Chapter 5

Role of Public and Private Research Participants

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Chapter 5

Role of Public and Private Research Participants

Throughout the history of agricultural research, no fixed pattern has developed with respect to the kinds of research performed by the U.S. Department of Agriculture (USDA), State agricultural experiment stations (SAES), and industry, and no principle has emerged to determine the role of each. Decisions as to where research is done in the public sector invariably have been decided ad hoc by discussion and agreement among the concerned parties. The administrative diplomacy required to reach such agreements has reached high levels of complexity in USDA and SAES. Such decisions frequently are arbitrary, expedient, inconsistent from year to year, and more influenced by pressures of the moment than by uniform, long-range guidelines or principles (1). In the absence of an accepted rationale for doing differently, these practices will likely continue.

It should be possible, however, to arrive at a rational and practical plan for assignment of roles to those who conduct postharvest technology and marketing economics (PHTME) research. Admittedly, whatever guidelines are determined must be agreed to. However, once articulated, made public, and used, a plan and guidelines would make clearer to all concerned the basis and logic of certain program decisions, encourage USDA and SAES to focus on the roles expected of them, and permit periodic reexamination over time. Ideally, application of the plan and working guidelines derived from it should result in a sufficiently clear delineation of roles that uncertainties concerning where research should be conducted and how it should be funded would be the exception rather than the rule. This chapter presents an analysis of the roles of participants in PHTME research and provides guidelines for delineation of roles among participants.

PRIVATE SECTOR DOMAIN

Although different segments of the agricultural industry perceive their roles differently, most are motivated by economic incentives. If management can foresee that the private rate of return is sufficient, funds are set aside for the research program. As discussed in chapter 4, industry research may result in benefits for both the private sector and society.

PHTME research in private industry tends to be profit oriented. In the food processing sector, such research primarily takes the form of new product development and new applications for products. This includes but is not limited to: 1) product line extension, such as new flavors, colors, package size, or minor variations introduced to supplement existing products; 2) development of existing products, such as modifications in the formulation, minor improvements in processing technologies, packaging, etc.; and 3) nonfood uses of farm products, such as for energy, lubricants, etc.

In the food distribution sector, the profit orientation includes developments such as improved truck-trailer design and use to lower transportation costs, development of railroad cars and containers for improved quality preservation, and electronic checkouts in retail stores to improve labor productivity.

Profit-oriented research by private industry also includes economics research. Demand and supply forecasting are used particularly by food processing companies to aid in *decisionmaking on purchasing* inputs so that the firm's costs are minimized. Also used are feasibility studies and market surveys.

In delineating the role of the private sector in PHTME research, certain distinguishing characteristics of private sector research in foodprocessing, handling, and marketing should be considered. * *First,* most private sector research tends to be focused on short-term applied problems for which there is an expectation of an acceptable return on the research investment. *Second,* it is unlikely that longer term basic inquiry into how biological, economic, and social systems function would be picked up by the private research sector if it were dropped by public research agencies. *Third even* though there may be substantial social benefits from private research activities through spillover effects, private industry generally is not concerned with concepts of consumer surplus or net social benefits from their research endeavors. *And fourth,* most private firms are reluctant to reveal knowledge that might cause existing technologies or processes to become obsolete prior to extracting the flow of economic returns from past investments in these techniques. Thus, an incentive exists to delay publication of knowledge possessing this potential impact, even if the research might have been carried out partly under the auspices of public funding.

Based on the above, the areas of PHTME research that are or should be *primarily* in the private sector domain are: 1) processes and techniques that are patentable and accrue into the capitalization of the firm, 2) research to meet Federal and State regulations, and 3) research to maintain or gain clientele.

Research on Patentable Processes and Techniques

Research and development pertaining to patentable processes and techniques is probably the most clear cut in terms of private sector involvement. Such research most nearly fits the one characteristic of private sector research discussed earlier—i.e., it is focused on short-term applied problems for which there is an acceptable return on the research investment.

Industry research on patentable processes and techniques commonly leads to gains for the firm and industry in excess of losses to society. * This observation is particularly applicable in the case of mechanization research, which accounts for a large part of this research activity. Much mechanization research has been induced by long-term increases in the price of labor. The gains to the firm or industry conducting such research often substantially outweigh the losses to workers (s).

The private sector has been an efficient source of new mechanical technologies in postharvest technology as well as in agriculture in general. Even when public funds have been expended in the mechanical technology area, many believe that the firms would have developed the technology without the public sector involvement. The demand for commercial development has appeared to be more important than the public research effort (4).

In late *1979,* former U.S. Secretary of Agriculture Bob Bergland, responding to a concern about public sector support for mechanization research, announced that USDA would no longer support research leading to the "replacement of an adequate and willing work force with machines. " Bergland stated that USDA would not put Federal funds into research when a careful review and analysis clearly indicate: 1) that the direct and immediate benefits will go to a limited number of locales while neither serving the national interest nor benefiting the general public; and 2) that the research poses a direct or an indirect threat to social stability, the national resource base, the environment, the national security, or the economic well-being of a significant number of citizens. Bergland immediately qualified these remarks by indicating that he had no objection to research and development designed to ease the drudgery of work rather than to replace workers with machines, but this distinction is not feasible either technically or analytically (4).

Bergland's statements gave impetus to a badly needed debate concerning the appropriate roles of public and private sector research. Supporters of public sector mechanization research have fre-

● These characteristics were identified in the unpublished USDA assessment "Postharvest Technology Research Assessment, " March 1979.

'It is recognized that there is some research, such as improvements in products, which has few, if any, losses to society.

quently attempted to interpret Bergland's remarks as an attack on mechanization rather than on the more fundamental question of the rationale for public sector funding of this research. Opponents of public sector mechanization research apparently are less concerned with the displacement of labor than with the failure of public institutions to consider laborers as well as farmers, processors, and retailers as part of their clientele and the failure to provide parity of treatment for laborers (4).

The implication of the mechanization debate for public and private research seems reasonably clear, The private sector has been an effective source of new mechanical technology. Lack of knowledge has seldom been a serious constraint on advances in mechanical and patentable technologies, Public research in this area may be justified primarily for its value in training new scientists and to linking biological and chemical research with mechanical technology.

Research To Comply With Federal and State Regulations

A firm operating in the United States must adhere to many Federal and State regulations in order to process and/or market a food product. These regulations include but are not limited to regulations concerning food safety, nutritional claims, shelf life, environmental pollution, and worker safety. A firm may need to conduct research to meet these regulations or mitigate their impacts.

For example, the basic purpose of nutrition labeling of food products is to provide accurate nutrition information to the consumer. Nutrition labeling is a voluntary/mandatory program—i.e., participation in the program is voluntary, but if a firm elects to participate, it must follow a mandatory labeling format and provide the necessary research data to support its label. When a processor makes any kind of labeling or advertising claim about the food's nutritional value or when the food is enriched with any essential nutrients, compliance with the nutrition labeling program becomes mandatory.

Another example of research to meet regulatory requirements is establishing the shelf life of food products. Many States require that manufacturers convey to consumers the length of time the product will maintain its quality, especially for perishable products. To develop these time intervals or dates scientifically, each food manufacturer needs to conduct shelf-stability studies on each product and determine the time at which sensory quality falls below the point of consumer acceptance. Research to comply with such regulations is often referred to as "defensive research."

Research To Maintain or Gain Clientele

A firm interested in maintaining or gaining clientele will conduct or have conducted for it research that is directed toward this end. The most explicit example is in the area of food quality. A firm differentiates itself from its competitors by providing a certain level of food quality. In order to maintain and ensure this quality level, the firm conducts research and analysis throughout the processing cycle. A firm also engages in product development research for the purpose of expanding its product line, further developing its existing products, or finding new applications for its products. A firm may also conduct economic research, such as market surveys, to determine what actions it may need to take to either maintain clientele or to gain new clientele. Significant incentives exist for the private sector to conduct this type of research, because the returns of such research accrue mostly to the firm.

PUBLIC SECTOR DOMAIN

There are certain areas of PHTME research which logically fall to the public sector. Public sector research efforts are in both basic and applied PHTME research. Public sector support of basic research generally benefits both society and the private sector. Because the results of basic re-

search are difficult to internalize to any particular private firm, underinvestment in basic research would result without public support.

In the case of applied and developmental research, however, an important issue that arises is the appropriate mix of public and private research investments. The private sector will stand to benefit from public investments in those types of research whose outputs are embodied in private sector products. Examples include the areas of chemical and biochemical research, mechanical research, the development of seed varieties, and food processing and fabrication. Although much of the research responsibility in these areas has been assumed by the private sector, public research activities are also maintained.

Public sector research may be justified on at least three grounds. First, because of the spillover effect, substantial social benefits are derived from a mixture of public and private research. *Second,* in the absence of public sector support, the direction of the research might tend to be biased strongly toward proprietary mechanical and chemical technologies. *And third,* for those situations whereby private research might have a detrimental effect on the structure of the industry (making a competitive structure noncompetitive, or a noncompetitive structure still more imperfect), a mix of public and private research may serve to preserve competition or reduce the amount of market power. The importance of this last basis for public investment in research is that most competitive industries provide a larger quantity of the product at a lower cost to consumers and a higher price to farm producers than would be expected from an uncontrolled monopolistic industry (9).

Because of the ease of imitation and lack of patent enforceability, it is likely that the private sector would substantially underinvest in many marketing economics research activities, Thus, much marketing economics research is supported by the public sector, even in those areas where substantial inducements exist for product development by the private sector. Few marketing firms, for example, conduct much research in aggregate consumer demand for food products. However, public sector research is available to large and small food marketers alike and to farmers and consumers for improved decisionmaking. Because of the difficulty of patenting the information gained by public research institutions, small marketing firms have been able to exist along with large firms. Thus, it has been thought to be in the best interest of society to support public investments in these types of research activities, because the social benefits would outweigh the costs incurred from an uncontrolled monopolistic industry (9).

Based on the above considerations, the areas of PHTME research that are or should be *primarily* in the public sector domain are: 1) research to provide basic knowledge, 2) research to support policymakers and action/regulatory agencies, and 3) research to enhance competition.

Research To Provide Basic Knowledge

Basic research may be defined as activity directed toward the production of new knowledge. The systems may be physical, biological, mechanical, economic, social, or political. Basic research is directed to specifying and quantifying interrelationships in a cause-effect context. It is concerned with theoretical concepts, the formulation and testing of hypotheses, and with enunciating laws and principles. Basic research is almost universally transferable.

Basic research represents the principal mode for developing the knowledge base necessary for future scientific and technological breakthroughs. These in turn frequently lead to significant economic benefits and improvements in social welfare. Within the academic sector, basic research also serves an important function in education of graduate students.

The public sector clearly has responsibility to fund and conduct some basic research. The private sector also supports basic research by funding and conducting it. Approximately 10 percent of agricultural industry's research and development funds are for basic research. However, little incentive exists for the private sector to increase this amount. For the most part, the results to be obtained from basic research are unknown and unquantifiable, and the payoff quite far in the future. This provides little incentive for private basic research. Further, even if there were ade-

quate incentives, the results of the research would be proprietary. Thus, for the advancement of science and future technological breakthroughs, the public sector, which makes known the results of basic research to the public, has a clear role in providing the fundamental knowledge on which these breakthroughs are based.

Research To Support Policy makers and Action and Regulatory Agencies

There are many users of research within government. Policymakers, both in the executive and legislative branches of government, are demanding more information from research and policy analysis before making decisions. In the PHTME area, policymakers at the Federal level include the Secretary of Agriculture, Secretary of State, Secretary of Treasury, Secretary of Health and Human Services, and the respective legislative and appropriations committees in Congress. Decisions these Federal policymakers need to make include the appropriate level of support prices for farm products, the level of U.S. farm product exports, the imposition of tariffs on imported food products, and the amount of the Federal budget that will be devoted to food and agricultural concerns. Information developed through research is needed for policymakers to be able to make informed decisions.

Action and regulatory agencies depend on research results in implementing their regulatory and programmatic responsibilities. In the PHTME area, these responsibilities include decisions on the use of food additives, the safety of irradiation of food as a processing technique, the detection of nitrosamines, chemical methods for detection and measurement of bacterial contamination of food, antitrust cases involving food companies, the effectiveness of marketing orders, and necessary regulations in commodity trading. Equally important to these agencies is research that analyzes the impact of these regulations. Action and regulatory agencies need to be informed of the regulations' benefits and costs. This information is useful in guiding the agencies in modifying or eliminating existing regulations, or establishing new regulations.

In the absence of research in the above areas, policymakers and action and regulatory agencies would not have an adequate knowledge base to make appropriate decisions. There seems to be little argument that research is needed to support these areas. The public sector is considered the best source for this research since it conducts research where the benefits accrue to parties other than those supporting the research.

Research To Enhance Competition

A major function of the U.S. Government is the maintenance of a free and competitive economic system. The system requires protection from monopolistic practices that would thwart competition. Public research can contribute to the maintenance or enhancement of competition in the agriculture production and marketing sectors. * For example, the flow of new technology from public research and development has contributed to competitive behavior in the seed and fertilizer industries (2). This is because the results of public research are disseminated to the public, as opposed to privately supported research, which is proprietary and has the potential of extracting monopoly profits to some degree over time.

A basic tenet of government is that it should not do what the private sector can or will do. This *tenet must be balanced as the private sector becomes more engaged in research and development while it becomes more monopolistic in character.*

The dilemma is particularly evident in applied and developmental research. For those areas of the marketing system where firms lack resources in terms of funds, scientific manpower, and facilities to conduct their own research, public sector research can provide new technology that not only increases productivity but enhances competition. Much of this research is of an economic/engineering nature and involves working with individual firms to test and evaluate the application of a technology to **an** industrywide problem.

*Public research sometimes does not contribute to the maintenance of a competitive structure; in some cases, it increases economies of scale. More public PHTME research needs to consider its influence on market structure and, hence, on competition.

The results of the evaluation are then publicized for the benefit of all firms in the industry. When new technology is adopted by a firm that results in cost savings, competition causes other firms to adopt the new technology rapidly.

For example, partial or full automation has been made possible for small dairy processing plants as a result of public research. Prior to this research, automated procedures were available only as complete package deals from equipment manufacturers. Research findings made it feasible for small plants, which cannot afford full automation, to purchase and install the parts of the system advantageous for their volume. An estimated annual reduction in labor costs of $50 million is possible, if the approximately 1,000 small plants involved adopt the research findings (7).

Much of public marketing economics research is directed toward providing information that, when used in decisionmaking, contributes toward economic competitiveness. Such research ranges from computers in electronic marketing of farm products to studies of the effects of policy instruments to maintain or enhance competition. For example, competitive marketing conditions do not prevail for many cattle producers. Most livestock markets are small, with high selling expenses and less than desirable buyer concentration. The vast majority of cattle feeders are too small to attract bids directly from a number of competing buyers. Likewise, the small number of buyers present in many auctions and terminal markets often leads to fraternalism among buyers, enhancing the potential for buyer collusion. Most producers lack timely information on prices in alternative markets and typically sell too few cattle to make good use of what market information they do obtain. One alternative to this problem is public research on conceptualizing and developing electronic markets. * This allows producers to reach alternative markets with the potential to expose market offerings of each seller to competitive bids from every buyer and the bids of each buyer to every seller. It can potentially provide instantaneous information on prices and other terms of trade and facilitate direct shipment of cattle from seller to buyer. Research indicates that electronic markets can perform these functions more rapidly than the conventional system, with greater accuracy and at a lower cost while increasing competition among buyers at the same time (3).

At the other end of the spectrum of research to enhance competition is public research that: 1) determines the competitive factors which affect market performance in the food and agricultural sector, and 2) measures the effectiveness of policy instruments to maintain or enhance competition. Such public research is vital to better understanding of what forces affect market performance and to determining the effect such policies as antitrust laws and enforcement have on competition.

● Electronic markets are so named because they use modern electronic devices such as telephones, computers, teletype networks, and TV-like two-way communication devices to create a market.

JOINT PUBLIC AND PRIVATE SECTOR DOMAIN

Some areas of PHTME research exist in which there is reason for research activity for both the public and private sector. These are areas in which the incentives for private research are not adequate, because many of the gains from private research in these areas are captured by other firms and consumers. The public sector may need to be involved to ensure the conduct of research from which the social gains exceed the private profit.

Research on New Food Sources and Their Development

This area is fertile for research from both the private and public viewpoint. From the private sector side, discovery of new food sources can possibly mean new and less expensive ingredients in food processing or more efficient usage of by-products of the manufacturing operation. The

public sector has an interest because of the concern about potential global shortages of food and concern for environmental pollution.

A good example is the improved utilization of cheese whey, an important large-volume byproduct in processing cheese whose disposal presented environmental and physical problems. The private sector incentive for research on cheese whey was its profit potential. The public sector conducted research on cheese whey because of concern for the environment and as a potential means of increasing the food supply.

These public and private research efforts had several results. First, liquid sweet whey could be combined with full-fat soy flour or soybean isolates to yield a free-flowing powder of good nutritive value. The whey-soy blend was commercially used by the baking industry, where it demonstrated better functionality than did nonfat dry milk in doughs processed by continuous baking equipment. Second, spray-dried whey protein concentrates could be incorporated into commercial soft drinks and drink powder without detectable change in flavor or appearance and with improved nutritional value from added protein. Third, low-lactose products from milk and whey could be readily prepared with conventional dairy plant equipment. Such products are suitable for consumption by lactose-deficient individuals (8).

Improved utilization of cheese whey has significantly reduced environmental pollution in many cheese-producing areas, and has increased economic returns to processors. The development of new ingredients has increased the variety, nutritional quality, and storage stability of foods, especially convenience foods, available to U.S. consumers. Dairy products aimed at a new consuming population, lactose-intolerant consumers, are commercially available in some areas. Development of whey-soy drink mix as a milk analog provided economic benefits to the processors while meeting the demand for this product in developing countries.

Research on Naturally Occurring Food Contaminants

Prevalent naturally occurring toxic contaminants in the food chain are mycotoxins. These are substances produced by molds under special circumstances; some are carcinogenic in animals. The best known mycotoxin is aflatoxin, which lowers feed efficiency and weight gain in livestock and in larger doses can cause death. This effect on livestock provides an economic incentive for the private sector to conduct research on mycotoxins.

When aflatoxin-contaminated feed is fed to milk cows, a related carcinogen can be found in milk. In humans, there is circumstantial evidence for its involvement in causing liver cancer. This provides the incentive for public sector research efforts even though the private sector is interested in the safety issue too. Certainly no company that intends to stay in business wants to produce an unsafe product. But whereas the individual firm is only concerned with that portion of the crop under its control, the public sector must be concerned with the safety of the entire crop.

These research efforts indicate that aflatoxin in corn, which is not detectable under ordinary conditions, can now be detected in less than 5 minutes by a fluorescence test. * Once detected, the amount in the sample can be determined by analytical procedures. The public sector held workshops for corn handlers (farmer elevator operators, millers, and processors) on detecting and measuring the toxin. These tests offer anyone in the marketing chain added protection against the financial hazard of buying contaminated corn. They also provide protection for the general public by reducing the chance that aflatoxin will enter the food chain.

● Research is continuing on this technology to improve its detection capability. Concern exists that ultraviolet gives too many false positives and thus is not precise enough.

Research on Yields in Relation to Productivity v. Nutritional Components

This area of research relates to the differing orientation of the private and public sectors. The private sector's first priority is to conduct research that will increase the output from a given input. This research can make more food available through improved processing, upgrading products, preventing waste, and providing for utilization of products previously not considered usable.

The public sector, while interested in increasing productivity, is also concerned with improved nutrition and health. The primary purpose of food is to provide nutrients required for body functions. With the industrialization-commercialization of the food and agricultural sector, ensuring the nutritive value as well as the safety of food has gained in importance because consumers are further removed from primary production. Processing and preservation technologies that expand output can improve the nutritional value of food, retain it in a stable condition, or cause it to deteriorate. The consuming public cannot know immediately which of these has occurred. Little incentive exists for the private sector to take this into account when attempting to increase yield or supply of food. Thus, the public sector also needs to be engaged in this type of research with multiple objectives.

USDA AND SAES ROLES

During the early history of the development of SAES, them was some concern about the relationship of the research stations to the land-grant colleges. There was even greater concern about the acquisition of Federal funding through USDA for support of SAES, free from excessive domination by the Federal Commissioner of Agriculture. The Hatch Act of 1887 resolved many of these issues and provided for a high degree of State autonomy in designing and conducting research.

Additional legislation providing support for the establishment and strengthening of SAES clearly recognizes SAES as entities distinct from the land-grant colleges. In the early years, the SAES were concerned almost totally with State and local research problems. As the stations grew and additional acts were passed by Congress providing wider use of funds, however, their research broadened to include regional, national, and international activities.

Meanwhile, USDA has developed a wide network of research laboratories, stations, and activities that not only includes national, regional, and international activities but at times involves strictly local problems.

This broad base for application of Federal and State resources to research problems has led some, including Congress, to question the degree of research planning and coordination that exists, especially at the top levels of administration. There seems to be considerable duplication of effort and vying for funds—including PHTME research—and Congress and other interested groups have increasingly been concerned *(6).*

Most agricultural research administrators—whether SAES, USDA, or other—recognize there is not unanimity of thought on how best to manage and carry out U.S. agricultural research and the appropriate roles of the various actors for an effective and efficient system.

An important consideration in establishing these roles in research is the source of funding for research in relation to the beneficiaries of the research. USDA is funded primarily by Federal funds and SAES by State, Federal, and private funds, and the roles of these research participants are generally more complementary than competitive. Under the Hatch Act of 1887 and the Research and Marketing Act of 1946, discussed in appendix D, SAES conduct research on local, State, and regional problems (cooperatively with one or more States). SAES have no direct mandate to conduct research on problems of national importance, although research on State and regional problems may contribute to the solution of national problems. USDA has responsibility for assuring the conduct of postharvest technology research directed at problem-solving in the

national interest, but to some extent must address the local and regional aspects of national problems.

The allocation of research responsibilities distributes itself very logically among the major performers. The Federal Government, either intra- or extramurally, must give highest priority to problems of national significance, and must, as a part of this responsibility, maintain an awareness of and take into account the contributions of the States and private industry toward national objectives. SAES, insofar as Federal funds are concerned, must give highest priority to concerns of the State and to those of the region of which the State is a part.

These roles have historical precedent and are logical today. As more is known about the beneficiaries of this research and are better able to quantify the relationships between funding source and beneficiaries, there is strong evidence for major Federal input to PHTME research, because the benefits of such research go to the general public and not any one State or region. USDA should work as a partner with SAES to achieve complementarily and cooperate with private and other public universities and industry to coordinate its own contribution to achieve national goals most effectively. Both USDA and SAES should collaborate when appropriate to assist the research performance and respect the integrity, role, and decisionmaking responsibilities of each institution.

In a more general sense, the Federal role in PHTME research should include:

- providing scientific leadership in the identification of research needs, setting the national research priorities, and in developing plans and programs to address those needs and priorities;
- supporting SAES in conducting research on agricultural problems of special concern to a specific locale, State, or region;
- providing substantive leadership and coordination to facilitate the flow of information among States and between the States and the Federal Government and to identify opportunities for and conduct or support research with a regional and national emphasis;
- assuring the development of new fundamental knowledge on which future advances depend, by supporting and conducting research in basic agricultural science; and
- maintaining a Federal research capability responsible for conducting basic and applied research in support of unique Federal missions such as research for regulatory and action agencies and research that enhances competition in the food and agricultural sector.

PRINCIPAL FINDINGS

- There is a role for public and private research efforts in PHTME research.
- The primary domain of private sector PHTME research is: 1) research on patentable processes and techniques (including mechanization research), 2) research to meet Federal and State food regulations, and 3) research to maintain or gain clientele.
- Public sector PHTME research should concentrate primarily on: 1) basic research, *2)* research to support policymakers and action and regulatory agencies, and 3) research that enhances or maintains competition.
- Both public and private research efforts are justified in areas such as: 1) research on new food sources, 2) research on naturally occurring food contaminants, and 3) research on yields in relation to productivity versus other objectives.
- The Federal role in PHTME research includes providing leadership in identification of national research priorities and conducting supporting research with a regional or national em-

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phasis; supporting SAES in conducting research of special concern to a locale, State, or region; assuring development of new fundamental knowledge by supporting or conducting basic research; and maintaining a research capability for conducting basic and applied research in support of unique Federal missions.

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