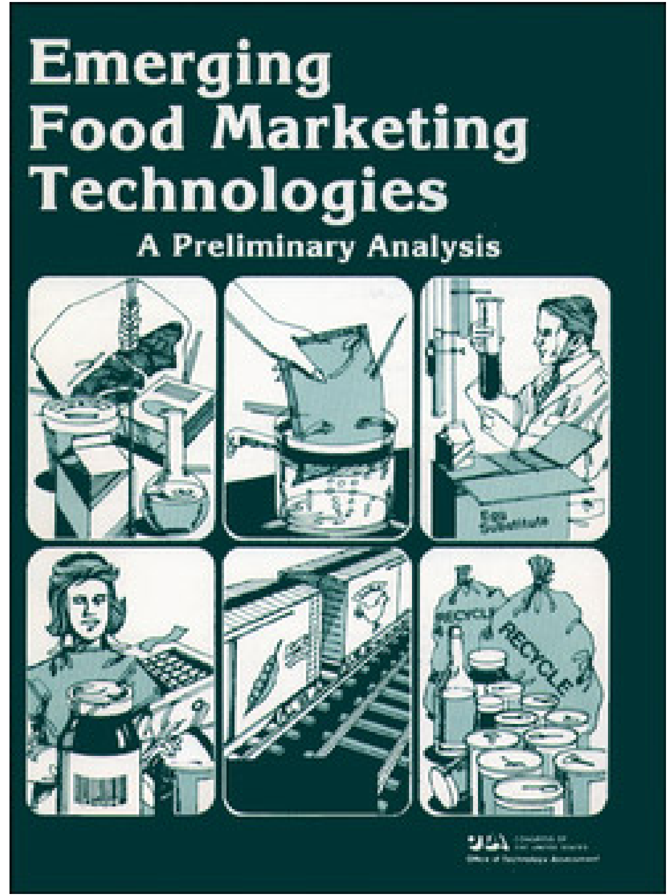
Emerging Food Marketing Technologies: A Preliminary Analysis

October 1978

NTIS order #PB-291039



Library of Congress Catalog Card Number 77-600131

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C. 20402 Stock No. 052-003-00612-0

Foreword

Food marketing technologies in the United States are undergoing major changes with a number of global implications. The purpose of this preliminary analysis was to gain a better perspective of these changes. It has helped to define the need for a major assessment of alternative global food futures.

The staff of the OTA Food Group conducted the preliminary analysis with the assistance of the OTA Food Advisory Committee and a 22-member Food Marketing Technologies Working Group. The analysis is a synthesis of many inputs and does not necessarily reflect the position of any individual.

We thank the Economics, Statistics, and Cooperatives Service of the U.S. Department of Agriculture for permitting Dr. William Gallimore to be detailed to the OTA Food Group to assist us with this analysis.

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EXECUTIVE SUMMARY

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The identification of new or emerging food marketing technologies that will have significant long-range impacts on society and the U.S. food system was the objective of this preliminary analysis.

Food marketing is defined as the activities that take place within the food system from the farm gate to the consumer. These activities include processing, wholesaling, retailing, transportation, and food service. In 1977 consumers spent $180 billion on domestically produced food. The marketing bill was $123.5 billion, or 68.6 percent of this total, which represents more than twice the farm value of that food.

Using a mail survey, a working group, and collateral staff work, the Office of Technology Assessment (OTA) has identified the social and economic factors that interact with and may be expected to influence the emergence and adoption of marketing technologies. The availability and cost of energy, supply of and demand for food (domestically and worldwide), environmental concerns, food safety, nutrition and health, and consumer attitudes are the major factors identified. Other elements include the availability and use of raw materials, importance of preventing spoilage and waste in the marketing system, and the effect of changing lifestyles on consumer preferences and attitudes.

These socioeconomic elements and the marketing technologies are outlined and analyzed using two differing scenarios. The first scenario assumes that only minor changes will occur in the socioeconomic climate through the year 2000 and that trends will continue basically the same as they are today. The second, which is felt to be the more realistic and applicable, assumes changes from the current situation that will effect concomitant changes in the food marketing system.

Each technology is examined from the following points of view:

- Its current state of development;
- The degree of probability that if and when developed it will be adopted into the marketplace;
- The extent to which it will be used;
- Expected impacts, both negative and positive, of the technology and where these impacts may be felt; and
- Significant policy issues that may be explored in connection with a given technology and the effect it may have on society.

On the basis of the foregoing, seven technologies were judged by OTA as highest priority.

- Texturing, binding, flavoring, and associated technologies that will pr~ duce engineered or fabricated foods to substitute either for a complete food (such as meat or dairy product substitutes) or for an ingredient or ingredients in currently produced foods.

- Technologies that provide quality assurance in vehicles used to transport food and food products. These include identification, tracking, and cleaning of contaminated vehicles; freight car design; and the use of certain vehicles to transport only food and noncontaminating, food-compatible commodities.
- Technologies that produce the reportable pouch, a multilayer plastic and aluminum package that will withstand heat processing and produce shelf-stable products in no need of refrigeration before opening.
- Electronic checkout in retail food stores, including systems able to scan the Universal Product Code currently printed on about 80 percent of food packages in grocery stores.
- Technologies to reduce the extent of food loss throughout the marketing system—including processing and packaging, transportation, and retailing—and in food service and home preparation.
- Electronic food shopping systems as alternatives to current retailing systems. These include warehouse-to-door delivery, automated mini-markets, and mobile automated markets that would travel to the customers. The effect of these systems would be to make food available in areas where the retailing system is now inadequate or to supply food in areas of special need.
- Technologies for recyclable and returnable food containers that would extend present technology beyond beverages to other applicable foods.

Most of these technologies are directly concerned with preventing food losses in the food system, conserving resources through more efficient processing methods or waste reduction in the delivery system, and producing new foods to substitute for traditional ones. Others, such as the electronic checkout and electronic food shopping systems, reflect concerns over technologies that may be economically justified but that may have undesirable consequences to society's quality of life. Some of these technologies are in use, some exist in the develop mental stage, and some are identified as areas where technological innovation is needed to respond to an existing, emerging, or potential problem. These technologies will have both positive and negative effects on agricultural producers, food manufacturers, processors, retailers, labor, and consumers. Will steps be taken to attempt to maximize the benefits and to minimize the negative consequences?

Chapter I

INTRODUCTION

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INTRODUCTION

There are two futurists' ideas that have particular relevance to this report. The first is that the future should be viewed not as a single future but many possible ones and that if enough people agree on a desirable future and work toward that end, this will essentially be the future that will unfold. The second idea is from the French futurist Bertrand de Jouvenel, who stated that to preserve the ability to make choices and not become victims of necessity, public policy leaders should identify emerging situations while they are still manageable and not yet at the crisis stage.

Although there are many differing conceptions of what the world or the United States may be like in the year 2000, the outlook is in general more optimistic than pessimistic. One accepted method of predicting and understanding possible changes in the world's future is to identify present trends. The following are some of those trends that certain futurists believe will, if they continue, make the world different in the future:

- Increasing world political unification and cultural standardization;
- Growing affluence for one-half to two-thirds of the people on Earth with continued poverty for the remainder;
- Decreasing importance of the family as a social unit;
- Less industry orientation of developing countries;
- Increased longevity and personal mobility;
- Rising educational levels; and
- Greater emphasis on religion.

That these trends, if continued into the future, will affect all segments of our lives is not in question; and since the importance of food in our lives cannot be questioned either, it is essential that we be aware of changing conditions that will affect the food sector. American consumers spent an estimated $180 billion[1] for domestically produced food in 1977, approximately two-thirds of which ($123.5 billion) was for marketing services. Because food expenditures have been increasing and marketing services take such a large share of these expenditures, there is the incentive by industry to develop and adopt technologies that will help lower marketing costs. The development of new products, the need to reduce energy consumption, and concerns over the food supply are other reasons for developing new food marketing technologies. On the other hand, the emergence of change in certain socioeconomic factors may create a climate that forces or encourages the industry to change, economic incentives to the contrary. Understanding the issues involved and their expected impacts on society are important considerations for future legislative and policy deliberations.

[1]This represents 25 percent of total consumer expenditures of $730 billion excluding energy and services. Stated another way, Americans spent $2.50 of every $10 at foodstores and away-from-home eating places. *Survey of Buying Power*, 1977.

OBJECTIVES AND PROCEDURES

Policy issues arise from either perceived or expected impacts resulting from the adoption of technologies. Impacts may be positive, negative, or a combination of the two; and not all impacts create policy issues. That is, negative impacts that are not severe or widespread may not be brought to the attention of policymakers, while technologies with primarily favorable impacts may create issues only as to whether policies should encourage their development and adoption.

The major purpose of this preliminary analysis was to identify and rank by priority food marketing technologies likely to raise major policy and legislative issues. Also included as part of this report is a discussion of social and economic factors that should be expected to interact with those technologies. These factors are equally as important to the execution of assessments in this area as are the technologies themselves.

Four types of technologies are discussed:

1. Available technologies in food marketing that will be more widely adopted,
2. Technologies in the development phase,
3. Technologies that will be developed and possibly adopted by the year 2000, and
4. Technological gaps.

A four-step approach was used in developing the information for this preliminary analysis:

1. Soliciting views on existing and emerging marketing technologies and related policy implications through mail surveys of specialists,
2. Preparing a preliminary report based on present marketing technologies and those new technologies revealed through the mail survey,
3. Convening a workshop to critique the preliminary report and elaborate on the issues, and
4. Preparing a final report based on all data.

Details of the procedures followed in the assessment are given in appendix B, and materials used by the working group are in appendix C.

Chapter II

PRIORITIES FOR TECHNOLOGY ASSESSMENT

Chapter II

PRIORITIES FOR TECHNOLOGY ASSESSMENT

Food marketing comprises the activities that take place within the food system from the farm gate to the consumer. This includes processing, wholesaling, retailing, food service, and transportation. This excludes all functions performed by producers on the farm. (See appendix A for background information on the U.S. food marketing system.)

An effective food marketing system should provide an adequate and continuous supply and variety of wholesome, nutritious foods to all consumers at reasonable prices and provide reasonable returns to producers and sellers. While simple to state, assessing performance is complex because cost efficiency is a major governing factor, and yet fulfilling other requirements may increase costs. For example, seeing that food meets safety standards may add to its cost. In the short run, a technology may increase efficiency and lower cost to the consumer, while in the longer run it could result in structural changes to the industry that could impede competition and result in less-than-reasonable prices for consumers. Any technology that would require a large outlay of capital and therefore drive out smaller firms could lessen competition and increase prices. Likewise, returns to the various segments of the system must be sufficient to attract needed capital and make changes necessary to meet performance standards.

The marketing system breaks down logically into two major segments: processing and distribution. Processing technologies are classified in this report under five headings: 1) preservation, 2) new and improved equipment and processing techniques, 3) new and modified food products, 4) new sources of food ingredients, and 5) packaging. Distribution technologies are classified under four headings: 1) wholesaling, 2) transportation, 3) retailing and food service, and 4) those technologies that cross over the above three in their application and effects.

PRIORITY SELECTION

Priorities for the processing and distribution technologies discussed in chapters IV and V are based on staff work, literature and research reviews, and contributions from public participants in the Office of Technology Assessment's (OTA) mail survey and workshops. The priorities are based primarily on probability of occurrence and expected impacts of each technology.

This section synthesizes the priorities and cuts across both processing and distribution and considers the total marketing system. It identifies the seven technologies that emerged as highest priority for future assessment (see table 1, which lists the major technologies or technological areas and the areas on which these technologies may be expected to impact). The criteria for setting priorities within this listing include how each technology affects or might affect the total marketing system, the probability of the development or adoption of that technology, and its expected impacts in relation to the food system and the social and economic climate (see chapter III).

Several technologies discussed in chapters IV and V represent technological gaps rather than developed technologies. Those technologies needing further research and development are identified at the end of this chapter.

Cross-fertilization occurs and no one impact can be singled out as the most important or far-reaching. In many cases, the adoption of Technology A will impact on Area A, while the adoption of Technology B will impact on Areas A and B and in turn affect the adoption or limit the impact of Technology A. This interrelation and interaction of technologies and impacts is, in the end, the most important consideration of a technology assessment.

Nutrition and food safety are affected by processing and packaging technologies but may also be affected by technologies in food distribution (wholesaling, retailing, transportation, food service) such as those in sanitation and loss prevention. Many of the distribution technologies are expected to affect industry structure, and in some instances this may affect how firms interact with each other, with other marketing segments, and with consumers. Capital requirements for many technologies are the prime cause for many of the structural changes that take place. Many technologies are adopted to improve productivity and substitute for labor (employment), and these generally will give rise to issues of job loss or labor relocation. The prospects for future increases in energy costs encourage development of energy-saving technologies, so that the energy-producing industries will be affected.

Many of these high-priority technologies are directly concerned with preventing losses in our food system, either through more efficient processing methods or waste reduction in the delivery system, and with producing new foods to substitute for traditional foods. This reflects the concern that between now and the year 2000 our food supply will have to be better managed and more efficiently utilized if the United States is to supply food needed in the rest of the world and keep domestic prices at reasonable levels.

What follows is a comprehensive summary of the seven highest priority technologies. They are also discussed in more detail in chapters IV and V, and the reader will be referred to the appropriate pages should more information be desired.

Table 1 .—Issue Areas of Food Marketing Technologies With High Priority for Assessment

Technologies / Impact Areas	1. Engineered foods	2. Sanitation in distribution	3. Retort pouch	4. Electronic checkout	5. Technologies to prevent food loss	6. Electronic food shopping	7. Recyclable, returnable containers
Marketing functions							
Processing	x	x	x		x		x
Packaging	x		x	x	x	x	x
Wholesaling		x	x	x	x	x	x
Retailing		x	x	x	x	x	x
Food service	x	x	x	x	x		x
Transportation	X	x	x		x		x
Nutrition	x		x		x	x	x
Food safety	x	x	x		x		x
Industry structure		x		x		x	x
Employment			x	x	x	x	x
Energy	x	x	x		x	x	x
Other resources	X		x		x		x

FABRICATED FOODS

The technologies that are used to produce fabricated, or engineered, foods are considered high-priority candidates for assessment because they are already in use, their impacts have already been felt, and it is highly probable that their development and use will continue in the years ahead. Sales of fabricated foods were more than $6 billion in 1972 and are expected to exceed $11 billion by 1980.

Fabricated foods may be divided into two types: ingredients (extenders and fillers) and analogs (substitutes).

The extender used most widely in meat products today is vegetable protein, usually from soy, in hamburger or meatloaf. Analogs are substitutes fabricated to resemble a specific traditional food, such as breakfast sausage from vegetable protein or non-dairy coffee whitener, cheese, whipped toppings, or egg substitute from vegetable oils.

Several advantages have been cited for these products: lower cost, extended food supply in times of shortages, reduction in energy use, better control of nutrient content, and more efficient utilization of resources. The issues that surface from the use of these foods, however, are already of serious concern to producers, consumers, and nutritionists, among others.

Because fabricated foods make use of a number of additives and unconventional ingredients about which official standards and regulations are frequently incomplete or in disagreement, many persons worry that those who consume these products are not being adequately protected. Others, however, believe that these regulations overly restrict the development and acceptance of what maybe a viable solution to the problem of maintaining an adequate, dependable, and nutritious food Supply.

Nutritionists and others are concerned about the effect consumption of fabricated foods may have on overall nutrient intake. While the use of vegetable protein as a meat extender or analog may be one way of pro tiding an inexpensive source of protein, the overall consequences of ingesting vegetable, rather than animal, protein (either in part or whole) have not been satisfactorily determined. On the other hand, these technologies afford the opportunity to supply specially formulated foods that will meet the dietary needs or improve the nutrient intake of selected target populations.

Two other issues that should be considered are adequate labeling and resource use. How should these foods be labeled to properly identify ingredients and yet not present barriers to consumer acceptance? If the use of these foods becomes even more widespread, how will this affect the agricultural production sector, particularly the meat, poultry, and dairy producers?

These technologies raise issues in the areas of food safety, nutrition, regulations, labeling, and resource use. (See chapter IV, p. 42.)

FOOD SANITATION IN DISTRIBUTION

Preventing the adulteration and spoilage of food is of concern throughout the food system. Since the problem of maintaining adequate sanitation is a serious one in the distribution system, particularly with the railroads, this area emerges as a high priority for assessment. Technologies and systems exist that could be used to solve this problem, although development of additional technologies is needed.

Contamination of food and food products in railcars has two major causes: cars are not cleaned adequately and may be infested with pests, chemicals, or micro-organisms; or cars used to transport food may have previously transported toxic substances, residues of which remain.

Several solutions to this problem are possible. Railroads need an efficient tracking system to monitor cars used to carry toxicants so they will not subsequently carry food or food products. Also, a method for detecting contamination in cars is needed. More thorough cleaning techniques must be developed for the rail system to have quality assurance in its freight car fleet.

Examples of possible technologies that have been suggested are:

1. Freight cars designed specifically for food products that will be more resistant to contamination and infestation.
2. Equipment and procedures for decontaminating freight cars. This would include trained inspectors operating with specific guidelines relative to food safety.
3. Freight cars specifically designed for food use and a system that will keep track of this "dedicated" fleet and schedule the cars efficiently. This must include an effective means of enforcement to maintain the integrity of the system.

A major policy issue in this area is funding the development of these technologies. At present, the railroads appear unable to secure the capital needed to initiate and maintain such a system. Serious attention should be given to the desirability of policies that would help railroads finance these needed improvements. If this system is needed and feasible, should it be encouraged through regulations, voluntary cooperation, or some type of incentive arrangement? (See chapter V, p. 54.)

RETORTABLE POUCH

The technology that produces the reportable pouch, while still being developed, has current applications; the pouch has received limited approval for use from relevant regulatory agencies (Food and Drug Administration and the U.S. Department of Agriculture). Further adoption and use of this technology can be expected to have strong impacts and far--reaching consequences throughout the marketing system, particularly in the areas of energy, food storage, transportation, and the environment. Owing to these expected impacts, reportable pouch technology ranks high on the priority list for assessment.

The pouch is a multilayer, adhesively bonded package that will withstand therm~ processing temperatures and that combines many advantages of the metal can and the plastic boil-in-the-bag. The quality of foods processed by this method is said to be superior to that of foods retorted in conventional cans, and taste tests indicate that it may approach that of frozen foods.

Energy savings are possible in processing because of shorter cooking times at lower temperatures. However, while the pouch itself would appear to offer savings in energy use, these savings can only be confirmed by a thorough analysis of different systems that are or might be used commercially.

Savings of as much as 50 percent (pouch vs. can) may be projected in the area of transportation owing to improved product-tepackage weight ratio. One question that must be answered, however, is the relative durability of the pouch for transportation purposes. Reportable pouches now in use are protected by an outer protective package, which limits the potential savings.

If this technology becomes widespread and inroads into the $17 billion frozen-food and $20 billion canned-food markets are as significant as expected, issues to be addressed include loss of revenue to producers of metal cans and industries producing raw materials, displacement and relocation of large segments of the labor force, and possibly considerable loss of jobs.

Environmental impacts of this technology may be considerable, in both a positive and a negative sense. The pouches are not recyclable, as compared to cans and most bottles, which would negate some of the initial energy and raw materials savings. However, reportable pouches can be used as fuel; therefore, even without recycling most of the energy initially expended in their manufacture could be reclaimed, while at the same time minimizing solid waste problems. It is essential that these problems be recognized, and that expected negative consequences be thoroughly assessed before industry attempts to revolutionize the food packaging industry.

ELECTRONIC CHECKOUT

Electronic checkout systems are already in use in about 300 stores, or less than 1 percent of all foodstores, in the United States as of the end of 1977, There is every indication, however, that the development and use of these technologies will continue to expand, with economic and social consequences for retailers, consumers, labor, and the telecommunications sector. Because of these impacts and the emotions they have aroused, electronic checkout technologies must be among those areas considered high priority for assessment.

At present, two electronic checkout systems have been developed. The first is an electronic cash register, which may be self-contained or tied to a central store computer. It relies on individually price-marked items and manual entry into the register. The second system, which has received the most publicity and generated the most opposition from consumers, is tied to a central computer and uses a seamer that reads the Universal Product Code (UPC) currently printed on a number of food packages. This system, like the first, has the potential to improve merchandising decisions resulting from better inventory control, improved labor scheduling, less need for storage space, more thorough analysis of sales, increased product movement, and better use of shelf space.

In addition, the UPC scanner system eliminates the need to mark prices on individual packages, since this information would be stored in the central computer and transmitted to the terminal when the UPC is read. Elimination of pricing has created most of the public opposition to this system. Bills have been introduced in more than 30 State legislatures and in the U.S. Congress to require that prices be marked on every item.

Opponents claim that lack of pricing deprives consumers of information they need to make rational purchase decisions and to assure proper charges. Proponents believe that this is outweighed by the many economic benefits that may accrue from the use of this system, stressing that this would probably result in lower food prices.

This technology will affect society in a broad sense. What particular components of the system generate savings, and how much of the savings are cash savings due to increased productivity of labor versus secondary savings from better management of inventory, pricing policies, etc. ? How much of these savings would be passed on to the consumer? How, in fact, would this technology affect consumer purchase decisions if products were not marked with individual prices? If this is indeed a problem, are there alternative solutions? How would widespread implementation of this system affect industry structure and competition, given the high initial capital required for installation (about $200,000 per store)? If individual prices were required by law, would this deter the growth of high-volume, low-price discount stores that might offer substantial savings to consumers?

The adoption of this technology would cause a reallocation of labor. How would this affect the 1.7 million foodstore employees and labor in related industries? Increased use of the electronic checkout may involve increased use of electronic funds transfer. What will be the impact on individual privacy and liability for losses and errors in the system? (See chapter V, p. 57.)

TECHNOLOGIES TO REDUCE FOOD LOSSES

Approximately one-fifth of all food produced for human consumption is lost annually in the United States. Technologies that reduce the extent of these losses can help in substantially increasing the food supply available from existing resources and will become increasingly important as worldwide pressure increases for more food. Such technologies include those that reduce waste in packaging and transportation throughout the marketing system and reduce losses that occur from pilferage and general lack of security control.

Waste resulting from mechanical harvesting might be reduced by improved harvesting technologies or by gleaning the produce left by mechanical harvesting. Waste resulting from spoilage and bruising in transportation might be reduced by using such alternatives as bulk packing at the field for shortdistance delivery to stores or by educating consumers of the benefits of damaged, but equally nutritious, produce. In addition, technologies are needed that will reduce the amount of food lost at the retail level by both pilferage and damage caused in handling.

Several questions remain unanswered, such as: What is the extent of loss in the marketing chain, when does it occur, and what technologies are available to reduce this loss? Another consideration has to do with the potential for utilizing produce that does not now meet grade standards because of size or blemishes, what consumer objections would have to be overcome to accomplish this, and would it be economically feasible? Technologies to reduce losses at retail, such as the electronic checkout for better inventory control, should be considered, as should better designed locking systems for railcars and trucks to reduce losses during transportation. (See chapter V, p. 61.)

ELECTRONIC FOOD SHOPPING

These technologies are not as likely to be widely adopted within the next 10 years as are the electronic checkout systems, but their gradual evolution would have very significant impacts on the marketing system, hence the high priority accorded them for assessment.

Three electronic food shopping systems are considered: warehouse-to-door systems, automated minimarkets, and mobile markets. These technologies apply primarily to large metropolitan areas and the special distribution needs of rural areas.

Possible advantages of ordering directly from warehouses and delivering directly to the consumer include savings in time to the consumer, in transportation costs, in fuel use, in convenience, and possible safety, particularly to the elderly. An assessment should analyze these technologies to determine whether they can indeed provide the same services as retail stores at less cost. Automated minimarkets, a convenience store where most items are dispensed automatically, as well as the warehouse-to-door system, are dependent to a certain extent on some type of credit, probably electronic funds transfer (EFT), which would be card-activated. Both systems are dependent, therefore, on the development and use of EFT technology.

Mobile markets would move products into certain areas on a scheduled basis. Tests indicate that this is a high-cost operation, but this cost could decrease if the operation were to become widespread.

The main advantage of all three systems is that they would make food available in imercity and rural areas, where such services may be at a minimum. The most apparent disadvantage is that with remote ordering or a smaller amount of food from which to choose, the consumer would be faced with a limited selection and in some instances would not be able to examine certain foods, particularly fresh produce, before purchase.

All of these technologies could be examined in relation to alternative systems, such as industry-cooperative programs for improving stores in the inner city, consumer cooperatives, and direct marketing by farmers in rural areas.

RETURNABLE AND RECYCLABLE CONTAINERS

Technologies for recyclable containers, returnable cans and bottles, and other refillable containers have a high probability of being an important part of our future; the impacts of adoption will be widespread. These technologies have developed because of socioeconomic pressure, and the pressure will in all events continue to build for new solutions through technology to the problems of conserving natural resources and reducing the expense of keeping our environment free of pollution from discarded containers. This is an instance of social and economic pressure creating demand that establishes the high priority given to these technologies for assessment.

Returnable and recyclable containers are being produced today, and many communities have set up collection points for cans, bottles, and other recyclable products. The public definitely seems interested in the concept of recycling, even if the specific technologies or systems to date may not have met with their approval.

These technologies fall into three categories: recyclable beverage containers, returnable and recyclable food containers, and the general concept of recycling applied to all food products. The issues, however, are generally the same for all and fall into the areas of economics and the most efficient resource utilization.

Returnables may add to the cost of distribution and handling of products (one study estimates a cost of 2 cents more per quart to deliver milk in returnable bottles), but whether this cost would be passed on to the consumer has not been determined, although it seems a reasonable assumption. Included in this issue is the high initial capital cost of converting production lines in bottling plants to handle returnables. An assessment should evaluate policies for overcoming such capital problems.

Delivery problems may also result from a widespread conversion to returnable bottles, since by law they cannot be transported in the same vehicle as new food products. This may give rise to new products that do not depend on bottles (such as powders to be mixed with water in the home).

Recovery and recycling of the materials from food containers may be one method of extending our natural resources. Various technologies for collection and processing of these materials have been initiated—for instance, large central high-technology plants for separating recyclable metal, glass, and other materials from refuse relative to separation by consumers of these materials before the refuse enters the recycling system. There may be no one system applicable for every situation, but people may have to make a choice of whether they wish to participate by paying for a centrally located or industry-based system with taxes or fees, or whether they would prefer to lower the cost by participating directly. (See chapter IV, p. 47.)

TECHNOLOGIES NEEDING MORE RESEARCH

Research is needed to further develop many technologies identified in this report that are not now in an adoptable state. The list below is not in priority order and does not include those technologies selected for high-priority assessment that would more clearly specify needs for more research.

The listing of these technologies should not imply that they are being advocated but rather that they are currently not developed to the point of adoption or that not enough research has been conducted to be able to assess their potential.

The processing and distribution technologies needing further research are:

1. More efficient utilization of water in processing (see chapter IV, p. 38),
2. Development of containers or railcars for better quality preservation (chapter V, p. 55),
3. Central cutting and packing of meat (chapter IV, p. 37),
4. Solar energy technology in processing (chapter IV, p. 40),
5. Meals-on-wheels and other delivery of complete meals to the home (chapter V, p. 60),
6. New analytical instrumentation and processes for detecting ingredients in foods (chapter IV, p. 39),
7. [ntermodal terminals constructed in main food distribution centers (chapter V, p. 56), and
8. Moisture reduction processes (chapter [V, p. 41).

Chapter III

SOCIOECONOMIC FACTORS

SOCIOECONOMIC FACTORS

This preliminary analysis calls attention to the likelihood of the emergence, adoption, and relative importance of food marketing technologies and their impact on and interaction with other such technologies, the marketing system, the Nation, and the world. To do this, one must first have identified those socioeconomic factors that may influence, and be influenced by, these technologies. There is a definite relationship between change in the socioeconomic climate and the development and adoption of new technologies. Given socioeconomic conditions may encourage or discourage the development and/or adoption of new technologies, while widespread adoption of technologies may, in turn, alleviate or exacerbate the conditions that influenced their development or adoption.

In order to identify all relevant socioeconomic factors, the Office of Technology Assessment (OTA) staff generated a preliminary list from a review of literature dealing with elements that may be expected to influence our future way of life. Two mail surveys were then conducted to identify those factors most likely to influence food marketing technologies (see appendix B for methodology). The processing and packaging survey included energy, pollution, health, and the supply and demand for food; the survey on distribution included energy, pollution, regulations, consumer attitudes, and the demand and supply for food.

Respondents were asked to comment on them and add others they felt should be included. Most respondents agreed with our list but added information and suggested additional factors. A summary of the socioeconomic factors most frequently mentioned is shown in table 2.

A working group was then formed of specialists in food processing, packaging, and distribution; members represented labor, universities, Government, and consumer groups. The initial list of factors was modified to include the ideas and comments of respondents to the survey and was made available to the working group, which made additional comments on the list.

SCENARIOS FOR THE FUTURE

One objective of the group was to estimate the possible time of development and adoption of the technologies. To this end, two scenarios were presented.

Scenario 1 projects that past and current socioeconomic trends will continue without major shocks into the future. It assumes the kind of environment one would expect if things evolve much as they have in the past 25 years.

The cost of energy and raw materials will remain about the same relative to other costs, and supplies will remain at the same level. Shortages will be transitory and will not

Table 2.—Socioeconomic Factors Influencing New Technologies as Indicated in Questionnaire Responses

Socioeconomic factors	Processing	Distribution	Total
Energy	49	14	63
Pollution	43	5	48
Demand food[a]	40	9	49
Supply food[a]	41	9	50
Health	44	—	44
Regulations [c]	5	12	17
Consumer attitudes[c]	2	9	11
Raw materials shortages	6	1	7
Prevent spoilage and waste	4	2	6
Changing life patterns, eating, lifestyles		4	7
Nutrition education	3	1	4

[a]These socioeconomic factors were in background materials sent in both letters.
[b]This socioeconomic factor was in background material sent with processing letter only.
[c]These socioeconomic factors were in background material sent with the distribution letter All other factors supplied by respondents. In some instances, respondents did not evaluate our list of socioeconomic factors or add any of their own.

cause major disruptions in the economy. The demand for food will continue at the same rate and prices will not rise drastically. The food supply will remain stable, with new sources adding to conventional production to keep pace with demand. Increased awareness of the relationship between nutrition and health will influence eating habits, which will be reflected in concern about food additives. Regulations will remain essentially unchanged. Lifestyle trends and demographic factors will not undergo drastic changes from current trends. Inflation will continue at 5 percent per year, median family income will rise to $25,000 by the year 2000, and consum-” ers will enjoy increased disposable income.

Scenario 2 depicts changes in current trends that can be expected to have more influence on the development and adoptionof technologies to the year 2000 than those in scenario 1 above.

Energy and raw materials prices will rise, as will our dependence on foreign imports, and supplies will be subject to periodic disruption for political economic, and other reasons. Foreign demand for food will increase, causing domestic food prices to increase. Alternative food forms and sources will be needed to augment food supply. In view of this, consumers, although concerned about health and food safety, will be willing to accept small risks and to use processed and fabricated foods. Regulations covering the testing and approval of food ingredients, including additives, will change. Food ingredients will be judged on benefits as well as risks. Some lifestyle factors will change, particularly in the area of central food preparation facilities. Inflation will increase at a rate of 7 percent per year, median family income will reach $21,000 by the year 20()(), and consumers will have less disposable income for discretionary use.

Participants in this study felt that scenario 2 was a more accurate forecast of future trends and that it would likely lead to the adoption of more new technologies than would scenario 1.

For a more comprehensive discussion of these two scenarios, the reader may refer to appendix C on procedures for the working group.

The remainder of this chapter addresses the socioeconomic factors identified as a result of OTA’s selection process. Just as the status of the technologies presented in this report should be updated periodically, so these factors should be reexamined from time to time. This will allow Congress to be alerted to continuations of and deviations from the status of these factors as presented here.

ENERGY AND OTHER RAW MATERIALS

The total food system consumes an estimated 17 percent of the total U.S. energy supply. The marketing sector consumes about 8 percent, the production sector 3 percent, and consumption at home the remaining 6 percent,[1] An increase in the price of energy has a domino effect through the economy—for instance, an increase in the price of energy will cause an increase in the price of steel that will be reflected in the price of canned goods that will in turn be passed on to the consumer.

The cost of energy will be a key factor shaping the development and adoption of food marketing technologies. It is felt that energy costs will continue to rise relatively faster than other costs, and this can be expected to act as an incentive to develop and adopt energy-saving processes throughout the food processing and distribution system as food moves through the marketing channels to the consumer. Many technologies are presently available that have been and will continue to be adopted and used in processing as the price of energy increases. However, in the long run new technologies will have to be developed and used to conserve energy until and unless new sources of energy are available. Packaging is second only to labor as a contributor to food cost, and therefore energy savings as an economic and technical factor must be an important element in assessing a packaging technology.

Because of the interrelationships among socioeconomic factors, trends and regulations in one area may work for or against potential energy savings in another. For instance, pollution abatement regulations may be energy-consuming. The convenience foods and individual packaging that consumers demand require more energy than unprocessed foods and larger packages. Some studies suggest that central storage and cooking of foods requires less energy than does home preparation.

Certain raw materials shortages may cause future problems in food marketing, especially in packaging. Plastic packaging materials based on petroleum have increased and will probably continue to increase in price. Other materials that may be in short supply include tin, aluminum, certain hardwoods (for pallets), and other raw materials.

To overcome these expected shortages will require technologies to provide substitute or alternate products at lower prices. Renewable resources may possibly be used to a greater extent than at present. Another possibility is the development of technologies that reduce the need for packaging,

Shortages of energy and to a lesser extent of other raw materials would mean relatively higher prices and would encourage the development of energy-saving technologies, However, the discovery and/or development of alternate energy sources—e. g., solar, geothermal—could dampen the increase in energy costs and adversely affect the development of energy-saving technologies. The positive impact of energy may be felt more in the processing and packaging areas than in distribution, as there appear to be more viable energy-saving technologies available for adoption in processing than in distribution.

[1]According to Energy Consumption in the Food System, processing accounted for 4.4 percent, wholesaling 0.5 percent, retailing 0.8 percent, and transportation 2.1 percent, for a total of almost 8 percent for the marketing system.

POLLUTION

Society seems to agree that our environment should be protected from pollution, but there is no consensus on the extent of pollution control needed or the price that should be paid. Most respondents to the survey felt that pollution control would bean important factor in food processing and packaging but less important in food distribution.

One way of offsetting the cost of pollution control is to convert polluting wastes to useful products. The consensus appears to be that while technologies exist to convert normally polluting waste to both animal and human foods, even more will be developed.

Waste may also be converted to energy and recycled back to the processing operations. Research is needed to determine if hybrid energy systems would make this feasible. Because of the high initial cost of waste-converting technologies and the need for large-volume processing to make them economical, economic incentives may be needed to pr~ mote transporting of wastes to central locations for processing.

New technologies or policies for economic incentives may be needed as well for solid waste management, including beverage containers and all other types of litter control, recycling, and resource recovery operations.

Pollution abatement equipment on transportation vehicles does add to initial cost and in some instances may add to operating costs, but it is felt that food distribution would not be materially affected by pollution abatement requirements.

DEMAND FOR FOOD

World population is expected to double from today's 4.2 billion by the year 2010, and" demand for food may be expected to increase accordingly. If the population increase is coupled with rising world income, as has been predicted, the demand would probably increase at a proportionately faster rate. Historically, rising incomes in developing and developed countries have resulted in an increased demand for animal protein and other foods requiring higher inputs of grain and other feedstuffs than vegetable protein, which can be consumed directly.

Domestic demand will reflect population increase, changes in economic climate and social values, and export policy coupled with foreign demand for U.S. farm products. The U.S. population is expected to reach 260 million by the year 2000, and total demand for food will reflect this increase. Some changing economic and social factors—older population with a large number of retired persons, singles maintaining homes, and more working women—have contributed to trends of less time spent on home preparation of meals and perhaps a change in types of food and packaging. However, these factors are not expected to affect total demand for food.

The U.S. policy on food and commodity exports through commercial channels and Government programs as the Food for Peace (P.L. 480) program will determine the availability of U.S. food for export. Our agricultural trade has shown a positive net balance of payments of about $12 billion for each year from 1974 through 1976 that offset the $8.5- to $1()-billion deficit in other sectors.[2] However, even though agricultural trade had a positive net balance of $10.6 billion in 1977, it was not able to offset huge deficits in oil and other imports for that year.[3] It is clear that continued exports of agricultural products to balance the purchase of oil and other imports will exert pressure to raise domestic food prices, especially in years when supplies are limited. Increased demand for food as outlined in both scenarios will have a very positive effect on the development and adoption of technologies in processing and distribution.

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[2]U.S. Department of Agriculture, Economic Research Service, *World* Economic Conditions in Relation to Agricultural Trade, WEC12, August 1977.

[3]U. S. Department of Agriculture, Economics, Statistics, and Cooperatives Service, *World* Agricultural Situation, WAS16, July 1978.

SUPPLY OF FOOD

Projections by the U.S. Department of Agriculture (USDA) indicate that conventional agriculture will be able to supply domestic needs to the year 2000 and perhaps beyond. This projection assumes average weather conditions and technologies that will keep productivity increases equal to past rates. However, unfavorable weather, a drastic energy shortage, or a leveling off of productivity rates could lower our expected food supply and mean that either additional land would have to be brought into cultivation by 1985 or new technologies would be needed.

A preliminary OTA staff study projects a U.S. surplus of total grains by 1985. World projections indicate a gradual tightening of the supply demand balance from a net surplus in 1978 to a slight deficit by 1985.

It is possible under these projected conditions that food prices could increase and food purchases will be more than the 16.8 percent of disposable income registered in 1976.[4] If conventional U.S. agriculture is not able to supply domestic and foreign demand at some acceptable price level, there will be an incentive to develop new unconventional food sources that depend on new technologies. One example might be the substitution of vegetable for animal protein, since the increase in the world demand for beef has been projected to increase 3 percent per year, with supply increasing only 2.5 percent per year. Supply conditions outlined in scenario 2 (conventional agriculture could not supply enough food at reasonable prices) would encourage the development and adoption of processing and distribution technologies.

[4] This statistic is a better indication of change in the cost of food purchases relative to disposable income than it is an actual measure of individual family food expenditures. Families with low incomes or those with large numbers in the family would have to spend a much larger share of disposable income for food than this figure indicates.

FOOD SAFETY AND NUTRITION

Consumers are concerned about the relationship between food and health and are increasingly interested in having more and better information on the nutritional and safety qualities of the foods they consume.

Consumers demand food that is free from harmful additives and from organisms that may cause illness. Some contend that additives may have an adverse effect on health; others contend that additives play an important role in food safety by preventing spoilage and preserving foods beyond their normal life span. Although additional regulations pertaining to food additives should be based on a risk/benefit analysis, determining risk and benefit for many food additives may be extremely difficult. The consensus of those participating in this study was that concern about additives could hinder development of fabricated foods unless criteria and processes for evaluating additives were modified. Some felt that more concern needs to be given to the naturally occurring organisms causing foodborne illnesses.

The other major concern in this area is the effect of quantity and kinds of food consumed on nutrition, Obesity caused by overconsumption of calories is one of the most serious health problems in the United States, more so than malnutrition or underconsumption of needed nutrients.

Concern about nutrition will likely increase in the years ahead. It would be in the best interest of consumers to increase and improve their habits, knowledge, and attitudes about food and its use through educational programs. This information should be provided in a form that they can incorporate into their daily lives and that clearly conveys the benefits and risks of consuming certain types of food.

The average American has been consuming steadily more fat and less carbohydrates.[5] Although total per capita consumption of sucrose is not much above that for the late 1920's, the per capita consumption of all sweeteners (natural and artificial) has increased, and there is concern about the large quantities of refined carbohydrates consumed by children and teenagers in soft drinks and snacks.'

'Since 1910, the per capita consumption of fat has increased from 4.5 ounces per day to 5.5, while per capita consumption of carbohydrates has decreased from 17,5 ounces per day to 13,4. However, there has been a small decrease in the consumption of saturated fat from 3.7 ounces per day to 3.3.

'Willis A. Gortner, "Nutrition in the United States, 1900 to 1974," Cancer Research, Vol. 35, November 1975,

A major concern in nutrition is the formulation of fabricated foods. From a technical standpoint, processed and fabricated foods offer the possibility of better control over nutritional intake. On the other hand, lack of fiber in our diet and excessive consumption of refined carbohydrates by certain age groups has been blamed on increased intake of fabricated drinks and foods. One fear is that increased consumption of fabricated foods may mean decreased intake of vitamins and needed trace minerals. Nutrition education may influence the kinds of food consumed in the future and indirectly, therefore, the technologies needed to produce them.

Workshop participants gener*ally felt that health concerns would have a net positive impact on technological development, particularly in the processing and packaging sector, and that the impacts would be stronger in the processing than the distribution sector.

REGULATIONS

It has been shown many times over that regulations can act to encourage or deter the development and adoption of technologies, and the marketing system is no exception. For example, the recent regulatory controversy surrounding the use of saccharin has spurred research into new alternative sweeteners; bills introduced in State legislatures requiring prices on all items in a retail store have rendered the future of the electronic checkout/Universal Product Code system uncertain at best.

It is alleged that many current transportation regulations discourage the adoption of technologies that would promote efficiency and save energy in the transporting of food. These regulations are administered by a number of Federal and State agencies and cover routes, rates, and equipment size and weight. The Department of Transportation has stated that "Very substantial improvements in fuel economy and overall transportation efficiency can be achieved by moderate increases in truck size and weight by the introduction of a simplified single nationwide size and weight code, " which does not exist today.

Other regulations affecting technological development are those on returnable bottles and on building materials and construction. Conflicting regulations by the Occupational Safety and Health Administration and USDA have been cited as detrimental to the full use of new construction technologies and maximum in-plant efficiency.

Regulations have also been a factor in hindering development of many processing technologies. Regulations are interrelated with health concerns, which in turn affect such technologies as fabrication and irradiation of foods. A recent statement by the Food and Drug Administration (FDA) points out that as the technology of fabrication advances and as more fabricated foods resembling traditional foods reach the market, there will be a greater concern over finding ways to assure the nutritional quality of food.'

[7]Stephen H. McNamara, "Nutrition Regulations by FDA in the Brave New World of Fabricated Foods, " speech delivered to the Food and Drug Institute Food Update 1977, Apr. 27, 1977.

Regulations in the processing area will have an overall negative impact onthedevelopment and adoption of new marketing technologies, while in the distribution sector the impact of new regulations will be positive relative to technological development.

CHANGING LIFESTYLES

Data on changes in household and family characteristics give a measure of changing lifestyles, From 1970 to 1977, the number of households increased 17 percent to a total of 74.1 million. Households composed of persons living alone or with nonrelatives increased 49 percent, the greatest increase of any category of households. Persons living alone increased 43 percent, one factor in reducing average household size from an estimated 3.14 persons in 1970 to 2.86 persons in 1977. The most rapidly growing segment of persons living alone is in the 12 to 24 years old age group, and the most rapidly expanding age group is from 18 to 44 years old.[a]

More wives are working, therefore demanding more convenience foods and increasing the amount of food consumed outside the home. [9] Two-income families are better able to afford these two more expensive types of food.

A recent USDA survey found that persons over 50 eat out less frequently than those under 50 and that the younger group uses fast-food outlets more frequently .10

It is difficult to assess the overall effect of changing lifestyles on technology because while demographic statistics are measurable and trends may be extrapolated, attitudes and beliefs are varied and often conflicting and of short duration. They are perhaps the hardest to predict with any degree of accuracy.

Consumers may want more convenience foods but may not like food additives or higher costs (although some convenience foods cost less than their home-prepared counterparts).]' Some want home gourmet cooking, yet many consumers prefer to eat out at fast-food outlets. Reacting to fads of unpredictable duration and dealing with what appear to be contradictory trends are among the problems faced by food processors and distributors.

There is no doubt that consumers are better educated and more concerned; they also appear to be more willing to join others in group actions such as cooperative buying clubs and cooperatively owned stores. Since retail stores are consumers' direct contact with the food marketing system, they must have consumer acceptance of or be able to overcome resistance to new retail technologies. Consumers may be more willing to try new foods, but they are also more willing to express their opinions of products and services.

There is little doubt that under certain conditions changing lifestyles will affect the development and adoption of technology in the years ahead. Changing lifestyles will probably have a small but positive effect on the development and adoption of food marketing technologies, especially under scenario 1 and particularly in the processing and packaging sectors under both scenarios. This

[8] Department of Commerce, Bureau of the Census, Population Characteristics, Households and Family *by* Type: March *1977*. Series P-20, No. 313, September 1977.

'One recent study estimates a 10-percent annual growth rate in away-from-home eating establishments between 1976 and 1981, which compares to a 13-percent annual growth rate between 1971 and 1976. See William C. Hale, "Rationalization of the U.S. Food Service Market and Opportunities for Supply Industries, " paper presented to American Paper Institute, Tissue Division, Oct. 17, 1977,

[10] Alden D. Manchester, *Eating* Out, National Food Situation, Economic Research Service, USDA, September 1977.

[11] Larry G. Traub, Convenience Foods-1975, Cost Update, Family Economic Review, USDA, Agricultural Research Service.

may reflect, in part, the visible changes in processing and packaging that have taken place to produce the many convenience foods now available.

INDUSTRY STRUCTURE

Structure as used here refers to the size of firms, market shares, and the way firms in an industry are linked together.

It is difficult to characterize the food industry as a whole, since it encompasses everything from giant to small firms. The four largest food processors had about 8 percent of sales in 1975, and the eight largest had about 13 percent. In 1976, the four largest chainstores had about 19 percent of the chainstore and independent grocery store sales (excluding convenience stores), and the eight largest about 27 percent. The trend over the years has been toward fewer and larger firms, and consumers and Government have expressed concern about the dominant market share of the large food chains in some geographical areas. This trend may become even stronger if ‘‘superstores, retail foodstores that also sell a large volume of non-food items, are successful.

While the number of wholesalers has remained steady, considerable change has taken place in the nature of wholesaling since 1960. Most large chains operate their own warehouse facilities and have integrated the wholesaling and retailing functions. In some areas, however, some chainstores have found it advantageous to discontinue their wholesale operations and have nonchain wholesalers supply their operations. Wholesalers have affiliated with their customers either in voluntary arrangements or as cooperatives, and wholesalers and distributors are becoming fewer and larger.

Participants in this study felt that industry structure would have a net positive impact on the adoption of technologies (although less on the distribution technologies under scenario 2). Since many technologies in this area require large capital investments and large volumes to operate economically, smaller firms may find it difficult to make such investments and compete effectively with the large firms.

OTHER INSTITUTIONS

Individual concerns may be expressed through acts that over time become institutionalized.

One such institution is organized labor, whose principal concern is with the adoption of technologies that threaten to reduce the number of jobs available or to change job status. The degree of concern and possible opposition depends on the severity of job loss or relocation, the union’s ability to gain support for its view, or the relative strength of the unions versus the industry involved. This may or may not, therefore, act as a deterrent to the development and adoption of certain technologies. In addition, union contracts act as a major impetus to wage increases, which tend to rise as prices increase; this can be expected to impact on the marketing of food as well as on other segments of the economy.

Other institutions that may influence technologies are those that come about through the organization of individual concerns—e.g., consumer groups—that may themselves exert influence on other groups or may influence local, State, and Federal institutions to work in their behalf. There is no doubt that such groups can have an effect, directly or indirectly, on the types of technologies that may be developed or introduced into the marketing system and the extent to which they are accepted and used.

FOOD WASTE

Approximately one-fifth of all food pro~ duced in the United States is never consumed.[12] It is wasted. This waste occurs throughout the production and marketing chain and may result from poor methods of harvesting, damage during transportation, inefficient utilization in processing, or spoilage. Spoilage leading not to total waste but to deterioration in quality may be caused by poor methods of preservation, rough handling, improper storage and temperature controls, or damage from insects, disease, and rodents. Significant amounts of food may be wasted at point of service in schools and other institutions, restaurants, and in the home.

Reducing this wastage should be of concern to all those involved in setting policy in the food sector, and interest in this area should stimulate new technologies in harvesting, waste conversion, and reduction of spoilage in the marketing charnels.

Increasing the amount and quality of food that ultimately reaches the consumer in proportion to the amount produced can have the beneficial effect of decreasing the energy used in both processing and transportation, reducing pollution through conversion of now-polluting wastes, and increasing the nutrient intake and therefore raising the nutritional status of Americans.

[12]U. S. Congress, General Accounting Office, Food Waste: An Opportunity to Improve Resource Use, CED-77-1 18, September 1977,

Chapter IV

PROCESSING AND PACKAGING TECHNOLOGIES FOR ASSESSMENT

Chapter IV

PROCESSING AND PACKAGING TECHNOLOGIES FOR ASSESSMENT

The processing and packaging technologies that the Office of Technology Assessment (OTA) considers of highest priority for assessment are listed (in priority order) in table 3. The list emphasizes those technologies with a strong probability of early occurrence and significant expected impacts. Given highest priority were those where the probability of adoption is considered high and that would be expected to have considerable impact if adopted. Technologies where probability of occurrence by 1985 is considered high but with moderate impacts or technologies where impacts are expected to be high but probability of adoption is considered low were given lower priority.

OTA staff ranked the technologies based on the information developed in the workshop and by collateral staff work. Detailed workshop discussions provided much of the information on impacts and issues for each technology and brought out additional points on development and adoption that aided in placing a general priority order for intended technology assessments on each of the technologies. (See appendix D.)

Technologies in this chapter have been divided into the following classifications: preservation, new and improved equipment and processing techniques, new and modified food products, new sources of ingredients, and packaging.

Processing is one of the series of operations performed on a product that aids preservation, makes it more convenient to use, produces a new food form, produces an ingredient for use in further processing, or produces a more palatable food. The number of plants and employees engaged in food processing is shown in table 4 under five broad classifications for 1963 and 1972. These data show the total size of the food processing industry and that the plants are becoming fewer and increasing in size, since the total quantity of foods processed has increased. Data for 1975-76 show that the top 100 food processors had food sales of almost $16 billion.[1] Total industry shipments of food and beverages, including imports, totaled about $193 billion.

Almost 4.4 percent of U.S. energy output is used in manufacturing food and kindred products, with about one-half of this consumed in the production of processing inputs. (The estimate may be conservative, as energy consumed on many capital inputs could not be estimated.)[2]

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[1] "The Top 100 Food Companies," *Food Processing*, December 1977.

[2] *Energy Consumption in the Food System*, prepared for the Federal Energy Administration by Booz, Allen, and Hamilton, Report No. 13392-007-001, December 1975.

Table 3.—Processing and Packaging Technoiogies With High Priority for Assessment

Technologies with high priority of adoption and high impact
1) Fabricated foods (p. 42)
2) Retort pouch (p. 46)
3) Recyclable and returnable containers (p. 47)

Technologies with high priority of adoption and moderate impact
1) Aseptic processing and packaging (p. 35)
2) Development of new sweeteners (p. 43)
3) Conversion of waste to human food and animal feed (p. 44)
4) Central cutting and packaging of meat (p. 37)

Technologies with low probability of adoption and high impact
1) More efficient water utilization (p. 38)
2) Irradiation (p. 36)

Table 4~.—Number of Plants and Employees for Food Processing

Type plant	Number 1963	Number 1972	Employees* 1963	Employees* 1972
Dairy products. . . .	7,885	4,590	257"	189
Meat packing.	5,300	4,437	300	308
Bakery	5,366	3,633	280	235
Canning & freezing	3,969	2,557	245	233
Grainmill products	3,555	3,080	113	111
Total	26,075	18,297	1,195	1,076

" Number of employees In thousands
SOURCE Olan D Forker and James L Pearson, The Food and Fiber Market System — Its Magnitude and Contribution,' speech presented at a workshop on Coordination of Market Research, May 9 1977, Washington, D C

PRESERVATION

One major aim of processing is to extend the storage life of foods through preservation techniques. Some methods preserve food in a state near the fresh form, while others produce drastic changes in shape, taste, and other characteristics, Preservation may change the form of the food very little, as in freezing, or completely, as in making cheese. Regardless of the end purpose of processing, preservation is a part of any process where the product is to be stored.

Preservation is not limited to the processing function; even fruits and vegetables to be sold fresh are handled by processing equip ment designed to minimize bruises. In same cases special washes and controlled-environment storage are used to aid preservation.

The principal techniques to extend shelf life and retard spoilage are those that act to remove or destroy potentially harmful micr~ biological organisms or suppress the activity of micro-organisms. Adverse changes in foods [spoilage) are caused by micro-organism or enzymatic activity, chemical reaction, or such physical or physiochemical changes as drying or crystallization. Microbial spoilage is the easiest to control, enzymatic conversions are more difficult to prevent, and chemical reactions are almost impossible to completely suppress. Techniques fall into three categories: removal, destruction, or suppression.

Removal may be accomplished by filtration when the product is water-soluble, and in certain instances by centrifuging, Such techniques generally must be combined with other methods in order to be effective,

The most widely used and effective technique for destruction of micro-organisms is heating, the only negative result of which is that beyond certain temperatures the quality of the product may be affected. Radiation is another method, although it may, at high levels, cause undesirable chemical reactions.

Other than destruction through heating, suppression of microorganic activity is the most prevalent method of preserving and increasing the shelf life of foods and food products. Techniques for suppression include cooling (refrigeration), freezing, and reducing water content. Freeze-drying, a method gaining acceptance but with economic disadvantages still to be overcome, combines the latter two techniques. Suppression by additive is a method used extensively in food processing, The additive generally changes the native characteristics of the food or food product—for instance, jellying, curing, and pickling by adding sugar or salt; fermentation; stabilization by adding alcohol or acid, In addition, such chemical or biological substances as preservatives or antibiotics may be added to a product to act specifically against microorganisms.

Modifications to and combinations of these preservation techniques are constantly being developed, and several specific processes, such as freeze-drying, that offer potential for greater use, are discussed in this chapter.

Aseptic Processing and Packaging

Aseptic processing brings together a pasteurized or sterilized product with a sterile package in a sterile environment, The process may be classified into three technologies: 1) ultra-high {temperature (UHT) pasteurization of liquids, combined with aseptic packaging, 2) aseptic canning of particulate foods such as fruits and vegetables currently frozen or canned, and 3) aseptic bulk storage of products.

Milk is the most common liquid sterilized by UHT processing and combined with aseptic packaging. The product will keep for several months without refrigeration and is currently available and used in many countries where refrigeration is at a premium. After opening, the product has to be refrigerated. It is being commercially marketed in Canada and test-marketed in the United States. Recent reports indicate that acceptance of the product in Canada has not been as good as expected, with flavor being the major problem. In addition to taste, the total energy use of this system must be assessed in relation to that used by other available systems.

Technologies are being developed that will permit heat sterilization of particulate foods so they can be aseptically canned. However, these technologies are not yet commercially developed. Presumably the products would be superior in taste and nutrition to conventionally retorted foods. Currently, only puddings and other nonparticulate foods are aseptically canned.

Aseptic bulk storage has been used for holding vegetables at field locations and in plants for further processing, Products have also been stored and shipped in aseptic rail tank cars. This method shows promise for overcoming some of the difficulties associated with products that must be harvested and processed in a short time, and it will have its greatest application in high-acid foods.

This discussion focuses primarily on the UHT pasteurization of milk in aseptic packages. The technology is currently in use and offers some concrete possibilities for an improved milk processing and distribution system, provided the taste of the product is made acceptable to U.S. consumers.

If widely adopted, the system would probably have a great impact on the production, processing, and distribution of milk. The impact is considered moderate, however, in that it concerns only one product and would not substantially affect the entire marketing system.

A smaller dairy herd would be needed for a given level of demand, since the long shelf life would permit carrying milk produced in the flush season over into succeeding months, when seasonal declines in production take place. Interregional production might be affected—for example, more milk might be produced in Wisconsin and less in Texas than at present. This also raises the possibility that producing and processing firms would become more concentrated and that smaller miik producers and distributors would be at a competitive disadvantage.

Distribution charnels would also be affected, since UHT milk could be handled in regular warehouse channels rather thari as a vendor item (such items are delivered frequently and on a regular basis to individual stores). This would have implications for labor contracts and potential shifts in labor concentration from drivers to warehouse workers or other occupations.

Consumers spent about $12.1 billion for fluid milk and cream in 1976. Because of the size of the industry, the fact that some cream is currently aseptically packaged, and the severity of market disruptions likely to occur, the first assessment of aseptic packaging should be on fluid milk and cream.

When technologies are developed that permit aseptic processing and packaging of solid foods, the impacts of these would need to be assessed relative to other technologies such as the retort pouch.

Bulk storage and transportation of fruits and vegetables would impact primarily on the processing and transportation system. The processing of fresh produce is now constrained by the period of harvest, and aseptic bulk storage would permit better and more flexible scheduling of processing operations, better utilization of facilities, possible decentralization of final stage processing, reduction in processing and transportation costs, and better utilization of the processing labor force.[3]

Bulk storage would cause relocation in labor, would require an upgrading of the rail transport system, and could result in better utilization of energy in transportation.

Irradiated Foods

Irradiation involves the exposure of foods to certain ionizing radiations—namely, either gamma rays or electrons. Irradiation is sterilization without heat and avoids many of the problems encountered with the use of heat. Foods sterilized by irradiation can be stored at room temperature indefinitely.

Irradiation of foods offers considerable potential for the preservation of products where refrigeration and other preservation methods are limited. Currently, food irradiation is approved in many Western European countries for extending the shelf life of certain perishable products, for controlling ripening of fruit, and for inhibiting sprouting of potatoes, and has been approved in this country for limited use to control sprouting of potatoes in storage and to eliminate insects from wheat. Irradiation significantly reduces the levels of nitrate and nitrites required to maintain color in cured meats. Currently, a variety of shelf-stable meat and poultry products superior to thermally canned products has been developed and could be made available to consumers when the Food and Drug Administration (FDA) approval is received.

There are two irradiation procedures for purposes of preservation: 1) low-dose irradiation used for pasteurization or in combination with another technology to prolong shelf life; or 2) high-dose irradiation to produce a shelf-stable product. The probability that shelf-stable foods produced through high-dose irradiation will be used extensively in the near future appears remote. Should it occur, the military would probably be the first user.

While there is considerable potential in this process, several obstacles must be overcome before this will become significant. Irradiation is defined as a food additive, therefore bringing it within FDA's jurisdiction, and each irradiated item must be proven wholesome. Irradiation may also cause undesirable chemical changes in foods. A potential obstacle to overcome is the public's possible apprehension about radiation. Although real progress has been made in the irradiation of food, the technology does not appear ready as a major method of preservation until the wholesomeness and safety questions have been resolved.

This technology has a low probability of occurrence but will have considerable impact if adopted. The implications for the food marketing system and the safety issues of concern to consumers place this technology high on the list of technologies expected to have strong but negative impacts.

Lowdose irradiation has the best chance of near-term adoption. The shelf life of products could be extended with the possibility of reducing loss in the distribution of food. Low-dose irradiation in combination with other methods of preservation, such as refrigeration, may offer the greatest chance for success.

High-dose irradiation produces shelf-stable products and would impact on the total marketing system. Consumer concern over the safety of the product from the irradiation process is an issue. If the process becomes economical and irradiation becomes a major method of food preservation, firms processing canned, dried, and frozen foods would be affected.

[3] "Purdue and Bishopric Share IFT's Industrial Award, " Food Technology, June 1976,

Freeze-Drying

Freeze-drying is contact drying which takes place at such a low vapor pressure that the temperature of the water drops below the freezing point. Freeze-dried products shrink very little and retain their original shape and much of their flavor.

For purposes of discussion, freeze-drying is divided into two technologies: freeze-drying combined with compression, and new methods of freeze-drying. Freeze-drying combined with compression will probably not be widely adopted by 1985, but it ranks about in the middle of all technologies based on impacts, with the negative about equal to the positive. When freeze-dried foods are compressed, the reduction in volume is from 4 to 2o times, saving space in storage, shipment, and display.

This process is currently in limited use. A big disadvantage has been its high cost; another is the large amount of energy the process uses. This is one reason for the search for new methods of freeze-drying. Currently, a method for gaining the volume-reduction advantages of compression without the need to use conventional freeze-dried starting materials is being evaluated, These methods have changed, but there have been no dramatic technologies to change the basic cost picture. Because of the high quality of the product and the potential for saving in transportation and marketing costs throughout the system, research is needed to find new methods that will lower the cost,

The major issue surrounding this technology is whether the process will become economically feasible. There are no known health hazards associated with the product. The technology is capital-intensive and, as with many such technologies, could increase concentration in the industry.

NEW AND IMPROVED EQUIPMENT AND PROCESSING TECHNIQUES

These technologies replace a present technology with little or no resulting change in the product but with a saving of inputs such as energy, labor, or water; a reduction in pollution; or an increase in output with less waste from the same quantity of raw material. Technologies that enable greater line speed in processing or reduce the degree of heat or time required in canning would be examples. Caustic peeling of fruits and vegetables reduces water consumption and waste in processing. Redesigning the washing equipment in poultry processing plants reduces water consumption and loads on the processing systems. New visual or electronic technologies for checking quality of food products fall in this classification.

Central Cutting and Packaging of Meat

In 1977, expenditures for beef were 2.1 percent of disposable consumer income and 4.5 percent for expenditures on all red meat (which includes beef, pork, veal, lamb, and mutton). Red meat accounts for 25 percent of the consumer food dollar. Any technology that would reduce meat marketing costs could have a significant effect on consumer income.[4]

Central cutting of beef involves cutting the carcass into smaller units before the beef is moved to retail outlets. An estimated two-thirds of the beef entering supermarkets in 1974 were broken down from the carcass.[5] This included beef precut at the packing plant, at wholesale centers, and at retail chain warehouses. There are different combinations of procedures and technologies. Boxed beef—where the packer breaks the carcass into primal cuts, vacuum-packs them,

[4]U. S. Department of Agriculture, Economics, Statistics, and Cooperatives Service, Livestock and Meat Situation, LMS-219, Washington, D, C., February 1978.

[5]John W. Allen, "A Look at Trends in the Meat Industry, " 1975. Paper presented at the Supermarket Institute Convention Workshop, May 6, 1975.

and ships them to the retailer in boxes—is about one-fourth of the movement to retail stores. Other combinations of technologies in systems generally involve retail store facilities or local wholesalers,

Central cutting and boxing of beef is felt to be economically feasible, and it is possible that opposition from labor unions has kept it from more widespread use. A recent U.S. Department of Agriculture (USDA] publication supports the contention that it is more economical to cut beef into retail cuts at central locations. The report, however, points out that present "boxed beef" is not the most efficient method and that in fact in some situations the more traditional methods of cutting the carcass at retail maybe more efficient.'

In view of the many differing systems and combinations of technologies involved in central cutting of beef, each major system should be assessed separately.

The health and economic impacts may be quite different between systems. Dr. Robert Angelotti, formerly of USDA, indicates that research is under way in the Department to determine the degree of contamination in beef cut in primals and vacuum-packed at central locations. Preliminary findings indicate that, ". . . vacuum-packaging of beef draws a purge of the body fluids which collect in the bottom of the bag and support a very different kind of microbial flora from that which is supported when meat is dry-hung in a refrigerator. Because the product has a 60- to 90-day shelf life in distribution, the organisms grow in the bottom of that bag and contaminate the muscle fibers which are separated, creating internal contamination which would not have happened if the meat had been hung dry."*

Appropriate questions may not have been asked during the development of this technology concerning product contamination as a result of this practice. The problem is not one of central cutting but of the type of packaging and the length of time the meat is held. It is critical to assess potential changes in the safety of the meat in relation to any change in the procedure for cutting and packing.

Central cutting of beef may impact on other areas as well. The number of meatcutters needed could be reduced, or relocation of workers might result as more meat is cut at central locations. Central cutting of beef into retail cuts raises the potential of loss at retail if the demand from day to day is not as expected. Once packaged as retail cuts, the meat must be sold within a limited time, although this could be up to 7 days if the meat is handled in a sanitary manner and stored at the proper temperature. Frozen retail cuts would eliminate this problem but world add t. the cost and in most instances meet with consumer resistance. The effect on energy consumption of a shift to frozen beef would be an important consideration.

More Efficient Utilization of Water in Processing

This is an area of technological need rather than of specific technologies. These technologies could reduce the amount of energy used in processing plants and the pollution from them. The probability of successfully developing these technologies is low, although specific technologies have been developed to reduce water consumption in poultry processing plants and in fruit and vegetable processing and packaging operations.

The positive impacts of these technologies would be on conservation of water and energy, resources expected to be scarce in the future; thus the impact of such technologies, should they be adopted, is considered high, since processing of most food products consumes vast quantities of water. Water-conserving technologies are not expected to raise many negative issues, but technologies that recycle water raise the possibility of contamination and associated health issues.

One needs to define the processes where water consumption is high and then determine what, if any, action is needed to encourage development of water-saving technologies.

[6]L.A. Deuwer and T.L. Crawford, Alternative *Beef* Handling Systems, Economic Research Service, USDA ERS-661, report from AER, Vol. 29, No. 3, June 1977.

*Working Group Proceedings on Emerging Food Marketing Technologies, Oct. 4, 1977, p.237.

Analytical Instrumentation and Processes for Detecting Ingredients in Foods

A technological process or series of processes that will identify ingredients in food plays an important role in food processing and safety. It need not be restricted LO a single ingredient and is obviously needed to detect toxic substances in food. This technology could complement the conversion of waste to food, where a major copncern is the safety of these foods and the kinds of residues that might be present.

Instrumentation of the type that will speedily and accurately detect ingredients in feed could have a positive effect in monitoring the processing and fabrication of certain foods because it would be capable of identifying not only toxic substances but also moisture, fat, and ai protein content.

Instruments capable of monitoring processing lines would provide a means of checking fabricated foods for possible toxic substances or contaminants and ingredient con tent. They would, therefore, be a positive influence on the development of, and possibly remove much of the concern about, the ' 'unknowns" in ersatz or fabricated foods.

The adoption of this instrumentation will add impetus to the existing policy dilemma of acceptable to!erance levels of certain additives, toxic substances, and carcinogens in food.

Microwave Ovens and Special Packaging

More than a quarter of the homes in the United States are expected to have microwave units by 1980. Available data projects over 6 million units in almost 10 percent of the homes in 1977. This trend could accelerate, since microwave cooking has been shown to save up to 70 percent of the energy in home cooking of some foods.

Microwave cooking in the home is compatible with convenience foods and fits in with the changes in lifestyles already under way such as the desire to spend less time in home preparation of foods,

Rapid expansion m the home use of microwave energy impacts on a number of areas, raises issues unique to home use of microwave energy, and reiates to other issues that are part of changing lifestyle.

Improvements have been made in design and production procedures of these units to prevent leakage of radiation. The issue is not completely dead, however, and consumers may resist buying microwave appliances or raise new issues associated with safety.

The rapid increase in home use of microwave ovens has spurred the development of new food formulations and packaging specially designed for microwave cooking, such as new paper trays and Ceramic containers spe~- cially designed for micrcwave or conventional oven use. Allthough it was developed as an answer to the speedy preparation of convenience foods, microwave cooking may in turn encourage the consumption of more convenience foods. This could mean more packaging and a consequent increase in energy use. Also, the effect of increased consumption of highly processed foods on nutrition and health should be considered.

If microwave units substitute for rather than supplement conventional ranges, there will be an impact on stove manufacturers. Many microwave units are built in foreign ccuntries and many electronic parts for 'J. S, makes are foreign products, This may contribute to an unfavorable balance of payments at a time when there is a deficit. Microwave units use less energy, therefore energv use may decrease, and there may be possible savings in home wiring compared to conventional ranges due to the decrease in energy needs.

Aquaculture

Aquiculture as used here refers primarily to the systematic cultivation of animal life in a water environment (in a broader sense it could also include plants). Catfish farming in the South is one example of aquiculture; crawfish, salmon, trout, and other fish are also produced this way, Recent experiments and pilot projects show promise for farming shrimp and other species.

Economics may discourage widespread expansion in the United States through 1985, although catfish and other species have been well accepted. Aquiculture could, however, make a positive contribution to the food supply and nutrition status were it to become more widespread. (One problem has been consumer acceptance of many species of fish and fish products made by aquiculture methods.)

Development of aquiculture is expected to evolve slowly, and the impacts on resource adjustments should be minimal. Technologies are needed to lower processing costs and more efficiently utilize the marine animals produced. Marine products are subject to contamination and spoilage, and new methods are needed in processing, preservation, and storage to minimize spoilage.

In some locations, toxic substances such as mercury have accumulated in fish at levels in excess of State or Federal levels established to protect human health. When this occurs, consumption of the contaminated fish is banned in the affected area, with an adverse economic impact on those directly involved. In aquiculture, the economic effects of such contamination would be more widespread and severe because of the large amounts of capital invested in the growing operations and processing facilities.

Solar Energy in Processing

The concept of solar energy as a technology in food processing includes dehydrating food with solar energy as well as utilizing solar energy to supply heat and power for processing operations. The U.S. Department of Energy (DOE), (formerly the Energy Research and Development Administration), is supporting a number of projects on the feasibility of solar energy in industrial heat processes, including heating water for washing food cans. Other studies are investigating the feasibility of using solar energy in industrial drying and dehydration, including prunes, soybeans, and onions.[7]

Unless a technology is developed that applies solely to food processing, specific impacts on food processing would be those associated with all processing plants, such as choice of location and level of energy requirements.[a] That is, conversion to solar energy in food processing would impact on energy suppliers in much the same way as conversion to solar energy in any large industry if the power from solar converters were supplied from central powerplants. If technology were developed that permits onsite generation of solar power, however, large firms would probably be able to convert before smaller firms and thus gain the competitive advantage. Large processing plants might also be more able to locate in areas with high probability of clear, sunny days.

Initial Preparation of Fruits and Vegetables in the Field

Much packing of fruits and vegetables is already done in the field. The original concept was to reduce the amount of waste produce shipped and to reduce work and pollution at the receiving site.

One facet of this technology that concerns loss prevention involves packing in bins that could be moved untouched through the system to retail outlets. Technologies for improved packing methods, better shipping containers, and controlled-atmosphere shipping should be considered. Aseptic bulk storage and transportation of processed tomatoes is an existing system that has potential for greater use. Waste is left at the production site, and the product is held and transported to a central point for further processing.

According to participants in the working group, these technologies have a high probability of adoption. The impacts will probably be positive. However, more information is required to determine which technologies may be the best under given circumstances, considering waste, cost, consumer preference, and other impact areas. For instance, bulk handling may be best for local and inter-

[7]U.S. Energy Research and Development Administration, Solar Energy *for* Agricultural and Industrial Process Heat, Division of Solar Energy, ERDA 77-72, Washington, D. C., June 1977.

[a]A comprehensive discussion of solar energy is found in Volume I, Application *of Solar* Technology to Today's Energy Needs, Washington, D. C.: U.S. Congress, Office of Technology Assessment, June 1978.

mediate distances, while some produce should be shipped in consumer packs with extensive secondary packaging. (See chapter II, Technologies to Reduce Food Loss.)

Mechanical Deboning of Beef

While poultry has been mechanically deboned for several years, approval for mechanically deboned beef (the bone and meat are pulverized together and the meat than separated from the bone particles) was withdrawn after objection by consumer groups. They did not appear to oppose the ccncept of mechanical deboning but wanted the label on the end product to clearly indicate that it contained mechanically deboned meat. The consumer groups were also concerned that meat deboned mechanically was more prone to bacterial contamination and would contain a small amount of pulverized bone. Consumers worried about the lack of information on the effect on health of increased intake of calcium from these bone particles.

USDA has proposed a new regulation requiring that the product be labeled as "mechanically deboned [type of meat) product,'' which wou!d require that there be not more than 20 percent of a meat-and-bone mixture in the product and placing certain other restrictions on use of the product. There were objections from the industry and others to this new proposal, which was then revised by USDA, Consumer spokesmen have questioned the research data attesting to the safety of the product, and industry groups have objected to the proposed name. Nevertheless, the regulations became effective in July 1978.

This particular technology and the opposition to its adoption underscore the need to include consumer concerns in the regulatory process and to accurately identify where the benefits will occur or where the disadvantages will be felt.

Mechanical deboning of beef will provide more edible beef or less waste from a carcass. The impact on producers is not clear; more edible products from a carcass make it more valuable, but better utilization of this technology would increase supply and depress prices unless new products were developed that would increase demand,

Major issues or concerns are product quality and the effects of long-term ingestion of pulverized bone. The labeling of mechanically deboned meat called for by consumers is a specific example of a labeling issue common to many ingredients derived from byproducts and waste.

This technology exists and is used today. The regulatory issue of ingredient labeling and the implications of this product on food safety, health, and nutritional status are serious concerns, as is its economics versus alternative deboning technologies.

Hot-Boning of Beef

Hot-boning of beef involves cutting the carcass into primals and removing the bones before the meat is chilled. This technology is considered to have a low probability of widespread adoption with relatively high negative impacts.

Advantages claimed for the technology are reduced energy costs for cooling, less space needed for storage, and less waste to ship. However, hot meat is claimed to be more difficult to cut than cold meat, and the change is resisted by the meatcutters, although this allegation has not been documented. In addition to energy and transportation aspects, health and safety, because of the possibility of contamination of the beef during hot-boning and associated procedures, are important societal issues.

Moisture Reduction Processes

Technologies exist that can dehydrate foods or reduce their moisture content (producing intermediate moisture foods) through one or a combination of treatments. The aim of these technologies is to produce a shelf-stable product.

New dehydrated foods are being produced through new applications or modifications of the drying processes. Vacuum foam-dried milk is one example. Another is continuous explosion puffing, a new system developed for processing fruits and vegetables which could substantially reduce preparation time and save energy.

The aim in producing intermediate-moisture foods is to reduce the water activity so the product will be shelf-stable yet have a moisture content higher than dehydrated products. A number of technologies are available that will produce intermediate-moisture foods such as fruitcake. The most common method decreases the water content and then infuses the product with soluble salt and sugars This changes the flavor and texture of the product, and consumers may consider some products to be of inferior quality.

Other possible techniques include reducing water activity and then applying a mild heat treatment. 'i'he immediate impact of this process could be to reduce energy use throughout tlie food marketing system, but these possibilities have yet t. be explored commercially.

If more foods are made shelf-stable through moisture reduction processes, this would imply some change in consumption habits, For consumers it would mean less need for freezer or refrigeration capacity with a corresponding saving in energy. If foods infused with salts or sugars become a significant part of consumers' diets, iheir impact on health and nutrition must be considered.

Dehydrated or partially dehydrated foods mean a saving in transportation and also in storage space. Energy needed for storage would be less than for frozen or refrigerated foods,

NEW AND MODIFIED FOOD PRODUCTS

These products genera!ly have been designed, engineered, or formulated from various ingredients including additives. They are made by structuring, texturing, shaping, or blending ingredients and in most instances use a combination of technologies. They may be made to resemble traditional items, they may be new forms of snack foods, diet foods, or other products, or they may be a new substance used as one ingredient in an otherwise traditional food product, such as non-caloric sweeteners.

The nutritional value of new and modified foods and ingredients depends on their formulation and may be nutritionally equal to or quite different from the food for which they substitute.

Fabricated Foods

The marketing of engineered or fabricated foods is widespread and will increase. Sales of engineered foods were more than $6 billion in 1972 and are expected to exceed $11 billion by 1980.[9] These are important technologies with important policy implications; for instance, vegetable protein, a major ingredient in engineered foods, has a high probability of increased use as a meat extender and to a lesser degree as a substitute for meat by the year 2000.

Fabricated foods include many dairy substitutes such as coffee whiteners, toppings, whey-soy blends, imitation cheese, and imitation milk drink. Meat substitutes include fabricated ham and sausage and steaks engineered from flaked meat and textured soy. (Soy protein is the major ingredient in fabricated meat and soybean oil in dairy products.) Other fabricated foods include substitutes for eggs and citrus products.

Fabricated foods fall into two categories, analogs and ingredients, which should be discussed separately. Analogs are those foods

[9]In 1976, fabricated dairy substitutes such as coffee whiteners and toppings had sales of $1 billion. Fabricated snack foods such as chips had $2.5 billion, fabricated cookies and candy had $1 .'7 billion, vegetable protein had $35o million, and fabricated beverages had $212 million.

fabricated to resemble a specific food in taste, texture, and color. They include complete substitutes foi' meat 1, synthetic drinks, and such substitute dairy produsts as cheese, coffee whiteners, etc. Ingredients refer to extenders, fillers and emulsifiers intended, for example, to replace part of the ground beef in a hamhurger with soy or to extend natural chocolate with a substitute These definitions are not mutually exclusive: in some instances, textured soy might totally replace ground beef and become an analog,

Although the level of use will determine the degree arid severity of impacts these products wi!l have on lhe marketing system, several general advantages of fabricated foods are the possibility of lower focal costs, extended food supply in times of shortage, better control of nutrition, better utilization of products, and reduction in energy use.

Many impact and issue areas are common to a large number of fabricated products, while other products raise issues unique to themselves. In general, fabricated foods raise issues of food safety, consumer acceptance, nutrition, and labeling: and specific fabricated foods raise suc]i issues as resource use and effect on the agricultural marketing system.

Food safety is an issues with many fabricated foods because they use a number of ingredients and additives for which different standards and regulations exist on which there is frequent disagreement. Some segments of the food system feel that the standards are restrictive and discourage the development of new foods, while others fee! consumers are not adequately protected from the effects of these ingredients and additives.

The nutrition issue depends to a great extent on the specific foods, their intended use, and how they are formulated. For example, vegetable protein extenders that substitute for only a fraction of protein intake are of less concern than a meat analog that would substitute for all or a major part of protein intake and would not raise the same nutrition issues. The FDA has proposed different nutrient standards for analogs and meat extenders.

At issue also is the proportion of our intake that might eventually be from fabricated foods and tbe effect on nutrient content of our total diet. On the other hand, fabricated foods may be formulated to supply special dietary needs or fortified to improve inadequate diets of selected population groups.

Tastes change slowly, and for fabricated foods to gain cofisumer acceptance they are manufactured to resemble the food for which they substitute. How should these foods be labeled to properly identify them and yet not present acceptance barriers'? This is a labeling issue in food service operations, where consumers may not know they are eating a hamburger extended with soy protein or meatloaf containing a vegetable protein extender. The latter is already in use.

Extensive use of fabricated foods affects agricultural resource use. The increased consumption of margarine, for example, has decreased the demand for butterfat, affected the dairy industry, and necessitated new policy decisions. The substitution of soy for animal protein can be expected to raise similar issues.

Two fabricated products that will raise many of the issues cited above and that are highest on the list for assessment include soy protein as both analog and extender for meat products and imitation cheese fabricated from vegetable oil and other ingredients,

New Sweeteners

Since a major health and nutrition concern in the United States today is obesity arid increased sugar consumption, there is strong incentive (economic and nutritional) to develop and produce new low-caloric sweeteners for use in food processing and the production of diet foods.

Some low-caloric sweeteners exist, and it is felt that the search for others will continue. Xylitol, an extremely potent sweetening agent made from the rhine of grapefruit, has fairly specialized uses; others would have wider applications. New corn sweeteners have been developed that, although they produce the same sweetness level with fewer calories than other sugars, do contain calories in some uses.

The only legal non-caloric sweetener on the market today is saccharin. The recent controversy over the use of this substance may have sparked some of the current interest in developing new sweeteners. Currently, saccharin labeling regulations require that foods containing this substance carry a warning of its possible hazards. This restriction will be carried for 18 months, at which time the safety question will be reevaluated. The outcome of this review may well determine the future use of other such sweeteners.

There is preliminary evidence that xylitol is a carcinogen. It is different from other sweeteners, such as cyclamates and saccharin, in that it is a naturally occurring sweetener. A closely related compound, xylulose, is produced in the body during normal metabolism; and there is a potential, through one simple chemical reaction, for the formation of xylitol from xylulose in small amounts. This issue of carcinogenicity, mainly related to the zero-tolerance levels established by the Delaney amendment to the Food, Drug, and Cosmetic Act, raises the very important policy question concerning the use of massive doses in animal testing for carcinogens.

The safety of any newly developed non-caloric sweetener will be a major issue, particularly concerning the type and length of tests undertaken before and after approval. An assessment of a new sweetener should go beyond the health issue, however, and assess the markets likely to be penetrated, the effect on total intake of different sugars, and the consequences to the processing industries. The cost of particular forms, whether liquid or solid; the sweetness; and other functional characteristics determine market use. Corn sweeteners have captured significant portions of the cane and beet sugar markets, with repercussions to domestic and foreign producers; and new sweeteners are expected to cause similar impacts and raise similar policy issues concerning support prices and import quotas.

NEW SOURCES OF INGREDIENTS

New technologies have resulted in new sources of ingredients for use in food processing. New methods of crushing combined with centrifuging now permit production of edible protein from cotton seeds. Certain membrane processes allow for the separation of edible protein from whey. Solvent extraction and texturizing give a variety of soy protein products. Processes using enzymes produce high-fructose corn syrups and other corn sweeteners. Single-cell organisms produce protein from a variety of processing wastes and other sources.

Conversion of Waste to Food and Feed

Research and development should continue on a wide range of processes to convert waste to edible products or feed and to better utilize agricultural production.

The first problem is defining waste. What is considered waste under one set of conditions may be considered a food under other circumstances. For example, whey is a waste if there is insufficient volume to justify the fixed costs required to purchase equipment that will convert it to edible protein. Additional economically feasible processes could produce useful products from wastes such as fruit and vegetable pulp and peelings and animal byproducts, which would reduce food losses in the marketing system.

Because of the different course materials and different technologies, there could be many different issues, However, in a discussion of waste conversion, three issue areas emerge: 1) getting approval as food products, 2) labeling for consumers, and 3) consumer acceptance.

Under the regulatory procedures in effect today, approval will be difficult to secure for foods generated from many wastes. The scientific base regarding the effects of toxin concentration in waste recycling is not very well known. The degree of difficulty depends in part on the source material; utilizing waste from a food product would not be expected to generate as many problems as converting a traditional nonfood waste to a food. Possible wastes mentioned for conversion to food or feed include vegetable pulp and peel, blood from animal slaughtering, waste from seafood processing, and trash fish. * Vegetable wastes would probably have fewer problems in product approval than many other wastes but could have problems due to possible residues on the pulp or peel.

Labeling the products presents another area of concern to consumers. The possibility of using a plasma fraction from blood collected during animal slaughtering as a functional ingredient or binding agent is a case in point, Labeling the ingredient as blood would probably discourage consumer acceptance. Should the product be labeled as to specific origin or just by the final ingredient name? This issue will be common to many of the food products produced from waste materials.

Consumers may reject many of these foods or food products, even when the foods have been approved, because of custom, taste, fear, or a number of other reasons. A factual, straightforward consumer educational program prior to the introduction of these new foods would give consumers a more rational basis for accepting or rejecting these products.

*Trash fish are any of various sea fishes that have no market value as human food but may be processed for oil or meal for domestic animals.

This entire area offers possibilities in the years ahead for providing more food and for alleviating pollution; however, there are many problems and many issues.

Processing Using Single-Cell Organisms

Agricultural waste can pollute, and because of this considerable research has been conducted on using single-cell organisms to convert these wastes to protein for humans and animals. For example, certain yeasts have converted byproducts from papermills to a food protein.

There is a greater chance of adoption if waste is converted to animal feed rather than directly to edible products for humans. The major problem is that it would be easier to secure approval if these products are used in animal feeds. Even so, the probability of adoption by 1985 is low.

A very positive impact would come from providing additional food from waste products. The negative impacts would be the same as those for converting any waste to food: the possible health hazard presented and the problem of labeling so that consumers would know the source and yet not reject the food, Also conversion of petroleum substrates to protein by certain single-cell organisms has produced concentrations of nucleic acids, which can cause adverse reaction when fed to humans.

PACKAGING

Packaging materials may be developed in conjunction with and be an integral part of a new processing technology, or the attributes of a new package or material may lead to the development of new products. In some instances, packaging innovations may simply be a new way of packaging a traditional product.

Packaging represented 13 percent of the almost $123.5 billion marketing bill in 1977.[10] In order of use, food packaging is in the form of paperboard packages, followed by metal cans, flexible packaging, and foil containers.

[10]U. S. Department of Agriculture, Developments *in* Marketing Spreads for Food Outlook, ERS Report No. *398,* March 1978.

Changing lifestyles have contributed greatly to the increase in packaging and packaging costs (more working women, the increase in one- and two-person households, and the growth of special activities such as camping].

Modern packaging materials, innovative designs, and sophisticated packaging machines have played an important part in the success of the food marketing system. For instance, new packaging technologies such as the oxygen scavenger packaging material, " can reduce the need for food additives or preservatives. However, there is considerable criticism of the packaging cost component of food marketing (13 percent, second only to labor.' as a contributor to marketing costs). Changing conditions, such as increasing energy costs and the need for recycling of resources in limited supply, are expected to influence the types and extent of future food packaging. These developments could include commercial adoption of the retortable pouch and recyclable or returnable containers in food.

Retortable Pouch

The reportable pouch technology, while still being developed, has current applications and has received limited approval for use from the relevant regulatory agencies. Further adoption of this technology can be expected te have strong impacts and far-reaching consequences throughout the marketing system, particularly in the areas of energy, food storage, transportation, labor, and retailing. For this reason, the reportable pouch technology ranks as a top priority for assessment.

The pouch is a multilayer (plastic laminate with a middle layer of aluminum foil), adhesively bonded bag that will withstand thermoprocessing temperatures. It combines many advantages of the metal can and the plastic boil-in-the-bag. Use of retortable pouch materials produced by three firms have recently been approved by the FDA; and [JSDA, which has jurisdiction over the integrity of the pouch system, has approved retortable pouches made from these materials. The weight limit for the pouches approved for use is currently set at 16 ounces. When relevant test data are available, USDA will give consideration to removing the weight restriction or increasing its limit. The quality of food processed by this method is said to be superior to that of foods retorted in conventional cans, and taste tests indicate that it may approach that of frozen foods.

There have been problems in sealing the pouches, and the ability of the pouch to retain its integrity in commercial applications has not been tested in the United States. Thus, the reason for limited approval by USDA. Problems have also been encountered with slow filling times compared to cans. With growing use and application, however, technical innovations are expected to overcome such problems as these. The technology is still in its infancy, and many questions cannot be answered with hard data at this time.

An extension of retort pouch technology is the steam table "tray pack, " which uses a metal tray instead of a pouch and which uses the same container for processing, transporting, storing, and reheating the food. Food prepared in this way generally consists of a complete meal. The size and shape are designed to fit on an institutional steam table, and institutions are expected to be the first major market for the tray pack. The shape saves energy in processing and produces a superior product. In addition, serving food directly from the tray pack further reduces the need for labor and energy that would normally be used for cleaning steam table trays.

Data on energy savings in the manufacture of the retortable pouch over that used for metal cans, glass jars, and certain frozen food containers are preliminary and do not yet answer the question of energy consumption for each total system. While the reportable pouch appears to offer savings in energy over containers for frozen and canned products, these savings can only be confirmed by an analysis of the different systems that are or might be used commercially. Energy sav-

"This is a laminate consisting of a polyester outer layer, an adhesive layer, aluminum foil, a Surlyn® * sheet, a layer of palladium as a catalyst, and an inner layer of Surlyn®. Oxygen travels through the inner Surlyn " layer and reacts with hydrogen in the presence of the catalyst to form H_2O, which is trapped between the two Surlyn® layers. (* Surlyn®: registered trademark by E.I. du Pent de Nemours & Co.)

ings are possible in processing because the system uses a shorter cooking time at lower temperatures.

Savings may be projected in the area of transportation owing to the !mproved product-to-package weight ratio; savings in weight may be as much as 50 percent for the pouch versus the can. Although comparative tests have shown pouches to be as durable as cans, questions will continue to be raised regarding the handling of this package unti! experience has been obtained under actual use conditions. Initially, an outer package is being used to safeguard against breaks due to flexing and abrasion. Eventually, it may be possible to move the pouch through the marketing system without an individual cover for eacli pouch. Thought should also be given to the fact that, if not individually packaged in an outer carton, the reportable pouch would probably prove more difficult to price-mark and display in retail stores.

In its early stage of development, the reportable pouch technology will become a viable one for packaging food and will probably compete at first with frozen rather than canned food. If inroads into the $17 billion frozen-food market and ultimately into the $20 billion canned-food market are as significant as they are expected to be, there are substantial implications for these two industries. Producers of metal cans (and industries producing the raw materials) would be affected in terms of loss of revenue, displacement or relocation of labor, and possibly considerable loss of jobs.

The availability and prices of the petrochemicals needed to produce the plastics used for the pouch may also bear on the adoption and success of this technology.

Environmental impacts of this technology may be considerable in both a negative and a positive sense. If methods are not found that permit the pouches to be recycled, the impact would be negative compared to that of metal cans, bottles, and other recyclable containers (which result in savings in raw materials and energy). However, retortable pouches can be used as fuel, and even without recycling most of the energy initially expended in their manufacture could be reclaimed, at the same time minimizing solid waste problems.

Recyclable and Returnable Containers[12]

Technologies for recyclable containers. returnable cans and bottles, and other refillable containers have a high probability of being an important part of our future and that the impacts of adoption will be widespread. These technologies have developed because of socioeconomic pressure, and the pressure will in all events continue to build for new solutions through technology to the problems of conserving natural resources and reducing the expense of keeping our environment free from pollution caused by discard ’xl containers.

A discussion of these technologies falls into three categories: recyclable beverage containers, the returning of all food containers, and the general concept of recycling applied to all products.

Recycling of beverage containers Elas received the most attention to date. Four States have passed laws requiring deposits on all beverage containers, anti the major aluminum producers have initiated systems for buying back aluminum cans. Localities have set up collection points for cans, bottles, and other recyclable products. There have been mixed results in all these enterprises-for instance, reduced pollution and litter versus inconvenience of traveling to the collection site—yet the public seems intercsted in the concept of recycling even if the initial specific technologies or systems may not have met with their approval,

Returning containers to the processor for reuse is another concept relative to this technology. Reverting to a returnable packaging system is not a panacea for sanitary problems; indeed, some new problems may be created by this system. The beverage or food residue in returnable containers readily support the growth of insects and other undesirable vermin, or harmful microorganisrns, which contribute to unsanitary conditions in

[12] The OTA Materials Group has been studying some of the issues raised in this section, and is preparing a report on "Materials and Energy From Municipal Waste" which is expected to be published in the latter part of 1978,

a store selling food products. The issue of food safety and sanitation needs to be assessed.

Returnables may add to the cost of distribution and handling products. One study estimates it would cost 2 cents more per quart to deliver milk in returnable bottles. Whether the total cost of the delivered product would be greater for other products is not clear. If cost did increase, this would undoubtedly be passed onto the consumer. Part of this cost increase is because of the high initial cost for converting production lines in bottling plants to handle returnables. Estimates of this cost have run into billions of dollars. Larger companies would be better able to afford the expense of this conversion and thus could put the smaller firms at a competitive disadvantage. An assessment should evaluate policies for overcoming these kinds of capital problems resulting from the adoption of technologies.

If recycling becomes an important system, new forms of delivery may result to alleviate the inconvenience of, and dissatisfaction with, returnables and recyclable; for instance, a syrup or powder that could be mixed with carbonated water at home (both technologies are available).

Most soft drinks are vendor-delivered, and returnables would deter a consolidated delivery system, since by law empty bottles cannot be carried in the same truck with food products. This may provide the incentive to bottle beverages in larger units, which would run counter to the recent trend for smaller bottles and cans.

Recycling of all glass food containers has been proposed in the Oregon legislature for two legislative sessions. This is an extension of the recycling concept beyond beverage containers and may foretell a trend towards eventually recycling many food containers and packaging materials.

Several large projects for reclaiming and utilizing materials from garbage have been initiated. These are high-technology plants for separating recyclable metal, glass, and other materials and then burning the remainder to produce heat. There have been both successes and failures with these projects. An alternative would be to have consumers separate material before the refuse enters the recycling system. This is a system that has been in limited use since the early 1970's. There may not be one system applicable for every situation, but people may have to choose whether they wish to participate by paying for a centrally located or industry-based system with taxes or fees or whether they would prefer to lower the cost by participating directly.

Carton-Can

The carton-can is a square container with a flexible inner bag. The inner bag may be foil, plastic, or a combination. Advantages claimed are that its square shape saves space and material in shipping, it can be incinerated, and some versions are retortable. It is being used in Europe for processed foods but is still considered experimental. The probability of widespread adoption in the United States is considered very low, and impacts are difficult to judge primarily because of insufficient information on cost, where the carton-can is likely to be used, and whether food safety issues are involved.

This technology is important only insofar as it may be a part of an alternative packaging system that could affect materials and energy use and the transportation system.

Chapter V

DISTRIBUTION TECHNOLOGIES FOR ASSESSMENT

DISTRIBUTION TECHNOLOGIES FOR ASSESSMENT

Consumers have become accustomed to having most foods they desire available any time of the year and throughout the United States. To provide this availability requires specialized production areas and elaborate transportation, storage, and distribution facilities.[1] Trucks, trains, barges, and in some instances airplanes for highly perishable fresh produce move food products from producer to processor, wholesaler, retailer, and in some instances on to the consumer. Those food distribution technologies the Office of Technology Assessment (OTA) considers of highest priority are listed in table 5. The list emphasizes those with a probability of early occurrence and significant expected impacts.

Table 5. —Distribution Technologies With High Priority for Assessment

Technologies with high probability of adoption and high impact
1) Technologies to improve food sanitation in transportation (p. 54)
2) Electronic checkouts in retail stores (p. 57)
3) Computer systems that improve retail store management (p. 59)
4) Technologies to reduce food loss (p. 61)
5) Electronic food shopping systems (p. 59)

Technologies with high probability of adoption and moderate impact
1) Improvement in trailer design and use (p. 56)

Technologies with low probability of adoption and moderate impact
1) Development of railroad cars or containers for better quality preservation (p. 55)
2) Technologies to enhance warehouse automation (p. 52)
3) Technologies for delivery of complete meals to home (p. 60)

As in the previous chapter, those technologies where the probability of adoption is considered high and expected to have considerable impact if adopted are rated the highest; technologies where the probability of occurrence by 1985 is considered high with moderate impacts and technologies whose impacts are expected to be high but probability of adoption is considered low are rated lower.

Other technologies discussed in this section are considered of lower priority because of insufficient data on economic feasibility or impacts. These priorities may change in the future as conditions arise that may influence their development or adoption.

The technologies discussed in this chapter are divided into: 1) wholesaling, 2) transportation, 3) retailing and food service, and 4) those technologies applicable to two or more of the above.

[1]The 1972 census reported 39,137 wholesale grocery establishments. 194,346 grocery stores, and 73,006 food stores not classified as grocery stores In addition. there were 253,136 eating places for away from-home food consumption.

WHOLESALING

Wholesalers receive food products from producers or processors/manufacturers, temporarily store them, and then distribute them to retail stores or other food outlets. Food retailers have integrated extensively into wholesaling and to some extent wholesalers into retailing, but regardless of ownership arrangements, the basic functions must be performed.[2]

General line wholesalers, those who carry a full line of groceries, and specialty whol~ salers, those who carry a special line of items such as frozen food and meat products, share the market. Specialty wholesalers represent about 90 percent of all wholesalers and account for about 60 percent of wholesale grocery sales.[3]

According to a survey by the Food Marketing Institute (FMI), in 1976 the typical wholesaler in their survey serviced 273 retail stores and operated a single distribution center. In addition to food distribution, the wholesaler provided such services as engineering, store design, product movement data, and accounting. Almost 87 percent of the wholesalers surveyed depended on manual selection and picking operations, 3 percent operated fully computerized centers, and the remaining 10 percent used belts and conveyors in a manual operation.[4]

Technologies To Enhance Warehouse Automation

Automating warehouse operations allows for faster handling of larger volumes of merchandise with less labor. Productivity in wholesaling could be improved by standardization in shipping containers, which would allow greater modularization and would make technology easier to apply to the sorting, assembling, and shipping of orders. Mechanical systems exist whose handling capability starts at 300,000 cases per week, a tremendous volume that in many instances would be feasible only through the consolidation of volume from several firms or as a public warehouse.

This concept has a low probability of adoption, but if adopted, it would cause negative impacts. The major issues would probably arise from the impact of consolidation on industry structure and conduct. Consolidation of physical operations could result in consolidation of other management functions. Consolidation of this type suggests a lessening of competition at the wholesale level. In addition, the possibility of consolidated warehouses building and operating stores might act to the detriment of small, independently owned stores without access to the financing of the consolidated groups; and the competitive relationship between smaller suppliers and the larger consolidated warehouses may be affected.

Other issues are the effect on geographic distribution and possible legal problems with State laws and regulations.

Warehouse Consolidation of Items Normally Supplied by Vendors

Vendors supply such items as beverages, bread, snacks, tobacco, and candy directly to stores. In many instances, the quantity delivered at each stop is small and the cost very high.

It would be possible to lower delivery costs if these vendor products were consolidated and delivered along with other grocery items. Other advantages could include better control of shelf space by store managers and elimination of the commission charge on many items, Continued increases in the cost of gasoline could push delivery costs higher, increasing even more the importance of delivery cost-reduction benefits.

[2]1ntegrated wholesale facilities (owned by the retailer) offer the possibility of better utilization of certain technologies between wholesaling and other distribution functions.

[3]U.S. Department of Agriculture, Economic Research Service, The Food and Fiber System—How *It* Works, Agriculture Information Bulletin *383,* Washington, D, C., March 1975.

[4]Timothy Hammonds, "Food Marketing Industry Speaks 1977, " speech at Food Marketing Institute Convention, 1977.

One deterrent to consolidation might come from labor, as many labor contracts include a commission on deliveries. Many store operators feel that the drivers perform services beyond actual delivery of products by maintaining the displays in an attractive manner. Store operators may not be willing to forego this kind of service.

This technology could work to the disadvantage of the smaller stores, who may not have daily deliveries from the warehouse, so that products that have to be delivered fresh almost every day (such as bakery items) could not be included in regular grocery deliveries.

Computer-Controlled Automation in Warehouses

Experience to date has shown that slower moving items are the first to be automated in warehouses; the fast moving items are handled in bulk with a forklift. Order picking, about 30 percent of the warehouse function, is currently automated; and some inbound functions that account for approximately 20 percent of the system are being automated. Since only the slower moving items are being automated, it has been estimated that "the most sophisticated system we have today is probably less than 15 percent of the warehouse operation. But it's growing . . . it's coming.

To date, many of the "automated" warehouse systems have not been cost-effective. However, the development of computers, scanning capability, and other supporting mechanization would probably result in the development of "industrial robotism, " enabling robot units to do many of the warehousing tasks. (Industrial robots are already widely used in the automobile industry for welding and other relatively complicated operations.)

[5]Gerald Peck, OTA workshop, Nov. 12, 1977.

Computer-controlled automation is part of the large concept of warehouse automation, raises the same basic policy issues, and should be assessed in concert with other automation systems. Labor would likely be displaced; firms with available capital would be the first to automate, possibly to the disadvantage of smaller firms. Competition in the warehousing industry could become a policy issue; however, such automation is expected to evolve gradually.

Electronic Interface Between the Retail Store and Warehouse

This technology would result from computer-aided store management and computerization by warehouses or other suppliers. One such technology permits a retail terminal to place orders directly to a warehouse computer. Eventually the ordering could be accomplished by a store computer, which keeps track of inventories without human intervention. An extension of this technology would permit communication between the warehouse and the manufacturer-processor computers.

Electronic interface should improve efficiency in ordering by reducing store inventories and minimizing the risk of running short of supplies. The effect on competitive relationships among firms in warehousing and distribution would have to be assessed. One issue would be possible discriminatory pricing against firms that could not use the electronic-ordering system.

TRANSPORTATION

The food transportation system has served us reasonably' well in the past. Intercity rail and truck transportation was 8 percent of the marketing bill for domestically produced agricultural products in l977, an increase from 7 percent in 1974. The figures do not include air and water transportation or intracity distribution, which would significantly increase the transportation component of the marketing bill.

The system, however, is currently being criticized for not being as efficient as it should be. Critics charge that it is overburdened by regulations that discourage the adoption of technologies which would promote efficiency and save energy. These regulations are administered by a number of Federal and State agencies; they regulate routes, rates, and equipment size and weight.

Other factors also contribute to railroad and motor carrier inefficiencies. For example, an estimated 20 percent of railcars are idle much of the time. Concurrently there have been spot shortages of railcars for hauling agricultural products. Inferior record systems that cannot locate idle cars in time and/or lack of priorities in freight car assignments are cited as reasons for this problem,

Trucks travel the highways empty because of poor scheduling and/or regulations that prevent them from picking up loads on backhauls (return trips). Another part of the transportation problem is one that also hampers other sectors of the distribution system—lack of standardization in containers and associated equipment.

In addition to the issue of efficiency, sanitation is a major factor in our food transportation system. Inadequate cleaning of railcars and trucks has led to food spoilage and waste that could be eliminated by the introduction of certain technologies or the use of existing ones.

Technologies To Improve Food Sanitation in Transportation

The subject of maintaining adequate levels of sanitation in food as it moves through the food marketing system emerges from this study as one of the top priority areas for assessment. Adulteration and spoilage of food, as has been pointed out, occurs at all steps; however, the problem is of particular concern from the point of view of transportation, specifically of the rail system. Applicable technologies exist to correct this problem, although additional development of technologies may be needed.

The basic problem is that much of the Nation's food, which moves by rail, is held in unsanitary conditions during transportation. Boxcars may be infested with rodents and insects and may contain microbiological and chemical contamination. There are documented cases of pets dying from pet foods whose ingredients were contaminated with toxic substances during shipment. Food ingredients are frequently rejected by the processor because they have become contaminated during shipment. Users frequently reject railcars or must decontaminate them before use.

Several factors contribute to the problem. The railroads do not have the technology for a. national commodity tracking system capable of identifying toxic substances or other contaminants that are transported in boxcars, nor of tracking contaminated boxcars to prevent their selection and use for the transportation of edible food products. Currently railroad boxcar classification procedures do not assure the selection of "food quality" boxcars for food transportation. Railroad inspectors determining classifications almost never, if ever, have academic training in food science and are generally not qualified to determine the suitability of a freight car for the transportation of food or food ingredients destined for human consumption.

Beyond the boxcar classification problems, a technological breakthrough in freight car cleaning techniques is needed. The principal boxcar cleaning technology of most railroads continues to be basically unsophisticated; unfortunately, it is best described as still in the "garden hose and straw boom era. " If the railroad industry is to have quality assurance in its freight car fleet, it must develop industry-wide techniques to clean freight cars that have been used for the transportation of bulk commodities, corrosives, or toxins or to detect insects, vermin, or other contaminants having a deleterious effect on freight quality.

An overriding problem is that railroads do not have sufficient capital to refurbish or renew the freight car fleet. Part of the problem may have been that neither public offi. cials, the railroads, shippers, nor the public have shown sufficient concern. The fact that no loss of human life has been traced to contamination by toxic substances in railcars does not minimize the problem.

One solution to this problem would be to have a fleet of "dedicated cars. " The best cars in the fleet would be designated to handle food only; a fine would be levied if a dedicated car were not returned to the assigned pool. A repair fee could be assessed against a railroad that allowed a car to be misloaded, which would permanently downgrade it to a non-food use. This system, when tried, has not worked very well because the railroads do not enforce the assessment penalties.

Examples of possible technologies are suggested for three specific areas:

1. Freight cars, designed specifically for food products, that will be more resistant to contamination and infestation.
2. Equipment and procedures for decontaminating freight cars. This would include inspectors trained and operating with specific guidelines.
3. Freight cars specifically designated for food use, with a system that will keep track of the cars and schedule them in an efficient manner. There should be an effective enforcing system to maintain the integrity of the system.

Technologies that improve sanitation in food distribution should lessen the chance of food contamination and reduce the concern over possible illness from this contamination.

The cost resulting from lack of sanitation in railroad cars is considerable. In addition to the chance the food will become contaminated, there is an economic cost of preventing it under the present system, When a full car is rejected, it must be returned to the shipper and the load reconditioned, restricted to an inferior use, or perhaps completely destroyed. There is the cost of the return as well as extra handling of cars. If the shipper finds a car unsatisfactory, time is lost in securing additional cars, or the shipper bears the cost of decontaminating and preparing the car. New technologies should reduce this economic loss.

A major policy issue will be the funding of these technologies. The railroads appear unable to secure the needed capital to initiate and maintain the system needed. Serious attention should be given to the desirability of policies that will be needed to help railroads finance these needed improvements.

Cooperation will be needed among the railroads and between railroads and ingredient suppliers and users. There is a need to determine whether this should be through regulation, voluntary cooperation, or some type of incentive arrangement.

Development of Containers or Railroad Cars for Better Quality Preservation

Technologies are needed to develop railroad cars for quality preservation of foods in the marketing system, Certain technologies may be applicable to trucks as well. Developments might include special controlled-atmosphere containers, specially designed cars using ambient air for cooling perishable products, solar-powered car~, or a central refrigeration unit for several cars that draws power from the train axle. These technologies will upgrade equipment primarily for cooling fruits and vegetables in railcars and trucks.

Besides improving the quality of both long- and short-haul shipments, these technologies are viewed as a means of moving food products through marketing channels with greater labor productivity and lower costs. The food service industry is interested in the container concept for deliveries to units, which would allow for better scheduling of delivery vehicles to keep them off the road during peak traffic hours. (These containers would probably be smaller than truck-size.)

The various technologies mentioned above should be assessed to determine economic feasibility, energy consumption, and the effect on food quality or safety. The only major policy issue expected to result from the potential adoption of these technologies will likely come from labor. Containerized shipments could affect the entire marketing system as different delivery methods, equipment, and labor requirements would likely surface.

Improvements in Trailer Design and Use

Adoption of technologies to improve truck trailer design and use should result in improved efficiency and lower transportation costs. Specific improvements include greater truck widths, increased capacity, and multiple trailers hauled by a single cab.

Increasing the normal truck width by a few inches would allow standard 48-inch pallets to be positioned side by side. This standard pallet size is already compatible with freight car loading but is impossible in nearly all existing trucks. These loading problems contribute to much space being wasted. The possibility also exists of reducing the size of the pallets instead of enlarging the trucks. The empty space left in freight cars would be more than compensated for by the increased efficiency in truck loads.

The adoption of these technologies depends in large part on changes in the regulations that control most aspects of the transportation industry. These regulations are currently not uniform among States; varying bridge and axle loads pose the major hurdles, and many States have restrictions limiting loads to single trailers.

If policies are set to encourage the development of more uniform standards and regulations, certain adverse impacts may be expected, such as an increase in the number and severity of accidents as truck weight and size increase. The cost of maintaining roads capable of handling increased tonnage would increase, and the distribution of these costs among Federal, State, and local agencies would have to be decided.

Adoption of these technologies would reduce the number of truckdrivers needed, and labor can be expected to oppose this change. This would probably affect only drivers; loading and unloading rates should not be affected. However, further information would be needed to pinpoint these technologies' justification relative to savings in fuel, increased labor efficiency, the negative impacts on highway safety and increased maintenance cost, alternative funding methods, and the expected impact on and opposition of labor organizations representing truckdrivers.

Intermodal Terminals Constructed in Main Food Distribution Centers

The intermodal terminal would be a large facility designed to receive unit trains of produce or manufactured goods, truck lots, and shipments by water. To be successful, the operation would require some type of standardized or containerized shipments allowing for easy intermodal transfer. The purpose would be to handle large quantities in an efficient manner, eliminating much of the delay of intracity or area delivery.

This concept would probably be a replacement for rather than an addition to our present delivery system, and adoption is much further in the future than many of the other distribution technologies. (The Agricultural Research Service has some preliminary work on a similar concept for a site in New Jersey.)

Terminals would impact on all facets of commercial food distribution and possibly even on international trade. The expected use of containers on ships, trains, and trucks would impact on the number of workers needed. In the absence of specific technologies and because the concept is unlikely to be adopted for some time, this technology is not highly ranked.

RETAILING AND FOOD SERVICE

Grocery stores account for more than 90 percent of all retail food sales for at-home consumption. The remaining 10 percent ineludes other foodstores such as meat markets, retail bakeries, and produce and dairy product stores. Recent trends are toward fewer and larger stores and more convenience foodstores. Although the size, type, and vocation of stores have changed, until very recently there were few technological changes in retail operation.

Adoption of the self-service concept substituted customer labor for that of the store employee. Shelves are still loaded by hand, and the price of each item is marked individually, although in some instances dairy, cured meats, poultry, and other products may be individually price-marked at central processing plants. In meat stores, cashiers still ring up each item, but automated checkout systems using the Universal Product Code (UPC) have been introduced on a limited scale. Although the UPC system eliminates the need for price marking, most items are still individually priced to overcome consumer objections.

According to the FMI, a survey of their members in 1976 showed average weekly sales of $72,425 and an average of over 9,000 items per store. FMI also reported that for the first time in 5 years, there was a general increase in real sales per square foot, per transaction, and per man-hour. Profit margins remain low, however, and if retail stores are to increase their productivity and profits to any extent, new technologies will have to be adopted,

The most recent publicized technology is electronic seaming at checkout and its possible use in conjunction with electronic funds transfer. Technologies for improving productivity in stocking shelves are being developed, but their success depends in part on standardization of containers and packages throughout the distribution system. Until there is more industry standardization on such items as packaging shape and size, improvements in retail store productivity will be somewhat limited.

Food service comprises both public and institutional feeding. Public organizations include commercial cafeterias, catering, and all other eating places serving the general public. Institutions include schools of all types, airlines and other transportation systems, penal institutions, and other non-public eating places.

The Economics, Statistics, and Cooperatives Service of U.S. Department of Agriculture (USDA) reports that in 1977, of the $180 billion spent by consumers on domestically produced foods, $55.8 billion was spent on food consumed outside the home. Of that about $44.1 billion (79 percent) was spent in commercial eating places and $11.7 billion (21 percent) was-accounted for by institutions.

Fast-food service is expected to be the fastest growing segment of the food service industry over the next 5 years, with an annual growth rate averaging 15 percent. Since most of these outlets are of the drive-in type, however, any restriction of gasoline supplies could dampen this prediction.

The fast-food service industry has readily adopted new technologies such as centralized controlled onsite cooking. This has allowed the use of relatively unskilled labor instead of trained chefs and yet has maintained acceptable food service. Preparing food in central plants and limiting menus have minimized the space and labor needed onsite and contributed to the labor productivity increases of these operations.

Electronic Checkout in Retail Stores

The electronic checkout system is a technology currently in use. Although approximately 300 U.S. stores presently have electronic checkouts with the capability of reading the UPC, there will be continued expansion of this new technology in retail grocery stores.

There are two basic checkout systems with many variations. The system using the UPC and seamers has received the most publicity and generated the most opposition. A scanner reads the product identification, weight, etc. from the UPC printed on the product and transmits this information to a central computer where prices are stored. The computer does all computations and relays this information back to the checkout unit in the store, which usually displays the price on a screen and prints it on the customer's receipt tape. Advantages claimed for the system are speedier checkout, no necessity to price-mark individual items, readily available information on inventory, and sale information on all items.

The other system is an electronic cash register which may be self-contained or tied in with a central computer. Items would be individually marked and entered manually into the system. If connected to a central computer, this system would have the same capability of inventory control and price and quantity transactions as the system with scanners.

The UPC scanner system theoretically would allow greater savings than the electronic cash register because it would eliminate individual pricing and increase productivity of checkers. Both systems have potential for improved merchandising decisions resulting from better inventory control, improved labor scheduling, less need for storage, more thorough analysis of sales, increased product movement, and better use of shelf space.

Most public opposition to the UPC scanner system has centered on the elimination of individually priced products. Opponents claim that elimination of prices deprives customers of information they need to make rational purchase decisions. Bills have been introduced in more than 30 State legislatures to require the price to be marked on every item, while allowing for exceptions regarding size and type of store. However, the passage of bills requiring price-marking could prevent a test to a system just being introduced. Also, not all consumers react the same to these systems. Some might prefer the UPC scanner system even without price marking, and these laws would restrict the choices available to them.

Underlying much of this consumer opposition is doubt about the benefits of the UPC scanner system over other systems and just where the positive and negative impacts would fall. Part of the problem is that consumer groups felt left out of the planning and introduction of the systems and felt instead that a system was being pushed on them. Also, industry disagreements and uncertainty over benefits and costs may have contributed to consumer unrest. However, consumer confidence may grow if the system reduces checkout errors and stems the increase in food prices.

There are a number of issues to be considered:

The first is determining what the economic impacts are, what particular components of the system generate savings, how much of the savings are cash savings resulting from increased productivity of labor versus the secondary savings from better management of inventory, pricing policies, etc. How much additional savings result from using the UPC scanners versus the electronic cash register system.

Second, the effect on consumer purchase decisions from the elimination of individual prices versus having a printed tape identifying ‘prices and products needs assessing.[6] There may be other alternatives to solving the pricing problem, such as providing consumers with the means for price-marking or better shelf price-marking. Eliminating the need for individual pricing opens up possibilities for automated or semiautomated stocking of supermarket shelves.

A third is the effect on industry structure and performance. The cost of installing a UPC scanner system now may run as high as $200,000 per store. This will probably decrease with volume production but still requires a tremendous amount of capital. It could become more difficult for smaller firms to compete, especially in the short run when larger firms have the capital to experiment and are the first to adopt the innovation. The electronic checkout system could accelerate the trend toward fewer and larger stores and fewer companies. This raises the issue of increased concentration in retailing and the impacts on competition and consumer prices. There may be a sociological impact as we move toward larger units that could become more impersonal and further alienate consumers. Also, if the adoption of the electronic checkout involves laws requiring individual price-marking, the growth of high-volume, low-price discount or warehouse-type foodstores could be adversely affected.

Adoption of the UPC scanner system could impact on small suppliers who might have difficulty meeting a requirement that all products have a UPC marking.

[6]For a study on the effect of removing individual prices, see Gilbert D. Harrell, Michael D. Hutt, and John W. Allen, Universal Product Code: Price *Removal* and Consumer Behavior in Supermarkets, Michigan State University Business Studies, 1976.

Fourth, labor would be adversely affected if there were increased productivity as expected. The latest census data show more than 1.7 million employees in foodstores, and many of these positions could be affected by widespread use of the electronic checkout. Checkers and stockers would lose positions, and the magnitude of these job losses needs to be determined. It may be possible to alleviate the impacts during a transition period by eliminating positions only through attrition or retraining these persons for other jobs.

Finally, electronic checkout suggests the possibility of increased use of electronic funds transfer, which raises the associated issues of invasion of privacy and liability for losses and errors in the system.

Computer Systems To Improve Retail Store Management

A retail storewide computer system that uses data derived from an automated checkout system and controls physical facilities for heating, lighting, refrigeration, scheduling of labor, and interfaces electronically with sup pliers will likely be adopted by 1985 and can be expected to have implications throughout the marketing system. (Electronic interface between wholesalers and retail stores is discussed as a separate technology in the wholesaling section of this chapter. Seep. 53.)

Adoption of such a computer system would be expected to greatly increase the efficiency of retail stores, including managing inventory to decrease retail storage needs, minimizing transportation, more efficiently utilizing shelf space, and improving labor scheduling and management. Labor would be affected in that it may involve more night shifts, split shifts, relocation, or job loss.

Would the savings generated by this efficiency be passed on to consumers, or would the computer technology be used by stores to increase their profit margin?

What would be the consequences of reduced energy consumption in retail stores? Energy is becoming an increasingly larger share of the retail operation. Computer-controlled lighting, refrigeration, and other power savers should reduce costs. Scheduling of power use during offpeak hours has implications for the generating capacity of power companies. The impacts should be positive, but if consumption were to be reduced below the long-range planning demand curves, the power companies could have excess generating capacity and would have to increase rates.

Electronic Food Shopping Systems

Three electronic food shopping technologies are considered: warehouse-to-door systems involving ordering by telephone; automated minimarkets; and mobile aut~mated markets. These technologies are applicable primarily to large metropolitan areas and to meet special distribution needs in rural areas. They are not as likely to be adopted by 1985 as the electronic checkout system, but their gradual evolution would have very significant impacts on the marketing system.

Increased recognition of the cost of driving to stores and the increase in high-density metropolitan living might contribute to the increase in these retailing innovations,

A number of warehouse-to-home ordering systems have been tried, with both successes and failures. Possible advantages include savings in time to the consumer, savings in transportation costs, and a possible increase in safety to the elderly and others. Whether this system would provide these services at less cost than conventional supermarkets is not known. The warehouse operators must do the picking that supermarket customers do for themselves, but there is the possibility that labor-saving innovations would lower costs.

The automated minimarket is basically a convenience store with most, if not all, of the items dispensed automatically. The warehouse-to-home and minimarket systems imply a system of payment based on some type of credit, probably related to electronic funds transfer (EFT), which in the case of the automated minimarket could be card-activated. The minimarket concept, therefore, is dependent on the development and use of EFT technology.

Mobile automated markets would move products into certain areas on a scheduled basis. Tests of this system have indicated high-cost operations, but cost would probably decrease if the operation were large-scale.

The principal advantage of all three systems is that food would be made available in areas where services are at a minimum. In some metropolitan areas, for instance, supermarkets have closed, restricting food outlets to small chains or individually owned stores.

One disadvantage is a restriction in the choices available to consumers and in their ability to examine produce before purchase. The question is whether consumers would be better off with limited choices under these automated systems than with a gradual decline in the present system.

All three systems should be judged against other possibilities, such as industry-cooperative stores in the inner city or direct marketing by farmers in the rural areas. Growth in types and size of retail foodstores has in the past depended on population density, income, and specific preferences and tastes.

Technologies for Delivery of Complete Meals to the Home

The delivery of complete meals to the home is a possible extension of electronic food shopping and could be the result of changing lifestyles already under way. Special groups, such as the elderly or handicapped, may look toward the benefits of home delivery of complete meals rather than the purchase of separate ingredients or commodities.

The concept has been tried with several variations for feeding elderly or incapacitated persons and children in special programs. The School Lunch Program in many instances is a special application of meal delivery. Much of the institutional feeding is catering on a meals concept.

The meals concept could result in poorer or better nutrition depending on the type of program or the meals themselves. Nutrition would be poor if the meals contained less fresh fruits and vegetables, consisted of highly processed or fabricated foods, and lost nutrients in storage and preparation. This concept, however, affords the opportunity to provide highly nutritious meals that could be tailored to supply the special nutritional needs of targeted groups. Specific programs would have to be assessed to determine the effect on nutrition and health.

Meals delivered to homes could have an adverse effect on the social life of the aged and handicapped, especially if going out for meals were a major social activity. This would be especially important if the delivery concept were the only practicable alternative. Conversely, there should be an evaluation of the benefits to recipients and to society of letting these people remain in their homes rather than being cared for in an institution.

Home delivery of meals could impact on the traditional marketing channels if a significant amount of food were delivered in this manner. The growth of the fast-food industry has affected the traditional way in which foods are distributed. These technologies do not have a high probability of occurrence by 1985, but the impact of such a shift would be substantial, and developments in this technology should be closely monitored.

Ordering Systems and Equipment To Minimize Intermediate Order Breakdown Before Shipping to Retail Stores

Intermediate breakdown involves subdividing bulk shipments received from a manufacturer or processor into smaller lots for delivery to individual retail stores. Adoption of new ordering systems and equipment technologies would allow the processor-manufacturer to package items and move them on pallets directly to the retail store. This system is currently being used in Europe for very large "warehouse" retail stores, and a reasonable assumption is that use in the United States would also depend on the development of such large, limited-item stores.

Widespread adoption of this marketing concept will be slow because of the historic development of our food distribution system.

The major advantages could not be realized within the major part of our existing system.

If the development of large retail stores is assumed, the impact of adopting such a system would be considerable because a major shift to larger and more concentrated marketing units would be required. Such units might be Government-controlled or a private system of units large enough to obtain the economic benefits of the special packaging systems. Government-controlled stores should be examined from the standpoint of available services and product choices and of responsiveness to consumer wants and needs. A system of privately owned stores should be assessed with regard to a possible increase in industry competition.

TECHNOLOGIES INVOLVING THE TOTAL DISTRIBUTION SYSTEM

The two technologies discussed in this section—technologies to reduce food loss and standardization in retail packages and wholesale containers—are both extremely important to the marketing system. The concepts underlying both of these technologies, however, by their nature do not fall neatly into the three other distribution categories; rather, they impact with equal emphasis in all three. For this reason, we have separated them from the other categories.

Technologies To Reduce Food Loss

These technologies include those that reduce waste in packaging and transportation throughout the system and reduce losses that occur from pilferage and general lack of security control. Loss-prevention technologies will become increasingly important as worldwide pressure increases for more food.

Loss occurs in field waste from mechanical harvesting, at the processing dock, in shipment to grocery stores, and in the retail stores. Another type of loss is the waste from not utilizing undersized or misshapen products that are nutritionally equivalent to produce graded higher. Consumers should have the choice of a nutritious product at a lower cost or perhaps of a food processed from waste.

There are divergent views on how waste reduction could be accomplished. In California some produce has been harvested, packed in wooden bins, and transported directly to the store for display. This eliminates intermediate order breakdown and the damage and waste that inevitably results, and customers are given an attractive product at a lower price. This marketing method might not be adaptable to long-haul shipment, where the emphasis needs to be on shipping containers and transportation methods that reduce damage in transit and storage. Much of the loss in retail stores is a result of internal bruising that starts with picking and transportation and continues to the retail shelf.

Technologies are needed to harvest and move more produce through the food system with less waste. However, in marketing certain fruits and vegetables the extent of loss and where the loss occurs must be determined first.

Alternative methods of harvesting and transporting should be assessed under differing production, storage, transportation, and retailing conditions. For example, field packing, transporting, and retail display of produce in bulk bins may be feasible under certain conditions but would impact the entire marketing system. The bins would have to be returned, salvaged for other uses, or destroyed. Displaying loose produce would cause changes in retailing methods, including pricing and packaging.

Gleaning produce left in the field by mechanical harvesters is one way of reducing field waste. However, securing dependable labor at a price that makes this technology economical may not be possible.

Another concern is utilizing produce that does not meet grade standards because of size or minor blemishes. Although this produce may be equally nutritious, consumers may not readily accept "second-best" produce or produce not in familiar packages. Since the cost of transporting lower grade produce may equal that of moving higher grade produce, the sale of lower grades might be discouraged.

Waste in food preparation and on the plate, both in the home and in food service operations, should be assessed. An assessment of the value of open dating on food packaging to help prevent waste would be a starting point in reducing waste in the home through using the date in inventory control on home shelves.

Pilferage loss occurs primarily in retail outlets and to some extent in truck and rail shipments. Supermarkets have claimed losses from pilferage as the reason they have closed stores in inner city areas. The different marketing alternatives discussed under electronic food shopping systems could possibly be an answer to the problem. Better designed railcars and trucks with more reliable locking systems would be a deterrent to theft in food shipments. Technologies that would reduce pilferage losses in stores and other segments of the marketing system are needed.

Standardization in Retail Packages, Cases and Pallets

The concept of standardized packages has been advocated as a means for improving efficiency in handling products moving through the food marketing system by reducing the number of different sizes and shapes, improving modularity, and making palletizing more efficient.

A determination of the extent of the benefits that would accrue from this system is needed. Standardization would result incest savings in packaging due to the need for less inventory and a possible saving in materials. However, standardization of retail packages might restrict the choice of available merchandise by presenting problems for manufacturers whose products might not conveniently fit those sizes. New technologies in handling food products might also negate some of the benefits.

The problem is complex, involving many segments of the food marketing industry. Unless new incentives or initiatives are forthcoming, technologies for standardization do not have a high probability of adoption by 1985, and the issue is likely to remain dormant.

APPENDIXES

APPENDIX A

THE FOOD MARKETING SYSTEM

DEFINITION OF THE MARKETING SYSTEM

Food marketing is defined as the activities that take place within the food system between the farm gate and the consumer. This includes processing, wholesaling, retailing, food service, and transportation functions and excludes all functions performed by producers on the farm. Figure A-1 shows the major components of the domestic food system in the United States, The marketing components of the total food system are identified separately.

In certain instances, lines between production and marketing are somewhat blurred. When marketing functions are vertically linked and controlled by producers with facilities located on farms, they would by definition be excluded from what normally would be considered the marketing system, An example would be egg producers who clean, size, grade, and pack eggs on the farm and then sell to wholesalers, retailers, or directly to consumers. Direct marketing covers producers who perform the necessary processing and packaging functions, if any, and retail the product. Farmers who sell their own produce at a roadside stand or "pick your own produce" operators would be included in this definition and would, therefore, not be a part of the marketing system as defined.[1]

The definition used here for a marketing system is suited for this report because it is general enough to include most marketing functions yet does put manageable boundaries on the areas being considered.

The marketing system performs the services necessary to move food from the producer to the consumer. Most products are processed, packaged, stored, and transported as they move through the marketing channels. The extent and type of these operations depend on the nature of the product and its location relative to the consumer. In addition to farm production, energy, labor, and other inputs are utilized by firms to perform marketing functions. Finally, there must be a flow of information to facilitate the orderly exchange of goods and services among firms in the marketing system.

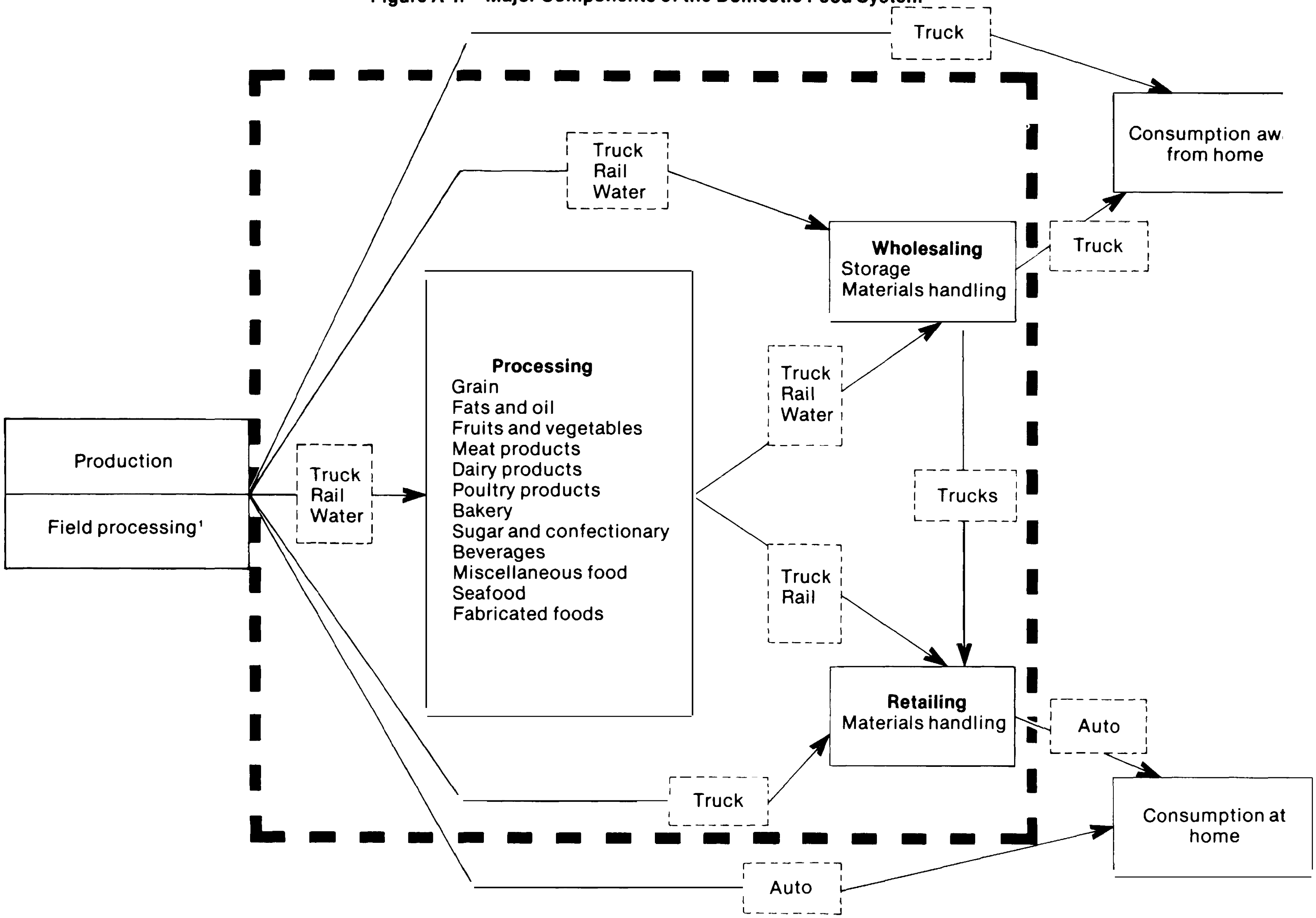
Private firms generally perform the marketing function, but other institutions such as local, State, and Federal governments usually provide inspection and grading services. Private and governmental agencies may also undertake research to increase efficiency at the individual firm level and in the system.

[1]H.R. Linstrom, Farmer to Consumer Marketing, U.S. Department of Agriculture, Economics, Statistics, and Cooperatives Service, Report No. ESCS-01, February 1978.

MEASURES OF THE SIZE OF THE FOOD MARKETING SYSTEM

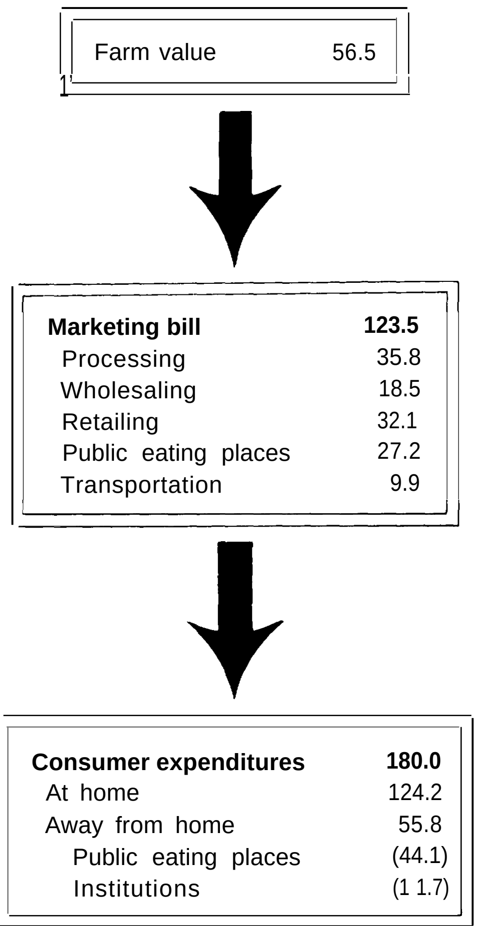
The food marketing system is large. Estimates for 1977 show that out of the $180 billion consumers spent on domestically produced food, the marketing bill was $123.5 billion (see figure A-2). This is more than twice the farm value of the food. Processing at

Figure A-1.—Major Components of the Domestic Food System*



¹Field processing includes cleaning, grading, and packaging of vegetables and fruit. Transportation shown by lines between major components. Marketing functions enclosed by heavy dotted line.
*Prepared by Office of Technology Assessment.

Figure A-2.— Farm Value, Marketing Bill, and Consumer Expenditures for Food, 1977
(billions of dollars)*



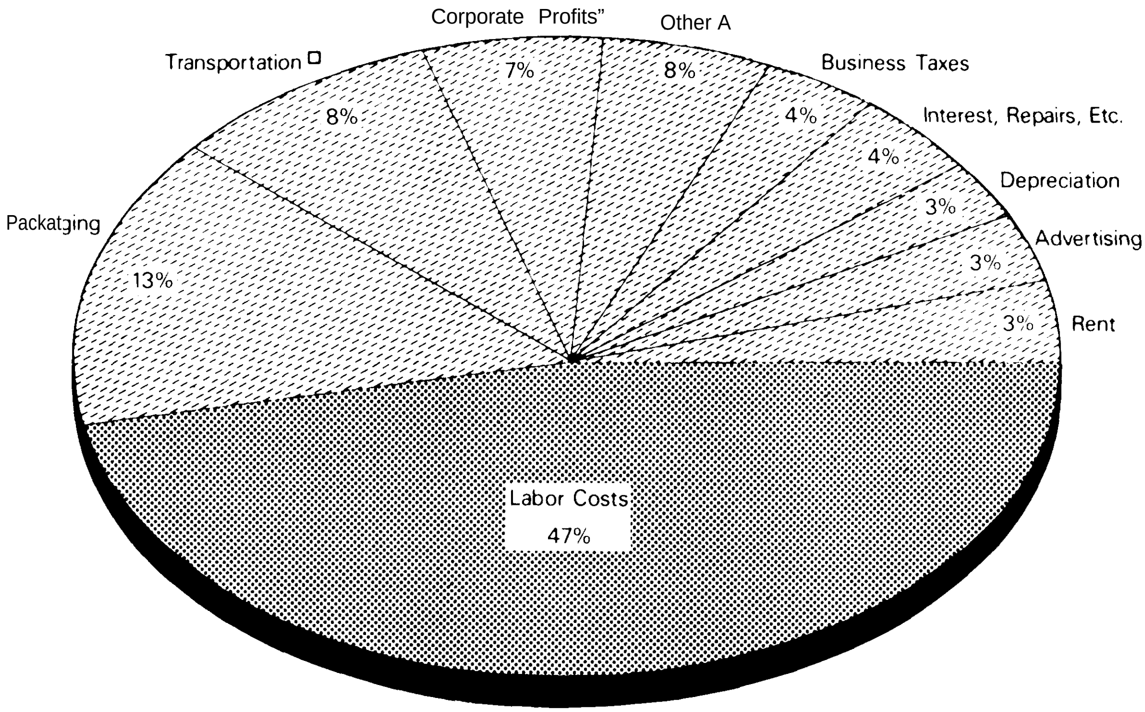
“ Domestic farm food only
SOURCE U S Department of Agriculture, Economics, Statistics, and Cooperatives Sew Ice, Agricultural Economic Report 398, Washington, D C., March 1978.

$35.8 billion accounted for the largest amount, followed by retailing at $32.1 billion. Sales of domestically produced foods were 25 percent of the total consumer expenditures (excluding energy and service) of $73o billion in 1973. Stated another way, foodstores and away-from-home eating accounted for $2.50 of every $10 worth of consumer expenditures.

Components of the marketing bill as broken out by the U.S. Department of Agriculture (USDA) include transportation, packaging, labor, profits, etc., and are shown as a percent of the total marketing bill in figure A-3. Labor costs are the largest at 47 percent, and packaging is second at about 13 percent of marketing costs.

Census data for 1967 and 1972, the latest available, show the size of the marketing system and changes that are taking place. These data are not comparable to USDA data on the marketing bill because they include food and kindred products rather than just data for domestically produced food. In 1972, there were 588,000 food marketing establishments with $356 billion in sales and 5.7 million employees (table A-l). The decrease in the number of establishments occurred primarily with processors and food retail stores, with only a slight decrease in the number of wholesale grocers.

Figure A.3.—Components of Bill for Marketing Farm Foods, 1976*



** Bill for marketing U.S. farm foods in 1976; shares for 1977 will closely approximate 1976 data.* ○ *Before taxes.*
◻ *Intercity rail and truck.* △ *Residual includes such costs as utilities, fuel, promotion, local for-hire transportation, and insurance.*

SOURCE: U.S. Departrnmt of Agriculture, Economic Research Service, Agricultural Outlook, AO-26, Washington, D.C., October 1977.

Table A.1 .—Establishments, Sales, and Employees for Food Marketing Firms, 1967 and 1972

Kind of business and year	Establishments (number)	Sales (thousands of $)	Employees (thousands)
Processors			
1967	37,521	**$83,975**	**1,650**
1972	28,184	**115,060**	**1,085**
Wholesale grocers[a]			
1967	40,055	**74,391**	**534**
1972	39,137	**109,815**	**585**
All foodstores[b]			
1967	**294,243**	**70,252**	1,444
1972	**267,352**	**100,719**	1,722
Eating places[b]			
1967	**236,563**	**18,897**	1,737
1972	**253,136**	**30,385**	2,317
Total—1967. , ...	608,382	$247,515	5,365
Total—1972.	587,809	$355,979	5,709

aprocessors of food and kindred products from U.S. Bureau of Census, Census of Manufactures, 1972. *Sub Series, General Summary* MC **72(1)-1,** Washington, D.C.
bus. Department of Agriculture, ***Market** Structure **of the** Food **Industries,*** Economic Research Service, MRR No. 971, September 1972.

APPENDIX B

PROCEDURES FOLLOWED IN THE PLANNING ASSESSMENT

Specific procedures followed in preparing the planning assessment are listed below. The sequence is chronological.

1. Individuals familiar with the writing of futurists were consulted for references that project what the future may be through the year 2OOO and beyond. From the futurists' general views of the future, a preliminary set of socioeconomic factors likely to influence the technologies that might emerge or be needed to fill certain gaps in marketing technology was generated. This basic set of factors was the foundation on which the rest of the planning assessment was built.

2. Studies on present and emerging technologies in food marketing were reviewed. This review gave the status of currently used technologies, those available but in limited use, and those in the development stage.

3. Two letters were sent to selected individuals. One letter covered technologies in processing and packaging; the other, technologies in transportation, wholesaling, and retailing. The first part of each letter included an explanation of the project and general instructions for the respondents. A list of socioeconomic factors considered important in shaping emerging technologies, along with a list of technologies, was given in the second part. Respondents were asked to select from the technologies on the list, and from those they suggested the five most important emerging technologies and the reasons for their selection.

4. A preliminary paper drew on data obtained in the literature review plus an analysis of information on the returns from the mailing. The socioeconomic factors were expanded by adding details from research reports and other sources. These factors were used to develop two scenarios for the future.

5. A workshop of specialists was given the preliminary paper to study. The working group, convened in a structured setting with the paper as background material, added indepth discussions on the technologies with special emphasis on the issues they raised, the urgency of these issues, and the need for assessment.

6. The planning assessment report utilized the panel data along with all other information to make a priority listing of technologies for assessment. Issues raised by the priorities were listed and discussed.

MAIL SURVEY

Steps 1 and 2 for completing this assessment were outlined in the introduction chapter of this report. The third step was to send a letter to specialists in food processing and distribution. The mail survey had two major objectives: to provide a broad coverage that would identify emerging technologies across the marketing system and provide information on stage of development and expected issues.

A letter covering processing and packaging was sent to 127 individuals and one covering food distribution to 94 (see appendix C). These letters were sent to selected food technologists, economists, extension personnel and others in schools and universities, industry and trade associations, Government representatives, consultants, and writers for trade publications.

The processing and packaging letter contained a list of socioeconomic factors expected to influence the development of processing and packaging technologies, and the distribution letter included those socioeconomic factors expected to influence wholesaling, retailing, and transportation technologies. Each letter also contained a partial list of technologies that were in limited use or in the developmental stage.

Respondents were asked to comment on the relevance of the socioeconomic factors and add to the list any others they considered appropriate. They were to comment on the list of technologies, add to the list, and then based on their evaluation of the socioeconomic factors, to select in priority order the five technologies they expected to raise the most substantive policy issues.

Replies were received from 38 percent of those receiving letters. The percentage of response was higher for those receiving the processing and packaging letter than for those receiving the distribution letter (see table B-l).

Table B-l .—Number of Responses to Letter by Type of Respondent

	Processing letter	Distribution letter
Total letters mailed	121	94
Respondents		
Total responses	58	23
University	25	7
industry.	15	9
Government	13	3
Consultants, writers	5	4

The mail survey provided information for the workshop sessions. Twenty-six processing and packaging technologies and 16 distribution technologies were identified for consideration in the workshop. A background paper containing the two lists was given to participants prior to their attendance at the workshop.

WORKSHOP

The purpose of the workshop sessions was to provide information that would help place in priority order those marketing technologies expected to raise policy issues needing concongressional attention. Twenty-one specialists in various fields participated in the workshop.

After a general orientation session, participants were divided into two subgroups. One subgroup of 11 concentrated on technologies in processing and packaging, and the other subgroup of 10 discussed distribution technologies. The participants represented industry, labor, research, trade, consumer, and Government organizations. They were assigned to either distribution or processing subgroups, depending on their knowledge or interest. A list of these participants can be found at the beginning of this report.

The two subgroups followed the same procedures and used the same materials, except that each group had the list of technologies appropriate for its area of work. The workshop consisted of an evening session (Session 1), one full day with Session 2 in the morning and Sessions 3 and 4 in the afternoon, and a concluding session (Session 5) the next morning.

Session 1: Orientation. This session covered workshop objectives and procedures.

Session 2: Priorities based on probability of adoption. The processing and packaging subgroup and the distribution subgroup met in separate sessions. The first hour was spent in discussing the technologies and socioeconomic factors and adding technologies working group members felt should be given consideration. The objective for both groups was to place a priority order on the technologies based on the probability of occurrence and adoption by 1985. In this priority ordering the subgroups did not consider impacts. Probability of adoption was estimated for each technology under two scenarios, each with different assumptions about the socioeconomic factors. Scenario 1 basically projected a set of socioeconomic factors that would not deviate from established trends. Scenario 2 indicated that energy would increase relative to most other costs and that the supply and price of other raw materials would be subject to disruption. Supply and demand conditions would cause an increase in domestic food prices, Consumers would turn toward a meal rather than a commodity concept. Worksheet A (appendix C) provided the means for converting the impact of each scenario to the probability of development and adoption of the technologies. Time limited the exercise to estimating the probability of adoption only to 1985.

Session 3: Priorities based on impact. The two subgroups met separately to determine a priority rating for technologies based on expected impacts, entirely separate from probability of adoption. A technology might have a low probability of adoption but could have severe and widespread impacts if adopted. Probability of adoption and impacts are both important criteria to consider in ranking technologies for priority assessment. The objective was to study the impacts and issues for each technology and then score the impacts on Worksheet B (appendix C). These scores were used to rank the technologies based on impacts and issues.

Session 4: Integration of results from Sessions 2 and 3, All members of the workshop met together in this session, before which OTA staff had evaluated Worksheets A and B and selected the technologies with the highest probability of adoption and those with the highest expected impacts for processing and distribution. In Session 4, impacts and issues for the highest priority processing and packaging technologies were discussed in detail. Worksheet C (appendix C) served as a guide for discussing the impacts and issues across the marketing system.

Session 5: Continuation, Discussion was concluded on the processing and packaging technologies. Most of the session was devoted to discussing the impacts and issues for the distribution technologies with a high probability of adoption and those expected to have widespread impacts. Both Sessions 4 and 5 were designed to maximize the synergism of the specialists as they interacted.

Some workshop members voiced concern over trying to determine a priority ordering of technologies with such a small number of workshop participants. However, the fact that they had access to the mail survey results and were selected for their individual knowledge covering most if not all marketing areas should compensate for the small number in the workshop.

The OTA staff utilized all the material from the workshop for a final priority list of technologies for assessment.

Congress of the United States
OFFICE OF TECHNOLOGY ASSESSMENT
WASHINGTON, D.C. 20510

EMILIO Q. DADDARIO
DIRECTOR
DANIEL V. DE SIMONE
DEPUTY DIRECTOR

PROCESSING LETTER

The Off ice of Technology Assessment (OTA) is a scientific advisory arm of the Congress. Created by Congress in 1972, OTA is one reflection of this Nation's maturing realization of the need for new institutional approaches to assure that our national public policy is based to the fullest possible extent on a clear understanding of the potential consequences, beneficial or adverse, of the use of technology.

We believe that consumers, industry, and society as a whole will benefit from looking ahead and identifying possible issues associated with emerging technologies before they become crises. Being ahead of the issues should provide the necessary time and understanding between Congress and affected parties for developing sound and equitable solutions.

In the food area, OTA is attempting to identify and analyze emerging technological and policy issues for the Congress. You are one of a select group asked to help in this effort.

As an initial step, we need your help to identify processing and packaging technologies. Your response should include existing, emerging, or needed technologies. Others will be asked to respond to other areas of food marketing, including wholesaling> retailing, and transportation. We are primarily interested in technologies that exist but have not been adopted or those most likely to be developed and adopted under the socioeconomic and institutional conditions expected to exist during the remainder of this century.

To provide a framework for your thinking on emerging technologies, we have identified a number of socioeconomic factors that should influence the development of technologies in food processing and packaging or that would be affected by the adoption of new technologies (see attachment). In developing this preliminary list of factors, we reviewed a number of publications by futurists speculating on the future by the year 2000 and beyond. We isolated a number of common factors that may shape the kinds of technologies emerging in food processing and packaging. As work progresses, factors may be added to or deleted from this basic list.

These socioeconomic factors should be viewed as important influences in the development of new technologies or adoption of existing technologies.

For example, one study estimates that manufacturing of food and kindred products accounts for about 4 percent of the total U.S. energy consumption. An increase in the cost of energy would probably result in increased money for research and development on technologies to save energy in processing and packaging. Similarly, changes in the other factors would be expected to influence processing and packaging technology.

With this brief explanation of conditions that will probably affect the adoption of technologies up to the year 2000, we are asking your help in the following ways:

1. Look at the socioeconomic factors we have included plus those you may wish to add, and give us your evaluation of the potential for each factor to promote or deter the development of technologies in processing and packaging.

2. A list of technologies is enclosed to stimulate your thinking. In the context of the problems indicated by your evaluation of the socioeconomic factors, criticize our list of technologies and then add to our list technologies that are currently developed but not widely adopted or those which will be needed to fill deficiencies in marketing technology in the years ahead. In the latter case, feel free to contribute technologies which may appear "far out" or "blue sky" but which conceivably could be part of food marketing in the year 2000.

3. From the technologies on our list combined with those you added, select the five technologies you consider should raise the most substantive policy issues for Congress. Briefly give the reasons for your selections.

4. Make any additional comments, suggestions, or explanations you feel are in order. The areas of food production, nutrition, and consumption are being given similar attention by others in OTA'S food program and the studies will be closely coordinated.

At this time we are primarily interested in brief responses to be sure we have explored the major avenues where marketing technologies may emerge and to get an indication of the priority ordering of these technologies. Responses will be analyzed and incorporated in a preliminary paper which will serve as the starting point for further input and analyses by a panel of experts. Your response within 30 days will be most valuable to our analysis. If you have any questions, please call one of us at 202-225-5949.

We thank you for your cooperation.

Sincerely,

Michael J. Phillips
Marketing Projects Leader
Food Program

William W. Gallimore
Staff Economist
Food Program

Congress of the United States
OFFICE OF TECHNOLOGY ASSESSMENT
WASHINGTON, D.C. 20510

DISTRIBUTION LETTER

The Office of Technology Assessment (OTA) is a scientific advisory arm of the Congress . Created by Congress in 1972, OTA is one reflection of this Nation's maturing rea1ization o f the need for new institutional approaches to assure that our national public policy is based to the fullest possible extent on a clear understanding of the potential consequences, beneficial or adverse, of the use of technology.

We believe that consumers, industry, and society as a whole will benefit from looking ahead and identifying possible issues associated with emerging technologies before they become crises. Being ahead of the issues should provide the necessary time and understanding between Congress and affected parties for developing sound and equitable solutions.

In the food area, OTA is attempting to identify and analyze emerging technological and policy issues for the Congress. You are one of a select group being asked to help in this effort.

As an initial step, we need your help to identify technologies in food distribution, including wholesaling, retailing, and transportation. Your response should include existing, or needed technologies. Others will be asked to respond to other sectors of food marketing, including processing and packaging. We are primarily interested in technologies that exist but have not been adopted or those most likely to be developed and adopted under the socioeconomic and institutional conditions expected to exist during the remainder of this century.

To provide a framework for your thinking on emerging technologies, we have identified a number of socioeconomic factors that should influence the development of technologies in wholesaling, transportation, and retailing or that would be affected by the adoption of new technologies (see attachment).

In developing this preliminary list of factors, we reviewed a number of publications by futurists speculating on the future by the year 2000 and beyond. We isolated a number of common factors that may shape the kinds of technologies emerging in wholesaling, retailing, and transportation. As our work progresses, factors may be added to or deleted from this basic list.

These socioeconomic factors should be viewed as important influences in the development of new technologies or the adoption of existing technologies.

For example, one study estimates that wholesaling, retailing, and transporting of food and kindred products accounts for about 6.6 percent of the total U.S. energy consumption. An increase in the cost of energy would probably result in increased money for research and development on technologies that would save energy in these marketing areas. Similarly, changes in the other factors would be expected to influence wholesaling, retailing, and transportation technology.

With this brief explanation of conditions that will probably affect the adoption of technologies up to the year 2000, we are asking your help in the following ways:

1. Look at the socioeconomic factors we have included plus those you may wish to add, and give us your evaluation of the potential for each factor to promote or deter the development of technologies in retailing, wholesaling, and transportation.

2. A list of technologies is enclosed to stimulate your thinking. In the context of the problems indicated by your evaluation of the socioeconomic factors, criticize our list of technologies and then add to our list technologies that are currently developed but not widely adopted or those which will be needed to fill deficiencies in marketing technology in the years ahead. In the latter case, feel free to contribute technologies which may appear "far out" or "blue sky" but which conceivably could be part of food marketing in the year 2000.

3* From the technologies on our list combined with those you added, select the five technologies you consider should raise the most substantive policy issues for Congress. Briefly give the reasons for your selections.

4. Make any additional comments, suggestions, or explanations you feel are in order. The areas of food production, nutrition, and consumption are being given similar attention by others in OTA's food program, and the studies will be closely coordinated.

At this time we are primarily interested in brief responses to be sure we have explored the major avenues -where marketing technologies may emerge and to get an indication of the priority ordering of these technologies. Responses will be analyzed and incorporated in a preliminary paper which will serve as the starting point for further input and analyses by a panel of experts. Your response within 30 days will be most valuable to our analysis. If you have any questions, please call one of us at 202-225-5949.

We thank you for your cooperation.

Sincerely,

Michael J. Phillips
Marketing Projects Leader
Food Program

William W. Gallimore
Staff Economist
Food Program

APPENDIX C

AGENDA, OBJECTIVES, AND PROCEDURES FOR THE WORKING GROUP

OBJECTIVES

The objectives of the working group will be to:

1. Identify those technologies with the highest probability of development and adoption.
2. Identify those technologies most likely to raise substantive policy issues for Congress.
3. Identify, in detail, the severity of impacts, The groups most affected by the impacts, and the issues arising from these impacts.

ORGANIZATION AND METHODOLOGY

For the initial session on October 12, the working group will meet together. For part of the session on October 13, the working group will be divided into two sections, one on processing and packaging and the other on food distribution, including wholesaling, retailing, food service, and transportation.

October 12,1977

6 to 7pm. Orientation meeting, with a brief explanation of the Office of Technology Assessment and presentation of the objectives and procedures for the working group.

October 13, 1977

Session 2: 8 to 11 a.m. The processing and packaging, and distribution subgroups will meet in separate sessions. Each group will be given a list of technologies for their assigned area of work and spend approximately an hour discussing the technologies and socioeconomic factors, clarifying questions, and adding information. The positive or negative effect of a selected number of socioeconomic factors on the technologies will be evaluated under two different scenarios. The group will then give their estimate of the probability of development and adoption of each technology by 1985 and the year 2000 for each scenario. This information will be used to select the technologies with the highest probability of emerging by 1985 and 2000.

Materials supplied: a) background paper, b) Worksheet A, and c) two scenarios of soci~ economic factors.

Session 3: 12:30 to 2:30 p.m. The two subgroups, meeting separately, will make a cursory study of the impacts and issues for each technology. There will be group discussion and interaction, then the subgroups will use Worksheet B to score the technologies based on the expected positive and negative impacts and issues the technologies are expected to raise.

Materials supplied: a) background paper, and b) Worksheet B.

Session 4: 3 to 6 p.m. The working groups will meet together and will consider those technologies from processing and distribution which have been selected as the most likely to emerge based on previous work by the subgroups. The group will discuss in detail the expected impacts and issues for each technology. Worksheet C will serve as a guide for this discussion.

Materials supplied: a) background paper, b) priority list of technologies based on probability of emergence, and c) Worksheet C.

October 14, 1977

Session 5: 8:30 a.m. to 12:30 p.m. The working group will be given two lists of technologies, one on processing and packaging and the other on distribution. These will be the technologies ranked by the subgroups as having the greatest impacts and raising the most substantive issues. Some of these technologies may have been discussed in the previous session if they were also the ones with a high probability of emergence. Using Worksheet C, the group will discuss the impacts and issues for each technology.

Materials supplied: a) background paper, b) list of technologies ranked by expected issues, and c) Worksheet C.

Attachment to Worksheet A: Scenario 1

This scenario projects socioeconomic factors that would show no major shocks either economically or socially and is the kind of socioeconomic environment expected if things continue to evolve much as they have in the past 25 years.

Energy and Raw Materials. The cost of energy will remain about the same relative to other costs. New sources of domestic oil will be discovered, and other energy sources will be developed. Our dependence on foreign oil will be decreased slightly, and imports of oil will not continue to grow as in the past. Shortages of other raw materials will be transitory in nature and will not cause major disruptions in the economy.

Demand for Food Domestic and foreign demand will not cause an unusual rise in food prices. There will be a continual demand for convenience foods in this country. Demand for beef, poultry, and other meats will increase less rapidly than in the past but will probably increase,

Supply of Food, The supply of food from traditional agriculture will be adequate, although there will be new products introduced in response to changes in price of food from traditional sources. These new products or ingredients will still be from traditional sources, augmented to a small degree from unconventional sources.

Health Concerns. There will be an increased awareness of the relationship between nutrition and health, and this concern is expected to influence eating patterns. The major concern will be over food additives, and this will be reflected in careful consideration of processed foods and foods fabricated from new ingredients.

Regulations. Regulations regarding the testing and approval of food ingredients will remain essentially as they are now. The Delaney amendment will be the guide for approving new additives. Regulations regarding transportation will remain essentially the same, although there will be changes that will allow for increased efficiency. Efforts will continue to curb pollution of the environment.

Changing Lifestyles.

- Older persons will make up a larger percent of the population.
- People will retire at an earlier age.
- The proportion of working wives will remain the same as at present.
- people will have more leisure time.
- Away-from-home eating will continue to increase.
- The family will remain the basic social unit, but there will be fewer meals prepared in the home, and the family will eat together less often.

Economics.

- Real median family income (yearly):

1975:	$14,000
1985:	20,000
2000:	25,000

- Inflation rate: 5 percent per year.
- Consumers will have more disposable income and more income for discretionary use.

Industry Structure. Structure refers to size and number of firms, market shares, and coordination among firms in an industry. The current trend toward fewer and larger firms in the food industry will continue.

Other Institutions. Labor's influence regarding the development and adoption of technologies increases.

Attachment to Worksheet A:' Scenario 2

Changes depicted for the socioeconomic factors in this scenario would be expected to have more influence on the development and adoption of technologies up to the year 2000 than those in Scenario 1.

Energy and Raw Materials. The cost of energy will increase substantially relative to other costs. Additionally, the supply of foreign oil and other strategic raw materials will be subject to periodic disruption for political, economic, and other reasons. Our dependence on imports of oil will increase, and the need to export agricultural materials to help decrease the deficit in our balance of payments will increase.

Demand for Food. Foreign demand for food will increase, causing domestic food prices to increase to the extent that alternative food forms and sources will be needed to augment the supply. The demand for convenience foods will continue in the face of rising prices. The per capita consumption of beef and pork will decline slightly.

Supply of Food. New sources of food from nontraditional sources will be developed. Traditional agriculture will be the main source but will not be sufficient to keep prices at acceptable levels. Methods will be sought to better utilize available food supplies.

Health Concerns. Consumers are concerned over nutrition and food safetv but are willing to accept small risks and to use more processed foods and foods fabricated from new ingredients.

Regulations. Regulations regarding the testing and approval of food ingredients, including additives, will change. Food ingredients will be judged on the basis of benefits as well as injurious effects. Regulations regarding transportation will be changed so that maximum efficiencies may be achieved. Efforts to curb pollution will be slowed, and lower standards will be accepted.

Changing Lifestyles.

- Older persons will make up a larger percentage of the population.
- Retirement age remains the same as at present.
- The proportion of working wives will increase.
- In addition to the traditional eating establishments, central facilities will be located in neighborhoods where meals may be eaten or taken home.
- Families will prepare and serve their meals on an individual basis, either by buying them at central preparation facilities or as convenience foods from retail outlets.

Economics.

- Real median family income (yearly):

1975:	$14,000
1985:	18,000
2000:	21,000

- Inflation rate: 7 percent per year.
- Consumers will have a lower percentage of their disposable income for discretionary use.

Industry Structure. Food industry structure will be under close scrutiny by the Federal Government, resulting in less concentration,

Other Institutions. Labor's influence regarding development and adoption of technologies lessens.

Attachment to Worksheet B: Explanation of Criteria for Determining Impact Scores

Short-Term Economic Effects. Short term would be up to 5 years after adoption of the technology. Refers to the net effect on employment, cost to the industry and to consumers, and other effects of a transitory nature. If both beneficial and harmful effects are occurring equally and at the same time, they should balance out. However, the negative impact may receive the greater weight, since, for example, the simple balancing of jobs lost and gained ignores the problems of dislocation.

Long-Term Economic Effects. Long term would include effects after 5 years from adoption and refers to the extent to which the technology will result in a net increase or decrease in the total quantity of economic goods and services produced in the long term. A favorable impact would generally reflect a more efficient utilization of resources, increased productivity of labor, or increased productivity of capital. An unfavorable economic impact would mean the contrary.

Effect on Quality of Life. Quality of life includes equity of income distribution, social mobility, diversity of opportunity and freedom of choice, the propensity of various groups to be cooperative or disruptive, and the general morale of society as a whole. Also included are improvements or declines in certain aspects of the standard of living such as convenience, variety, quality, etc. These are related to income and employment but are considered separately for assessment.

Effect on Quality of the Environment. Refers to externalities, or public and private disservices resulting from economic activities. Pollution, urban congestion, and worker safety are the major categories. For example, if the technology increases the amount of pollution or congestion generated by production and/or consumption of the goods or services, it gets a negative score, or, conversely, a positive score if the opposite is true.

Effect on Nutrition and Food Safety. The direction and degree of impact on food safety by adoption of the technology. The score should reflect a judgment of the net effect. Nutrition refers to whether the nutritional quality of the food is increased or decreased, while safety indicates whether a technology would increase or decrease the safety of food.

Effect on Conservation of Resources, This measures the net effect of the technology on resources, especially energy and others in critical supply. This would include efficient use of nonrenewable resources plus substituting renewable for nonrenewable resources, such as packaging material from cellulose instead of petroleum products.

Worksheet C: Guide for Assessing the Impacts and Issues From Adoption of Technologies

The following guide is presented in matrix form to show the possible impact of a technology adopted in one sector of food marketing over the whole system and extending to other primary segments of society and secondary or more long-term effects that should be considered. The major purpose of the guide is to assure that as many issues and impacts as possible will be covered in the time allowed. Additional impacts and issues may emerge and be added to those listed as the technologies are discussed.

The guide sheet may be used initially to check the important impact areas. The group discussion will then bring out the exact nature of the impacts and the possible issues.

WORKSHEET A— IMPACT OF SELECTED SOCIOECONOMIC FACTORS ON NEW TECHNOLOGIES

SCENARIO # ___ Session No. 2

	SOCIOECONOMIC FACTORS								Probability of Occurance by 1985		Probability of Occurance by 2000	
	Energy and Raw Materials	Demand for Food	Supply for Food	Health Concerns	Regulations	Changing Life Styles	Industry Structure	Other Institutions	Development	Adoption	Development	Adoption
	- 0 +	- 0 +	- 0 +	- 0 +	- 0 +	- 0 +	- 0 +	- 0 +				
1.												
2.												
3.												
4.												
5.												
6.												
7.												
8.												
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11.												
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14.												
15.												
16.												
17.												
19.												
19.												
20.												

DIRECTIONS:

WORKSHEET B—EXPECTED IMPACTS OF THE TECHNOLOGIES

Impacts*	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
TOTAL																				
NEGATIVE																				

Directions for Scoring—Score each impact on a +3 to -3 scale for each technology. A zero would indicate a balancing of the positive and negative impacts or no impacts expected.

*See attached explanation.

WORKSHEET B—EXPECTED IMPACTS OF THE TECHNOLOGIES

(Continued)

Impacts*	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	3	38	39	40
TOTAL																				
NEGATIVE																				

Directions for Scoring—Score each impact on a +3 to -3 scale for each technology. A zero would indicate a balancing of the positive and negative impacts or no impacts expected.

*See attached explanation.

Technology No. ______________

WORKSHEET C—IMPACTS AND ISSUES OF NEW FOOD MARKETING TECHNOLOGIES

FOOD MARKETING SEGMENTS

Effects	Processing		Packaging		Wholesaling		Retailing		Food Service		Transportation		Consumers	
	Impact	Issue	Impact	Issue	Impact	Issue	Impact	Issue	Impact	ISSUE	Impact	Issue	Impact	Issue
Economic Effects														
Scale														
Location														
Employment														
Demand for Food														
supply of Food														
Quality of Life														
Workers Safety														
Structures and Institutions														
Quality of Environment														
Pollution														
Nutrition and Food Safety														
Product Quality														
Nutrition														
Safety														
Conservation of Resources														
Energy														
Other														

APPENDIX D

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