Chapter 1

Executive Summary

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INTRODUCTION

During 1982, American consumers spent $298 billion for food. Approximately 30 percent of that actually went toward on-farm production costs. The remainder was spent on postharvest activities and marketing.

The phrase agricultural postharvest technology and marketing economics (PHTME) includes all technological and economic transformations that occur to agricultural products between harvest and consumption. PHTME encompasses storage, assembly, processing, packaging, warehousing, transportation, and distribution of agricultural products through the institutional food trade and wholesale and retail outlets.

The U.S. Government today funds research on these subjects, but the question is whether or not it should continue to do so. Accordingly, the House Agriculture Committee requested that OTA examine the role of the public sector in PHTME research. This memorandum presents the results of that examination, focusing on:

1. the development of public sector research;
2. identifying and, where possible, measuring the costs, benefits, burdens, and quality of the research;
3. examining the role of public and private research participants;
4. evaluating public sector research programs; and
5. findings and conclusions for Congress.

The OTA analysis finds that U.S. labor and capital productivity of postharvest technology and marketing sectors is poor relative to on-farm productivity and that increases in postharvest technology and marketing costs have contributed significantly to the U.S. inflationary spiral since 1972. Concurrently, there have been significant declines in research on postharvest technology and marketing.

The United States relies on Federal agencies, State agricultural experiment stations (SAES), universities, and private industry to carry out PHTME research. Historically, the rationale for public sector agricultural research has been that farmers and other businesses have neither sufficient economic incentive nor scale of operation to conduct their own research. In addition, many experts believe that a competitive agricultural structure fosters more rapid adoption of new technology; free information, as supplied by public research institutions, is one technique used to promote such a structure.

The food and agricultural research establishment today is facing new problems that place severe strains on the research system. * In response, there is an ongoing search for ways to improve the effectiveness of the research system while reducing costs. Because of this, some of the past arguments in favor of publicly supported PHTME research are being questioned.

Some executive branch members, including the U.S. Department of Agriculture (USDA) and the Office of Management and Budget, have argued that it is no longer necessary to increase investment in certain forms of research—including PHTME research—implying that private firms have sufficient resources to conduct their own research, and that information ultimately will become available to smaller firms. Thus, the executive branch has made a number of attempts to decrease public support for PHTME research over the last 10 years,

● These problems are discussed and analyzed in detail in the 1981 OTA report An *Assessment of the United States Food and Agricultural Research System.*

FINDINGS AND CONCLUSIONS

An earlier OTA study, An *Assessment of the U.S. Foodand Agricultural Research System,* determined that the United States does not have well-articulated and clearly achievable national food and agricultural goals. This is a major deterrent to directing PHTME *or* other research efforts. Vague or implicit goals provide little help in formulating policies or giving the research community direction. For example, such stated goals as "making two blades grow where one grew before, " or "provide an ample supply of food," or "provide food at a reasonable price to consumers" are open-ended, unmeasurable, and do not provide any specific guidance to the research community. What is an "ample supply" or a "reasonable price" for food? Have we already achieved this goal or is it a long way off? How do we know? Such questions must be answered for a goal to be useful in policy formulation and in planning a research agenda.

Examples of what more explicit goals *might* be for the PHTME sector are:

1. Discounting inflation, real retail prices of agricultural products should be held to less than an X percent increase within the next decade.
2. The total volume of nonrenewable energy consumed in the PHTME sector should be held constant during the next 5 years, and should decline by X percent within 10 years.

By specifying explicit national goals, society, through its elected representatives, notifies the research community of societal wishes. Research then can be directed toward attaining these goals.

Research Benefits and Beneficiaries

PHTME research provides a *range of benefits,* including:

- *Increased Productivity and Reduced Real Cost of Food.* –Productivity in the PHTME sector is lagging relative to on-farm productivity. Seventy percent of consumers' food cost is attributable to food assembly, processing, transporting, and distribution. Opportunities exist to increase postharvest productivity by developing new or improved technologies that will reduce the cost of those operations that add to the cost of food once it leaves the farm. Such technologies should: 1) increase labor productivity, 2) improve processing and preservation, and 3) increase marketing and distribution efficiency.
- *Ehhanced Food Quality, Safety, and Nutrient Content.* —PHTME research could improve operations such as food storage, handling, shipping, intermediate processing, packaging, delivery to merchants, and shelf life, and thus influence nutritional value and product quality. For instance, some nutrients, notably vitamins and fats, are sensitive to changes in pH, oxygen, heat, light, and can be depleted during transport, storage, or processing, Technologies could be developed to inhibit mycotoxins and infestation by insects and rodents. PHTME technologies also have helped improve diets through food enrichment—e.g., addition of vitamins B_1, B_2, and niacin to cereal products, vitamin D to milk, and iodine to salt.
- New *or Improved Food Products.* —Research can help develop nontraditional food sources as alternatives to today's highly capital- and energy-intensive food production and processing. Substitute foods and ingredients already have been developed by using diverse raw materials. For example, raw soybeans are now used to produce soy flour, protein concentrate, soybean isolates, or textured products. Because the importance of plant protein in diets is expected to increase relative to meat, fish, and egg protein, research in this area may have great potential for providing food to the world population at reduced costs.
- *Information for Decsionmaking.* –The ME of PHTME is marketing economics research. Work in this area helps provide information to farmers, processors, distributors, consumers, and policymakers, which improves the effectiveness of their decisionmaking. Information can range from economic forecasts on grain crops to cost-benefit analysis of food

regulations—e.g., food labeling, marketing orders, and food safety.

- *Industry Competitiveness.* —Some PHTME research measures the competitive relationships among firms providing a similar set of products or services. This research can examine factors such as the degree of market concentration, barriers to entry, types of competing organizations, and regulations that affect competitive behavior. The information provided is useful for: 1) affected businesses and the public to help understand the forces shaping the industry, 2) business groups developing long-range plans, and 3) policymakers designing alternative legislative proposals or regulations to ameliorate, maintain, or enhance competitive relationships.

PHTME research benefits can accrue to a number of *beneficiaries,* including:

- *Farm Producers.* —By improving storage, processing, retailing, and transportation systems, postharvest technologies enhance the value of farm commodities by letting producers distribute the sale of products over time. Thus, farmers can obtain increased income by selling products off-season or in nonproducing areas. In addition, marketing services increase information available to producers, increasing their chances to sell at more favorable market prices.
- *Consumers and General Economy.—Tech*nological changes in the postharvest or marketing sectors that reduce the costs of product transformation or marketing services can reduce retail prices for consumers. Similarly, consumers also can benefit from improved market or price information which leads to more informed decisionmaking. In addition, consumers benefit if food quality, nutrition, safety, and convenience are improved.

  The distribution of PHTME benefits varies with income. OTA found that the ratio of consumer benefits to family income was almost four times higher for the lowest income class than for the highest. Thus, PHTME technologies have a greater beneficial impact on low-income families than on high-income families.
- *Marketing Firms.* —Marketing firms also can benefit from PHTME research, depending on the competitive structure of the industry. In a competitive economic environment, firms that adopt more efficient and productive technologies might pass the savings on to consumers. This could provide a higher price for farm producers and lower retail costs for consumers. Some firms may retain some of the cost savings in the form of increased profits. The PHTME sector has elements of both economic environments depending on the commodity or food product.
- *Labor and Other Input Suppliers. —New* technologies can foster increased labor productivity, allowing for increased wages and salaries without necessarily increasing retail prices. The result can be a wider variety and more abundant supply of goods and services. However, when more productive postharvest technologies are adopted, the displaced labor force must find other employment.

Trends in Research Funding and Relationship to Research Beneficiaries

In comparison to production research, PHTME research has not been a major public sector priority. Combined USDA and SAES expenditures for PHTME research equaled $260 million in 1981 and accounted for 18 percent of total USDA and SAES agricultural research expenditures, while production research accounted for 69 percent. Further, public expenditures for PHTME research in constant dollars have *increased only 1.6* percent between 1966 and 1981. Since 1978, constant dollar expenditures for PHTME research have *declined* 8 percent.

USDA and SAES individual expenditures, however, show two different and distinct patterns. USDA expenditures for PHTME research (including funds transmitted to SAES and other agencies) *decreased 17* percent in constant dollars between 1966 and 1981. In contrast, SAES expenditures for PHTME research *increased 32* percent in the same period. By 1980, SAES had increased its share of the total public expenditures for PHTME research from 38 to 51 percent.

The majority of SAES funds for PHTME research come from State appropriations. These appropriations increased from 43 to 56 percent of SAES funds for PHTME research between 1966 and 1981. Federal funding of SAES postharvest research from 1966 to 1981 declined from 53 to 38 percent. Thus, State appropriations now provide over one-half of the expenditures for PHTME research in the SAES. This is important when considering the relationship between research beneficiaries and source of funding.

OTA found that the majority of the benefits from PHTME research flow to those regions and States with high concentrations of population. In all geographic regions except the Northeast, the total benefits accruing to residents outside the region where the research is conducted are at least four times greater than the benefits accruing to the residents in the region.

The bulk of PHTME research at present is conducted in the major farm-producing States and is mainly supported by State appropriations. Thus, taxpayers in the major agricultural States, such as the Midwest States, are subsidizing PHTME research for consumers in the less intensive agricultural States, such as in the Northeast. When research benefits the wider public, funding can be more equitably provided by the Federal Government. The inequitable distribution of costs and benefits of PHTME research argues for increased Federal Government support.

Quality of Research

In the debate between the executive branch and Congress on funding PHTME research, critics frequently point to declining quality of the research, faculty, and graduate students as reason for not supporting public PHTME research. Such assertions are subject to question. A review of relevant literature failed to find any formal methods for evaluating the quality of research. Thus, the perception that the quality of agricultural research is declining is based solely on informal judgments.

This study attempted to find credible ways of measuring the quality of PHTME research. One measure examined was the number of citations of: 1) PHTME publications in peer-reviewed journals, and 2) PHTME patents. Using these approaches, OTA found that PHTME is providing a body of scientific literature that is roughly comparable to that produced in other applied sciences. Further, PHTME research is providing patents that are subsequently cited by the private sector. On the other hand, the OTA review was consistent with the view that PHTME researchers may not be aware of relevant research in closely related scientific disciplines and that some research programs could be better organized.

Public and Private Research Sectors

Public and private participants contribute to PHTME research. However, no fixed pattern has developed with respect to kinds of research performed by USDA, SAES, and industry, and no principle has been apparent in determining the role of each. Decisions as to who performs what research in the public sector invariably have been decided ad hoc, and are often arbitrary, expedient, and inconsistent from year to year. These decisions also are easily influenced by immediate pressures rather than being guided by uniform, long-range principles. More clearly defined roles could help each sector contribute more fully in their respective areas.

Role of Private Sector Research

The private sector is motivated by market incentives. If management believes that the private rate of return will be substantial, resources are allocated for research. This memorandum estimates that the social returns from private research are approximately double the private investment returns. Some distinguishing characteristics of private sector PHTME research need to be taken into account when considering its role: 1) most private sector research tends to be focused on short-term applied problems; 2) longer term inquiry into biological, economic, and social system structure and function would not tend to be supported by private sector research; and 3) even though there may be substantial social benefits from private research, private industry generally is not concerned with the net social benefits from its research endeavors and is reluctant to release information that might cause technologies

or processes they use to be adopted widely before they benefit from the economic returns that accrue to new, cost-cutting technologies.

Thus, the areas of PHTME research that are pri*marily in* the private sector domain include: 1) *patentable processes and* techniques-research that most nearly fits short-term applied problems; 2) *research to meet Federal and State regula*tions—research needed for a business to stay in operation while meeting social objectives; and 3) *research to maintain or gain new clientele.*

Role of Public Sector Research

The OTA study shows public sector research to be justifiable for at least three reasons: 1) because benefits are distributed beyond those who bear the costs, and substantial social advantages are derived from both public and private research; 2) in the absence of public sector support and guidance, PHTME research might be biased strongly toward mechanical and chemical technologies, since economic returns can be extracted in the short run; and 3) for those situations where private research might be detrimental to industry competitiveness, a mix of public and private research may best preserve competition or reduce market power.

Thus, the areas of PHTME research that *are primarily* in the public sector domain include: 1) *basic knowledge, 2) information to support policymakers and government action and regulatory agencies so* that informed decisions can be made, and 3) *research to enhance competition,* through development of technologies and information that is disseminated to the public.

Joint Public and Private Sector Research

Some areas of PHTME research merit both public and private sector research. This is the case when social returns exceed private profit because a large share of the gains from the private research can be captured by other firms and consumers. Thus, research that is best done jointly by the private and public sectors includes: 1) new food sources and their development, 2) naturally occurring food contaminants, and 3) yields in relation to productivity versus nutritional components,

Management of USDA Research

Three research agencies in USDA conduct and fund PHTME research: the Agricultural Research Service (ARS), Economic Research Service (ERS), and Agricultural Marketing Service (AMS). Each agency reports to a different USDA Assistant Secretary, a factor that complicates planning and coordinating PHTME research.

ARS is not organized to manage, conduct, or be responsive to broad regional and national PHTME research needs. When the 1972 reorganization of ARS transferred line responsibility to four regional administrators, the National Program Staff was left without direct responsibility for program development, staff selection, and resource allocation. This reduced the ARS ability to plan, manage, and conduct research on broad problems. This agency thus lost national technical leadership. In addition, PHTME research is identifiable as an individual research entity at the national level, but no such distinction exists at the regional or area level. Not only does this provide opportunities for duplication, but it increases the likelihood that broad regional and national PHTME research will not receive adequate attention and that Federal funds appropriated for these purposes will be used inefficiently.

ERS allocates a large part of its resources to PHTME research; nevertheless, the expenditure is not identified as a separate research activity. PHTME research is fragmented, with an accompanying loss in direct cooperation with ARS laboratories and university departments of agricultural economics.

AMS is an action agency with a small research program that focuses on wholesale market development. AMS distributes market news to the agricultural community, inspects and grades agricultural food products, and conducts other regulatory activities. Few AMS activities are devoted to market development. Its research program suffers both by being isolated from the main PHTME research programs and by being located in an action agency which, given its mission, has a low priority for this research. A research program that supported the major mission of the agency probably would be of more value.

USDA and SAES Roles

The allocation of research responsibilities between USDA and SAES is distributed logically. The Federal Government, either intra- or extramurally, must give highest priority to problems of national significance, and must, as a part of this responsibility, be aware of States and private industry contributions toward national objectives. SAES, insofar as Federal funds are concerned, give highest priority to State and regional concerns. As more is known about the beneficiaries of this research, and in particular the relationship between funding source and beneficiaries, there is increasing evidence to support a major Federal effort in PHTME research because for most technology development, the beneficiary is the U.S. public generally rather than any one State or region. Thus, the Federal role includes: 1) providing leadership in identifying national research priorities and conducting supporting research with a regional or national emphasis; 2) supporting SAES so they conduct research of special concern to a locale, State, or region; 3) assuring development of new, fundamental knowledge by supporting or conducting basic research; and 4) maintaining a research capability for conducting basic and applied research in support of unique Federal missions.