A National Program of Research for

FOOD AND NUTRITION

Prepared by

A JOINT TASK FORCE OF THE
U. S. DEPARTMENT OF AGRICULTURE
AND THE STATE UNIVERSITIES
AND LAND GRANT COLLEGES

FOREWORD

The United States Department of Agriculture and State Agricultural Experiment Stations are continuing comprehensive planning of research. This report is a part of this joint research planning and was prepared under recommendation 2 (page 204, paragraph 3) of the National Program of Research for Agriculture.

The task force which developed the report was requested to express their collective judgment as individual scientists and research administrators in regard to the research questions that need to be answered, the evaluation of present research efforts, and changes in research programs to meet present and future needs. The task force was asked to use the National Program of Research for Agriculture as a basis for their recommendation. However, in recognition of changing research needs it was anticipated that the task force recommendations might deviate from the specific plans of the National Program. These deviations are identified in the report along with appropriate reasons for change.

The report represents a valuable contribution to research plans for agriculture. It will be utilized by the Department and the State Agricultural Experiment Stations in developing their research programs. It should not be regarded as a request for the appropriation of funds or as a proposed rate at which funds will be requested to implement the research program.

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This report has been prepared in limited numbers. Persons having a special interest in the development of public research and related programs may request copies from the Research Program Development and Evaluation Staff, Room 318-E Administration Bldg., USDA, Washington, D.C. 20250.

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HIGHLIGHTS OF THE REPORT

Agriculture has national responsibility for production of food needed to sustain life and health. To provide the proper assortment of foods, it is essential to know what is required. Food and nutrition research in agriculture is aimed at achieving maximum efficiency of our human resources through the consumption of adequate diets and proper use of foods. It aims to provide maximum consumer satisfaction from foods. Research in food and nutrition must provide the basic knowledge required for planning and evaluating programs for improving the nutritional level of diets of all people.

Benefits from food and nutrition research include an extended productive life and life span. These are realized through a delay in the onset of old age and prevention of illness secondary to consumption of poor diets or irregular habits of eating. In turn, costs are lowered through reduction in work days lost, lower expenditures for medical care, and improved efficiency on the job. Better knowledge of the nutritional values enables consumers to use their food dollars more efficiently to provide good nutrition.

The projected effort for food and nutrition research is only 1.9 percent of the 1977 research program for agriculture. This is out of proportion to its potential benefits and inadequate in terms of needs to achieve national goals.

Training grants are needed to meet a critical shortage of scientists and educators in the fields of food and nutrition.

Research needs of highest priority relating to food choices, habits, and consumption are:

1. Accurate measures of food intake of individuals

2. Knowledge of factors affecting food choice

3. Determination of how to bring about change in undesirable food habits

Research needs of highest priority relating to quality of food in homes and institutions are:

1. Knowledge of effects of conditions during food storage, preparation, holding, and serving on the structure and chemical components responsible for eating quality and nutritive value

2. Effects on food safety of different practices of storing, preparing, and especially of holding food

3. Study of physiological factors concerned in the sensory perception of food quality and food preferences of individuals

Research needs of highest priority relating to human nutritional well-being are:

1. Determination of specific human requirements for nutrients in the food supply

2. Assessment of the nutritional values present in each of our foods

3. Knowledge of the extent and nature of the nutritional problems in the U.S.

To meet the goals set for these priority researches in food and nutrition, a greater effort than is projected in the National Program of Research for Agriculture will be needed.

INTRODUCTION

This Report has been prepared by a joint task force appointed to develop a coordinated State-Federal program of research for food and nutrition during the decade ahead. As recommended by the USDA Agricultural Research Planning Committee, the review and the projected researches expand on several problem areas of the National Program of Research for Agriculture (October 1966). The three major problem areas covered all pertain to Goal VII, to protect consumer health and improve nutrition and well-being of the American people. They are: Research Problem Area RPA 703 - Food Choices, Habits, and Consumption; RPA 704 - Quality of Food in Homes and Institutions; RPA 708 - Human Nutritional Well-Being. Together they constitute a consumer-oriented program of research in food and nutrition.

The Report was prepared by representatives of the USDA and State Experiment Stations, with the assistance of special advisors made available to the task force. USDA members and special advisors were appointed by Assistant Secretary George Mehren; members representing the States were appointed by Dr. Roy L. Lovvorn, Chairman of the Experiment Station Committee on Organization and Policy.

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Prior to the appointment of the Task Force on Food and Nutrition, the Subcommittee on Research Program and Facilities of the Agricultural Research Planning Committee make recommendations on the most effective division of research effort between the USDA and the States. Their manpower recommendations and allocations were based on the projections for 1972 and 1977 in the National Program of Research for Agriculture. The joint task force has noted these allocations but has not developed separate recommendations. It has, however, commented on the inadequacy of the total level of effort projected for the several research problem areas.

The findings and recommendations which follow bear on the principal charge to the task force, that of "indicating areas of research which need emphasis."

ROLES AND GOALS OF FOOD AND NUTRITION RESEARCH IN AGRICULTURE

Responsibilities of Agriculture for Food and Nutrition Research. National responsibility is vested in the Secretary of Agriculture for the production of enough food and a proper assortment of foods to meet the nutritional needs of the Nation's citizens within the general framework of their food habits and standards. To assist in carrying out this responsibility, the Department and State Agricultural Experiment Stations have conducted research in nutrition and the effective household use of food for more than three-quarters of a century. The results have helped to guide long-range programs of food production, marketing, and distribution; have provided critical information for many of the Department's policy decisions; and have served as the basis for programs to guide consumers in food selection and use.

Nutrition is the focus in a major national goal of the USA, "Freedom from Hunger." The Secretary of Agriculture recently has elaborated on this in saying "It is, and should be, our national goal that every single American child will have the advantage of an adequate, nutritious diet." This goal can be achieved only through the efforts of many individuals and groups, and many agencies of the State and Federal governments. Agriculture has a major interest and responsibility for assuring that our food supply affords optimum nutrition and the maximum efficiency of use of our human resources.

Other agencies of the Federal Government also have significant programs in nutrition. The Public Health Service of the Department of Health, Education, and Welfare, is concerned with maintenance of health and opportunities of disease control through improved nutrition, with nutritional abnormalities, with nutritional problems of the chronically ill or aged. The Food and Drug Administration is concerned with special nutritional products intended for food or drug use. The Children's Bureau has a concern for the health and welfare of children and their mothers. The Department of Defense and the National Aeronautics and Space Administration must relate nutritional knowledge to special food rations being developed, to particular stress situations, and to logistical problems in feeding a select population group. Each of these programs is oriented toward a particular mission of the agency. Agriculture's mission is our food supply and man as a consumer.

To fulfill its mission, Agriculture must provide expertise on the inherent properties and nutritive value of foods, human requirements for foods and nutrients, and ways consumers can use food products to their greatest advantage and satisfaction. Adequate up-to-date information about the Nation's dietary situation is essential to provide the baseline for national

programs. Food and nutrition research must develop the basic knowledge required for planning and evaluating programs for improving the nutritional level of all people.

The Objectives and Benefits of Food and Nutrition Research. The basic and applied research in food and nutrition in this Report is consumer-oriented. It is characterized by an emphasis on food as a dynamic force throughout the lives of normal, healthy persons. The three primary objectives are to:

1. Provide up-to-date information about the diets and nutriture of the U.S. population.

2. Develop procedures for household and institutional use of foods which will preserve nutritional, sanitary, and wholesome qualities.

3. Determine the requirements for nutrients and the nutritional and eating qualities of foods to provide a basis for recommendations of assortments of foods that can best assure the nutritional well-being of all people throughout their life span.

The benefits of food and nutrition research are great and far reaching. They affect each of us at all stages of our lives. The benefits include increased personal satisfaction, improved health, decreased food cost, and the resulting higher levels of living associated with economic and health gains. More specificially, the benefits are:

1. Individuals - benefit from improved health, a longer productive life, a greater sense of well-being, more satisfaction with the foods they eat, higher income because of fewer work days lost.

2. Families - increased purchasing power, fewer illnesses, higher incomes, money saved by reduced food losses or lower medical expense.

3. The Nation - benefits from greater productivity springing from a healthier, more vigorous and efficient labor force, a stronger economy due to fewer work and wage loss days, reduction of costs for medical and hospital care.

4. The World - healthier, more physically able people, particularly in developing countries, with increased chances to reach their genetic potential in stature, mental capacity, and life span, and the physical and mental health needed for self-determination.

5. Science - research in food and nutrition has opened up new avenues of scientific theory and contributed significantly to scientific progress through investigations in basic chemistry, physiology, and pathology directed to solving human food needs.

The magnitude of these benefits from research in food and nutrition can be illustrated with a few examples:

The life span of some strains of laboratory animals has been extended by more than 50 percent by changes in certain components of an apparently adequate diet[1/]. Nutrition research can point the way to substantially extend the productive life span of man by diet improvements which can delay the onset of senescence and degenerative changes associated with the aging process.

Nutrition is one of the factors that can modify the onset and extent of heart and vasculatory disease. The economic costs of deaths from heart disease were calculated as $31.9 billion in 1962[2/] During 1960-62, heart disease was diagnosed or suspected in 28 million adults in the U.S. When nutrition research has progressed sufficiently that specific dietary recommendations can be made, it may be possible to modify a sizeable percent of the heart and vasculatory cases and increase the productive life span and work efficiency of people with tendency toward such afflictions.

It is recognized that good nutrition is a positive factor in maintaining health. Proper diet can help the individual resist digestive and respiratory illnesses. Each one percent decrease in the number of work days lost due to acute digestive and respiratory illnesses would benefit the national economy by over $2.1 billion each year. This estimate is based on the average industrial wage rate in May 1967 and estimates of lost work days[3/] due to these two types of illnesses.

1/ Diet as a Factor in Length of Life and in Structure and Composition of Tissues of the Rat with Aging. USDA Home Economics Research Report No. 24, Oct. 1964.

2/ Derived from A National Program to Conquer Heart Disease, Cancer, and Stroke, vol. 1, 1964. A report to the President from the President's Commission on Heart Disease, Cancer, and Stroke.

3/ Vital and Health Statistics, Series 10 - No. 25, U.S. Dept. of Health, Education, and Welfare, as quoted in Table No. 106, Statistical Abstract of the United States, 1966.

There are 20 or more countries in the world with lower rates of infant mortality than the U.S. Sweden has less than half the infant mortality rate of the U.S. Some 9,000 lives would be saved annually in the U.S. if 10 percent of the infant deaths could be prevented by improved diets for the mothers.

Action programs of the Department in cooperation with the States to improve the diets of children and disadvantaged families also benefit from research in food and nutrition encompassed in RPA's 703, 704, and 708. Some examples are cited below:

School Lunch Program - Food and nutrition research provides the recommendations for amounts and kinds of foods to be used in school feeding programs, as well as guidance for school food service operators. The nutritive value of the Type A lunches served is evaluated periodically. In Fiscal Year 1967, over 3.1 billion Type A school lunches were served in schools in the United States and its possessions. The average daily participation in the program was over 18 million. All of these children benefit from the advances in knowledge accruing from research included in this Report.

Food Stamp Program - Two million people were participating in the Food Stamp Program in October 1967. Food stamps were being distributed to needy families in 843 areas or counties of the U.S. Nutrition knowledge will continue to be needed for evaluation of the effectiveness of this expanding program and for development of guidance materials for program aids.

Food Distribution Programs - In September 1967, approximately 3.1 million people received food commodities distributed through agricultural programs. Estimations of the nutritive value of the foods distributed and their contribution toward a good diet are based on research. Guidance materials for use with disadvantaged families are developed from research information. An assessment of the nutritional impact of food distribution programs requires expanded research in food and nutrition.

Applied Nutrition Programs in Agriculture are Based on a Small Effort in Nutrition Research. It is evident from statistics in the National Program of Research for Agriculture that food and nutrition research has not had high priority in the past and is expected to be maintained at about the same proportional level ten years hence.

The overall research program in food and nutrition in the State Experiment Stations and the USDA covered in this Report involved only 193 scientist man years in 1966. This amounts to 1.84 percent of the research outlined

in the National Program of Research for Agriculture. Projections to 1977 would inappreciably increase the proportion of effort for food and nutrition research to 1.92 percent. The urgency for such research is far greater than is suggested by this level of support.

The projected levels of research for Fiscal Years 1972 and 1977 are inadequate in terms of needs to achieve national goals. The priority researches identified in this Report will need strong support in order to provide a sound base for food and nutrition programs urgently needed in the decade ahead.

Table I. Current and Projected Research Effort *

	Scientist Man Years		
	1966	1972	1977
National Program of Research for Agriculture	10,457	14,377	18,297
Food and Nutrition Research			
RPA 703	26	29	34
RPA 704	25	25	25
RPA 708	142	254	292
Total Food and Nutrition	193	308	351
Percent National Program	1.84%	2.14%	1.92%

*From National Program of Research for Agriculture, October 1966

Experience has shown that for applied nutrition programs to succeed, they must be integrated into governmental planning and program responsibilities. Such planning merits high priority. It is logical that agriculture will assume a leadership role. And, it is logical that nutritional needs serve as a basis for developing programs of food distribution.

Training Grants are Needed. The National Program of Research for Agriculture considered the problems of availability of manpower and concluded that "doctoral degree graduates during the next decade should adequately meet the needs for scientists required for agricultural research." This optimistic

general conclusion does not hold for many of the disciplines needed for research discussed in the present Report. For example, the number of young scientists completing Ph.D. degrees in nutrition each year inadequately meets the need to replace losses. During the academic year 1964-65, only 37 Ph.D. degrees were conferred in nutrition, exclusive of the fields of animal nutrition. It is apparent that relatively few students are electing to prepare for teaching or research careers in the field of human nutrition. While some of these manpower needs might be alleviated by persons trained in biology or in the animal science disciplines, there is strong competition for the services of these scientists.

It is clear that there is a critical shortage of scientists and educators in the fields of food and nutrition in the United States. Many new State and community colleges are being established to meet the demands for higher education. There is strong competition for students, teachers, and research scientists in all fields. Applied nutrition and food science programs also are expanding and are demanding increased numbers of people with educational backgrounds in food and nutrition. The availability of jobs which do not require a Ph.D. are enticing many people to join the labor force with only a Bachelor's or Master's degree.

Efforts should be made immediately to develop the manpower required to maintain the integrity of present research programs in food and nutrition and to keep pace with the expansion needed to achieve our national goals. Nutritionists, biochemists, biophysicists, geneticists, physiologists, food scientists, and behavioral scientists will be needed if adequate research in the problem areas of human nutrition is to be conducted. At present, these scientists are in great demand by the health and medical science fields as well as agriculture.

If Agriculture is to maintain research programs in food and nutrition, it is imperative that it assume some of the costs for education and training of the scientists. In order to give appropriate emphasis to the urgent research needs in human nutrition, it is strongly recommended that the USDA seek legislative authority and obtain sufficient funding to initiate and finance programs of training for students and young scientists who will be needed in the future for food and nutrition research. Training grants are needed both at the pre- and post-doctoral levels. Funding for these should supplement the funds represented by proposed increases in scientist man years for research.

A PROGRAM OF RESEARCH ON FOOD CHOICES, HABITS, CONSUMPTION (RPA 703)

SMY Previously Recommended by SAES/USDA[1/]

	1966	1972	1977
States	8	9	10
USDA	18	20	24
Total	26	29	34

To achieve the potential benefits from food and nutrition research, it is essential to determine what people eat and to identify those segments of the population where diets need improvement. The research program on food choices, habits, and consumption is designed to determine current food consumption patterns; to relate these patterns to desired nutritional levels (from studies in RPA 708); to identify factors affecting food choices, habits, and consumption; and to develop information on how to improve dietary practices. This information is basic to improvement programs whether they are educational or other types of action programs.

Information Currently Available. Estimates of food consumption in the United States come from three general sources: per capita food disappearance, surveys of household food consumption, and special studies of individual food intake.

The Economic Research Service publishes quarterly and annual estimates of per capita food disappearance at the retail level (RPA 506), and the Agricultural Research Service calculates the nutritive value of this food. These estimates of national per capita food disappearance are derived in large part from the well-established system of measuring agricultural production in the United States. Adjustments for food imports, exports, and changes in inventory are incorporated. These data are useful in evaluating broad, long-term changes in food disappearance patterns. They do not reflect actual food intake, and are of limited use to those interested in nutritional status of selected groups or segments of the population. The per capita food disappearance data do not show the variation between urban and rural residences or the effects of such factors as income, education, sex, and age.

1/ See page 4.

Food consumption surveys are conducted about every 10 years by Agricultural Research Service (RPA 703). The most recent nationwide survey of household food consumption was made over the 12-month period April 1965 through March 1966. The data provide estimates of food available at the family household level on a nationwide basis, but they do not provide a measure of food intake by individuals. These surveys present valuable information on the money value and quantities of foods used over a 7-day period during the spring, summer, fall, and winter, with classifications for various levels of income, location of residence and geographical areas, and other factors such as education and age of homemaker. These data do not include food consumed away from home.

The nutritive content of the food used is adjusted to a male adult meal basis; its adequacy is judged by comparing with the Recommended Dietary Allowances of the National Academy of Sciences-National Research Council. Calculations of the nutritive content of the food supply must be continually updated as new food products are developed and consumption patterns change. This information is valuable for it permits assessment of changes in food purchase patterns and evaluation of their nutritional impact.

In addition to the nationwide study, smaller-scale special purpose household surveys are frequently designed to estimate the effect of programs in agriculture on the diets of families, or to study in depth the food consumption and dietary levels of specific population groups.

The third source of information is special studies conducted to measure and evaluate food intake of individuals in selected groups of the population. Food intakes of 14,500 individuals during a 24-hour period were obtained in the nationwide study during the spring of 1965. The data included food consumed outside the home. These data represent cooked and prepared food ingested by individuals, as contrasted with the household food consumption data calculated on a "raw food" basis. Until the 1965 survey, no nationwide study of the food intake of individuals had been made, although occasional small studies of specific age groups have been undertaken.

Questions yet to be answered include: How typical or representative is this one-day diet? Will the 14,500 observations be adequate to determine where the pockets of inadequate nutrition are in the U.S.? If not, what is required?

Priority Research Needs. Research on food choices, habits, and consumption is needed in the following important areas:

1. Information on household food consumption as well as nutrient intake of individuals related to actual nutritional health of the same people. This information is needed to answer the

following types of questions: What is the present-day dietary situation? Whose diets are most in need of improvement? In what respects do their diets need improvement? How do they differ by income, family size, region, etc.? What changes in food consumption patterns have occurred and what changes may be expected in the future? What is the potential demand for specific foods? To obtain such information, new methodology is needed, including studies to determine the minimum reference period (1, 2, 3, or more days) needed to provide satisfactory data in national and small scale surveys. Problems of coordinating such studies with accompanying nutritional status information on the individuals (RPA 708) must be solved.

It is important that the household food consumption studies be continued. Data collected in the nationwide survey should be expanded to include food consumed outside the home. New methodology is needed to obtain such data.

Research is needed to determine if there are significant differences in food intake between days of the week and seasons of the year (some study of this problem will be possible from the study of individual food intake during one day by 14,500 individuals in the randomly selected 7,500 households participating during the spring of 1965). Such information will indicate possible need to include several seasons and more adequate coverage of weekends as well as weekdays in nationwide household surveys of the diets of individuals.

The rapid changes in supply of new food products, economic conditions, and consumer food habits affect the individual dietary. Special surveys need to be undertaken to keep abreast of such changes and their impact on food consumption practices. Periodic sequential surveys of food intake (and the nutritional status, RPA 708) of selected population segments where there is a likelihood of nutritional problems are inadequately provided for in the current system. Biennial surveys of low income groups, specific age groups, and ethnic minorities would be extremely valuable in identifying potential nutritional problems.

The patterns of food consumption (RPA 703) must be related to the baseline data of dietary needs developed in RPA 708 to determine where the pockets of malnutrition are in the U.S. On the scale this information is envisioned, an automatic data storage and retrieval system would be required. A project of this scope requires planning at the Federal level for uniformity

of sampling and data collection techniques.

2. Multidisciplinary research on motivations in food choices. It is important to know what factors influence food usage to correct inappropriate dietary habits through educational and action programs. Research on motivation contributing to food choices will necessarily be multidisciplinary and will require the combined efforts and expertise of such specialists as nutritionists, psychologists, physiologists, food scientists, food economists, marketing specialists, sociologists, and cultural anthropologists. It needs to be closely related to research on sensory perception of food qualities described under RPA 704. Research of this scope on a team basis has been done only for small population groups and never on a nationwide basis. Such research can also be useful for nutrition work in the developing countries. Research on motivation in food choices should include the following factors:

   a. Cultural, social, esthetic, and psychological. Race and nationality, religion, status symbols applied to food, acceptance of responsibility for nutrition of the family, influence of fads, influence of advertising, and factors influencing food rejection. Greatest emphasis is needed on the role of these factors in influencing food choices.

   b. Family food expenditures. Money available for food, availability and relative price of food including seasonal supplies, and access to the market.

   c. Household food management. Consumer practices as affected by shopping facilities, available transportation, and handling of heavy food parcels; facilities for food preparation, storage, and clean-up; ability to evaluate use of convenience foods in terms of cost, time, waste, palatability, and nutritive value.

   d. Consumer skill, knowledge, and ability. Food purchasing, cookery, and knowledge of nutrition.

   e. Sensory perception of food qualities (RPA 704).

3. Designing, testing, and evaluating programs to effect change in the use of food. Methodology needs to be developed on how to persuade people to change to better diets. How effective have both educational and other action programs been in bringing about desired dietary changes? How do we increase efficiency in bringing about changes? Information which will answer these

questions needs to be developed as a basis for increasing program efficiency. Research in this area also will be useful for work in developing countries (RPA 602).

An alternative to motivating people to change their food habits is to fortify existing food products to alleviate dietary deficiencies. Before fortification is undertaken, consideration must be given to factors such as nutrients available in present food supplies, special need for and suitability (nutrient balance and cost) of the food to be used as the nutrient carrier, and acceptability to consumers for whom the food is designed.

Manpower Needs. There is a growing realization of the importance of the social or behavioral science disciplines in the understanding of food habits and in developing effective nutrition education programs. Methodological research is needed to develop this aspect of nutrition information. Behavioral scientists from a variety of disciplines need to be made aware of the opportunities for work in this field. Development of multidisciplinary teams either within an appropriate academic climate or as a part of the Federal program would greatly strengthen the research outlined above.

The Long Range Study which undertook to define, on the basis of present scientific knowledge, the level of effort that would constitute a good investment of public funds recommended an increase from 26 to 29 scientific man years by 1972 and a further increase to 34 scientific man years by 1977. A total increased effort during the next decade of eight scientific man years will permit only a partial attack on the research recommended. If the collection of data on food intake of individuals is to be implemented on a continuing basis, the research effort will need to be doubled. In addition, an early, priority program on research methodology will be required to develop feasible methods for collecting food ingestion information on a nationwide basis.

A PROGRAM OF RESEARCH ON QUALITY OF FOOD IN HOMES AND INSTITUTIONS (RPA 704)[1/]

SMY Previously Recommended by SAES/USDA[2/]

	1966	1972	1977
States	14	14	14
USDA	11	11	11
Total	25	25	25

The health and well-being of the consumer is affected by the preparation and utilization of food in the home and in various institutions serving food in quantity. In addition, the overall satisfaction of the public is influenced by the total quality, including appearance, flavor, texture, nutrient content, and safety of the food as presented for consumption.

The Importance of Research on Quality of Foods. It is unfortunate that in the outline describing the National Program of Research for Agriculture, the applications of the food sciences have been scattered throughout various research areas. Because of this, the importance of the food sciences to agricultural research has not been emphasized and the need for training as well as research has been overlooked.

The organization of the National Program of Research for Agriculture according to a sequence of operations in the production, distribution, and handling of foods tends to under-emphasize the importance of basic research that is not limited to a single step in the agricultural process. Basic research in food science that is appropriate to agricultural research includes the following:

1. Study of the physiological factors involved in the sensory perception of food quality. This logically includes both the relationships between taste and odor thresholds and food preferences, and the mechanisms of taste and odor enhancement and inhibition.

1/ Numerous aspects of research now being accomplished and needed in the future under this research problem area were not adequately described by the previous title, "Home and Commercial Preparation of Food," which had been used in the National Program of Research for Agriculture.

2/ See page 4.

2. Investigations of the chemical composition and structure of foods in relation to such qualities as appearance, texture, and flavor.

3. Development of instrumental methods for the objective evaluation of food quality and acceptability.

The benefits from an adequate research base in food quality are considerable. They accrue to the homemaker and to the institutional food service operator alike.

The quality attributes of foods which have been maintained through production, processing, and marketing can be seriously affected if foods are not properly handled in the home or institution. The production, processing and marketing aspects of foods are changing rapidly and the consumer is continually confronted with new products and new methods of preparing food. Portion control in institutional food services, the use of more "convenience" foods partly or wholly prepared outside the home, increasing use of vending machines, new packaging materials, and new processing methods that present the foods in a different manner have become well established and have changed habits of food selection, storage, and cooking. Increased employment of women has resulted in less time available for food preparation at home and has increased desire for fast cooking methods and more convenient food forms. Increased facilities for freezer and refrigerator storage in homes have made possible once-a-week food shopping, but has increased the problems of retaining quality. Problems also have been encountered in maintaining the quality of frozen foods, particularly combinations of foods prepared by the homemaker as a means of saving time and labor. Technological advances have yielded many new forms of foods such as dried, concentrated, and partially prepared foods. Consumers need guidance in selecting the most satisfactory forms of foods for their needs, taking into account cost, labor, time, nutritional values, and eating satisfaction.

Institutional consumers also face difficult problems. Meals away from home now approximate 38 billion a year at an annual cost of about $36 billion. Volume feeding consumes 30 percent of the U.S. food output. There are a growing number of food preparation centers servicing mobile lunch wagons, lunch counters, vending machines, cafeterias, and some schools and hospitals. Expansion of health benefit programs such as Medicare has increased the number of nursing homes serving small numbers of persons. The need for special food services such as the School Lunch Program and meals for elderly and welfare persons is increasing. Shortage of trained food managers and increasing minimal wage costs for unskilled labor are resulting in critical problems in the maintenance of nutritional and safe qualities of food, as well as acceptable eating quality.

At present, the consumer cannot be completely assured of the safety of food prepared in or away from the home. Large numbers of incidents involving food-borne diseases are reported annually. A summary of food-borne and water-borne diseases in the 1966 Yearbook of Agriculture, Protecting Our Food, indicated over 90,000 reported cases during a nine-year period. It is known that many more cases go unreported. The total number of days lost from productive work because of this particular problem constitute a large economic loss to the nation. In numerous cases, the cause has been recognized and eliminated, but in many incidents the etiology of the disease has not been clearly established. Continued changes and innovations in the several aspects of food production and marketing will confront the consumer with new and different food safety problems, such as viral and microbiological contamination (RPA 702). Research aimed at improving methods of handling foods in homes and institutions must also be related to the problems of food safety.

Improper handling of foods during the preparation step in both the home and the institutional food service can result in food of low or unacceptable eating quality, and serious loss of nutrients. Further, the food may be unsafe to eat. Its consumption can result in illness, together with lost school or work days.

There must be a continued, strong research program to improve our present level of information on effects of preparation procedures in the home or institution on nutrient content of foods.

Major emphasis also must be placed upon further defining desirable quality characteristics of foods and upon determining the effects of numerous treatments on these characteristics. This must be tied to an understanding of how food preferences are established (RPA 703). Food preferences are developed early in life, vary among individuals, and are not easily altered. Successful implementation of nutrition recommendations depends upon the willingness of people to eat the foods suggested. We know very little about how combinations of foods and alteration of food texture and flavor can influence people in making and maintaining changes in diet when nutrition science dictates that changes are essential.

Priority Research Needs. Research in RPA 704 is designed to provide the knowledge needed to guide consumers in preparing nutritious, wholesome, and palatable foods. So that benefits from proper storage, preparation, holding, serving, and handling of food can be realized by the consumer, research must be conducted in the following areas:

1. The effects of different storage, preparation, holding, and serving practices on the various chemical components and structure of food. Changes in components such as protein, carbohydrate, fat, other nutrients, pigments, and enzymes

need to be related to alterations in food quality, including flavor, texture, appearance, and nutritive value. Priority should be given to these basic studies.

2. The effects of different storage, preparation, holding, and serving practices on the wholesomeness and safety of food. This research should receive increased attention. These studies can include microbiological, viral, and pesticide residue problems.

3. The physiological factors which affect sensory perception of food quality. These sensory factors need to be related to food preferences of individuals. Opportunities of improving acceptability of foods through enhancement or inhibition of perception of tastes or odors should also be explored.

4. The development of new principles or improved methods for cooking foods. Continued research must be done on new processes for cooking in the home or institution, such as the use of linear and non-linear temperature programing, effects of cooking under inert atmospheres, or use of different heat sources such as ultrasonic and micro-wave equipment. Effects of these processes must be related to alterations of food quality, including nutritional values.

5. Formulation and use of special foods. An important segment of the population requires specially prepared foods because of medical conditions. Improvements of food formulations to meet particular needs, such as diets providing low fat, low sugar, and low levels of certain amino acids, should be continued.

   There is also need to develop recipes to be used with food supplies or supplements intended for use in developing countries. This calls for knowledge of the food preferences and practices of indigenous populations, of the influence of dietary deficiencies on flavor preferences, and knowledge of the culinary equipment and facilities available to the population in the developing countries.

Manpower Needs. The suggested allocation of 25 scientist man years with no opportunity for growth over the next decade for RPA 704 does not appear adequate in the light of research deemed important in increasing our basic knowledge about food quality, including flavor, texture, appearance, safety, and nutrient content. Therefore, an increase of 10 scientist man years is recommended.

It is further recommended that increased emphasis be given to basic investigations. An understanding of the mechanisms that are responsible for quality perception, and a fundamental understanding of the changes that take place at the cellular and molecular level in foods, would make possible a more systematic and logical approach to improvements in food products, as well as food handling in the home and institution. It is important to realize that without this fundamental knowledge, much of the research on improved methodology will have to be repeated for each new food.

The recognition that research tied to education and training programs has multiple benefits to the total scientific effort makes it desirable that a significant portion of the additional manpower recommended under this research goal be placed where it can contribute to the training of scientific manpower.

A PROGRAM OF RESEARCH ON HUMAN NUTRITIONAL WELL-BEING (RPA 708)

SMY previously Recommended by SAES/USDA[1/]

	1966	1972	1977
States	103	187	218
USDA	39	67	76
Total	142	254	294

The Current Focus in Nutrition. Despite the near eradication of major deficiency diseases in the U.S., many nutrition problems of major importance remain with us. Nutrition research must increasingly deal with less obvious but debilitating aspects of nutrient deficiency, as well as a significant problem of overnutrition. It must also deal with the complexities of nutrient interrelationships presented by food and diets, such as the roles that cholesterol, polyunsaturated fats, carbohydrates, and other food constituents may play in atherosclerosis. Increased emphasis is being placed on new aspects of "well-being" in which diet plays a role.

The results of nutrition research indicate that over 40 nutrients are essential to human health and well-being. However, due to insufficient information on the quantitative requirements for these nutrients, recommendations on the desirable levels of intake are available for only 9 nutrients and calories. Even these recommendations are applicable only to population groups, not to individuals within these groups.

Current nutrition research includes a strong emphasis on the roles of individual nutrients in isolated systems rather than in the whole organism. There is a need for expansion of research to relate these findings to human needs and to the foods to meet these needs.

To achieve the goal of maintaining nutritional health of the individual throughout life, it is essential to expand and improve practical guidelines for food combinations to fulfill nutritional needs while retaining eating qualities that meet consumer satisfaction. These guidelines are useful to consumers, the agribusiness complex, and government agencies alike. In the further development of guidelines, priority attention will need to be given

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1/ See page 4.

to gaps in our knowledge of human requirements for nutrients, nutrients in specific foods, and nutritional problems in the U.S. The guidelines for food combinations must conform to socio-economic considerations and cultural food habits of the individual. Thus, the guidelines must also be related to food consumption, preferences, and habits (RPA 703), to knowledge of the effects of home and institutional procedures on retention of nutrients and eating qualities (RPA 704) and to the overall problem of composition of foods as they are consumed (RPA 708).

Priority Research Needs. Research to answer the following questions will provide a sound basis for use of foods in assuring human nutritional well-being:

1. What are the specific human requirements for nutrients in our food supply? Knowledge of nutrient needs is basic to all efforts to improve nutritional levels. There is a real need for support of studies directed to the nutrition of the individual in the environment in which he lives and works. Agriculture has a special role in developing information needed to show how best to fulfill man's nutrient requirements from the food supply.

   The Recommended Dietary Allowances of the Food and Nutrition Board, National Academy of Sciences-National Research Council, provide guidelines of desirable levels of intake for a few nutrients. However, many other essential nutrients are not included in these guidelines because requirements have not been established with sufficient accuracy.

   Adequate information is lacking on special and differing nutrient needs of the very young, the elderly, the rapidly growing adolescent, and those undergoing long periods of stress. Furthermore, recommendations for populations as a whole do not reflect the needs of individuals with specific characteristics. Research must bridge this gap.

   Available information does not permit the setting of lower and upper limits of nutrient intake for optimum nutritional health. To obtain this needed information, it is important that methods be developed so that assessment can be made of any special nutritional needs of individuals throughout their lives. Deficiencies too minor to produce immediate disability may cause impairment of a critical organ or function of the body, resulting later in ill health and early death. Methods need to be developed whereby the deficiencies are recognized early enough that dietary change may avoid serious or permanent damage.

To delineate human nutrient requirements, knowledge also is needed of both short term and long term effects of nutrient excess or imbalances, especially as these may occur in foods or diet patterns.

Too little information is available on adaptation of the body to different levels of food intake.

The combined effects of various food components on metabolic response has resulted in marked effects on the health and the life span of experimental animals even when rather small differences in dietary composition were involved. Age, sex, heredity, and stress may influence the response to food combinations in quite different ways. Knowledge of these interrelating effects is needed to determine the nutritional requirements and the desirable patterns of food intake of individuals throughout life.

2. What nutritional values are present in each of our foods? Diet planning is dependent upon knowledge of kind, amount, and biological availability of nutrients in our food supply. Comprehensive reference tables on the composition of foods as they are consumed are needed to evaluate the nutrient content of the diets of households and individuals, to establish guidelines for selecting foods for normal or special diets, and to guide research workers, government regulatory agencies, and industry. Although a wealth of data is available in tables of food composition, many nutrients, and many of the foods as they are now on the market, are not included.

   Biological availability has yet to be defined for many of the forms of nutrients as they occur in foods. It is known that the availability of many nutrients for intestinal absorption can vary greatly from one food to another. Current and accurate information on the full spectrum of biologically available nutrients in our food supply is needed to provide guidelines for food combinations to increase the effective use of our food supply. Composition data developed through study of changes in nutrient content during processing, storage, and preparation for consumption (RPA 704) thus must be considered.

   Computerized data retrieval systems for which the USDA would assume major responsibility are strongly indicated because of the volume of food composition data and need for continual revision.

3. What is the extent and nature of nutritional problems in the U.S.? Detailed knowledge is needed of the state of nutrition of population groups, with emphasis on those with poor food habits caused by low income or inadequate nutrition knowledge (RPA 703).

   It is important that research on methods of determining malnutrition be expanded to include moderate but chronic deficiencies. Better criteria are needed to measure in detail the nutritional status of individuals. The extent to which important nutritional problems occur among different segments of the population and the reasons for their occurrence are largely undocumented. The location of pockets of malnutrition in the U.S. needs to be identified. Baseline data are needed to help set priorities for both research and action programs. The patterns of food consumption (RPA 703) must be considered in relation to the state of nutrition of population groups. Such information can lead to improved use of funds in applied programs involving food assistance, health and welfare, and nutrition counseling.

4. How can the nutrients in our food be used to increase our effective life span? Identification of nutritional involvements in the aging process in normal, healthy individuals holds the hope of increased life expectancy, vigor, and productivity. However, information on normal changes that occur with aging and the influence of kind and amount of food on these aging processes is extremely limited. Such studies must include emphasis on nutritional effects early in life. Improvements in health and productivity through diet need to be better documented.

5. How does nutrition affect intellectual development and behavior? Identification of those factors in nutrition affecting mental alertness, intelligence, learning ability, and behavior of man could lead to food habits offering both social and economic gains through increased ability of the individual to function in society. Controlled studies of semi-starvation clearly document the irritability and unreasonableness of men whose food intakes do not meet their requirements. Such studies are of value in understanding behavior of certain segments of our population as well as the behavior of poorly fed populations in the developing countries.

   There is need for information on the relation of a period of malnutrition, especially early in life, to learning ability.

6. Can new sources or combinations of food provide special nutritional values? Identification and nutritional evaluation of crop and animal sources or by-product materials not now being effectively used for human feeding despite their nutritional potentials will be increasingly urgent to meet world food needs in the decade ahead. For example, oilseed concentrates and protein isolates are gaining acceptance as foods. Opportunities for developing and evaluating new protein sources, new formulations for special nutritional needs, and new sources of calories; e.g. medium chain triglycerides, hold considerable promise because of indicated needs. Information developed should assist researchers in agriculture (RPA 403, 406, 410, involving new and improved fruit and vegetable products, food products from field crops, and new and improved meat, milk, and egg products) and industry in their endeavors to develop markets for new food products.

Need for Multidisciplinary Research. There is an urgent need for multidisciplinary, cooperative work in human nutrition. Additional human metabolic studies are needed to provide basic information on requirements and utilization of nutrients from various food sources. Interpretation of nutritional needs is dependent upon application of findings with laboratory animals to studies on human beings.

Relatively few laboratories are looking at the needs of normal individuals of particular age groups. No laboratory is presently involved in studies of nutrient needs of healthy individuals at all stages of life. The magnitude of personnel and resources needed to make a significant impact in this direction suggests the desirability of developing centers of excellence involving multidisciplinary research teams with ample provision for training graduate students. Providing existing facilities with major equipment, operational funds, and training grants will improve the present capabilities.

Models for interdisciplinary nutrition programs in various regions of the U.S.A. would provide unique teaching, training, research, and service facilities. These facilities are needed to better define the problems and plan specific research projects to attain answers to urgent questions raised in this Report. Furthermore, a few well integrated multidisciplinary demonstration programs should be planned and funded if we are to approach optimal nutrition for most of our citizens in the near future and effectively use our technical knowledge, experience, and foods to help developing areas of the world raise their standards of living (RPA's 602 and 603). These multidisciplinary regional model programs would provide needed and unique training facilities for American as well as foreign students.

There is also a need for vigorous support of research delving into the underlying biochemical, physiological, and pathological changes in reference to diet. In the past, nutrition has borrowed rather than developed the basic science needed to provide the ideas for its more applied problems. This can no longer suffice. The "chain of evolution of ideas" may not logically develop the needed basic concepts unless nutrition research is involved throughout. The research outlined in this Report can and should be applied all along this chain.