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TOWARD THE NEW

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a report
on better foods
and nutrition
from agricultural
research

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TOWARD THE NEW

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Prepared by Agricultural Research Service

Contributors to this publication: Elizabeth M. Adams, Elizabeth D. Bollt, Robert E. Enlow, Robert W. Funderburk, Marshall Gall, Daniel P. Griffin, W. D. Hutchinson, Eula Mae Kelly, Robert E. Picardi, Edgar A. Poe, Jr., and Joyce Schroeder.

Toward The New:

A Report on Better Foods and Nutrition From Agricultural Research

WHEN it comes to diet, man has known what is good for him for considerably longer than he has known *why* certain foods are good for him. As early as the 13th century, for example, burned sponge was being eaten as a protection against goiter. People did not know that the ash of burned sponge contained iodine; they knew only that the substance seemed to help. Similarly, cod-liver oil was being used to prevent rickets centuries before vitamin D was discovered, and lemonade was being sold as a cure for scurvy long before vitamin C and its significance were understood.

But man was not satisfied with this haphazard understanding of his daily nourishment. Through the centuries, he observed, experimented, and wrote down what he learned. In time, the science of nutrition came into being. Although it is still not an exact science, we now know a great deal about how food affects the human body, and why.

We know about vitamins—what they do and what illnesses they prevent. We know about the need for certain inorganic substances—iron, manganese, iodine, and others. We know that protein is essential to health and growth, and that of the 22 known amino acids, at least eight must be included in the diet. If our knowledge of nutrition is not complete, it is surely adequate to assure unprecedented levels of physical and

mental well-being for all of the world's peoples.

Unfortunately, not everyone does enjoy good nutritional health. In spite of all we have learned, substantial numbers of U.S. citizens, as well as inhabitants of less prosperous countries, still fail to get enough of the right kinds of food.

That is why agricultural scientists continue to delve into the mysteries of nutrition, food, and food production. They are seeking in the first place to put the knowledge that we have to work, to instill in the public mind the importance of sound, sensible eating habits. Then, they are striving to find ways to make food and food supplements more plentiful, so that no one need be denied the advantages of a proper diet.

Admittedly this is a large order. Nevertheless, dramatic strides have been made both on the farm and in the laboratory.

For example:

- *Frozen orange juice concentrate.* This remarkable product, perfected by scientists from the Agricultural Research Service and the Florida Citrus Commission, provides a delicious, convenient, year-round source of vitamin C for millions of consumers. Further, it brings in an estimated quarter-billion dollars a year at the marketplace—more than twice the value of the entire citrus crop 30 years ago.

• *Dehydrofreezing.* This process combines the economy of dehydration with the flavor-holding advantages of freezing. ARS scientists found that they could remove half of the water from fruits and vegetables, then freeze them. The technique is used to process large volumes of fruits and vegetables for manufacturing—the apple slices in commercially baked pies, for example, and the vegetables in canned soups and stews. Shipping and storage costs are reduced, and savings are passed along to the consumer in the form of lower grocery bills.

• *Vitamin B-12.* Soon after vitamin B-12 was discovered, ARS researchers learned that it was a critical factor in the diets of poultry. They developed two means of producing large quantities of the vitamin by fermentation. Soybean meal and the B-12 supplement became the basis for the modern broiler industry. The result was another nutritious, moderately priced food item available in quantity throughout the country.

• *Food composition tables.* Approximately 2,500 food items have been analyzed by ARS nutritionists for vitamin content, caloric level, and other elements of composition. Tables containing this information are used by doctors, teachers, dietitians, and many others. Probably the most comprehensive battery of nutrition statistics ever assembled, the tables provide an educational tool that will

help solve nutritional problems all over the world.

Agricultural science contributes to human nutrition in many other ways. Plant scientists, for example, are finding ways to increase crop yields; engineers are performing wonders with automation; chemists are developing new food supplements; and other specialists are finding better ways to transport, store, protect, and distribute food products.

These innovative efforts make up the subject matter of the articles that follow. Each article, I feel, discloses something of the intensity of effort that goes into agricultural research, as well as some of the dedication with which the agricultural scientist approaches the challenges of food production and quality. Although the work discussed here is new, it has one thing in common with the first uncertain steps in the science of nutrition: It is without value unless its meaning and significance are made clear to consumers. This bulletin is offered as one step in that continuing educational process.



George W. Irving, Jr., Administrator
Agricultural Research Service

What Americans Eat . . . Why It Is Important To Know

DURING the past 35 years, the U.S. Department of Agriculture has made five nationwide surveys evaluating the quantity, money value, and nutritive content of diets in this country. Each of these dietary profiles has proved a compass for action—giving impetus to far-reaching developments in food and nutrition programs.

“This is particularly true of our latest food survey in 1965–66,” says Dr. Faith Clark, Director of the Consumer and Food Economics Research Division, ARS, who has helped conduct all five surveys. “Results showed some surprising trends in our eating habits.

“In a decade of economic expansion and rising incomes—even affluence—when Americans could choose from the greatest abundance and variety of nutritious food in history, U.S. family diets were not as good as they were in 1955.

“From this we must conclude that many of our people are making poor choices from our food abundance. American families at all levels of income need guidance in meeting their nutritional requirements.”

The 1965–66 survey—like earlier ones—reinforces the need for increased consumption of milk and non-fat milk products, fruits, and vegetables. Better food sources of iron are also urgently needed.

Dietary Situation: 1965 Versus 1955

Fifty percent of the households surveyed in 1965 met or exceeded USDA's definition of good diets. This compared to 60 percent rated good in the 1955 survey—a drop of 10 percent.

Moreover, the percentage of families with poor diets was higher in 1965—21 percent compared to 15 percent in 1955.

The remainder of the 1965 diets were fair—somewhere between good and poor.

Dietary levels were rated good if the household food supply met the 1963 Recommended Dietary Allowances (RDA) of the Food and Nutrition Board-National Research Council for seven nutrients—protein, calcium, iron, vitamin A value, thiamin, riboflavin, and ascorbic acid (vitamin C).

Diets designated poor provided less than two-thirds of the RDA for one or more of the seven nutrients. In USDA surveys, two-thirds of the allowance for any nutrient is considered a level below which diets could be nutritionally inadequate over an extended period of time.

“We are not saying,” Dr. Clark comments, “that the fifth of our population with poor diets was hungry or malnourished. Poor diets in the long term usually lead to poor nutrition, but there is no way to relate the findings from our study directly to the malnutrition and health of the American people. It was not designed for that purpose. Physical examinations and biochemical tests would have been needed.”

In both 1955 and 1965, the nutrients most frequently below allowances in household diets were calcium, vitamin A, and vitamin C. In 1965, more households were short in these three nutrients than in 1955. Decreased use of milk and milk products (primary source of calcium) and of vegetables and fruits (vitamins A and C) contributed to this decline.

The average household in 1965 used 10 percent less food from the milk group (milk, cheese, cream) than in 1955. Consumption of whole fluid milk declined 19 percent, but consumption of nonfat dry milk more than doubled. Findings suggest that the drop in milk consumption was associated with the increased use of soft drinks and other beverages.

Protein presented no problem in most American diets in either 1955 or 1965. In each study, only one in every 100 households had amounts of protein below two-thirds of the recommended allowance. This does not mean, however, that there were not isolated groups within our population that did not get enough protein.

Calcium and Iron Needed Most

When diets of individual family members in the 1965–66 survey were studied and compared with the 1968 recommended dietary allowances for sex-age groups, it was found that calcium and iron were the nutrients most often below recommended allowances. See the chart on page 10.

Failure to meet the recommended allowances for calcium was apparent in every age of female beyond age 9. Girls of age 15 to 17 and women of age 35 and over had diets that averaged only about two-thirds as much as recommended.

Generally, the males in our population did better. Young men between 18 and 34 years had average diets above the recommendations for calcium. But boys between 9 and 17 years and men 35 years and older were low in calcium.

Among older men and women, average diets of men 75 years and over and of women 65 and over were below recommended allowances for calcium, vitamin A, and riboflavin. In addition, men 75 years and over had less vitamin C than suggested, and women 65 and over had diets below recommendations for thiamin and iron.

The sex-age groups not getting the suggested levels of iron were principally infants and young children; girls and women between the ages of 9 and 55; and boys in the 12 through 14 age group.

Survey results showed that average amounts of iron in the diets of babies and children under 3 years were only about one-half of the recommended amounts. Average diets of girls and women from 12 through 54 years furnished less than two-thirds of the recommended amounts. So the need for iron in these sex-age groups poses a particular problem.

In fact, the Food and Nutrition Board states that the recommended iron allowances for some age groups cannot be met by ordinary food products without additional fortification.

Fortification and Enrichment

In an effort to meet these needs, the USDA is exploring the possibilities of fortifying foods with iron and other needed nutrients. Whenever possible, this will be done by fortifying the foods used in greatest amounts by the sex-age groups whose diets we are trying to improve.

Estimates have been made to indicate dietary improvement that could be achieved if certain foods were fortified to specified levels—for example, if milk were fortified with iron and if bread, cereals, and pasta were fortified to higher levels of iron, calcium, thiamin, and riboflavin than presently used.

ARS food economists—using survey data of the amount of milk consumed by individuals in various age-sex groups—estimated 10 milligrams of iron per quart of milk as the amount of additional iron needed to bring diets low in iron within acceptable allowances.

Now, a new process is being tested by ARS chemists that may make it possible to fortify pasteurized whole milk at the rate of 10 milligrams per quart. The process does not cause objectionable off-flavors over a storage period of 15 days—the normal storage life of pasteurized milk.

Findings from the survey are also being used to develop new enrichment programs. For example, when the 1965 survey showed a marked increase in the use of unenriched bakery products by the American people, the Secretary of Agriculture immediately asked the milling and bakery industry to review the possibility of uniform enrichment.

Even in the 30 States and Puerto Rico that now have enrichment laws there are no requirements that bakery products such as pies, cakes, doughnuts, rolls, and cookies be enriched. Yet we are eating more of these products than ever before.

The Department is already fortifying certain foods that are being distributed to needy families. Examples of foods recently fortified are: Dehydrated potato flakes (vitamins A and C); some fruit juices (vitamin C); and nonfat dry milk (vitamins A and D). Such fortification is in addition to the usual standard enrichment of wheat flour, cornmeal, and grits. Also recent specifications for cornmeal, grits, and rice have called for amounts of iron above the minimum levels of commercial fortification for foods labeled enriched by the Food and Drug Administration.

How Income Affects What We Eat

The overall assortment and amounts of food used by U.S. households in 1965 were sufficient, on the average, to provide plenty of calories, protein, vitamins, and minerals to meet nutritional goals. This does not mean, however, that everyone in the Nation was well fed.

Why not? Because average values conceal the great variation in the amounts and kinds of food used by individuals within each household and by different households.

Food choice and use, in turn, depend on a number of factors including income, habit, likes and dislikes, education, and family and ethnic background.

How does income relate to diet? Do the rich always eat well and the poor poorly?

Dr. Daniel A. Swope, Chief, Food Consumption Branch, ARS, answers this way, "Our dietary findings show that increased income and higher expenditures for food do not in themselves assure a good diet. Education and motivation are needed, too.

"Although the higher the family income, the better the diet generally is, a substantial proportion of families with incomes of \$10,000 or more had food supplies that did not measure up to recommended levels for all nutrients. And surprisingly enough, 9 percent of the families in this income bracket had diets rated poor by the criteria of the survey."

As the family income decreased, the dietary situation was usually less favorable. For example, at the low end of the income scale—families with incomes under \$3,000—only a little more than a third of the families had diets that provided the recommended amounts of nutrients. About the same share had poor diets.

"Families with higher incomes," Dr. Swope continues, "spend more money on the average for food at home per person than families with lower income. For example, families with incomes of \$10,000 or more spent \$11 for food per person during the survey week compared to the \$7 spent by families with incomes under \$3,000.

"It is interesting to note that low-income families average more food value for their money. This, in part, reflects the fact that a number of the less expensive foods give good nutritive return in relation to their cost. An example is nonfat dry milk. Another is enriched bread and flour.

Low-income families on the whole fared less well nutritionally because they had less money to spend for food."

Dr. Swope adds that some low-income families probably had good or fair diets instead of poor ones because of the additional foods provided by commodity distribution or free food stamps.



Trends In Our Eating Habits

An overview of the 1965-66 survey shows some trends in eating habits:

- *The growing popularity of snacks is evident.* As a people, we are eating a surprising amount of food and drink between meals. More youths in the population and more snacking in general contributed to the increased use of soft drinks, coffee, potato chips, crackers, cookies, doughnuts, ice cream, and candy.

Trained interviewers collected information from homemakers in 15,000 households and from a sample of 14,500 individuals for the latest nationwide food survey.

- *Differences in regional food patterns are disappearing.* Improvements in processing, transportation, and storage have made possible consumption of the same foods throughout the Nation. Seasonal fluctuations in food supplies are less pronounced also.

- *Foods that require less preparation in the home are gaining favor.* There are noticeable shifts from fresh citrus fruit to frozen and chilled juices and lemonade; from fresh to frozen vegetables; from fresh to processed potatoes; and from flour and mixes to purchased bakery products (up 14 percent since 1955).

- *Families at all levels of income are eating more meat, poultry, and fish.* Meat is obviously one of our preferred foods. When there is money to spend, it is likely to go for this food group.

In the spring of 1965, urban families in the lowest third of income were eating more meat, poultry, and fish than families in the highest third in spring 1942, which was before wartime rationing of meat went into effect.

- *Household consumption of milk and milk products and of fruits and vegetables declined about 10 percent between 1955 and 1965.*

- *Other changes seem to indicate that some people are increasingly concerned about the consumption of fats and are more selective in the kinds of fats they use.* Shifts were from butter and shortening to margarine and oils, and from fresh whole milk, evaporated milk, and cream to fresh skim milk and nonfat dry milk.

Food Surveys: Past and Present

Let's take a look at the five USDA nationwide surveys and see how they have advanced food and nutrition programs in this country.

The first survey in the mid 1930's proved the truth of President Roose-

velt's startling statement that one-third of the people in the Nation were ill-fed. These findings prompted the enrichment of white flour and bread with three of the B-vitamins and iron—stimulated nutrition education—and pointed up the need for a National School Lunch Program.

Also, at this time when thousands of families were fighting depression and drought, the Agricultural Research Service set up its first food budgets to help people get adequate diets with limited resources. These food plans at four levels of cost and nutritive content were widely used throughout the 1930's by economists in planning production programs, by home economists, by welfare workers, and by homemakers.

Now, more than 35 years later, these basic plans—adjusted and modified to keep pace with changing economic conditions and advancing nutrition knowledge—still serve the Nation in many ways.

The economy food plan is at the core of the definition of poverty originally proposed by the Social Security Administration. This low-income plan helped set up a yardstick for measuring poverty and variations within poverty that is used by the Office of Economic Opportunity and other assistance programs.

Welfare agencies base their food allotments to needy families on USDA food plans, which are kept up to date and published quarterly in an ARS periodical, *Family Economics Review*.

Recently the plans have been used in many proposals for expanding the Food Stamp Program.

In 1942 and 1948, smaller-scale studies showed that diets had improved considerably compared with the 1936 survey. Improvement was attributed to better economic conditions, to a wiser choice of foods by people because of nutrition education, and to the enrichment of white bread and flour which was then underway.

During World War II, survey data helped in the development of food rationing and price-control programs.

Results of the 1955 survey showed progress, but pointed up need for dietary improvement even in upper income families. To help fill the educational gap, ARS prepared its widely distributed Leaflet 424, "Food For Fitness: A Daily Food Guide."

Baseline data for the pilot food stamp program also came from the 1955 survey.

Then came the fifth nationwide survey in 1965-66, the most extensive ever attempted. In addition to a sample of 7,500 households in spring 1965, it included 2,500 households in each of the three succeeding seasons—summer and fall 1965 and winter 1966—a total of 15,000 households in all.

For the first time in the history of food surveys, data were collected on the kinds and amounts of food eaten in a 24-hour period by a sample of 14,500 individuals. This means that facts on the food intake and nutritive value of the diets of men, women, boys, girls, and infants are available for the first time on a nationwide basis.

"These findings," Dr. Swope points out, "add an important new dimension to dietary surveys. They not only tell us how food supplies are allocated within a household, but, more significantly, they pinpoint which persons within families had diets in need of improvement.

"From this information, we can find out what sex-age groups are low in several nutrients and need a better diet. Then we can concentrate on these groups in nutrition education."

Implications For Action

"Undoubtedly, the clearest implication from the 1965-66 nationwide food survey is that our nutrition education programs should be intensified," summarizes Dr. Clark.

"New, imaginative approaches are needed because we are still facing the same dietary shortages we had 15 years ago. In addition, the latest survey revealed some adverse shifts in our eating habits that demand our attention."

Here are some of the directions taken by the USDA in its expanded food and nutrition programs:

- **Continuation and expansion of the nutrition aide program by the Federal Extension Service.** In 1970, this program will be operational among low-income families in all 50 States, the Virgin Islands, Puerto Rico, and the District of Columbia. A total of 5,000 aides were at work in 1969.

- **Development by ARS of research-based publications and guides to help homemakers (at various income levels) choose and use food wisely.**

- **Wide dissemination of nutrition information on television and radio.**

- **Acceleration of all nutrition education programs coordinated by the Federal Interagency Committee on Nutrition Education.** State and local nutrition committees have stepped up activities. New committees have been formed.

In addition to these educational programs there have been expanded efforts in the Department's food assistance programs.

Electronic equipment was used to analyze data from the 1965-66 survey.



- Enlargement of the Food Stamp Program in 1969 to serve approximately 3½ million people in about 1600 counties and independent cities.

- Improvement of diets of low-income families by increasing amounts of needed nutrients in foods included in Commodity Distribution Programs. In 1969, more than 3½ million people got USDA donated foods.

- Improvement of diets of vulnerable groups—infants, preschool children, and pregnant and nursing women—through distribution of selected nutritious foods to them as a supplement in Commodity Distribution Programs.

In fact, by early February 1970 there were only 264 counties in the United States that were without any kind of family food program.

Also, there have been continuing investigations into the further enrichment and fortification of foods.

Findings of the spring 1965 survey

of individual diets suggest nutrition education programs might be directed to these specific sex-age groups in our population whose diets particularly need improvement:

Adolescent girls, most women, but especially those up to 55 years and those 65 years and older, and older men, especially those 75 years or older.

The nutrients most often below recommended dietary allowances and good sources of these nutrients are:

CALCIUM—milk and milk products (other than butter), flour and cereal products with added calcium, and dark-green and leafy vegetables.

IRON—lean, red meats, organ meats, dark-green vegetables, dry beans and peas, whole-grain and enriched grain products.

THIAMIN—lean pork, dry beans and peas, whole-grain and enriched grain products.

RIBOFLAVIN—milk and milk products (other than butter), meat, espe-

Nutrients below Recommended Daily Allowances in diets of individuals in the United States.

NUTRIENT INTAKE BELOW RECOMMENDED ALLOWANCE							
SEX-AGE (YEARS)	PROTEIN	CALCIUM	IRON	VITAMIN A VALUE	THIAMIN	RIBO-FLAVIN	ASCORBIC ACID
MALE AND FEMALE:							
UNDER 1							
1-2			* * * *				
3-5			* * * *				
6-8			* *				
MALE:							
9-11		*					
12-14		* *			*		
15-17		*	* * *				
18-19			*				
20-34							
35-54		*					
55-64		* *					
65-74		* * *					
75 & OVER		* * *		*		* *	*
FEMALE:							
9-11		* * * *	* * * * *		*		
12-14		* * * *	* * * * *	*	*		
15-17		* * * *	* * * * *	*	*		
18-19		* * * *	* * * * *	*	*		
20-34		* * * *	* * * * *	*	*		
35-54		* * * *	* * * * *	*	*	*	
55-64		* * * *	* * * * *	*	*	*	*
65-74		* * * *	*	*	*	*	*
75 & OVER		* * * *	*	*	*	*	*

BELOW BY: * 1-10% ** 11-20% *** 21-29% **** 30% OR MORE

AVERAGE INTAKE OF GROUP BELOW RECOMMENDED DIETARY ALLOWANCE, HAS-NRC, 1968
U.S. DIETS OF MEN, WOMEN, AND CHILDREN, 1 DAY IN SPRING, 1965

U.S. DEPARTMENT OF AGRICULTURE NEG. AGS. 5967-69 (4) AGRICULTURAL RESEARCH SERVICE

cially organ meats, dark-green and leafy vegetables.

VITAMIN A—whole milk and cream, butter and fortified margarine, liver, egg yolk, dark-green and deep-yellow vegetables, and some deep-yellow fruits, such as apricots and cantaloups.

Besides these public action and educational programs, Dr. Clark believes that diets in this country can be greatly improved by what people do for themselves—through self-education and self-motivation.

Here are two examples of individual action that could bring results.

As a member of the snacking public, you can be more selective in your choice of between-meal treats. Make a point of choosing snacks that contribute needed nutrients to the day's diet. Milk and raw fruits and vegetables (for example, carrots) are nutritious snacks.

If you are an adolescent boy, or a man between the ages of 20 and 64, you can probably improve your diet by cutting down on foods that are high in fat content. Survey results show that males in these age groups are getting 45 percent of their calories from fat—this is considered too high a level for optimum health.

Looking Ahead

And what about future USDA dietary surveys? What additional insights will they provide to close the nutrition gaps indicated by the most recent survey? Will they continue to guide our nutrition education and food programs?

ARS food economists and statisticians are already planning the next nationwide food consumption survey—the one to be made in the 1970's. They are examining not only the content of the next survey but the methods of collecting data as well.

Changes in survey procedures will be made to assist in pinpointing popu-

lation groups or specific foods or nutrients that need closer study. More emphasis will be placed on food habits and menu patterns, including the significance of away-from-home eating in the diets of families and individuals.

Special surveys will be made to help researchers find better ways of collecting food consumption data. For example, will records kept by households provide better data than that previously obtained by the recall method? Also, research workers will look into the possibilities of getting information on food intake of individuals for more than one day.

As people's eating habits change, as new foods emerge, and as shifts in dietary standards take place—food consumption surveys must keep pace. Continuing research by ARS will see that they do ■

Carbohydrates, Fats, and You

PICK the right parents if you want your body to respond properly to the food you eat.

Inherited characteristics are an important factor in determining how our bodies use food, according to Dr. Mildred Adams who headed the Carbohydrate Nutrition Laboratory of Agricultural Research Service until her retirement on July 31, 1969.

"We also know that foods interact, and carbohydrates (sugar and starch) can no longer be considered only a source of calories. Carbohydrates—as well as heredity—affect how the body uses the fat you eat," states Dr. Adams. "We have a long way to go before we can crack individual nutritional needs."

Carbohydrates Play Complex Role

Carbohydrates, long considered chiefly a source of food energy, have

a much more complicated part to play in nutrition. Different carbohydrates produce different effects in the body, depending on the heredity of the eater and the rest of his diet. The type of carbohydrate not only affects fat metabolism, but may influence the progress of degenerative diseases (such as atherosclerosis, associated with cholesterol deposits), which were previously linked mainly with fats in the diet.

Carbohydrates should not be considered equal and interchangeable in the diet. At one time, scientists regarded all carbohydrates as nutritionally similar sources of calories. But research with laboratory rats indicates that the amount of fat in the diet may not be as important as the type of carbohydrate combined with the fat. Rats are commonly used in studies of human nutrition because they resemble humans in many respects in their response to food.

Recent research by scientists of ARS has produced some interesting results with the carbohydrate, sucrose, which is furnished primarily by cane and beet sugars in the diet. To determine the effect of the kind of dietary carbohydrate on fat metabolism (taking into consideration the age and heredity of the subject), studies were made with two rat strains which had been kept for several generations in a laboratory at the Agricultural Research Center, Beltsville, Md.

The fat metabolism of the two strains of rats was known to differ. Each group was fed a high-cholesterol diet containing 25 percent egg and one of these carbohydrates—sucrose, glucose, or cornstarch. In both strains of the animals fed sucrose, changes in the amount of liver fat occurred as early as 150 days, and fat and cholesterol levels were higher.

In one strain of rats, liver weight increased with age when the diet contained sucrose, and there was a marked rise in both cholesterol and non-cholesterol fats. No significant change was noted when the carbohydrate was cornstarch or glucose.

In the second strain of rats, liver cholesterol levels were higher with sucrose in the diet than with the other carbohydrates, but the levels of all three carbohydrates were low compared to those in the first strain of rat.

Research results do not make sucrose into a dietary culprit. Adverse responses to sugar are not due to sugar alone but to its interaction with other foods and to the particular inherited characteristics of the individual under investigation.

Students Volunteer For Studies

In the summers of 1965 and 1966, 10 female and nine male college students voluntarily ate controlled diets and helped analyze their own body

reactions in a study on the role of carbohydrates in nutrition.

During the research, they lived in student quarters at the University of Maryland, a few miles from the ARS Human Nutrition Research Laboratory at Beltsville.

The volunteers were divided into teams equalized for height and weight. One team ate a high-starch diet for 30 days and a high-sugar diet the next 30 days. The second team ate the reverse. The diets included meat, vegetables, fruits, and juices. Wheat starch, served in baked biscuits and wafers, furnished 84 percent of the carbohydrates in one diet. Sucrose, served in hardsauce patties, furnished the same amount of carbohydrate in the other diet.

When blood samples of the volunteers were analyzed for the effect of their controlled diets, it was found that the levels of certain enzyme catalysts important in metabolism varied with the type of carbohydrate they ate. Cholesterol levels in the blood were higher with the sucrose diets than with the starch diets, but the differences were not significant. The study may not have been long enough to show significant differences.

Dr. Adams emphasizes the need for more information on the role of carbohydrates—(1) their possible effect on the length of life, and (2) how they may affect the way the body uses other foods.

Our Bodies Need Fat

Fats play an important role in man's food needs and are one of the dietary essentials.

Fats add variety and flavor to many foods, are concentrated sources of energy, contain vitamins A and D, and supply fatty acids that are essential for growth and health. Fat tissue in the body supports, protects, and insulates vital organs and areas. Also,



Results of research in foods and nutrition reach the consumer through numerous USDA publications.

fats take over some of the functions of protein, sparing protein for its specialized roles.

Linoleic acid is an essential unsaturated fatty acid and a part of many fat molecules. One of its functions is to keep the skin healthy. This fatty acid must be supplied by food because the body cannot make it.

Safflower, corn, cottonseed, and soybean oil are all high in linoleic acid. Peanut oil, poultry fat, and fish oils provide some linoleic acid. The fats of beef, lamb, milk, pork, and coconut oil contain very little linoleic acid. Margarines and shortenings differ widely in linoleic-acid content; the amount depends on the raw materials used and the extent to which they are hydrogenated.

In recent years, polyunsaturated fats and oils have become popular. They are easy to digest, and certain amounts of these fats are needed to meet your body's requirements. However, too many may be harmful.

As part of its research on fats, the Department of Agriculture has awarded a grant to the Medical School, University of Nebraska, Omaha, for a 4-year study to determine the effect that polyunsaturated fat may have on such factors as reproduction, physical development of the young, intelligence, and the aging process. These studies are still in progress. In earlier research at the University, it was found that rats fed high-unsaturated diets did not learn as rapidly as those fed diets that were lower in unsaturated fat.

It has been frequently demonstrated that polyunsaturated fats can reduce cholesterol levels in the blood. However, nutritionists of the Human Nutrition Research Division say that under certain conditions, increasing the polyunsaturated fat in the diet can raise—rather than reduce—blood cholesterol levels.

Cholesterol is a component of the membranes of body cells. It is made in the body and is a normal constituent of blood. According to Dr. Duane Benton, Acting Chief of the Lipid Nutrition Laboratory of ARS, there are indications that a high level of cholesterol is associated with heart disease.

“Sex, too, is apparently a factor in heart disease,” says Dr. Benton. “The disease is more prevalent in men than women through their fifties. However, the chance of heart trouble becomes about the same for both sexes when they reach their sixties.”

Research is going on in ARS to determine the relationship of fats and oils to cholesterol accumulation. There are no conclusions from these studies yet, but we know that the use of fat by the body is affected by many factors including: (1) the type of carbohydrate in the foods we eat, (2) our vocations and interests—whether active or inactive, (3) the stresses and strains of daily situations, (4) the aging process when our bodies become less active, and (5) our heredity.

Fats Change Weight Little

In studies at the University of Maryland, College Park, ARS and the College of Physical Education of the University compared rats fed high-fat and low-fat diets. They found that the diets high in fat and low in carbohydrates were no more effective in reducing body weight than the diets low in fat and high in carbohydrates.

Four groups of rats were studied. One group ate unlimited amounts of feed, one group exercised and ate unlimited amounts of feed, another group ate restricted amounts of feed, and the fourth group exercised and ate restricted amounts of feed. In each group, some rats ate a high-fat diet and some ate a low-fat diet.

There were no significant differences between the body weights of rats eating high-fat diets and rats eating low-fat diets in any of the four groups. However, there were differences in the amount of body fat. The bodies of the rats that ate high-fat diets contained significantly more fat than the bodies of the rats that ate low-fat diets—with one exception. There were no differences in the amount of fat in the bodies of the inactive rats that ate restricted diets, whether these diets were high or low in fat content.

For this study, mature male rats in individual cages were used. Before the study started, all of the rats were freely fed a diet high in carbohydrates and low in fat.

During the 6-week study, half of the rats were placed on a high-fat, low-carbohydrate diet. Cornstarch, the carbohydrate source, was reduced from 57 percent in the previous feed to 16 percent; beef tallow, the fat source, was raised from 7 to 30 percent. The rest of the colony stayed on their previous diet.

Some of the rats were allowed to eat all they wanted; others, on both diets, ate meals reduced in calories by 35 percent.

Some rats on each feeding program swam 1 hour each day. The other rats were caged with no special opportunity for exercise. The effect of the exercise was studied. Rats that received unlimited feed of a low-fat diet and no scheduled exercise were used as the basis for comparison. The researchers found that feed restriction reduced body weight about 24 percent, and exercise alone reduced body weight 10 percent. With both exercise and feed, weight loss was about 37 percent.

In future research, scientists plan to test human volunteers to check the extent to which the findings with rats can be applied to man.

SOURCES OF CARBOHYDRATES



U.S. Food Patterns Are Changing

Yesterday the heavier person was considered the better nourished. Today our goal is to be slender and to keep our cholesterol and blood pressure at moderately low levels. Some people are cutting calories and becoming selective in the types of fats used.

We are eating more of our calories in sweets than ever before. Between 1909 and 1968, starches in foods, such as grain products and vegetables, decreased from about 68 to 48 percent, and sugars and other sweeteners in the diet have increased from about 32 to 52 percent of the total carbohydrate intake.

There have been shifts from butter and shortening to margarine and oils, and from whole milk, evaporated milk, and cream to skim milk, low-fat milk, and nonfat dry milk. "Filled" milk products and nondairy milk are beginning to appear on the market.

The public should be aware that many imitation-milk products have higher percentages of possibly harmful saturated fat than milk from the cow. Filled milk products contain skim milk with added vegetable fat—sometimes coconut oil—in place of natural butterfat. Nondairy milk products, advertised as containing "vegetable fat," usually contain coconut oil. The imitation-milk products are often purchased by persons on low cholesterol or reducing diets. Although classified as a vegetable fat, coconut oil is highly saturated.

ARS scientists are exploring ways of lowering the fat content of foods. For example, they developed a semi-soft cheese recently tested in four supermarkets in the suburbs of Washington, D.C. The cheese, named EUDA, has a bland but distinct flavor. Its big advantage is that it is made from skim instead of whole

milk and has a lower fat content than most other cheeses.

About three-fourths of the buyers, later interviewed by telephone, said they planned to make additional purchases of the new product. EUDA could be a profitable sideline for an established commercial cheese producer.

Another ARS product, dried skim milk, can be whipped into a low-calorie dessert topping.

The key to its whipping ability is homogenization of the skim milk before it is dried to a powder. When the powder is reconstituted with water and whipped, a brilliant white foam is produced that resembles stiffly beaten egg whites. The foam will hold its shape for more than an hour.

Although the foam has a bland taste, it may be sweetened with sugar or a sugar substitute and flavored by adding vanilla extract or fruit-flavored jam or jelly.

The Agricultural Research Service is continually carrying on research to determine the nutritional needs of our population, to find out the nutritive value of foods, and to produce better foods to fill human needs. Results of studies are made available to the consumer to help him choose foods that give the greatest return in health ■

SOURCES OF FATS & OILS



Keeping Food Safe To Eat

KEEPING food safe to eat is a primary mission of the Agricultural Research Service. For what good is food abundance unless that abundance remains wholesome?

ARS is approaching the problem of food safety from many fronts, including research, regulation, and public information.

Dr. Ernest E. Saulmon, Director of the Animal Health Division, ARS, introduces the subject of food safety in this way:

“Food travels a long way before it is ready for our dinner table or picnic lunch. Along the way, it is subject to contamination, to insect attack, and to deterioration.”

Major Foodborne Illnesses

At times, individuals are victims of foodborne diseases caused by bacteria. We cannot, of course, blame

all of our digestive troubles on bacteria alone. The age, physical condition, and environment of those who become sick are also important. And it's just as likely that a non-food source is responsible.

When bacteria do cause illness, however, it is likely to be one of the illnesses discussed here.

Salmonellosis

Salmonellae constitute a large group of organisms, one of which causes typhoid fever in man. Fortunately, typhoid fever is rare in the United States, but other Salmonellae are a frequent cause of disease, ranging from mild diarrhea to death.

“About 20,000 cases of salmonellosis are reported each year,” Dr. Saulmon states, “but the actual number of cases probably exceeds two million. While all age groups are susceptible, the very young and the



Cleanliness is the first step in helping prevent foodborne illnesses in the home.

elderly seem to contract the highest percentage of severe cases.”

Bacteria responsible for salmonellosis are widespread in nature. They live and grow in the intestinal tracts of human beings and animals. Humans get salmonellosis by eating contaminated food or through contact with infected persons or carriers of the infection. Insects, rodents, and pets also transmit the infection.

Because *Salmonellae* have the ability to survive and multiply outside the living host, it is important that food be protected against contamination at all times.

Products such as eggs, meat, and poultry are most suspect as transmitters of the disease. In fact, most outbreaks of salmonellosis occur after eating food that has either not been fully cooked or has not been properly refrigerated after preparation. This is the reason for the high incidence of salmonella infections traceable to custards, salads, and reconstituted milk or egg products.

Salmonellosis can be controlled through personal hygiene and proper storage, as well as by paying careful attention to food preparation and

handling. Food that has been cooked thoroughly is safe, but can become a problem if recontaminated and then kept at room temperature.

“We know,” he continues, “that *Salmonellae* in food are destroyed when the food is heated to 140° F. for 10 minutes or when heated to higher temperatures for less time. Refrigeration at 45° inhibits the growth of *Salmonellae*, but they remain alive in the refrigerator or freezer, ready to do mischief if given the opportunity.”

The chain of infection is so devious that local, State, and Federal health agencies are involved in the control of salmonellosis. The Agricultural Research Service is cooperating with other agencies to control salmonellosis in livestock, particularly poultry. One cooperative effort is a voluntary program to control pullorum disease and fowl typhoid in chickens and turkeys, and typhimurium infection in turkeys.

Through the years, ARS scientists have helped control *Salmonellae* by setting sanitation guidelines for the processing of poultry, fish, and animal products.

ARS has also helped develop test procedures for the isolation of salmonella organisms from animal feeds and feed ingredients.

“The complete elimination of *Salmonellae* is still not possible,” Dr. Saulmon says, “but the incidence of salmonellosis can be reduced significantly by minimizing infection in domestic animals, by improving food handling practices, and by increasing attention to protecting processed foods.”

Perfringens Poisoning

Perfringens poisoning is caused by spore-forming bacteria (*Clostridium perfringens*) that grow in the absence of oxygen. These spores can withstand temperatures usually reached in cooking most foods. Surviving bacteria continue to grow in cooked meats and

gravies, particularly those held without adequate refrigeration.

Perfringens poisoning is transmitted by eating food contaminated with abnormally large numbers of these bacteria. To avoid this illness, cool cooked meats rapidly and refrigerate them promptly below 40° F.

Staphylococcal Poisoning

To many people, staphylococcal poisoning is known simply as "staph". The bacteria (*Staphylococcus aureus*) that produce the disease are fairly resistant to heat. They grow vigorously and produce a heat-resistant toxin at temperatures between 44° and 115° F.

Humans get staphylococcal poisoning by eating food containing the toxin, but staph may also be transmitted by food handlers who carry the bacteria.

The growth of bacteria that produce the toxin is retarded by keeping hot foods above 140° F. and cold foods below 40°. The toxin is destroyed by boiling for several hours or by heating the food in a pressure cooker at 240° for 30 minutes.

Botulism

"Botulism," Dr. Saulmon states, "is the rarest type of food poisoning in the United States. It is also the deadliest. Only 116 cases of botulism were reported during the years 1952-1960, but about 65 percent of these resulted in fatalities."

Botulism is caused by spore-forming bacteria (*Clostridium botulinum*) that grow and produce toxin in oxygen-free areas, such as sealed containers. While the spores themselves are harmless, the toxin is a deadly poison.

Home-canned vegetables, meat, and poultry may contain the toxin if they are not properly processed in a pressure canner. Low-acid foods held in the refrigerator for longer than 2 weeks are also susceptible.

The toxin that produces botulism may be destroyed by boiling from 10 to 20 minutes, depending on the kind of food used. The bacterial spores in food, however, can be destroyed by high temperatures obtained only in the pressure canner. More than 6 hours is required to kill the spores at boiling temperature (212° F.).

"In June 1969," Dr. Saulmon continues, "as part of our educational responsibilities, the Agricultural Research Service issued a guide to homemakers to help prevent illnesses caused by contaminated food. You can obtain a copy of Home and Garden Bulletin 162, 'Keeping Food Safe To Eat' free by writing to the Office of Information, U.S. Department of Agriculture, Washington, D.C. 20250."

Research For Food Safety

"It would be difficult," Dr. Saulmon affirms, "to discuss in detail all of the ARS research efforts devoted to the prevention or detection of foodborne diseases. Success in two areas of keeping food safe to eat are well worth describing, however. One concerns probably the most dreaded disease of meat, trichinosis. The other involves the preservation of one of our most valuable foods, milk."

Diagnosing Trichinosis

"Trichinosis is a disease caused by microscopic, threadlike worms that live in the muscles of hogs. Although the number of hogs in this country infected with trichinae is very low, it is still possible to get trichinosis.

"Humans contract this disease when they eat raw or undercooked pork or pork products that contain these trichinae. You can prevent trichinosis, however, if you cook the pork to an internal temperature of at least 137° F."

Perhaps the most hopeful note concerning trichinosis is to be found in 1969 research by ARS that verified a method of detecting this disease.

"This new approach to the detection of trichinosis," Dr. Saulmon says, "is called the 'pooled-sample digestion technique'." It is employed at the time of hog slaughter, and involves mixing a 5-gram portion of the diaphragms of 20 different hogs.

After the mixture is digested in a pepsin-acid solution, trained personnel in packing plants are able to examine the material for trichinae under a microscope. If trichinosis is detected, the 20 hogs are examined one by one, and the infected animal can be quickly traced to its origin.

"It is conceivable," he adds, "that this method could lead to the eventual eradication of trichinosis in the Nation's swine. For now, though, our best advice to consumers is not to sample uncooked pork, and to heat all pork products to an internal temperature of at least 137° F."

Keeping Milk Longer

Another significant research development has shown that the storage life of milk can be extended.

"We all know that milk is perishable," Dr. Saulmon comments, "but apparently it is not nearly as subject to deterioration as we formerly believed."

With normal household refrigeration (45° to 50° F.), milk keeps an average of 7 days. Recently, however, ARS scientists demonstrated that by simply lowering the storage temperature of milk to slightly above freezing, the storage life of milk can be extended to as long as 7 weeks."

Research also indicated that milk pasteurized under higher-than-normal temperatures would keep 20 weeks or more. This longer life span for milk could prove important in cases of national emergency. It also may lead to

changes in the storage and distribution practices of the fresh milk industry.

Controlling Insects Nonchemically

"Certain household insects," Dr. Saulmon explains, "can carry some of these dangerous bacteria. It is far easier and less costly to combat these insects in their natural environment and to deny them access to our storage facilities and kitchens."

"There is a continuing search for new methods of insect control," Dr. Saulmon points out. "These range from less persistent insecticides to nonchemical devices such as hormones, light response, and sex attractants."

In 1968, ARS dedicated the "Biological Control of Insects Research Laboratory" on the campus of the University of Missouri at Columbia. This new laboratory is the only one of its kind in the Midwest. Here, scientists are conducting experiments to exploit promising insect predators and parasites in the control of destructive insects of growing crops and animals.

Natural Enemies of Insects

"There are also many insects," Dr. Saulmon continues, "that cause decay and deterioration of food in storage. While competing with man for food, they contribute only their larvae and eggs, and thereby contaminate food otherwise fit for consumption."

Fortunately, there are alternative ways for combating these insect saboteurs of our food supply. Recent ARS research has revealed about 35 different kinds of viruses that attack insects in stored foods. Most of these viruses are fatal to the insects, and as far as we know, will not affect warm-blooded animals.

"Some of these organisms are so

The use of a pressure canner is the only sure way to kill the bacterial spores that cause botulism.



selective," Dr. Saulmon comments, "that they will attack only one or a few species of insects."

After thorough toxicological tests to insure safety to warm-blooded animals, the more promising of these microorganisms will be taken from the laboratory for testing in storage facilities.

"We know," Dr. Saulmon continues, "that these organisms already exist in nature, and may be present in our food normally. All we need to do is to learn how to manipulate them to provide safe and effective insect control."

Safe Packaging

"One of the most obvious ways to avoid food contamination," Dr. Saulmon says, "is to keep the insects away from the food all along."

In this area, ARS research has recently developed food packaging that eliminates any minute openings or cracks through which even tiny young insects could squeeze.

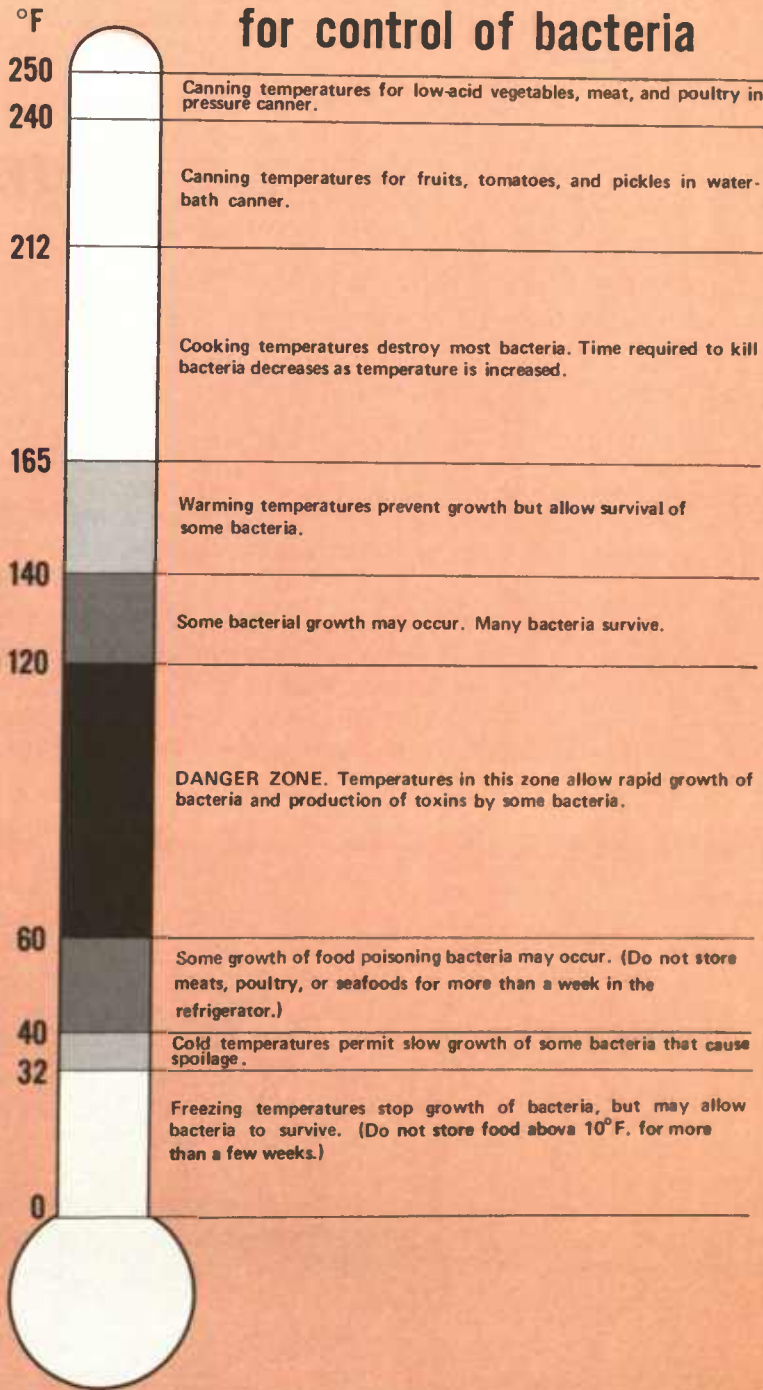
A few species of more enterprising insects will chew through packaging to reach the food inside. To stop them, ARS has used a light application of repellent on the outside of the outer ply.

But despite promising developments, today's food supply still depends largely on the use of pesticides.

Limiting Pesticide Residue

"Many people today," Dr. Saulmon comments, "are concerned lest pesticides used to protect food in the field or during the marketing process remain on foods in the form of residue. We are continually reminded of the incipient danger to our health, while the full story, including the magnificent effort of allied Government agencies to determine and limit pesticide residue, is rarely told."

TEMPERATURE OF FOOD for control of bacteria



For a number of years, the Food and Drug Administration, U.S. Department of Health, Education, and Welfare, has calculated pesticide residues in the dietary intake of individuals in the United States. In these so-called "market basket" studies, food samples are collected from five cities six times a year.

Food samples prepared by standard directions are then analyzed for various types of residues. Over the past few years, results of the studies have shown that pesticide residue levels in the diet are well below the Accepted Daily Intake (ADI) established by the Food and Agriculture Organization and World Health Committee.

For example, carbaryl and malathion are two pesticides used to protect growing tomatoes from such insect pests as flea beetles, tomato hornworms, mites, and tomato fruitworms (corn earworms).

Exhaustive tests have shown that residues of 10 parts per million of carbaryl and 8 parts per million of malathion present no hazard to man, and still other tests at market points show that these residues have dissipated far below the allowable tolerance level.

Although these residues are minute—a book $\frac{1}{16}$ inch thick is 1 part per million of a stack 1 mile high—and measured in parts per million or billion, ARS scientists wanted to know the effects of cleaning fruits and vegetables that had been grown with the aid of pesticides such as carbaryl and malathion.

It was found that kitchen washing, for example, removed more than 90 percent of the carbaryl and malathion residues on the tomatoes. The remaining carbaryl and malathion residues were reduced to near zero after the tomatoes were peeled. Hot water immersion proved itself the most effective peeling agent ■

Tracing Elements Through the Food Chain

A physician swabs a frail, young patient's arm with alcohol before injecting a measure of soluble iron.

A soil scientist studies the results of tests to determine the iron content of soils and food crops growing on those soils.

What is the connection between physician and soil scientist? They both are combating iron-deficiency anemia, probably the world's most widespread nutritional disorder. Like scientists of many disciplines, they are concerned with trace elements and their effect on human health. This interest is growing because of recent findings by the Agricultural Research Service and medical science that show, for example—

- Iron absorption can be increased greatly in laboratory animals by combining it with the amino acids histidine or lysine.

- Zinc aids in healing wounds in some cases following injury or surgery. It also affects animal reproduction.

- Selenium can be added to soils to eliminate deficiencies in sheep that cause white muscle disease in their lambs.

- Cadmium in excessive amounts can lead to high blood pressure in people.

These and similar findings are of direct interest to soil scientists, plant physiologists, biochemists, and animal nutritionists at the U.S. Plant, Soil, and Nutrition Laboratory, Ithaca, N.Y. The laboratory is operated by ARS in cooperation with Cornell University. Scientists there are studying dozens of trace elements in the food chain—from soil to plant to animal. Their challenge: Can we control the levels of these elements in the food chain so that they better parallel the needs of consumers?

This Agricultural Research Service laboratory is literally a miniature Scotland Yard when it comes to detecting elements in soil samples, and in plant and animal tissue. There, scientists have at their fingertips such sophisticated detection equipment as—

- Atomic absorption spectrophotometer to analyze plant and blood samples for such elements as magnesium, calcium, chromium, and cadmium.

- Isotope counter to trace radioactive elements through the plant

cycle—from soil to plant to animal—and within a plant or animal.

- Gas chromatograph to identify unknown substances in various materials under study.

In fact, such equipment is largely responsible for the increased success scientists are achieving in determining the part trace elements play in plant and animal life.

“We must know the movement of micronutrients from the soil to plants—and into the animal or human food chain,” says Dr. W. H. Allaway, who directs the laboratory. Equipment such as the isotope counter has helped determine what happens to different trace elements when they are added to soils.

Fortunately, plants provide an effective barrier against several trace elements that could be poisonous to animals. These include arsenic, iodine, beryllium, fluorine, nickel,

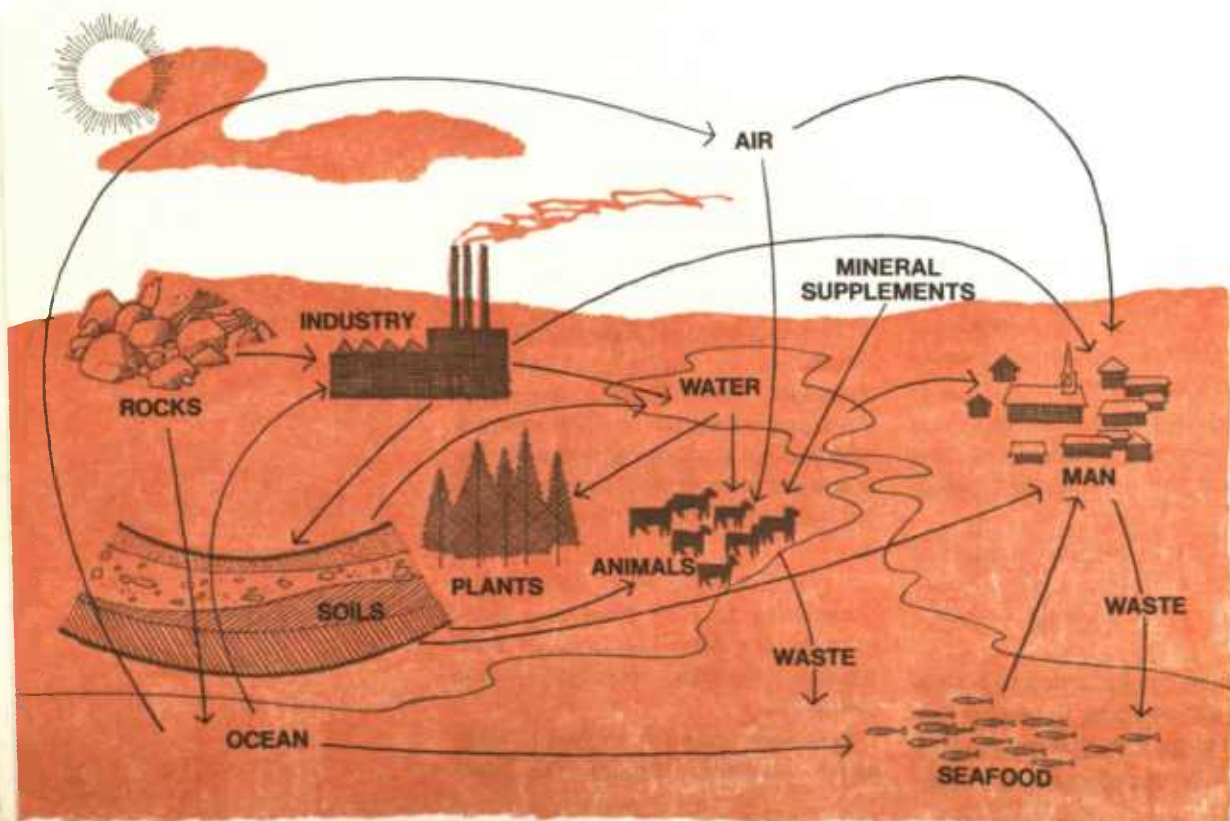
and vanadium. Plant growth would cease or be greatly depressed before these elements could accumulate to levels that would be dangerous to man or animals.

It is possible, on the other hand, for plants to grow at normal or near-normal rates and still contain enough selenium, cadmium, molybdenum, or lead to be harmful in feed or food.

It is also possible for feed and food plants to grow normally even though they do not contain enough of certain elements to meet the dietary requirements of some animals. These elements include cobalt, chromium, copper, iodine, manganese, selenium, and zinc.

Two challenging questions facing the staff at the U.S. Plant, Soil, and Nutrition Laboratory, then, are these: Do the soils in certain areas produce crops lacking in some elements that are essential to animals and man,

Trace elements move through countless cycles in the environment. All of these cycles affect man and his environment.



even though not required by plants? Are there potentially harmful minerals in the plants from certain areas?

Deficiencies of trace elements are not new. To illustrate this point, Dr. Allaway tells the story about Indian Chief Chocorua, who, as the legend goes, put a curse on the people of Saco River Valley, New Hampshire, for taking his land. The so-called "curse," which fell upon the cattle, was actually a cobalt deficiency of the soils in the valley. Cattle refused to eat; they became anemic, weak, and emaciated. Many died.

This cobalt deficiency has since been overcome by animal scientists. Their modern-day cure for Chief Chocorua's "curse" came as cobalt salt in the form of salt licks or feed supplements. Fertilizers containing trace amounts of cobalt are also applied to pasture soils. ARS scientists helped resolve this problem by mapping areas of cobalt deficiency in the eastern United States.

Once agricultural scientists have found a plant or animal deficiency, questions then arise: What is the best way to overcome the deficiency? Should we add the trace element to the soil? To feed crops? Or as a treatment to livestock?

Iron: Present But Unavailable

But what if the element is present but tied up chemically and unavailable? This is the case of iron, required by both plants and animals. If deficient in soils, it can be added effectively as a soil treatment or in sprays on food or feed crops. Either way supplies the crop with its needs. Why, then, do we hear so much about "iron-tired blood" in humans?

Dr. Darrell Van Campen, a biochemist at the Ithaca laboratory, explains it this way: "In most cases, a deficiency of iron in plants or animals is due to its poor availability. We add

a soluble form of iron to the soil or plant, and this takes care of the crop need."

But if food crops contain iron, why do people suffer from iron deficiencies?

"The reasons for poor iron utilization by individuals aren't really known," Dr. Van Campen says. "We do know that iron-deficiency anemia is very high among peoples in low-protein areas. This is true particularly where protein needs are met primarily by plant rather than animal protein."

Following this lead, Dr. Van Campen began studying amino acids, the structural units of proteins, and their effect on the utilization of iron by laboratory rats. There are about 20 amino acids in most proteins. Some of these are good iron chelators—that is, they have the ability to combine with iron in a form that is soluble and can be absorbed into the bloodstream.

The results with the amino acids, histidine and lysine, were both dramatic and graphic.

When iron alone was injected into rats, only 5 percent was absorbed into the bloodstream in 3 hours. If lysine was added to the iron solution, about 50 percent of the iron was absorbed in the same time; if histidine was added to the iron, the absorption exceeded 75 percent in 3 hours.

These results were obtained by injecting radioactive iron and the amino acids directly into a tied-off section of intestine. (See illustration, page 26.) In another approach, radioactive iron and histidine were given to rats through a stomach tube. Histidine given in this manner also increased the absorption of iron but not as much as the injections.

Dr. Van Campen is highly enthusiastic about these results and their implications. He stresses, however, that before histidine or lysine can be used to increase the absorption of iron, "they should be tested for effec-

tiveness under clinical conditions and the effectiveness compared to that of other methods of treating iron-deficiency anemia.”

But these approaches suggest treatment—a dose of soluble iron as a treatment against anemia. What of a cure? In fact, what about a cure for deficiencies of both iron and protein?

ARS scientists already have developed protein food supplements for use in countries where the supply of protein, especially animal protein, is limited. Peoples in these same countries also suffer from iron-deficiency anemia. Further research may demonstrate that adding histidine or lysine to these protein food supplements at levels needed to provide maximum absorption of iron will serve to solve the problem of both iron deficiency and protein deficiency.

Zinc: New Roles in Life

Zinc, like iron, can be “present but unaccountable” in the diets of animals. For this, and other reasons, scientists have renewed interest in the part zinc plays in human health. It is known that zinc has a role in healing following wounds and surgery, that zinc affects animal reproduction, and that zinc may be beneficial in counteracting detrimental effects of cadmium.

Coupled with these nutritional and health needs is concern over the availability of zinc. The decline in the use of galvanized metals in plumbing systems, oddly enough, has decreased the amount of zinc available to animals and humans. Zinc deficiency in plants is becoming more widespread so its availability in food and feed crops is probably declining. Even of more concern, however, is the fact that zinc is less available in plant proteins than in animal proteins. And plant proteins in human foods far

exceed the use of meat as a source of protein in underdeveloped parts of the world.

It is in this climate that Dr. Jean Apgar, a biochemist at the Ithaca laboratory, is studying the role zinc plays in the reproduction of rats.

While trying to raise rats on a soybean meal diet, Dr. Apgar discovered that the females had a difficult time in reproduction. Soybean meal contains zinc but in a form that is unavailable, a fact learned in the 1950's by animal nutritionists in hog-feeding experiments.

Dr. Apgar observed that pups born to female rats on zinc-deficient diets died shortly after birth, and the females themselves underwent excessive stress and bleeding. Addition of zinc to the diet enabled the females to deliver normally and to raise litters successfully.

Even when Dr. Apgar fed adult rats an adequate zinc diet up to breeding time, and then took them off zinc, the same problems arose. “They became so zinc-deficient in the 21 days required for pregnancy that delivery of the pups took as much as 24 hours,” she said. (Two hours is normal for the rat.) “Sometimes the females died. And even if they managed to deliver, the young hardly ever survived.”

When Dr. Apgar fed female rats a zinc-deficient diet for 3 weeks and then attempted to breed them, only a small number mated. And of those that did mate, very few were able to carry the pregnancy through the full 21-day term.

What are the implications for humans? Dr. Apgar said that very little is known about the incidence of zinc deficiency in humans, partly because there are no very good tests for zinc deficiency. And when tests are made on laboratory animals, there is little correlation between the level of zinc in the blood, hair, or urine and the development of zinc deficiency in the animals.

In a study of iron absorption, histidine and radioactive ferric iron were injected into tied-off sections of rats' intestines.



"It is possible that marginal zinc deficiencies do occur in people but are not detected," she says. "This is particularly likely when you consider that rats, sheep, and cattle store zinc in very limited amounts. An animal becomes deficient very quickly after zinc is removed from the diet. Zinc requirements also seem to be higher than was previously thought."

Dr. Apgar considers it possible that the female rat's need for zinc in reproduction has a counterpart in woman. However, all that is known at this time is that the level of zinc in the blood goes down during human pregnancy. And it is lower after delivery in the blood of women on plant diets than in the blood of women eating some animal protein.

Selenium: Necessary But Toxic

Each trace element has its own distinct complexities. But selenium, perhaps better than any, illustrates the very narrow margin between too little and too much.

Dr. Allaway keeps his hand in as a working scientist, besides directing the laboratory. He, Earl Cary, and Joe Kubota are working on selenium. "Even though selenium is essential to animal life—in very small amounts—it is more poisonous than arsenic," he says, "and is less abundant in the earth's crust than gold."

The margin between too little and too much selenium in feed for cows and sheep is critically narrow—less than one-fifth an ounce in a ton of hay. Too much selenium causes growth of the animals to be depressed, hooves to break off, and hair to fall out; too little results in white muscle disease in calves and lambs. At levels higher than one-fifth of an ounce per ton, cattle and sheep may die.

This is a major reason why deliberate additions of selenium to foods or

animal feeds are prohibited in the United States. Injections of selenium are permitted, however, to prevent white muscle disease in lambs and calves.

The Ithaca lab has developed a map of the United States showing regions where feed crops are deficient in selenium and regions where crops contain adequate amounts. (See map, page 29). They did this by collecting and analyzing over 3,000 samples of forages, and making use of information from earlier studies of selenium content of wheat and feed grains.

As the map took shape, one thing became obvious. The shipment of feed grains from the west central United States to the Northeast has helped meet the selenium needs of dairy cattle and poultry in selenium-deficient areas of the Northeast.

But what about treating soils with selenium? Would the resulting crop contain enough of the trace element to prevent white muscle disease in lambs and calves?

To find out, scientists at the Ithaca laboratory teamed up with scientists of the Oregon Agricultural Experiment Station in a study on an Oregon alfalfa field known to be deficient in selenium. Half of the field was treated with selenium; the other half was not treated.

Over half of the lambs born to ewes fed alfalfa from the untreated part of the field developed white muscle disease. Twenty percent of these died. In contrast, none of the lambs born to ewes fed alfalfa from the treated portion of the field got white muscle disease. Meat from these lambs did not contain selenium at levels toxic to people.

The research didn't end there, however. It was important to know what happened to that portion of the selenium applied to the Oregon field and not used by the alfalfa. Only about 2 percent of the selenium was taken up by the alfalfa crop in the first

3 years after application. The rest remained in the soil. Would it be available to other crops? And was there a possibility that it could be taken up in amounts that would be toxic?

The scientists tackled these questions by "tagging" a number of different soils with radioactive selenium, growing alfalfa on them for a year, and hunting for the selenium that was left in the soils. It turned out that most of the selenium left in the soil was in one of two forms, both of which are quite inert and unavailable to plants. Application of selenium to the soil, therefore, may have a place in future efforts to improve the quality of feed crops.

Magnesium: Its Complex Interactions

Overcoming a deficiency in plants or animals often isn't as simple as adding selenium to the soil or cobalt to a cow's diet. ARS Soil Scientist D. L. Grunes will attest to that. He is working with a complex magnesium deficiency that affects lactating cattle, primarily.

The malady is grass tetany, often called "grass staggers" because animals develop stiff legs and give the appearance of staggering. In late stages of the disease, the animal may fall down, have convulsions, and die. The level of magnesium is low in the blood of affected animals. Grass tetany has caused losses of more than 10,000 cattle in California and Nevada in recent years.

Dr. Grunes, who is working with State and ARS scientists in California, Georgia, Idaho, Nevada, and North Dakota, points out that grass tetany strikes as a result of a combination of several interacting conditions:

- When a cow is lactating and losing magnesium to her milk;

- When a cow is grazing cool-season grasses (crested wheatgrass, ryegrass, wild rye, and tall fescue, for example);

- When the weather is cool, most often in early spring but also in the fall;

- When the content of grasses is high in certain organic acids, such as *trans*-aconitic acid;

- At times when a cow's diet is high in potassium and nitrogen;

- And recently in southeastern States when cows grazed pastures that had been fertilized heavily with chicken litter.

Despite these complex interactions, Dr. Grunes feels, "We are well on the road to determining how cattlemen can eliminate grass tetany."

In Nevada, for example, cooperating scientists induced tetany in lactating cattle by causing them to ingest equal parts of potassium chloride and organic acids. These compounds obviously interfered with metabolism and the use of magnesium by the cattle.

Affected cattle usually recover from grass tetany if they are injected with calcium-magnesium gluconate in the first few hours after symptoms occur. "The problem with this treatment," Dr. Grunes says, "is one of timing. If treatment is delayed 8 to 12 hours after the first symptoms occur, chances of recovery are slight. And cattlemen, particularly those with range cattle, don't visit their herds that frequently."

What, then, do the scientists feel is the solution? Dr. Grunes hopes soon to be able to come up with a formula-based on weather reports—that can be used to warn stockmen against grazing certain pastures. That is why it is important to pinpoint precise cool-weather temperatures and all grass species that influence the disease.

Challenges: Many and Complex

In summary, scientists at the U.S. Plant, Soil and Nutrition Laboratory feel many questions remain unanswered—both with trace elements now under study and those they hope to study. Here are some of the challenges, element by element:

ZINC—Can we manage our soils and our food crops in ways that will provide people with the essential zinc they need in their diets?

SELENIUM—Can we control the level of selenium in soils, crops, and animal feeds at a level that will prevent selenium deficiencies in animals without any danger of selenium toxicity?

MAGNESIUM—Can we supply magnesium from soil to plant to animal in amounts that will prevent grass tetany in cattle, sheep, and goats?

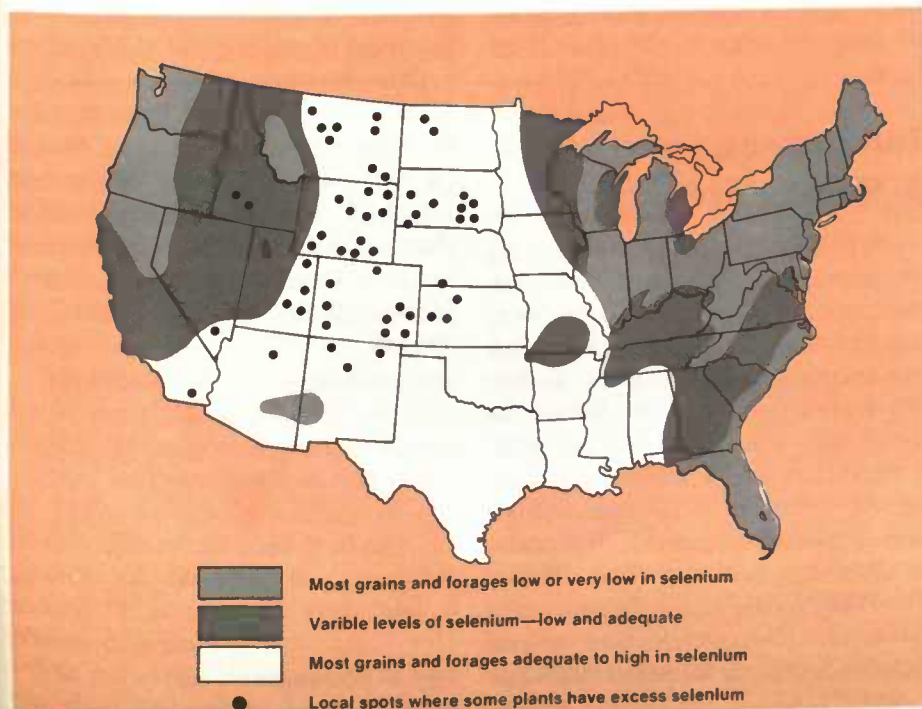
CHROMIUM—How much chromium is there in food plants? Can we increase this amount to protective

levels? Are there any adverse side effects from increasing chromium content of food plants? (Chromium has been found to help, along with insulin, in the prevention of diabetes in older people.)

CADMIUM—If cadmium, as many medical authorities believe, leads to high blood pressure in people, can we develop soil management practices that will reduce the amount of cadmium in foods?

Complicating the problem is the fact that some cadmium enters food from polluted air and some from the soil. How much cadmium is given off, for example, in the exhaust of vehicles powered by diesel engines traveling our highways? How much of this cadmium then is taken up by crops growing along highways?

J. F. Hodgson, ARS soil scientist at the Ithaca laboratory, will conduct research to find some of the answers. His preliminary studies indicate that there may be very important differences in the cadmium concentration in plants growing on different soils.

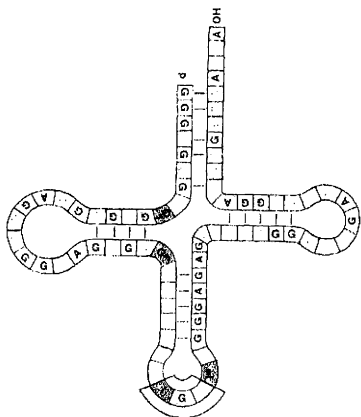


Levels of selenium in crops have been mapped in relation to animal needs. This is a forward step in overcoming deficiencies and in warning against toxicity of this essential element.

These differences are related more to the parent rocks and the natural processes of soil formation than to differences in pollution of the soils with cadmium from fuels or other manmade sources.

In general, Dr. Allaway feels that information on trace elements eventually will become a routine part of the diagnostic techniques used by the medical profession. When a patient is examined by a diagnostician, a sample of blood will be taken and analyzed for a number of different trace elements. The patient will then be treated to adjust the levels of trace elements to a "desired range."

"The challenge facing agricultural scientists," Dr. Allaway points out, "is to develop a food supply that has uniform or standardized amounts of trace elements for the major types of food. In some cases, it may be possible to control trace-element levels in food so that people will receive the desired amounts of these elements through the food they eat. With the more stubborn trace elements, it may be necessary to provide supplements. Overdosage in the supplements is less likely if we know the precise levels of trace elements in the major food types."



The complex task of identifying alanine tRNA structurally is illustrated in this linear chain of the molecule.

The Unknown: A Nobel Prize

Concern for answers to underlying problems of plants, soils, and nutrition has led some of the scientists at the laboratory deep into the unknown. An example is the work of Dr. Robert W. Holley (now with the Jonas Salk Institute), who directed an ARS-Cornell University team of scientists at the laboratory. The team determined the structure of a nucleic acid—a discovery that earned Dr. Holley the 1968 Nobel Prize in Physiology or Medicine. The nucleic acid was an alanine-accepting transfer ribonucleic acid (tRNA).

Since the first tRNA structure was determined, 17 others have been identified structurally by scientists in many other parts of the world. The Ithaca work provided the guidelines for these additional findings.

The importance of this breakthrough is apparent when one considers that knowledge about nucleic acids is knowledge about life itself.

Transfer RNAs are the smallest of the known biologically active nucleic acids. They select and carry activated amino acids to the protein building sites within the cell.

Ultimately, many scientists believe the research will lead to ways of altering genetic characteristics of living organisms by modifying the structure of nucleic acids. These acids have a role in cancer growth and the transmission of virus diseases.

Seven years of research (1958-64) were required by the Ithaca team to develop the procedures and identify the structure of alanine-accepting tRNA. In contrast, 15 months later a second tRNA—a tyrosine-acceptor—had been identified structurally at the Ithaca laboratory by Dr. J. T. Madison and G. A. Everett, both members of the original Holley team.

Other members of the team, besides Holley, Madison, and Everett, were Dr. Jean Apgar and Susan H. Merrill of ARS, and Dr. Mark Marquisee, Dr. J. R. Penswick, and Dr. Ada Zamir of Cornell. The team received the U.S. Department of Agriculture's Distinguished Service Award in 1965 ■

Breeding For Better Meat

JUICIER, more tender, and more nutritious meat. This is one of the major and continuous goals of agricultural research.

Meat is an essential part of our diet. It is an excellent source of the high-quality protein needed for growth and repair of body tissues—muscles, organs, blood, skin, and hair. It also supplies other important nutrients—iron, thiamin, riboflavin, and niacin.

What do American consumers prefer in meat? Beef is by far our first choice. Then comes pork, chicken, turkey, veal, and lamb in that order. In 1969, we ate an average of 109 pounds of beef, 66 pounds of pork, 37 pounds of chicken, 8 pounds of turkey, 4 pounds of veal, and 4 pounds of lamb.

The per capita consumption of beef has risen 69 percent in the last 20

years. We are also eating more chicken—about twice as much—and more turkey per person now than we were then. The per capita consumption of pork has remained about the same, but lamb has shown a decrease.

The U.S. meat and poultry industries are the world's largest; output last year was about 36 billion pounds of meat and 10 billion pounds of poultry. Behind the scenes of these vast industries, agricultural research scientists are seeking to further improve the quality of the products and reduce the costs of production.

The Federal Government (principally the U.S. Department of Agriculture), the States, and private industry all participate in this research. They work closely together, cooperating in research projects and exchanging the results of their independent efforts.

The Benefits From the Research

Both the meat-animal producer and the consumer benefit from this research. By applying the results of the studies and experiments, the producer increases his per-unit production of high-quality products, but with less than proportionate increases in his production costs. The consumer, in turn, buys better-quality meat with less fat and more protein.

The value of the research to the producer is well illustrated by this fact: Live-animal market prices for cattle, sheep, and swine vary from year to year, but they averaged about the same for the years 1966-68 and 1949-51. Yet, because of increased efficiency in production, producers have been able to "stay in business" and produce more meat per capita than ever before in spite of higher operating costs.

The outstanding example of increased efficiency has been in the production of chicken meat. And here is how the consumer benefited: In 1949-51, the nationwide average retail price of frying chickens was 61 cents per pound. By 1966-68, the price had fallen to 40 cents per pound.

Consumers now pay more for most kinds of red meat than they did 18 or 20 years ago, but the price increases have been due largely to increased marketing costs, not to higher farm prices. Considered over a period of years, red meat prices have risen less than the prices of many other consumer products.

The research with livestock and poultry covers all phases of production—feeding, management, breeding, and disease control. Advancements in any of these areas can lead to better meat and to lower production costs.

"Breeding—the science of genetics—offers the best opportunity for

the improvement of livestock and poultry," says Dr. Everett J. Warwick, Assistant Director of the Animal Husbandry Research Division of USDA's Agricultural Research Service. "In fact," he adds, "the long-range success of a beef herd, for example, depends more on the genetic procedures and breeding practices followed than on the breed selected."

Today, livestock and poultry breeding involve the use of three basic, often interrelated techniques:

- Performance testing—the selection of breeding stock on the basis of records of performance.
- Crossbreeding.
- Artificial insemination.

Livestock and poultry breeders and producers may use one or more of these techniques in their breeding programs. For example, the beef cattle producer may use stock of a single breed or he may crossbreed. Crossbreeding may be done by natural mating or by artificial insemination.

Performance Testing

Research has shown that various economically important traits are highly heritable in livestock and poultry. These include traits that contribute both to efficiency of production and to quality of the product. Methods have been developed for measuring or evaluating many of these traits in the live animal.

In performance testing, systematic measurements are made and records are kept on the "performance" of the individual animals in these traits. Those that excel in the traits—as indicated by the records of performance—are selected for breeding. The "best are mated to the best" to produce offspring that are genetically superior in the more economically important traits.

Let's look at performance testing specifically in the breeding of beef

attle—in many ways our most important meat animal.

Highly heritable, economically important traits in beef cattle include the ability to grow rapidly, mature early, and use feed efficiently. Appreciable genetic improvement can be made in these traits by selecting breeding stock on the basis of the differences in performance of the individual cattle in these traits.

For example, selection of breeding cattle with higher weights at weaning and with higher rates of gain after weaning results in calves superior in these traits. Such calves require less feed per unit of gain and less labor to reach slaughter weight.

The genetic improvement tends to be permanent when breeding is done on the basis of performance records. Each new generation adds a measure of quality or productivity or both. Substantial herd improvement is possible within a period of 10 to 20 years.

At present, only a very small percentage of beef cattle breeding is done on the basis of performance records alone. The main reason is the lack of adequate techniques for objectively measuring or evaluating carcass quality in the live animal.

Carcass quality is of fundamental importance to the beef cattle industry. The desired, meat-type steer is thickly muscled (particularly in the regions of the more preferred, or higher-priced, cuts—the back, loin, rump, and round) and has a minimum of excess or outside fat. Thickness of muscling and the ability to produce high-quality lean without a thick covering of excess fat are both heritable traits. However, measurement or evaluation of these conformation traits in the live animal is still done largely by “eye.” Therefore, selection for the improvement of carcass quality requires subjective evaluation.

But, according to Dr. Warwick, the use of performance records in beef

cattle breeding is increasing each year. He predicts almost complete conversion to this technique within 10 years. “As we improve our present methods of evaluating carcass quality in the live animal,” he says, “‘eyeball’ judgment will be replaced to an ever-increasing extent.

“The greatest opportunity for genetically improving beef cattle rests with the purebred breeder, who maintains the seedstock herd,” adds Dr. Warwick. “Over a period of time the inherent productivity of a beef herd depends largely on the bulls used.”

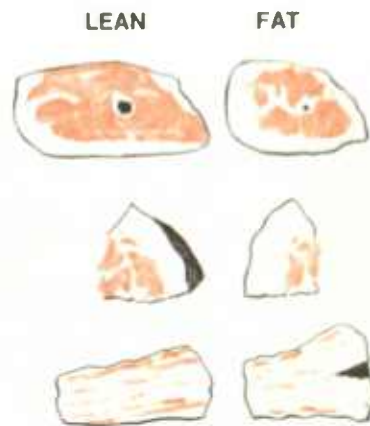
Poultry breeding is now based completely on performance testing and performance records, and swine breeding is almost so. Techniques and tools have been developed for measuring or evaluating carcass quality—as well as other economically important traits—in the live animal.

For example, for a number of years, the market demand has been for the lean, “meat-type” hog. To help breeders breed this type, ARS and State agricultural experiment station scientists cooperated in the development of three accurate methods of measuring backfat thickness in the live hog. Using one of these techniques, breeders can identify their superior animals—those with the least backfat that will have higher yields of lean cuts.

By selective breeding, based on records of performance and backfat determinations, ARS scientists have been able to breed more and more lean meat into hogs. Experimentally, progress has continued even after 14 generations of selection for backfat thickness.

Pork producers, on a national basis, have made great progress in breeding hogs with less fat. Since 1950, lard produced per hog slaughtered has been reduced by over 25 percent, or about 8 pounds per hog. To the consumer this means bigger and leaner

Meat animals can be bred to produce more lean meat.



loins and hams. And the producer also benefits—lean hogs tend to be more efficient in the feedlot and to produce more pigs per litter than fat hogs.

To date, sheep breeders have not adopted performance testing to the extent that breeders of other meat animals have. However, Dr. Clair E. Terrill, Chief of the Sheep and Fur Animal Research Branch of the Animal Husbandry Research Division, predicts an increase in the use of this technique. He feels that more effective breeding practices are needed for sheep and that selection on the basis of performance records is the answer.

Crossbreeding

Stated as simply as possible, crossbreeding is the mating of the males of one breed to the females of another. It is not a new technique by any means. A fact perhaps not generally realized is that most of the existing breeds of meat animals were originally developed from crossbred foundations.

Hybrid vigor in the offspring is the hoped-for result of crossbreeding. It results from the contribution of good genetic traits from each of the breeds used in the cross. In a successful match, so much hybrid vigor may be generated that not only will the offspring be more productive than the average of the two parents, but more productive than the superior of the two parents.

Livestock producers, especially sheepmen, practiced crossbreeding long before its genetic basis was understood. Corn breeders made the first real scientific advancement in the practical use of the phenomenon of hybrid vigor. Chicken and swine breeders soon followed their lead, but cattlemen were slower to use crossbreeding extensively.

One reason that many cattle producers delayed practicing crossbreeding was that experiments in breeding

can be expensive. Another reason was that they had to be “educated” to the new look in crossbred cattle. Crossbred cattle frequently mix the traditional coloring and markings of the parents.

But ARS experiments, conducted in cooperation with several State Agricultural Experiment Stations, showed that crossbreeding could produce highly productive cattle of top market quality. A good herd of beef cattle could bring greater net returns with systematic crossbreeding than with conventional straight breeding. Crossbred cattle gave birth to 3 percent more calves. The calves were more vigorous and grew faster. More lived to reach weaning age and were heavier at weaning.

Crossbreeding stimulated production of the “meat-type” hog. More than 30 years ago, ARS scientists crossed the Danish Landrace breed—already known for its efficient meat production—with several domestic breeds and came up with a hog that produced leaner loins, hams, and bacon. Since that time, meat-type strains of hogs have been developed in most breeds. Commercial producers use these in crossbred combinations to improve efficiency of production.

Crossbreeding experiments with sheep have produced promising results. Crossings between two, three, and even four different breeds yielded increasingly larger lamb crops and heavier lambs at birth.

Ewes in farm sheep flocks generally lamb once a year. They usually mate only during late summer or autumn, and the lambs come in late winter or spring. But since ewes deliver about 5 months after conception, theoretically they could produce two lamb crops a year.

ARS scientists are trying for an average of more than one lamb crop per year. They crossed several breeds which showed some ability to mate

out of season naturally and started the "Morlam" (more lamb) type. Some Morlam ewes lamb every 8 months—an extra lamb crop every 2 years. Top Morlam ewes have produced two lambs per pregnancy, or six lambs in 2 years.

With ewes that mate in the spring, lamb would be available in the fall when it would bring premium prices.

Finnish-Landrae sheep—a breed noted for large "litters" of lambs—have recently been imported into the United States and are being tested in crosses.

Crossbreeding has long been a major factor in poultry production. The modern well-fleshed, yellow-skinned broiler you buy in the supermarket is the end result of many past crossings between different breeds and different strains of the same breed.

In developing the female parent line of today's broilers, breeders stress the ability to lay well and to hatch well. In the male parent line, the emphasis is on growth and conformation; egg production and hatchability are secondary.

Poultry breeders often specialize. Some breed only the male parent line; others breed only the female parent line. Most poultry breeding firms employ well-qualified geneticists.

ARS scientists recently crossed a chicken and a quail and came up with an intermediate-size hybrid. They were not trying for a market bird—they were simply experimenting. Someday, however, such experimentation may produce a new, highly acceptable product.

Artificial Insemination

At present artificial insemination is not widely used in beef cattle, swine, or sheep breeding. One reason is that it is difficult for the breeder to watch for and detect estrus (sexual receptivity) in a large number of female animals, perhaps roaming over many

acres of land. Breeding (artificial insemination) without regard to estrus would result in a very low rate of conception.

Another reason in the case of sheep and swine is the perishability of ram and boar semen. Cattle semen can be preserved for long periods—15 years or longer—in the frozen state. But, as of now, it is not possible to preserve ram or boar semen by freezing. Such semen can be kept only 1 or 2 days in a refrigerator before use.

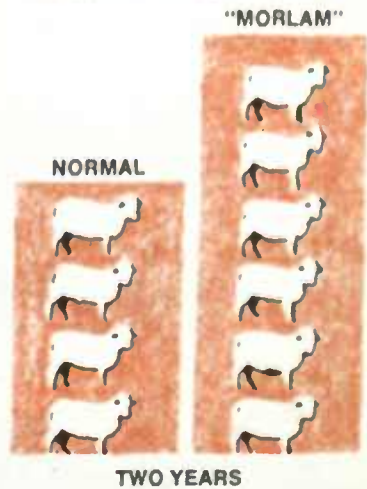
But Dr. Warwick predicts increased use of artificial insemination in livestock breeding. "Artificial insemination permits more offspring from the best males," he says, "and more offspring from the best males means more superior offspring."

"Planned parenthood" may be one answer to the problems of artificial insemination in livestock breeding. Scientists are testing different drugs or compounds which, when administered to the female animal, inhibit estrus and ovulation until the treatment is stopped. By treating his animals, the producer can, in effect, synchronize estrus in his herd; all will come into estrus within 3 or 4 days after the treatment is stopped. At that time, he can round up the herd, breed it artificially in short order, and then release it back to the range.

The principle of "planned parenthood" is still in the experimental stage. One problem has been the subnormal rate of conception in some cases.

Artificial insemination is widely used in the turkey industry. In many flocks of heavy-type turkeys where low fertility has been a problem, it has completely replaced natural matings. Artificial insemination has resulted in better fertility and more poults per hen than would have been possible under natural matings.

SHEEP PRODUCTION



"Morlam" ewes produce three lamb crops every 2 years.

ARS's Role

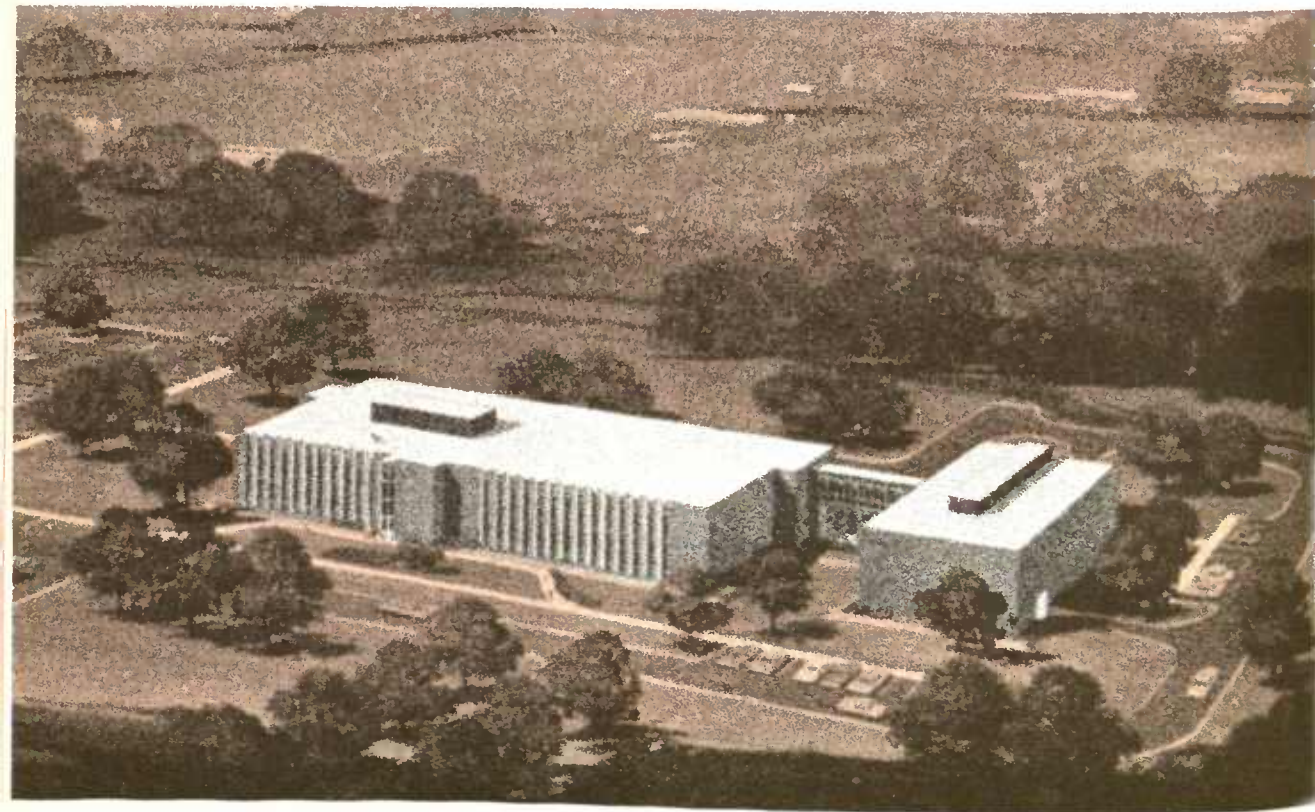
What is ARS's main objective in its research work in livestock and poultry breeding? Dr. Terrill was talking specifically about sheep research when he made the following statement, but it also applies to the work with cattle, hogs, and poultry:

“Our efforts in research on breeding and in other areas are aimed primarily at increasing the efficiency of production, which should, in turn,

result in meat at lower cost to the consumer.”

In 1969, ARS dedicated a new U.S. Meat Animal Research Center at Clay Center, Nebraska. At the Center geneticists, nutritionists, physiologists, meat scientists, engineers, and other scientists will combine their knowledge and efforts in a teamwork approach toward improving meat quality and reducing production costs. The ultimate benefactor? — the consumer ■

Better quality meat and lower production costs are the goals of the new United States Meat Animal Research Center at Clay Center, Nebraska.



The Potato: Something Different These Days

At a quick glance, potatoes would seem to be one of the most popular foods in America. Yet, in the 1950's, people weren't buying many potatoes. The annual per capita consumption of this vegetable fell to almost half of what it was in 1910. In fact, we were consuming 100 pounds of potatoes per person per year, while the average Russian consumed 400 pounds.

One reason for this drop in potato consumption in the 1950's was the growing concern of the public with caloric intake and the mistaken belief that potatoes were high in calories. Another reason was the growing competition from other foods. In addition, American homemakers became more time-conscious and impatient with the task of food preparation. Peeling, cutting, boiling, and frying potatoes took too much time.

Concerned with the declining popularity of the potato, the Agri-

cultural Research Service and other agencies in USDA, along with private industry and universities, accelerated and broadened their research programs. In the past 10 years, ARS research has yielded additional information on potato consumption; new handling, storage, and processing improvements; new forms of processed potatoes; and many new potato varieties.

This work served to strengthen and stabilize potato consumption. Per capita figures show that, today, Americans eat approximately 112.6 pounds of potatoes per year.

The Misunderstood Potato

Over the years, the potato has been the subject of many extraordinary misconceptions.

Many Europeans once believed that potatoes caused leprosy; the

Scottish and Russians believed that eating potatoes was sinful since potatoes were not mentioned in the Bible; and the Irish believed that potatoes were an aphrodisiac and tended to increase the production of offspring. Now, in America, potatoes have the reputation of being fattening.

All of these mistaken beliefs have arisen from the fact that people just don't understand the true nature of the potato.

What's Really Inside

Although potatoes are higher in calories than most vegetables, they are considerably lower than many other foods in the daily American diet. A food composition study of the Consumer and Food Economics Research Division of ARS shows that 100 grams of baked or boiled potatoes surprisingly have fewer calories than the same amounts of avocados, lima beans, bran flakes, prunes, rice, and sweetpotatoes. Potatoes prepared without butter or cooking oil, or served without gravy

also have fewer calories than most fruits canned in heavy sirup.

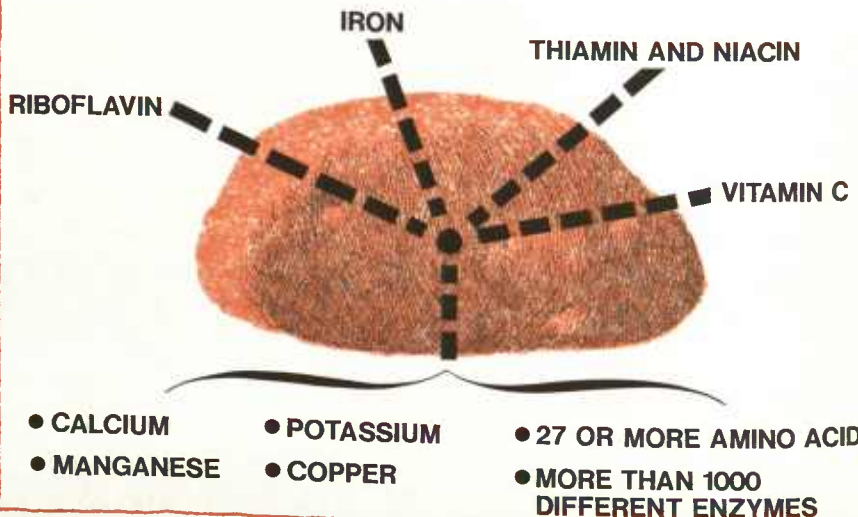
Most people consider the potato fattening because of its starch content. Yet, starch and other nutrients make up only 20 percent of the potato; 80 percent is water.

If potatoes were your only daily source of nutrients, they would provide all of the riboflavin, 1½ times the iron, 3 to 4 times the thiamin and niacin, and more than 10 times the vitamin C you need. Potatoes also contain magnesium, potassium, phosphorus, calcium, copper, and other important mineral elements, and 27 or more amino acids. The amino acids account for much of the protein supplied by the potato.

In fact, a diet of whole milk and potatoes would supply almost all the food elements necessary for the maintenance of the human body.

The Irish famine in 1845 proved a hapless example of the value of potatoes. The Irish had found that potatoes were the most efficient food crop they could grow. It provided more food energy and nutrition on

Potatoes provide all these nutrients



less acreage than any other crop. The Irish became so dependent on the potato as their major food source that when "late blight", a disease then unknown, wiped out the entire crop, widespread famine occurred. Nutritional deficiency resulted in a plague epidemic, which drove many Irish families to our shores.

Potatoes have significant amounts of vitamin C. During the Civil War, scurvy was almost unknown in prisons that served potatoes. In those which did not, this deficiency disease took many lives.

Composition and Quality

Basic research in the laboratories of the Eastern and Western Utilization Research and Development Divisions of ARS seeks to build up a reservoir of information relating to the composition and physical properties of the potato. This information assists processors in controlling such problems as flavor, odor, color, and texture deteriorations.

The amino acids in the potato are important to processors as well as nutritionists. The golden color of potato chips, for example, results from the reaction between amino acids and sugars. Sometimes the reaction goes too far and causes a burnt flavor and color in the chips.

In an intriguing project, chemists at the ARS Plant Products Laboratory in Wyndmoor, Pa., are "deep fat frying" tiny disks of filter paper impregnated with a sugar and two or three amino acids. By studying the reaction that takes place, these scientists are seeking to understand the mechanisms that produce the color. If the exact nature is found and then controlled, the consistency of potato chip flavor and color would improve.

Scientists estimate that the potato contains more than 1000 different enzymes. One of these, tyrosinase, is a complex of several enzymes and

is responsible for the darkening of raw potatoes after they are peeled or cut. This darkening is caused by a compound called melanin, which is formed by action of tyrosinase.

Melanin is not only the dark compound that troubles potato processors, but is the principal pigment in human beings as well. The color of our hair, eyes, and skin are all due to melanin. In humans, melanin is formed by action of tyrosinase in a series of reactions similar to those in the cut potato. When a human being, by heredity or by spontaneous mutation, is deficient in the gene responsible for tyrosinase, melanin does not form. An absence of melanin results in a condition called albinism. Since albinos seem to function normally, tyrosinase would appear not to be an essential enzyme—at least not for man.

Scientists at Western Utilization are trying to determine how essential tyrosinase is to the potato. If the level of this enzyme can be decreased without affecting the normal nutritional components, composition, or texture of the potato, then a potato may be bred that will not blacken during storage, or darken before or after cooking.

The Processed Potato

"The upsurge of potato processing reversed the declining trend of potato consumption," says Dr. R. H. Treadway, Assistant Director of Eastern Utilization. "Since the late 1950's potato consumption has gradually increased."

Before potatoes were marketed in processed form, housewives would spend hours preparing potatoes and end up with only a few different ways to serve them. Now, with the help of ARS research, today's cook has a choice of over 50 different forms of potatoes that can be prepared in less than half the time.

If she wants mashed potatoes for dinner, she can choose frozen potatoes that are diced, already whipped, sliced, or shredded; or, dehydrated potato granules or flakes; or, dehydrofrozen potato chunks. In the future, she may buy explosion-puffed dehydrated potato pieces that will be very quick to cook and flavorful, too. Many of these and other forms of processed potatoes can be prepared in a variety of ways.

In ARS, the processing methods and the processed potato itself are constantly being improved through the research efforts of the Utilization Research and Development Divisions.

Grocery shelves offer an abundance of processed potato products—dehydrated “instants” and other convenience items, canned potatoes, or ready-to-eat chips.

“Sunburned” French Fries

French fries of the future may have less oil content and fewer calories as a result of ARS research. Recently, scientists at Western Utilization Research Laboratory at Albany, California, developed a

process of “sunburning” raw potato strips under infrared lamps.

The intense heat from these infrared lamps apparently forms a thin shell on the potatoes. This shell prevents the potatoes from absorbing too much cooking oil during frying. In fact, ARS scientists discovered that treated strips absorb 20 to 25 percent less oil during frying than untreated ones. Yet, the treated strips do not lose the desirable cooked-in-oil flavor.

The thin shell not only prevents excess oil from entering the french fries, it also helps preserve their shape, form, and appetizing appearance after cooking.

The future for this new process looks very bright. Results from the small-scale testing at our Albany laboratory have been so encouraging that construction of pilot-scale equipment is planned by ARS. Potato processors who have seen the new process work are interested

Potato Flakes

The popular product, potato flakes, is one of the many successes to come from research and practical experiments in the Engineering Laboratory at Eastern Utilization.

A couple of engineers in this laboratory thought a better mashed potato product might be made by spreading the mash on the surface of a heated, revolving drum, letting it dry, then breaking up this thin sheet into flakes.

A complete pilot plant for the peeling, slicing, cooking, mashing, and drying of potatoes was then set up in the lab. The resulting mashed potato product was found to conserve remarkably the flavor and texture of fresh potatoes.

Explosion Puffing

This laboratory also developed a processing method called “explosive puffing” which is already being used



on some fruits and vegetables. Scientists are now working to adapt this process to the potato.

The potato chunks are first partially dehydrated, then placed into a "puffing gun." In a sealed chamber, they are heated to a pressure higher than the atmosphere, then the pressure is suddenly released, exploding the pieces out of the gun and onto a chute.

The "explosion" creates tiny channels in the pieces through which the remaining water is easily removed in the final drying. The chunks remain nearly the same size as they were before processing because the water inside of them is now replaced by air. The air in these tiny channels allows the chunks to dry very quickly. This rapid drying prevents shrinkage.

The processed chunks look remarkably like fresh ones. Flavor is retained better than with ordinary dehydration methods. In addition, this new process saves time in the kitchen. The only preparation needed is to heat the chunks in water. They are ready to eat in 5 or 6 minutes.

Dehydrofrozen Potatoes

Dehydrofrozen potatoes, based on a process developed at Western Utilization, are made by precooking potato cubes or slices, evaporating sufficient water to reduce their weight by 50 percent, and then freezing them.

Loss of color, flavor, and texture is much less in the early stages of dehydration than in the later stages. Thus, by stopping the dehydration halfway through and then freezing, these qualities can be conserved to a greater extent than with conventional dehydration. Dehydrofreezing is the reverse of freeze-drying and is much less expensive.

Water Pollution Control

A new potato peeling process under development at Western Utilization will help to decrease potato processing wastes that cause water pollution. Potato processing plants produce huge amounts of water-polluting substances. Of these, 80 percent results from the potato peeling process.

In the frozen food case, you find a variety of prepared potato dishes and a choice of packaged potatoes in different forms, shapes, and sizes.



Most plants now remove peels with high-pressure sprays after the peels have been softened by steam or a lye solution. A large volume of wash water containing the peels goes into the water-treating facility, then into rivers and streams.

The experimental system called "dry" caustic peeling uses lye and very hot temperatures to peel the potatoes. The only water used is in washing off the potatoes after they are peeled.

Since water spray is not used, the peel wastes can be kept separate from other water-borne wastes. Without the peels, the organic content of the water is reduced at least 75 percent before it reaches the waste treatment facility. The peels can be burned, or perhaps neutralized and used in mixed feed for cattle.

Scientists at Eastern Utilization are working on the waste problem in connection with potato starch factories. They are using the process of reverse osmosis, which is being used experimentally to remove salt from saline water. Potato waste water flows through tubing surrounded by a membrane that only allows the passage of water. The water escapes leaving a concentrated solution from which it is easier to remove valuable and useful components. These scientists are working on ways to remove and recover protein, potassium, phosphate, amino acids, and organic acids. The only thing left in the waste water would be sugars.

If ARS scientists can find an economical and effective method to do all this, potato processing and starch plants would not only have cleaner waste water, but also could produce a number of new products. The protein can be used as a food additive, the potassium and phosphate for fertilizer, the amino acids as a food additive for taste as well

as nutrition, and the organic acids for the citric acid component in soft drinks.

Potato Varieties

The potato is perhaps the only food crop being commercially grown in every State of the Union, and being harvested somewhere almost every month of the year. As a result of plant breeding, natural adaptation, or a little of both, potatoes grown in different climatic regions differ greatly. Even the same variety adapted to another region may vary considerably in taste, composition, and texture.

So, if you buy any Western Russet potato (often called an "Idaho baking potato") that was not grown in Idaho, do not be surprised if there are taste and textural differences.

These variations in potatoes make potato breeding very complex. Scientists doing potato investigations in the Crops Research Division, ARS, must take into account: yield; cooking quality; color of tuber; color of flesh; shape and smoothness of tuber; resistance to important diseases such as viruses, late blight, scab, verticillium wilt; resistance to insects such as the potato leaf hopper, potato flea beetle, tobacco flea beetle, green peach aphid; and resistance to nematodes.

Moreover, each new variety must be bred specifically for the growing conditions in a particular region.

Breeding for Pest Resistance

In 1910, when potato breeding was actively undertaken by USDA scientists, the primary objective was to find a new variety that would be resistant to virus diseases. These early studies expanded into an ARS potato breeding program that has contributed many disease- and



nematode-resistant varieties, for example—Sebago, Kennebec, Pungo, Cherokee, and Wauseon.

The emphasis on breeding varieties resistant to diseases and nematodes gradually shifted to breeding varieties with better marketing and cooking quality. The increased use and success of pesticides in controlling pests made it possible to shift breeding emphasis to horticultural characteristics and quality.

In view of the growing concern about the effect of pesticide residues in the environment, ARS plant breeders are now turning more of their attention to breeding multiple pest-resistant varieties.

The objective is to develop varieties with excellent horticultural characteristics, and good quality with multiple pest resistance. "Our research has been fruitful, but we have a long way to go," says Dr. Raymon Webb, Leader of ARS Potato Investigations. Emphasis on insect-resistant varieties didn't even begin until the mid-1960's.

ARS statistics show that between the years 1951 and 1960, the average annual loss of the potato crop was 40 percent. This percentage reflects losses due to insects, nematodes, diseases, and weeds, even with the use of available pesticides. "Without pesticides," adds Dr. Webb, "the amount of potatoes, or any other food crop that would survive would probably not be enough to feed the people in our country."

Plant breeders and geneticists are now working with several wild potato varieties from South America. Through the process of natural selection, wild varieties are, in isolated cases, more resistant than cultivated ones. By crossing selected wild varieties with domestic ones and studying the inheritance patterns, these scientists are trying to breed more resistance back into the domestic potato.

In spite of the fact that insect resistance studies are recent, Crops Research Division scientists already have several lines that are resistant to certain types of insects. These varieties are not ready for release because it takes 10 to 14 years to develop and adequately test a new variety.

Breeding for Processing

Scientists are also adapting potatoes to meet the needs of processors.

With the aid of ARS research, growers now raise potatoes "tailor made" for specific uses. Round varieties high in solid content are used for potato chips; long tubers are used for french fries. Generally, potatoes high in solid content process better and keep better.

Two recent varieties, Ona and Ormonte, are excellent for chipping (potato chips). Two others, Alamo and Wauseon, are especially adapted for heat-processed products, such as canned soups and dehydrated foods, as well as for potato chips ■

Fresh Fruits In a Changing World

LOOKING back through time to the late 1800's and the early 1900's one sees the general store—a small, wooden building with narrow doorways and small windows.

Merchandise was everywhere—whatever one could desire or so it seemed. But the shopper for fruit found the pickings slim. Possibly there were raisins, prunes, apples, and pears doled out in bulk form from their original shipping containers. Except for some local fruit, no fruits that needed special attention were carried. Without refrigeration, fresh fruits could not be stored long or shipped far.

In dramatic contrast, today's food stores are large, well lighted, and air conditioned; large refrigerated displays hold a wide choice of fresh fruits.

The long step from the general store to the supermarket is the story of improved marketing, and what has happened to fruits in this transformation vividly reflects the impact of marketing research.

The food industry is an exciting one. It has accomplished marvels for the American public. Supermarkets have become an American symbol throughout the world—a symbol of a plenteous supply of food.

ARS marketing researchers are on the job all along the marketing network—stepping up efficiency, cutting costs, improving quality and reducing losses. Their big push: to find better ways to transport fruits to market; and to make fresh fruits available to consumers on a year-around basis.

Today's marketing system moves fruits faster and farther than would have been dreamed possible years ago. Fresh strawberries, for instance, are picked and precooled in the morning, and sold in a distant market the same day.

We also have learned a great deal about how to retain the vitamin and mineral values in fresh fruits. Truly we have almost eliminated the calendar; most fresh fruits are now available the year around.

Early Research and Refrigeration

The first reference to USDA research on fruit handling and storage appeared in the Agricultural Report of 1874. It reported on the condition of Massachusetts cranberries that were cooled after harvest.

The impetus for refrigeration of fruit began with the Department's assignment to provide fresh fruits for the Paris Exposition of 1900. The result was that fresh fruits on exhibit were maintained in refrigerated facilities continually throughout the Exposition.

Beginning with the work of this pioneer group, ARS scientists have contributed the know-how behind modern methods and equipment for precooling; the present facilities and service for transit refrigeration; and knowledge of the specific environmental requirements of different fruits.

Refrigeration makes it possible for perishable foods to be shipped long distances. Today a New York City housewife may buy citrus fruits from Florida or California, apples from Virginia or Washington, pineapples from Hawaii.

Some of these perishable fruits travel several thousand miles to reach the New York supermarket and are a week or more on their journey; plenty of time for the fruit to spoil. Here, refrigeration plays its role, but so does the air surrounding the fruit.

"Some rail and trailer lines now offer modified atmosphere service to their customers," says Robert F. Guilfooy, Jr., mechanical engineer with the Transportation and Facilities Research Division, ARS.

"For example, more than 20,000 mechanically refrigerated cars are now in service. This represents nearly one-third of the mechanical and ice-bunker type cars now in use."

Supermarket Safeguards

To help improve the quality of marketed fruits, ARS marketing researchers supply growers and packers guides for precooling fruits before shipment.

This job of furnishing the highest quality fruit at the lowest possible price starts at the farm and extends to the retail store. Every retail firm has a quality maintenance program to help accomplish this.

Peaches, for example, are separated into lots with the same degree of ripeness. The green ones are put aside for ripening while the ripe are sold immediately.

The wholesaler and the retailer part of the job consists of purchasing a known quality of fruit and preventing any more than the minimum amount of physical and biological deterioration.

Quality control in the retail firm starts with buying guidelines—guidelines usually developed and enforced by USDA. Inspectors check the arrival condition of the fruit to be sure the buyers' minimum specifications have all been met.

Heat Treatments

Heat has long been recognized as an effective means of reducing spoilage in fruit.

H. S. Fawcett, a plant pathologist at the University of California Citrus Experiment Station, Riverside, reported in 1922 that washing lemons for 2 minutes in water heated to 115° to 120° F. would control brown rot much better than the copper sulfate bath then being used.

This treatment was immediately put into use by commercial lemon packinghouses. In more recent years, hot water or vapor-heat treatments have proved effective for peaches, raspberries, blueberries, strawberries, and fresh figs.

"Fishyback" container is lifted from truck to ship.





Deep-pocket pulp trays provide excellent protection for apples during shipment.

Pickers riding a mechanical harvester can gather five times as much fruit as pickers with conventional equipment.



Dr. Harold T. Cook, Director of the Market Quality Research Division, ARS, points out that the treatments must be developed specifically for each kind and each variety of fruit and for some kinds of disease. Also, it is important to protect the fruit following heat treatments. Benefits of the treatment would be quickly undone if the fruit were cooled afterward in water that was not clean.

Mechanical Harvester

ARS engineers have built the prototype of a mechanical harvester that could revolutionize the handling of crops destined for the supermarket.

The self-propelled machine handles many jobs previously done by pickers except for actually selecting fruit and pulling it from the tree.

The new machine has been designed for apples, but it has also been tested on peaches, pears, and plums. Pickers riding the machine can harvest five times as much fruit as pickers with conventional equipment.

Four pickers, one sitting and one standing on each side of the mechanical harvester, select and pull the ripe fruit and place it between twin conveyor belts which carry it to the bin. The belts are padded with foam rubber and grip the fruit gently but firmly.

When the bin is full, it is gently placed on the ground and an empty one takes its place. A picker who doubles as operator pushes the switches to make the transfer.

While the bins are being switched, the mechanical aid stops. It automatically starts again when the empty bin is in place. Except for turning at the end of a row of trees, it steers itself, leaving the four pickers free to select and pull the fruit.

New Instruments

To help improve the quality of market fruit, ARS marketing researchers have developed a new instrument that uses sound waves to sort fresh fruits for ripeness and freedom from internal defects.

Eventually, researchers believe instruments will tell growers when to harvest their crops for the best quality and tell packers when to take fruits out of storage and put them on the market for peak flavor!

Another promising technique using light transmitted through fruit is being tested. This one should enable growers to sort blueberries according to ripeness.

The amount of light transmitted measures the pigmentation and is closely related to the degree of ripeness and the general condition of the fruit.

Packaging

Many changes are taking place in packaging fresh produce—for example, a gradual change from wood to corrugated fiberboard and plastic containers for fresh fruit.

New packaging that protects apples, pears, apricots and prunes from bruising, is light in weight and reduces freight charges.

The use of plastics in packing and shipping of fresh fruits is a recent development. In addition to the regular polyethylene films, shrink and nonshrink films made from polyethylene, polystyrene, polypropylene, and polyvinyl chloride are being used to wrap and bag fresh fruits. Moisture-resistant molded plastic trays and shipping containers are also being developed.

To help improve the quality of market fruits and save consumer time, ARS is working with Florida citrus packers in exploring the market for packaged ready-to-serve peeled oranges and grapefruit halves. Thin-

skinned oranges, such as Tangelos and Honey Murcotts, look attractive after they have been peeled and properly packaged.

In other research on protecting food quality, ARS marketing researchers developed a molded pulp tray to protect apples from bruising. (See illustration page 46.) These trays have deep pockets that protect the apples even better than the commonly used shallow cup trays. The pockets are deep enough so that posts between the pockets rest against the trays above, thus eliminating all overhead weight from the apples.

Improvements in packaging have contributed greatly to our marketing system. But much work lies ahead in developing better packages and shipping containers. These improvements will also expand market outlets for fresh fruits.

Containerization

ARS investigators are searching for better ways of shipping fruits to consumer markets. A prototype van container—a trailer “reefer” without wheels) was developed in 1963 that features an entirely new concept in refrigeration.

The van container can be transported by railroad, flatcar, ship, or airplane. Refrigeration is zoned to permit different temperatures in different parts of the van.

Because of this compartmentalization, simultaneous shipping of several kinds of food in the same load is possible.

Containerization can bring better and lower cost handling and transport, fewer product losses, and more rapid movement. By reducing the number of handlings of individual packages, containerization cuts costs from mechanical damage and pilferage.

For fresh fruits and other perishable foods, containerization means less exposure to unfavorable tem-

perature and humidity, and less damage from excess heat or freezing.

ARS marketing researchers are working closely with shippers, processors, receivers, distributors, and retailers to achieve wider use of containerization.

Transportation

World population growth is spiraling at rates that, if unchecked, will require doubling of world food supplies by 1980 and tripling by the end of the century.

To keep pace with this growth, new developments in air transportation include planes that will do more than one kind of transport job and planes that will haul a bigger payload.

Airlines haul many millions of pounds of fresh fruits from California each year. Transit time for strawberries average about 17 hours by air from growing areas in southern California to wholesale markets in the eastern United States.

About 32 percent of this time is spent on the plane, almost 50 percent at airports, and 18 percent in trucks going to and from airports.

Truck shipments often move directly to the retail store. The direct service from point of production to retailers means a quick turnover and economies in operation. Speed also gives opportunity for delivery of perishable goods in fresh condition.

Unit trains of van containers have been suggested as a possible way to cut the cost of shipping fruits and other products that move in large volume from California, Florida, and other States to markets in the East. The unit train is a large number of railcars—100 or more—moved as a unit from origin to destination without stopping at intermediate yards along the way.

These unit trains might also travel between the East and West coasts to make the United States a bridge for containerized shipments between



USDA inspectors check fresh fruit on a refrigerated railroad car.

Europe and Japan and other countries across the Pacific.

Distribution Centers

ARS marketing and transportation specialists have guided the planning of many large food distribution centers. These centers serving large metropolitan areas may have 75 to 125 large trucks delivering to retail outlets. Trucks furnish some products with special atmospheric conditions during the trip from warehouse to retail store.

These facilities centralize a city's marketing facilities into one strategically located complex, which moves food faster at less cost.

In the past, wholesale food centers in most cities were crowded, inefficient, and unsanitary. At peak business hours, retail truckers found them almost inaccessible.

Food spoiled in these outdated markets, and food bills went up to pay for the spoilage.

ARS researchers are changing this aspect of our cities.

They have developed plans for modern, sanitary, efficient wholesale centers for many of our major cities. These modern one-story facilities took the place of many outmoded buildings scattered throughout metropolitan areas.

Better refrigeration in these centers permits additional savings by reducing spoilage, waste, and product deterioration of fruits and other foods.

Supermarkets of Tomorrow

Marketing research that has brought us from the general store to our modern supermarkets, will also take us into the market of the future.

Agricultural science will continue to develop fruit that can be harvested more easily, stand up better under handling, and look, feel, and taste better. According to Dale L. Anderson,

Transportation and Facilities Research Branch, ARS, "Varieties of tropical fruits will be greatly expanded."

"Research will result in new varieties of fruit that will be grown for the home trade. Special high-quality brands may feature products in supermarkets such as the fruit-of-the-month clubs now handle," Mr. Anderson says. He then spoke of other futuristic trends:

- We will see more ready-to-serve items such as prepared fruit salads. Improved packaging will help deliver these fresh salads to consumers in good condition.

- Environmental packages in which fruits will be held in the proper atmosphere and humidity to bring them to the consumer at peak of freshness will be more in evidence than today.

- Produce may reach the supermarket in van-sized refrigerated containers which will be dropped at the store and serve as refrigerated storage until empty.

- Production will be planned to fit sales patterns which will be closely predicted by computers.

- Customers will select produce in an atmosphere more like picking fruit from the tree. Produce departments may be sub-departmentalized into "orchard," or "tropical gardens."

ARS strives to bring the housewife and her family the finest of fresh fruits, in the most usable form, with all the built-in conveniences essential to modern life.

Research goes on at every step in the production and marketing system. The results can be seen in every American supermarket as well as in many foreign countries. ■

A Better School Lunch For Your Child

THIS year, your child's school lunch will probably contain less fat than before, and he may be served some tasty new dishes, such as Chinese pie or peanut butter cake—thanks to ARS nutrition research.

“On any schoolday, visualize 19 million children sitting along both sides of a lunchroom table that extends from Washington, D.C., to 150 miles north of Anchorage, Alaska. Then, visualize 4,750 tons of milk in half-pint cartons, and 3,300,000 pounds or 82 carloads of ground beef for hamburgers, plus 19 million buns.”

This is how Dr. Ruth M. Leverton, Assistant Deputy Administrator of ARS, describes the daily size of the School Lunch Program. Dr. Leverton is coordinator of ARS research in human nutrition, including that on school lunches.

The School Lunch Program is a basic part of the nutritional and educational programs of the Nation. It operates for about 180 days, and uses a billion dollars worth of food a year.

Dr. Leverton explains that ARS contributes to the School Lunch Program in three direct ways:

- (1) Development and revision of the Type A lunch;
- (2) Acceptance studies to increase participation; and
- (3) A continuing program of recipe development.

The “Type A” Lunch Pattern

To make the School Lunch Program work for child health, school food managers needed a framework they could use—week in, week out—to help them plan well-balanced menus. To fill this need, USDA nutritionists developed the Type A lunch.

“The goal of the meal pattern,” says Dr. Leverton, “is to provide flexibility for school lunch managers, while safeguarding the nutritional needs of the children.”

The pattern gives only general guidelines, since facilities, available funds, and tastes differ from

The School Lunch Program helps safeguard students' nutritional needs for energy and growth.



school to school and region to region. It consists of specified amounts of the following: a protein-rich food, served in a main dish or in a main dish and one other menu item; two or more vegetables or fruits, or both; whole-grain or enriched bread; butter or fortified margarine; and fluid whole milk, served as a beverage.

(A Type B pattern that consists of a sandwich and milk, and a Type C pattern—only milk—are not now in use in the School Lunch Program.)

The Type A lunch is a practical result of many years of basic nutrition research. This research—much of it done by the U.S. Department of Agriculture—has resulted in isolation and identification of many important nutrients, analysis and calculation of the amounts of these nutrients in foods, and establishment of the amounts we need for good health. The Type A lunch sets a specific nutritional goal: To provide at least one-third of the nutrients and food energy a child needs in a day, as stated in Recommended Dietary Allowances (RDA) determined by the National Academy of Sciences-National Research Council.

Dr. Leverton explains that the RDA supply a “margin of sufficiency” above the minimum requirements for good health.

Nationwide Survey

But, how do we know that the Type A pattern is still doing the job, in line with the latest research finding? To find out, ARS researchers planned and directed a nationwide survey, completed in 1967.

Says Dr. Leverton, “This study was not designed as a test of the schools’ compliance with the guidelines, but as a tool to help us see if the Type A pattern needs to be updated.”

First, the ARS research team, in cooperation with the staff in USDA’s Food and Nutrition Service that administers the school lunch funds, selected 300 schools at random from all regions of the United States to take part in the survey. They explained the study to State and district project supervisors, who trained a collector for each school.

To begin, the collector arrived at the school cafeteria in time to join a group of sixth graders in the lunch line. She selected the Type A lunch that was being served that day—for example, barbecued chicken, fluffy rice with parsley butter, buttered zucchini squash, french bread and butter, orange-raisin ambrosia, and milk. She finished going through the line, put her tray aside, and again walked to the end of the line. Altogether, she went through the line four times, selecting the Type A lunch each time.

At last, she was allowed to sit down—but not to eat! Instead, she collected all edible parts of the lunches, and discarded bones and other inedibles. She listed kinds of food in the lunch, and described how they were prepared. Then, she cut the food into small pieces, packed it in plastic bottles supplied by the research team, and returned it to the school kitchen, where it was stored in the freezer.

In order to obtain a representative sample from each school, the collectors followed this routine for 1 week in each school. Then, they packed the filled bottles in dry ice and shipped them to the testing laboratory. There, chemists analyzed the lunches for nutrients and food energy.

Revising the Pattern

On the whole, the findings in the survey confirmed the reliability of the Type A pattern as a tool for good nutrition.

Every one of the 300 schools served lunches that contained at least enough of protein and two of the B vitamins, niacin and riboflavin. The chemists did not analyze for vitamin C, but ARS nutritionists believe that the use of fruits and vegetables as required in the Type A pattern provides at least enough of this nutrient.

Nearly all of the lunches contained adequate thiamin, another B vitamin. More than 85 percent contained adequate calcium, and the rest came close to the goal of one-third of the Recommended Dietary Allowance.

"Now we come to some of the significant shortages in the lunches," says Dr. Leverton. "The first is iron. Two-thirds of the schools served lunches that did not reach the goal."

In some cases, the lunches were simply too small; many lunches that failed to meet the goal for iron also failed to provide adequate food energy. However, lack of iron also resulted from poorly planned menus. Improving the iron in these lunches is difficult, because there is no single group of foods that is rich in iron that can be incorporated into the Type A pattern for daily emphasis.

"Instead," says Dr. Leverton, "small amounts of iron are found in a wide variety of foods. Thus, to help insure an adequate amount of iron in the school lunches, several worthwhile sources need to be used daily."

About one-third of the schools served lunches that did not meet the goal for vitamin A. Although the schools whose lunches were low in this nutrient served foods that contain vitamin A about as often as the rest of the schools, the foods they used as sources were generally only fair sources, such as tomatoes, instead of the dark-green and deep-yellow vegetables and certain fruits that are rich in vitamin A.

Many of the lunches contained more than enough fat. In the lunches

from one school, 55 percent of the calories came from fat. And more than one-third of the schools served lunches with more than 40 percent of their calories from fat.

Since it is considered wise to keep the percentage of calories from fat below 40, the nutritionists have decided to lower the requirement for butter or margarine from 2 teaspoons to 1, to help keep down the percentage of fat in the lunches.

A surprising number of the lunches did not contain sufficient food energy. To provide one-third of the food energy needed by most sixth graders, a lunch should contain about 735 calories for a girl and about 800 calories for a boy. Although the average lunch contained 735 calories, several contained less than 600 calories, and a few contained less than 500.

In most cases, larger servings could remedy this shortage. Or, children could be permitted second helpings. (This is already done in many schools.) Cafeteria managers have been reminded, too, that older boys and girls need more of most foods in the Type A lunch than do younger ones.

Acceptance Studies

Making sure the school lunch ends up in the child instead of in the garbage disposal is just as important as seeing that the lunch is well-balanced in the first place. A finicky youngster who refuses fruits and vegetables may be missing important vitamins. And a child who won't drink his milk probably is not getting enough calcium.

Related to this is the problem of getting children to participate in the School Lunch Program. Even schools that serve attractive, well-balanced lunches that meet the nutritional goal often have youngsters who bring just a sandwich from home and fill up on candy and soft drinks.

The Type A lunch is designed to provide at least one-third of a child's daily food needs.



ARS scientists standardize recipes submitted by school food managers.

As Dr. Leverton expresses it, "Bringing school children and the Type A lunch together intimately is strictly a people-to-people program—and a complex one."

The child brings many experiences with him to each noon meal, including those with the hard-sell techniques of the mass media.

"The school lunch is definitely a soft-sell program," she continues, "and yet many of its customers believe that only things promoted by the sight and sound of the hard-sell technique are worthy of their attention."

But, what can be done to see that children buy the school lunch and then eat it? To help answer this question, ARS, in cooperation with the Louisiana Agricultural Experiment Station, made a survey in 1968.

Students from 17 high schools were asked what made them decide to buy the school lunch. Most students replied that the leading factors were how the food was prepared and the quality of the food. They also said the appearance of the lunchroom, how long it took to go through the cafeteria line, and the amount of time allowed for lunch affected their decision to some extent.

To find out how much and what part of the school lunches the teenagers ate, the researchers took the filled trays as the students came out of the cafeteria line, and carefully weighed the contents. Then, the students went back through the line to receive another similar lunch. After lunch, the students returned leftovers to the scientists, who listed and weighed what had not been eaten.

Not surprisingly, the boys left less food on their trays than the girls. Boys ate more of high-protein foods, and more milk, bread, and desserts, and as much of the fruits as the girls.

On the average, the girls ate more vegetables than the boys. It is im-

portant to note, however, that both the boys and the girls ate only a little more than half the vegetables and two-thirds of the fruits they had selected. Starchy vegetables were more popular than dishes that contained leafy vegetables. Tossed salad, cabbage slaw, and spinach went largely uneaten. More of fresh fruits were eaten than of canned fruits.

The protein-rich foods, usually in the main dish, were generally popular with the teenagers. Spaghetti with meat sauce, smoked sausage, and frankfurter with chili were favorites. Students left some of the meat salad, "sloppy joes," and pizza.

The researchers calculated the amounts of vitamins, minerals, and other nutrients in the lunches. They found that the lunches contained adequate nutrients for teenagers, except for food energy, which was too low for the boys. However, students were allowed to get second helpings, and this would have made up for the low food energy. If the students had eaten all the foods they took on their trays, they would have received one-third of their daily food needs.

But nearly one-half the vegetables and nearly one-third of the fruits—as well as substantial amounts of other foods—were left uneaten. Therefore, the amounts of vitamins A and C, and perhaps other nutrients, that the students actually received were drastically reduced.

According to the report of the study, "Information gained so far has reinforced the evidence that the school food service . . . is making available nutritious meals for high school students. The real problem involves getting students to eat at school and to eat what is served."

Dr. Leverton points out that the attitude of parents in encouraging their children to eat and enjoy a variety of foods is probably the real

Students taste and rate new foods from ARS-developed recipes.



solution to the problem. And parents, too, need to understand how the School Lunch Program benefits their children.

Recipe Development

To help make school lunches more attractive to students—to encourage wider participation and cleaner plates—ARS nutritionists are constantly on the lookout for appetizing, nutritious recipes that are popular with children.

An ARS food laboratory in Beltsville, Md., is responsible for the development of recipes suitable for use in school lunch kitchens. These new recipes help school food managers plan lunches that meet nutritional goals and appeal to children's tastes.

"The school lunch director needs to know the kinds of foods and the forms in which they are acceptable to children of different ages and interests," says Dr. Leverton.

Sometimes, ARS-developed recipes include as ingredients some of the newer forms of familiar favorites, such as instant mashed potato flakes or frozen fruit juice concentrates. And, the new recipes often utilize surplus commodities that USDA donates to the School Lunch Program.

School food service has come a long way since the early 1900's, when Federal and State Extension workers helped set up school lunch programs in rural areas. A widely used arrangement in those days was for all the children in a classroom to contribute food for one hot dish each day. Usually, the dish was prepared by the teacher and was intended to supplement a cold lunch brought from home. This procedure called for much ingenuity on the part of the teacher, and obviously, the quality of the results varied from day to day.

Recipe experimentation still goes on in the modern, stainless steel kitchens of today's school food service. In this way, the ideas for new recipes often come from the schools themselves. ARS food specialists at Beltsville, Md., study recipes submitted by schools. To be accepted for further testing, a recipe must contribute to the Type A lunch pattern, and be easy, fast, and economical to prepare in large quantities.

ARS scientists translate the amounts of ingredients in these recipes into exact measurements of tablespoons, cups, ounces, and pounds, and compute the amounts needed for 100 servings.

The next step is testing by a consumer panel. The panel is made up of laymen—usually USDA employees in other disciplines—who rate the dish for taste, texture, appearance, and overall acceptability.

If the panel gives it a good overall rating, the recipe is tested in school cafeterias. The cafeteria manager serves the dish at least three times, and records how much of the food the children ate.

In 1965, each State School Lunch Director was asked to submit several school lunch recipes that were favorites with children. Recipes came in from all parts of the United States—for example, Chinese pie (a ground beef and mashed potato casserole) from New Hampshire, caramel peanut-butter rolls from Wisconsin, and tomato spoon salad from New Mexico.

After the recipes were standardized by ARS scientists, the foods were taste-tested by a consumer panel. In February 1967, nine of the recipes that scored high were chosen to be tested at schools in selected States throughout the country.

Students were asked to rate the new foods "excellent," "very good," "good," "fair," or "poor." Results were tabulated and reported in 1968.

Leading the popularity parade were peanut-butter cake, caramel peanut-butter rolls, country fried steak, cornmeal cookies, cornmeal yeast rolls, and Chinese pie. Most of the children rated these recipes "excellent," "very good," or "good." The other three—carrot relish (raw cabbage, carrots, green peppers, and onions), corn mock-shue (corn, tomatoes, chopped onions, and green peppers), and tomato spoon salad (canned tomatoes, chopped onions, and green peppers)—were rated "fair" or "poor" by most children.

The survey pointed up that, nationwide, children's preferences are remarkably similar. In general, children from all parts of the country liked the same recipes and disliked the same recipes.

Interestingly, even the recipes most children rated "fair" or "poor" were rated very high by the consumer panel of adults. This emphasizes the importance of testing new recipes on young taste buds instead of relying entirely on an adult panel.

New Directions

The Child Nutrition Act of 1966 permits USDA to help support school breakfast and dinner programs.

The School Breakfast Program has come about largely as a result of increased public concern for the nutrition of children from low-income families. ARS has established a pattern for the school breakfast: At a minimum, the school must provide milk, fruit (or fruit or vegetable juice), and bread or cereal; and, if possible, a protein dish should be included. This pattern may be modified after the School Breakfast Program is adopted by more and more schools.

A school dinner program is not yet underway. If it comes into being, the pattern will be the same as that for the Type A lunch.

In 1968, Congress passed legisla-

tion to provide Federal assistance for child-care centers, settlement houses, and certain other institutions. These programs would help feed young children and perhaps provide year-round group feeding programs for all needy children of high school age and younger.

A special committee of nutrition and health experts has recommended that USDA give special attention to the nutritional requirements of needy children. In 1969, the committee suggested that the School Breakfast Program be expanded to all schools that now offer the school lunch. They also recommended that larger portions be served needy children. In this way, the lunch could provide as much as one-half of the children's food needs for a day, to make up for possible inadequacies at home.

Looking forward to this increase in institutional feeding, Dr. Leverton foresees that the School Lunch Program will come to play an even greater role in child nutrition.

"Its value has been amply demonstrated during these first 20 years," she says of the program. "Its potential is as great for the next 20 years for helping to—

"Close the nutrition gap between food available at home and total food needs, thus meeting current nutritional needs for the child's growth and development;

"Shore up some nutritive reserves for the child's future growth, development, and well-being;

"Establish good eating habits through repeated experience with desirable practice;

"Reach parents with aids for maintaining nutritional health of their children; and

"Acquaint teaching staff with the value of encouraging children to eat and enjoy a variety of good foods." ■

New Foods For a Hungry World

A variety of new foods have been developed by the Agricultural Research Service to help feed a hungry world. Many of these are high-protein processed foods—child food supplements and improved oilseed flours, for example.

At the same time, plant geneticists are developing higher protein varieties of corn, wheat, and sorghum that are adapted to areas of the world that are short in food protein.

“But protein is not the only nutrient the hungry world needs,” says Dr. Frederic R. Senti, Deputy Administrator of ARS for Marketing and Nutrition Research. “Calories from starch, sugar, fats, and oils are also needed. So are many of the vitamins and minerals.”

ARS has concentrated on meeting protein needs. Most of the world population relies on cereals as a major source of protein. For example, cereal

gruels are basic foods for infants and children in less developed countries. But milk is in short supply in these countries, and cereal gruels without milk are too low in protein content and quality to meet the requirements of growing children.

Recently, new foods have been developed that are designed to supply all required nutrients. These are the formulated, or blended, foods that are made by mixing several ingredients. The blended foods are intended as dietary supplements and not as a sole or complete source of nourishment.

“Inclusion of these foods in the donation program overseas was in recognition of the needs of specific population groups that were not being adequately met by existing food programs,” affirms Dr. Senti. “Chief among these were the needs of children, pregnant women, and lactating mothers in the developing nations.”

Child Food Supplements

One of the new blended foods developed by ARS scientists in cooperation with industry is a child food supplement called Wheat-Soy Blend (WSB). WSB is made of approximately 74 percent wheat flour that contains wheat protein concentrate, 24 percent soy flour, and 2 percent vitamins and minerals. The new blend has been sent to several developing countries for acceptance testing.

Wheat protein concentrate, a principal ingredient of the new food, originates from byproducts of the milling industry. Some 5 million tons of wheat milling byproducts are produced in the United States each year. They contain an estimated 800,000 tons of good-quality protein.

Although some of these byproducts go into the production of breakfast cereals, they are used mainly as a source of low-cost feed for livestock. Unrefined, they usually are too fibrous and dark colored to be attractive as human food. Wheat protein concentrate, however, has acceptable texture and color. The fine-grinding and sifting techniques used to extract the protein concentrate were developed by ARS scientists in cooperation with the milling industry.

All the blended foods are relatively low in cost. One of them, CSM, costs the government less than 8 cents a pound. By September 1969, more than a billion pounds had been shipped abroad and distributed in more than 100 developing countries. Corn, soybean, and milk products are the main ingredients of CSM.

Three and one-half ounces of CSM daily give one-half or more of all the known nutrients and one-third of the calories required by a 1- to 3-year-old child. Other foods in the diet are expected to provide

a substantial part of the remainder of the needed nutrients.

In areas in Biafra where CSM has been fed, a dreaded protein-deficiency disease called kwashiorkor has nearly disappeared among children. Children with bloated stomachs, gray skin, and reddish hair—the symptoms of kwashiorkor—were seen in large numbers in the past.

Where CSM has been fed in India, night blindness has been reduced. Night blindness is a symptom of vitamin A deficiency, and vitamin A is one of the nutrients supplied by CSM. After eating CSM for a short time, children were able to see in the dark for the first time in their lives.

"CSM is served in a variety of ways in developing countries," Dr. Senti says. "It can be made into soup, beverage, gruel, bread, or pudding."

Efforts continue to develop modifications of CSM. For example, a form has been developed that disperses in hot water to form a smooth, nonsettling beverage. Research has been completed on the stability of the blend as it relates to moisture content and temperature. Stability is very important to the preservation of the product during storage and distribution and to the flavor and texture of the product when it is eaten.

"Besides developing the specifications for CSM, ARS scientists worked with industry to develop methods of cooking cornmeal for CSM," Dr. Senti adds.

Corn is the principal ingredient in CSM, but wheat is the chief cereal component in the new blend, WSB. WSB and CSM are similar in content of protein, amino acid, and fat.

Since wheat and corn are widely grown around the world, ARS scientists hope that the formulas for WSB and CSM will be copied by countries that will eventually be able to make their own food blends

from wheat and corn grown on their own land. The scientists hope these foods can be produced by techniques within the economic and technological capabilities of the developing countries.

Two other new blended foods for infants have been developed under ARS grants to Israel. One is a flour made by mixing soy protein and bananas. It can be prepared as a beverage. The other is a mixture of ground chick peas, sesame flour, and low-fat soybean flour. It can be prepared as a gruel.

Soybean flour is an important ingredient in many foods used in a hungry world. Dr. Senti points out that ARS scientists developed a simple process for the preparation of soy flour, which makes it possible for villagers to prepare flour locally from soybeans with inexpensive, hand-operated equipment.



Protein-Fortified Wheat Flour

Another new food is a high-protein flour made by mixing 70-percent ordinary wheat flour and 30-percent wheat protein concentrate extracted from wheat milling byproducts.

The flour-concentrate mixture is known as Protein-Fortified Wheat Flour, Blend A. By the end of 1969, several million pounds of the flour had been prepared for distribution to India and Iran. This is the first large-scale commercial use of the concentrate, which is obtained by regrinding and sifting the coarse byproducts.

The flour-concentrate mixture contains about 25 to 30 percent more protein than regular wheat flour. Moreover, the protein in the mixture has more food value than the protein in ordinary wheat flour because of its higher lysine content. The wheat protein concentrate also is rich in



Villagers in developing nations use the "village process" to make soybean flour.

A scientist inspects a culture of mold used in making tempeh. The mold seems to increase resistance to disease.



A 3-year-old youngster makes his own evaluation of tempeh as a food.

niacin, thiamin, riboflavin, and iron. Calcium and vitamin A are added to the flour-concentrate mixture.

The addition of vitamin A to new cereal-based foods for hungry people became possible with the development of a beadlet form of the vitamin. Ordinarily, vitamin A is an oily liquid that is unstable when moisture is present. ARS scientists cooperated with industry in developing the beadlet form that is stable at moisture levels found in flour and cornmeal.

"All the flour and cornmeal foods used in the overseas donation program are enriched with vitamin A, calcium, niacin, thiamin, riboflavin, and iron," Dr. Senti adds.

Cottonseed Flour

In yet another approach to better foods for a hungry world, ARS scientists have developed a process called the liquid-cyclone process (LCP). It improves the nutritional value of cottonseed flour. The process could play a major role in increasing the food supply in those developing countries that grow cotton.

Cottonseed flour prepared by conventional methods contains a green pigment called gossypol. Gossypol gives the flour an undesirable color and lowers its food value. This pigment has been largely removed from LCP flour.

To make LCP flour, specially ground cottonseed meal is put in a thin mixture, or slurry, with an organic solvent and run under pressure into a cone-shaped device called a liquid cyclone. Spinning the liquid throws the coarse meal particles outward and downward to be drawn off the bottom. The fine particles are forced to the center and upward to be drawn off the top.

The larger particles include the gossypol and are low in protein. They are used in some animal feeds.

The smaller particles contain 65 to 70 percent protein and are relatively free of gossypol. These particles are finely ground into edible flour.

"The liquid-cyclone process has been set up on a pilot-plant scale for operation in India," Dr. Senti explains. "Much cottonseed is produced in India but heretofore none has been processed for human consumption."

LCP flour has a bland flavor and a light creamy color. Up to 25 percent of it can be added to wheat bread mixtures. When LCP flour is added, the bread contains about 20 percent protein, or about double the protein in regular wheat bread. LCP flour also can be used to make beverages, gruels, and other foods.

Numerous experiments indicate that each 100 tons of cottonseed should yield about 18 tons of high-quality, edible flour. Thus, the United States could produce about 2 million tons of the flour annually and the rest of the world could produce another 6 million tons.

Tempeh

Tempeh is a fermented soybean food popular in the Orient. In studies aimed at making it a more versatile food in combatting world hunger, ARS scientists developed simple and uniform processes for making tempeh from wheat and rice as well as from soybeans. Combinations of these grains and soybeans are also used.

Modern methods of producing tempeh have made it a more palatable food. The old method of making tempeh in the Orient consisted of wrapping the soybeans in banana leaves. But in the new method, perforated cellophane bags or trays are used. When tempeh is made by modern methods, it loses its undesirable beany flavor.

ARS scientists also have discovered that tempeh contains compounds that inhibit the growth of some bacteria. The mold used in fermenting the soybeans to make the tempeh produces the antibacterial compounds.

These compounds may stimulate growth and increase disease resistance in humans as do many antibiotics fed in small proportions. Antibacterial compounds extracted from tempeh and from the tempeh mold growing on skim milk or soybean meal were tested by ARS scientists against 25 species of bacteria. Eleven species were affected by the compounds and nine species stopped growing completely. Four species of bacteria inhibited by the antibacterial compounds are often found in the human intestinal tract.

Cheese Whey Beverages

ARS scientists have used cheese whey to develop two new beverages. One drink contains whey and soy flour with citrus flavoring. The other combines whey and cream with

chocolate or fruit flavoring. Whey is a low-cost, highly nutritious by-product of cheese manufacture.

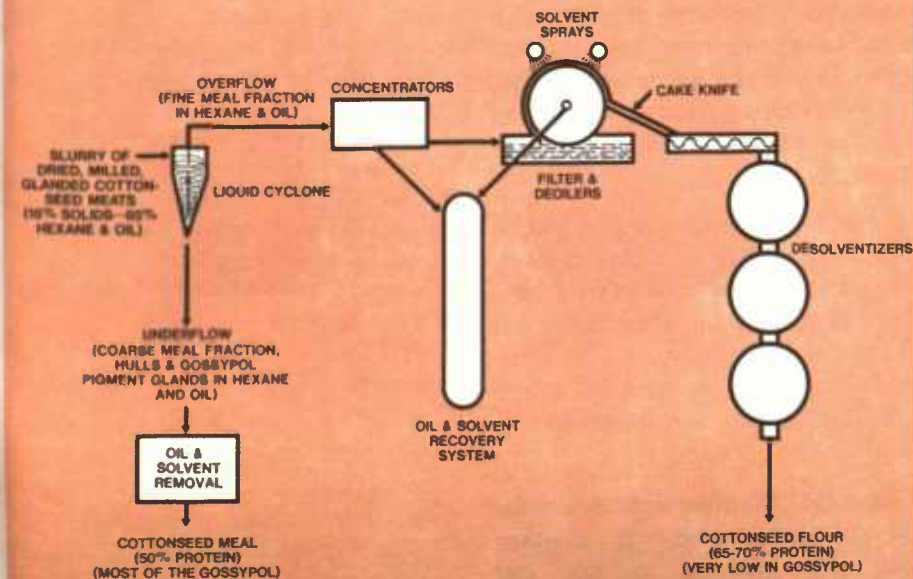
The citrus-flavored whey-soy drink can be made either as a liquid concentrate or as a powder. The whey-cream beverage is made as a sterilized concentrate that can be diluted with water for drinking.

Because of its high food value and moderate cost, ARS scientists hope the whey-soy drink will find a place in improving the diet of the people in the developing countries.

The whey-soy drink can be made from the highly acid whey of cottage cheese as well as from the sweet whey of cheddar cheese. To make this drink, soy flour is added to the whey as it comes from the cheese vat. The flour and whey are homogenized to increase dispersion of the soy flour and then are heated under vacuum to remove volatile substances and improve flavor. A stabilizer is added to the mixture to prevent the soy protein from settling out.

LIQUID CYCLONE PROCESS

DIVIDES COTTONSEED INTO FLOUR FOR FOOD AND MEAL FOR FEED



The liquid-cyclone process (LCP) divides cottonseed into flour for human food and meal for animal feed.

ARS scientists believe that whey can become a valuable addition to the aid program in developing countries. Dr. Senti reports that more than a billion pounds of cheese whey solids are discarded in the United States each year. This creates a serious waste disposal problem.

Better Flavored Sufu

In another development, a long-time popular food in the Far East has been improved. The Chinese have been making a soybean cheese called sufu for centuries, but it took modern day scientists to develop a surefire method of producing good sufu with no undesirable off-flavors.

The research—part of a continuing program to find better ways to use soybeans in meeting world food shortages—was conducted under an ARS grant to Taiwan. Soybeans are becoming more widely grown and new varieties are being adapted to various countries. Both sufu and tempeh are important soybean foods.

The key to making sufu without a beany flavor is to ferment it with a pure culture of the fungus *Actinomyces elegans*. The scientists found that acceptable Western flavors can easily be incorporated into the soy cheese during the last manufacturing step—the brining process—by adding essences such as garlic, wine, or pepper.

Sufu is made from a soybean curd called tofu, which is widely used in the Orient in soups and other foods. The tofu is cut into cubes, immersed in an acid-saline solution, and sterilized. The cubes are then inoculated with the fungus and incubated at 68° F. for 2 to 3 days.

Then the cubes are aged in a solution containing table salt or other agent that prevents spoilage and

halts mold growth. Sufu, the final product, is soft, pale yellow, and has a pleasant taste and aroma.

Research Continues

Many of the foods popular in a hungry world have been improved by enriching them with proteins, vitamins, and other nutrients. Today, ARS scientists continue trying to determine which nutrients the body needs, in what amounts, and which foods supply them.

Work is being done to obtain more knowledge about the requirements for amino acids, vitamins, minerals, and other nutrients by various age groups. We also need to know more about how our bodies handle fats and carbohydrates. ARS scientists are working to solve these and other nutrition problems because good nutrition is a lifeline to sound physical, emotional, and mental health. ■

More Information on Foods and Nutrition

The USDA publications listed here offer a wide range of consumer information on foods and nutrition. They include research-based facts on nutrition and weight control, guidelines for food selection and meal planning, tips on food management, menu suggestions, and a choice of recipes.

Single copies of these publications—prepared by the Agricultural Research Service—can be obtained free from your county extension agent or by writing to the Office of Information, U.S. Department of Agriculture, Washington, D.C. 20250. Send your request on a post card and include your ZIP code.

Family Fare—A Guide to Good Nutrition.....	G 1
Nutrition—Food At Work For You.....	GS 1
Eat A Good Breakfast To Start A Good Day.....	L 268
Food For Fitness—A Daily Food Guide.....	L 424
Food For Families With Young Children.....	G 5
Home Canning of Fruits and Vegetables.....	G 8
Home Freezing of Fruits and Vegetables.....	G 10
Food Guide For Older Folks.....	G 17
Money-Saving Main Dishes.....	G 43
Potatoes in Popular Ways.....	G 55
Home Care of Purchased Frozen Foods.....	G 69
Home Freezing of Poultry.....	G 70
Nutritive Value of Foods.....	G 72
Food and Your Weight.....	G 74
Storing Perishable Foods in the Home.....	G 78
Food for the Young Couple.....	G 85
Conserving the Nutritive Values in Foods.....	G 90
Freezing Meat and Fish in the Home.....	G 93
Family Food Budgeting—for good meals and good nutrition.....	G 94
Eggs in Family Meals—A Guide for Consumers.....	G 103
Vegetables in Family Meals—A Guide for Consumers.....	G 105
Home Canning of Meat and Poultry.....	G 106
Poultry in Family Meals—A Guide for Consumers.....	G 110
Cheese in Family Meals—A Guide for Consumers.....	G 112
Beef and Veal in Family Meals—A Guide for Consumers.....	G 118
Lamb in Family Meals—A Guide for Consumers.....	G 124
Fruits in Family Meals—A Guide for Consumers.....	G 125
Milk in Family Meals—A Guide for Consumers.....	G 127
Baking for People With Food Allergies.....	G 147
Cereals and Pasta in Family Meals—A Guide for Consumers.....	G 150
Calories and Weight—A USDA Pocket Guide.....	G 153
Pork in Family Meals—A Guide for Consumers.....	G 160
Apples in Appealing Ways.....	G 161
Keeping Food Safe To Eat.....	G 162