leaders of many public breeding programs would happily have avoided the work involved in completing and returning the questionnaires. Only repeated reminders from the director of the national maize program succeeded in ensuring their cooperation. Based on this experience, it seems unlikely that an IARC researcher working independently would have been able to collect data on the activities of public breeding programs.

Information about the level of private-sector investment in maize research, as well as information about the products of private breeding programs, was collected by interviewing representatives of India's leading maize seed companies. A list was developed of all companies known to have in-house maize breeding programs. After initial contacts had been made by mail or by telephone, interviews were scheduled with the managing directors and/or directors of research of these private companies. Eventually, 21 leading seed companies were interviewed one or more times, including a number of companies having links to multinational corporations and a number of national (Indian) companies. A formal questionnaire was used during these interviews, although much qualitative information was also obtained through open-ended questioning and recorded in notebooks.

Collecting data on the activities of private seed companies posed a number of challenges. Most of the seed company representatives, while quite willing to meet with us, seemed suspicious about the motives of the study. We sought to allay their suspicions in several ways. First, when meeting the company representatives for the first time, we went to considerable lengths to explain why the results of the study would ultimately benefit the private sector. Second, we pointed out that we recognized the sensitivity of some types of information (e.g., information on pedigrees, information on revenues) and indicated that we did not expect the companies to provide such information. Third, we indicated that our final report would not discuss the activities of individual companies; rather, all of the information collected through the survey of seed companies would be published only in the form of aggregate (or average) figures pertaining to the seed industry as a whole.

Interestingly, the attitude of many seed company representatives differed depending on the identity of those conducting the interview. When NARS researchers participated in interviews, seed company representatives were considerably less candid in describing their activities and in discussing those of the national maize program. Asked about this directly, many seed company representatives admitted that they were willing to be more outspoken with IARC researchers because IARCs are recognized to be neutral players, rather than potential rivals. Many seed company representatives also said that they tended to be more circumspect in the presence of NARS researchers in order to avoid potential misinterpretation of comments that might be construed as critical of the national program. Despite our best efforts, many private company representatives declined to provide detailed information about some of the topics in which we were interested. Particularly sensitive topics included:

- *Level of investment in maize research.*

Many of the seed companies we interviewed were reluctant to provide precise estimates of their level of investment in maize research. In some instances, this was probably because the companies did not know precisely how much they were investing in maize research, particularly when maize research was being carried out in conjunction with research on other crops. In other instances, however, it seemed clear that the requested information was available, but that the company representatives were simply not willing to provide it. One possible explanation is that for tax purposes, some companies allegedly misrepresent the level of their research investment. Under Indian law, investment in agricultural research is subject to lower rates of taxation than other types of commercial investment; thus, companies have a clear incentive to overstate their level of research investment. According to several respondents, some companies have sought to obtain tax relief by reporting large-scale acquisitions of land, buildings, and equipment as research investment.

- *Sources of breeding materials.*

Because of its obvious commercial sensitivity, we made no effort to collect detailed information about the pedigrees of proprietary hybrids. However, we were struck by the unwillingness of most private companies to divulge even general information about the source germplasm used in their breeding programs. Company representatives frequently claimed that such information would provide a competitive advantage to competitors, but this seems unlikely considering the extremely general nature of the information we were requesting. One possible explanation is that many companies may have been trying to hide the degree to which their materials contain germplasm “poached” from competitors. Virtually all of the respondents indicated that the practice of poaching materials from other seed companies is widespread in India, although only a few companies admitted that they themselves engage in the practice.

- *Sales of improved maize seed.*

Most of the companies which participated in the survey were reluctant to provide precise figures on the quantities of seed they had sold in recent years. Many provided data on the quantities of seed which had been produced, but further questioning usually revealed that in most years, not all of the seed that had been produced had actually been sold. Two factors seem to contribute to this reluctance to reveal sales data. First, since sales increase whenever a variety or hybrid is perceived to be widely used, companies have obvious incentives to exaggerate the commercial success of their materials. Second, since business taxes are assessed on seed companies as a percentage of their gross revenues (which are directly determined by sales), companies have an incentive to understate their precise sales figures. Interestingly, in these two cases the incentives to distort the true sales figures work in opposite directions.

We have described these “problem” topics in some detail in hopes of sensitizing others who may be contemplating similar work. Based on our experience, one thing is clear: the fact that research evaluation studies can potentially produce results which run contrary to the interest of those being evaluated affects the quantity and quality of information provided. Although it was not always possible to verify the accuracy of the data we were given, in many cases we were given incomplete information, and in some cases we were given false information. Those undertaking research evaluation work therefore must take special care in addressing certain sensitive topics. Questionnaires should be repeatedly and thoroughly pre-tested to ensure that respondents will be willing to provide the needed information, and if possible questions should be designed to permit sensitive information to be verified through cross-checking (for example, seed production and processing capacity should be consistent with reported sales volumes).

5. Issues pertaining to the mechanics of collaboration

Participants in this workshop may want to devote some time to a discussion of the mechanics of carrying out collaborative research projects involving partnerships between NARSs and IARCs. Although much lip service is paid to the large potential benefits of research partnerships, those of us who have participated in collaborative work know that special care is often needed to ensure success. The point is rarely mentioned, but the additional transaction costs involved in collaborative research can be daunting. Institutions normally have their own sets of policies and operating procedures, whose reconciliation may require considerable effort. Most researchers feel they already spend too much time on administrative activities such as negotiating memoranda of understanding, obtaining approval for projects, securing funding, implementing mechanisms for disbursing funds, and writing reports. In collaborative studies involving researchers from NARSs and researchers from IARCs, these tasks are often magnified. On the whole, the potential benefits of collaborative work do exceed the costs, but researchers should be aware of the additional administrative workload associated with

most collaborative projects and should be willing to invest additional time toward ensuring that things run smoothly.

Logistical matters aside, it must be recognized also that collaborative research brings greater potential for professional misunderstandings. This is understandable, since criteria governing ownership of data sets, assignation of authorship, and publication format may differ between countries, between institutes, and even between disciplines. One strategy to ensure harmonious working relationships is to develop -- at the beginning of any study -- explicit, mutually acceptable guidelines concerning these issues. Several IARCs now make such guidelines a standard component of every collaborative research agreement.

6. Conclusion

Using the IARI-CIMMYT Maize Seed Industry Study as a point of departure, we have described a number of technical constraints, practical considerations, and institutional realities which affect the way research evaluation and impacts assessment studies are designed and carried out. In hopes of provoking meaningful discussion among the workshop participants, we have tried to present a balanced view, not only highlighting the potential benefits of collaborative studies, but also mentioning the potential costs.

Among the technical constraints we have mentioned, perhaps the most important is the lack of a conceptual framework which can be used to identify non-tangible research outputs (particularly information) and to measure the economic benefits associated with these outputs. With few exceptions, the literature on returns to research other than breeding is still quite limited. Despite the recent rise in interest in research evaluation methods, little applied work has been done on quantifying and valuing the output from non-breeding research, for example, crop management research and policy research.

Unable to deal with non-tangible outputs, most applied research evaluation and impacts assessment work has focused on what is measurable. This has resulted in a heavy emphasis on studies focused on plant breeding, because of its relatively visible products. Our work on the public and private maize seed industries of India poses no exception: we have focused on germplasm and pretty much ignored everything else. However, as we have discovered, even plant breeding is difficult to evaluate because of the practical difficulty of collecting reliable data. On the inputs side, it is often very difficult to obtain reliable estimates of research costs. Administrators of public breeding programs (both NARS and IARCs) generally do not keep very good track of their expenditures, and private seed company representatives are often reluctant to provide this information out of fear that it may be exploited by competitors. On the outputs side, while it has been possible to assemble a comprehensive listing of the OPVs and hybrids developed by public breeding programs and private companies, it is difficult to estimate the impacts of these materials at the field level. The area planted to improved materials can be estimated only roughly, and the yield gains in farmers' fields associated with adoption are poorly understood.

Last but not least, those engaging in research evaluation and impacts assessment studies must acknowledge institutional realities. Research evaluation work is not like other research, since the results provide a yardstick which can be used to judge the performance of others. Research evaluation and impacts assessment studies thus are potentially threatening, and the scientists charged with carrying them out can find themselves in a difficult position. Inevitably, this constrains the choice of topics, limits the quantity and quality of available data, and influences the types of analysis which can be carried out.

References

- Lopez-Pereira, M.A. and M.L. Morris. 1994. *Impacts of International Maize Breeding Research in the Developing World, 1966-90*. Mexico, D.F.: CIMMYT.
- Singh, R.P.; S. Pal; and M.L. Morris. 1994. *Maize research and development in India: Contributions of the public and private sectors*. (forthcoming)