

## Nutrition and Food Commodities in the 20th Century

SHARON A. MARTINI\*<sup>†</sup> AND MARSHALL PHILLIPS<sup>†,§</sup>

<sup>†</sup>Journal of Agricultural and Food Chemistry, P.O. Box 625, Concordville, Pennsylvania 19331-0625, and

<sup>§</sup>Strategic Bioconnections, 6 Rebecca's Lane, Thornton, Pennsylvania 19373

Nutrition in the 20th century is examined with respect to changes in the American diet due to changes in the economy and evolution from an agrarian to an industrialized society. The American farm family diet from two regions of the United States during the 1930s is studied on the basis of overall availability of food commodities. A discussion of the diet staples and differences in farm family health is presented and related to nutritional deficiencies. Beginning in the 1920s through the early 1930s dietary deficiencies became a major focus of public health officials in the United States. Identification of the cause of these human nutritional deficiencies prompted significant research by government agencies such as the U.S. Department of Agriculture, Food and Drug Administration, and National Institutes of Health. Medical schools, universities, pharmaceutical corporations, and private institutions directed their resources into basic chemical research and clinical trials to assess the role of vitamins, minerals, proteins, lipids, carbohydrates, and nutrients for improving human health and nutrition. Chemists played an important role in the discovery of vitamins, minerals, and essential nutrients, validating the efficacy through tedious clinical trials. They developed synthetic vitamins affording food manufacturers and pharmaceutical companies the opportunity to capitalize upon fortifying foods for consumers. The American chemist was also responsible for the development of commodities to maximize crop yield through pesticides and fertilizers.

**KEYWORDS:** Nutrition; commodities; health; history; economy; Great Depression

### INTRODUCTION

The beginning of the 20th century was met with a revolution in the United States' transition from an agrarian to an industrialized society. It is important to understand the American diet as agricultural evolution changed eating habits. We must revisit past nutritional history and recognize the direction of modern nutrition as a result of the Great Depression. We will examine the effects of poor nutritional habits necessitating government intervention by constructing federal educational, research, and aid programs, the emergence of food companies, private research, and the changes that evolved. This will involve the role of chemical science in nutrition and nutritionists as well.

We begin with a brief personal memoir of life as it was having been raised on a farm, with first-hand experience of the agricultural cycle as was typical of many American farms. To a Nebraska farmer during the Great Depression, an only child was expected to give 110% effort to complete the daily chores. A typical farm had some beef cattle, several dairy cows, pigs, sheep, chickens and a team of horses. The first order of business each morning was milking the cows, feeding the livestock, collecting the eggs, and cleaning the barn of animal waste: all before noon. In the spring, the fields were tilled and planted with wheat or corn. We also planted a vegetable garden with tomatoes, beans, peas, peppers, squash, carrots, lettuce, radishes, potatoes, and onions. During the summers, we cut hay in the early afternoon and the

following day we would rake the hay and bale it in the late afternoon. We were lucky to have a tractor and other modern farm implements. We would milk again in the evening, eat our evening meal of meat, potatoes, vegetables, and fruits, and then go back out to the barn to finish our chores. It was imperative to grow as much hay and grain as needed to sustain one's own livestock. Early summer afternoons were spent cultivating the vegetable garden, mending fences, and farm equipment. Autumn days were spent on a ladder in the orchard picking apples, pruning the trees, digging up potatoes, or helping with the butchering. Vegetables and fruits were canned and stored in the root cellar for use during the winter months. There was not much time for play; our outlet was to attend a 4-H club meeting once a month on a winter night to learn agricultural technology or plan livestock production projects, or occasionally we attended a seasonal tureen supper at the Grange Hall for farm families. The big event each summer was the County Fair, where we exhibited our 4-H livestock projects, hopefully earning cash prizes. Sometimes as recreation, my dad and I would fish in the Missouri River for catfish and my mother would fry them for dinner. We all went to town to market on Saturdays with a strict budget to buy flour, sugar, coffee, citrus fruits, and sometimes a candy bar or chewing gum. We consumed the commodities that we produced on our farm providing surreptitiously essential nutrition. Thus we prevailed.

Not all farm families lived as well. The farms of the American South typically kept only a pig and some poultry; dairy cattle and forage crops were scarce. The southern farm family might have

\*Corresponding author [telephone (610) 361-1053; e-mail samartini@comcast.net or jagfoodchem@comcast.net].

subsisted upon grits, biscuits, gravy, pork, poultry, collard greens, rice, peaches, and sugar cane products. Many of these farmers were sharecroppers who relied upon cotton and tobacco commodities, which did not contribute to the family nutritional needs with wholesome food products. Poverty, due to the poor economy, blocked acquisition of essential commodities. Lack of cold storage prevented consumption of dairy staples. Farms in the southeastern United States had other issues with which to cope such as floods, droughts, and insect infestations resulting in complete crop failure; however, the warmer climate extended the growing season. The Dust Bowl of the 1930s spread across the Southeast and into the southern Midwest, rendering the prairies desert wastelands.

I remember listening to the radio when Franklin D. Roosevelt (FDR) proclaimed in his Second Inaugural address: "I see one third of the nation is ill-housed, ill-clothed and ill-nourished" (1). This statement would eventually propel the United States into a nutritional revolution.

Many of our farm neighbors began to vanish and sell or completely abandon their farms as farming was no longer a viable means to support a family. Farmers were forced to seek employment in the cities in industries such as steel or textile mills and as laborers in manufacturing jobs (2). Others found themselves migrating to work in coal mines to support their growing families. Some leased their lands to wealthy landowners and took day labor positions in towns.

The Great Depression of the 1930s left many urban families waiting in bread lines while farm families felt the pinch of falling commodity prices by as much as 40–60% (3, 4). Some family farms maintained their ability to produce adequate amounts of staple foods to sustain their own families and a slight surplus to trade with their rural neighbors. Many Americans, including Native Americans, Mexican Americans, and African Americans, were deeply affected by the Great Depression. The unemployment rate was nearly 25% at the low point of the Great Depression (5).

Children who were deprived of milk, calcium, and vitamin D contracted rickets. Lack of citrus fruits containing vitamin C gave way to scurvy. The scarcity of whole grains and essential oils led to poor immunity and then to infection. The lack of lean meats containing amino acids and B vitamins led to growth issues in children and other diseases such as pellagra and beriberi (6). These diseases were poorly understood.

## ECONOMIC IMPACT

The high unemployment rate and disintegration of nuclear families necessitated women finding work as domestic servants, rendering them unavailable to prepare properly balanced meals for their families. Food conglomerates noted this need for prepared foods and capitalized upon the idea.

Immigration from western European countries such as Germany, Italy, France, and Poland was driven by economic factors affecting the people in their homelands. In the early 20th century, the demand for unskilled labor in manufacturing in the United States brought the immigrants to settle in the urban centers. At the turn of the 20th century, the American farm began to incorporate mechanization into the daily chores; therefore less manual labor was required. Machinery such as steam tractors pulled implements to work the soil and harvest the crops. The self-propelled combine, an implement used to harvest cereal grains and corn, was introduced in about 1944 and became the standard implement on the vast farms of the Midwest (7). Those previously employed as farm laborers found themselves seeking employment elsewhere.

After the 1929 stock market crash, loans were not readily unavailable for farmers to buy seeds, fertilizer, pesticides, fuel, farm equipment, and other necessary supplies to sustain their daily agricultural practices. Some farmers were share-croppers or simply leased the land, so when capital was scarce, they were forced to leave the farms to find a steady means to support their families. After moving to urban centers, families quickly spent the cash money paid to them as they sold their farms and possessions. They found housing rental fees much higher in cities, and with the necessity to purchase all foods, many families were forced to accept public welfare or charitable assistance. Meat was very expensive. Shortly after his first inauguration, FDR called a special session of Congress in 1933; one of the first pieces of legislation to be passed was the Agricultural Adjustment Act (AAA), which established the concept of supply and demand "parity" to help stabilize commodity prices and give farmers more purchasing power (8). Farmers were paid by the government to refrain from producing crops to control the surplus supply of commodities such as rice, corn, wheat, peanuts, tobacco, cotton, and milk. In 1938, the AAA was amended to include the federally funded crop insurance program (9). These basic policies remain in effect today.

The tillable land that had been cleared years before could now be used more efficiently and the crop yield maximized as a result of chemical research on fertilizers, pesticides, and soil analysis. Addition of technology such as irrigation promoted crop growth on land that could not be used before. Commercial rail transportation and improved roads allowed farmers to quickly ship their products to markets in distant cities. The Rural Electrification Act of 1936 sought to build electric infrastructure to power farm homes, barns, and machinery (10).

Agribusiness developed as a profitable venture for farmers who prevailed in keeping their farms viable by means of either previously accumulated wealth or introduction of desperately needed new ideas in agricultural technology. These farmers many times assumed the risk that their farming efforts would fail, and some never got ahead while others prospered. Some realized that developing businesses that supported agriculture in services such as seed, fertilizer, and equipment dealerships were an alternative means of staying involved in agriculture. According to the 2002 Farm Census, nearly 2 million farms are still owned by families or individuals; this is down from 10 million in 1910 (11).

## FEDERAL INTEREST IN NUTRITION

The U.S. Department of Agriculture (USDA) had long been established before FDR uttered these profound words proclaiming that malnutrition was prevalent in this country; President Abraham Lincoln signed the Agricultural Act in 1862 (12). In the 1890s, the necessity for food laboratories became apparent due to the ambition of Wilbur Olin Atwater. His insight elucidated the need for understanding nutritional science, and he eventually received federal support. He fostered the education of Americans in basic nutrition by speaking to church gatherings, business organizations, and the general public at the Chicago World's Fair in 1893 with a food analysis show performed by a group of chemists (13). Dietary standards were introduced by Dr. Hazel K. Stiebeling and her associates at the USDA as "dietary allowances" during the Great Depression (14). The USDA research laboratories were established in 1942 to ensure the quality of meat products (15).

By the 1950s, crop agriculture had evolved, producing corn, wheat, oats, barley, rye, and soybeans. Cattle, pigs, sheep, and poultry were fed with the least expensive feedstuffs without knowledge of proper animal nutrition. Marketing of commodities

was driven by a concern that commodity-derived foods should be available to consumers at a reasonable price. The commodity producers were subject to the vagary of the markets and many uncontrollable circumstances. These farmers banded together to form collective bargaining trade groups. The USDA set regulations for commodities to support the growers and protect consumers. Commodities took a prominent position in politics as elected officials scrambled to protect the interest of constituent farmers.

## RESEARCH, EDUCATION, AND NUTRITION

We have witnessed nutritional issues in the United States beginning with its colonization in the 17th century with the first generation of children born here. In 1770, a French scientist, Antoine Lavoisier, discovered the mechanism of metabolism by which oxidation produces body heat, and he became known as the "Father of Nutrition and Chemistry" for his work (16). The word "nutrient" derives from the Latin word *nutrire*, meaning to "nourish or provide with the food or other substances necessary for growth and health" (17). Casimir Funk invented a term for those nutrients that were essential to life from the words "vital" and "amine"; hence, the term vitamin was coined in 1912. His research also elucidated the root causes of some vitamin deficiency diseases. For example, his studies on beriberi attributed the disease to a vitamin B deficiency (18). The occurrence of rickets became noticeably more prevalent in children as families moved to the cities and children spent less time outdoors with less exposure to sunlight, which eventually became attributed to a vitamin D deficiency (19).

Between 1912 and 1937, vitamins A, B, C, D, and E were discovered, and artificial syntheses for some of these vitamins were developed by chemists (20). In 1929 the Nobel Prize in Medicine was awarded to Professor Frederick G. Hopkins and Professor Christian Eijkman, who were instrumental in exposing the importance of vitamins in nutrition (6). Many other Nobel Prizes in physiology, medicine, and chemistry were awarded to scientists worldwide for their specific discoveries and research related to vitamins and health.

One of the pioneers in nutrition education is E. V. McCollum, who is credited for the discovery of vitamin A. During the period between 1906 and the 1920s, McCollum and his colleagues relentlessly examined the proximate composition of major commodities such as beans, wheat, and corn for their effects on nutritionally related diseases, such as rickets and pellagra. Their basic work in ration design excluding one particular amino acid per experiment to discover the effects upon health eventually revealed the essential amino acids and their function in the prevention of disease. For nearly 60 years, Dr. McCollum made significant contributions to biochemical nutritional studies, developing methods for the fractionation of amino acids from hydrolysates (21). In 1950, the Edman degradation method for sequencing amino acids in peptide chains became a valuable tool for chemists to study proteins (22). Today, modern proteomics is paving the way toward understanding protein function and synthesis.

To effectively analyze foods for their nutritional value, chemists were faced with developing new separation methods. During the 1960s, many advanced instrumental methods were developed to analyze and determine complex food components such as amino acids by gas chromatography (GC) (23) and trace minerals by flame atomic absorption spectrometry. The 1970s brought development of high-pressure liquid chromatography (HPLC) methods for better separation and faster elution of compounds that were previously difficult to separate by earlier

chromatographic methods. Capillary columns for GC also made their debut in the 1970s, reducing the required sample size and increasing the separation capacity.

Then in the 1980s, automation and computers made light work of running samples, integrating data, and generating reports. Also with advances in electronics, various detectors were developed promising lower detection limits.

These instrumental methods became standards for chemical analysis in nutritional value, food safety, and toxicology, such as the analysis of pharmaceutical or pesticide residues in food.

Methods for the purification, isolation, identification, and characterization of proteins became important for the future of nutritional chemistry. The study of lipid and carbohydrate structure was essential to understanding nutrition. Biochemistry was at the forefront of metabolic study via food and nutrients, defining the nutritional value of food and feed stocks.

A dedicated platform became necessary as a repository for all of the specialized research generated. The American Chemical Society fostered dissemination of information by launching the *Journal of Agricultural and Food Chemistry* in 1953 to support the research efforts of its members of the Agricultural and Food Division.

Chemists played a major role in the development of more profitable commodities in terms of maximizing crop yield. Chemical fertilizers have been known for centuries, but the first synthetic fixed-nitrogen fertilizer was produced in 1903, and the process efficiency was refined in the 1930s (24). The 1940s brought the development of specialty formulations of chemical fertilizers as a result of soil analysis. In the 1940s, during the war years, pesticides were synthesized to control crop invasion by insects, fungi, weeds, and rodents (25).

The abundance of food in the United States was now adequate with these contributions. The U.S. government sought to provide guidance to Americans for proper nutrition. During World War II, the Recommended Dietary Allowance was introduced as a guideline for optimal nutrition (26). In 1946, the National School Lunch Act was established as a result of the noticeable number of World War II draftees who failed the preinduction physical examination due to malnutrition (27). The general population began to perceive these guidelines with the commercial advertisements announced on the radio and later on television.

The push toward better American nutrition was driven by government agencies such as the U.S. Food and Drug Administration (FDA), U.S. Department of Agriculture, nonprofit public health organizations, legislative bodies such as the Senate and House of Representatives, the Executive Branches, activist organizations, and consumers themselves. In response to this, the food companies, nutritionists, commodities brokers, agricultural lobbyists, and more activists saw fit to seize this opportunity to capitalize on the nutrition movement, which was essential to public health. The media played a crucial role in getting the message to the American people. The science of nutrition burgeoned, especially in areas with access to the media. But malnutrition had been difficult to remedy even into the 1960s in poor areas such as parts of Mississippi and Appalachia due to isolation, variable climate, long-established eating habits, and various physical demands of the afflicted (28).

Public education regarding proper nutrition became a topic in elementary school science and health classes. The importance of a good breakfast was accentuated in schools with posters and on television commercials during the 1950s and 1960s. Home economics for young women became a popular and required course in American public education. Some young women became interested in higher education in home economics as career dietitians and nutritionists; these programs were facilitated by

the Cooperative Extension Service of the USDA, which became established in some state-owned universities (29). Dental health was emphasized by offering fluoride tablets to rural school children whose home water was supplied by wells or springs.

The early study of milk chemistry fostered the understanding of infant and childhood nutrition. Milk production increased with the introduction of antibiotics, hormones, and optimized feedstuffs. The pasteurization and homogenization processes bolstered the shelf life of milk. Advances in flow cytometry for sperm sorting have allowed gender preselection for production of female dairy animals (30, 31). Beef, poultry, and pork production benefitted from nutritional studies as well. Animal science and veterinary medicine became much more widely studied and funded at leading universities (32). Agronomy, horticulture, and animal science and production were popular majors for first-generation, college-bound American farm children who decided to continue their agricultural education at the states' land-grant colleges. Additional course work in business management, economics, and accounting bolstered the future farmers' business acumen. Bringing these ideas home to the farm for practical application aided in the agricultural development that we have witnessed over the past 60 years.

In 1963, the Codex Alimentarius Commission was established by the Food and Agriculture Organization of the United Nations (FAO) and World Health Organization (WHO) to regulate standards for foods to protect public health and set fair trade customs in the industry (33).

The original graphic food pyramid was introduced in 1992 and was modified in 2005 with advances in the study of personalized nutrition and diet, based on age and activity level (34). In 1992, the majority of packaged foods were required to bear a nutritional information label (35). The label was designed to reveal the nutritional net worth of a food product with regard to the number of calories, carbohydrates, protein, fat, fiber, and trace nutrients, such as sodium, on the basis of a measured serving size. Additional labeling to reveal the ingredient composition of the prepared food was required, in order of abundance. Newer standards were introduced in 2004 requiring that food manufacturers now list potential allergen contents such as peanuts, tree nuts, wheat, cow's milk, fish, crustacean shellfish, soybeans, and eggs (35). Food companies tout beneficial properties of their products by banner labeling with statements such as "contains antioxidants, folic acid, or fiber". Consumers now question the use of artificial preservatives, and food companies have been forced to reinvent alternative means of food preservation such as with natural antioxidants and complex packaging techniques. Much research has been presented with respect to food preservation.

We now must cope with obesity as one of the major causes of disease such as diabetes, cancer, and atherosclerosis. An entire multibillion dollar industry of weight management has emerged and entranced a modern society with an obsession for fitness. Many food manufacturers have opted to reformulate their recipes to exclude *trans*-fats, which have been linked to atherosclerosis and heart disease. Even some health insurance companies offer their subscribers discounts for health club memberships and medical weight management programs. Holistic nutrition has attracted a subset of Americans who subscribe to macrobiotic, "organic", vegetarian, or even vegan diets. The advent of television to the airwaves has served as an invaluable education tool for the global consumer, as has the Internet more recently. The world of nutraceuticals and dietary supplements has affected the American diet as consumers are bombarded by information in magazines and on television convincingly touting the benefits of these products.

## COMMERCIAL FOOD PRODUCTION

The world population has relied upon commercial bakers of bread for many millennia; it is no different in the United States. Bread and meat products were probably two of the first foods prepared for commercial sale. The reasons for the emergence of commercial foods were that many people did not have the means to bake or hunt due to lifestyle. Hence, convenience foods were born.

Commercially prepared foods demanded an extended shelf life so that the products could be mass produced, shipped, purchased, and consumed at the leisure of the buyer. Food companies began to hire chemists to develop their products and ensure product quality for the demanding consumer. Technologies to accomplish this were developed through the simplest means such as salting and temperature control to development of the most sophisticated chemical preservatives and packaging techniques.

Supermarkets began emerging in urban centers before the 1920s, mass distributing these prepared foods along with meats, produce, dairy products, and household goods (36). The consumer appreciated "one-stop" shopping.

During the first World War, military and civilian chemists collaborated to evaluate foodstuffs and food products that would be suitable to sustain the troops. Nutrition was of marginal concern, but safety, integrity, and content designation became important issues to maintain human health. The rigors of feeding the troops during World War II led to the development of prepared foods that were nutritious and easy to prepare on the battlefield. Ancel Keys, a public health scientist at the University of Minnesota, developed K-rations, a complete day of three prepared nutritious meals (37), which has evolved into the meals-ready-to-eat or MREs served during modern war time. Extensive funding was allocated to developing packaging and preservation systems.

In 1941 the FDA promulgated addition of a set of vitamins and minerals to wheat flour (38). Breakfast cereals were enriched with vitamins and minerals to give children a dose of essential nutrients on a daily basis. Vitamin D was added to milk. Iodized salt and multivitamin tablets became readily available.

The demand for prepared foods has increased exponentially over the past 60 years. Value-added products derived from commodities such as corn, wheat, soybeans, and rice have gained popularity. Food processors use inexpensive commodities to formulate complex foods that serve the consumer yet boost company profits. A prime example is chicken nuggets (39).

Dual-income families and economic prosperity have afforded more disposable income for luxuries such as frequent restaurant dining, ready-to-eat foods, and complete frozen meals that affectionately became known as TV dinners in the 1950s. Career women relied upon prepared foods for easy meals that could be prepared in 30 minutes or less after a long day at work. Serving these convenience foods has given rise to a lifestyle that may not necessarily have a balanced and nutritional diet as a priority.

The family-owned and -operated restaurants, taverns, and diners of the 1920s–1950s offered home cooking for travelers and those who could afford a meal outside the home on special occasions. Families often offered their ethnic cuisine for Italian, German, French, or Southern American dishes.

During the 1960s the fast-food industry accelerated our dining habits by offering simple foods in a simple atmosphere with walk-up or drive-through window service to eat in or take out. These restaurants offered mostly hamburgers, hot dogs, and French fries. Pizza had long been an option along with Mexican and Chinese food. Later in the 1980s, other ethnic cuisines became widely popular such as Thai or Indian.

The 21st century has seen further evolution in eating habits with the boom of the “casual dining” restaurant offering ease of dining outside the home at any time, offering options for its more health-conscious patrons. Some restaurants print suggestions in their menus that certain foods, wines, and beverages may be better nutritional choices, offering information such as fat content per serving. Fast-food restaurants have fortified their menus with more nutritious options such as salads and fruits.

Obesity in the United States has increased to a record high, especially in children (40). Children during the first half of the century got more exercise due to limited indoor activities, whereas today's children are attracted to video games, computers, and nonphysical activities. Adults also worked at jobs that involved more physical labor, whereas today many of us work indoors at desks or in laboratories.

#### CURRENT ECONOMICS AND THE FUTURE OF NUTRITION

The current economic situation in the United States may be handled differently than that in the Great Depression with respect to basic human resourcefulness. Before the Great Depression, many people were already below the poverty level. Today, we tend to have better financial security and we are able to reduce spending on luxury items and redirect funds into basic housing and food needs. Programs are in place to aid the food insecure, and the USDA has recently revamped the antiquated Food Stamp Program, which was introduced in 1939. The new Supplemental Nutrition Assistance Program (SNAP) uses electronic debit-type cards issued to qualified recipients, automatically reloading monthly. As before, the allotted credit may be used for basic food staples including fresh fruits and vegetables, meats, eggs, breads, cereals, and dairy products (41). We are more educated with respect to basic knowledge of proper nutrition. Poverty in farm families is at its lowest historical level (42), although we may see farm families severely affected once again because modern farms concentrate on producing one or two crops rather than a full complement found on the dinner table.

Americans have enjoyed relative affluence in the past few decades. Many of us have adopted the lifestyle of dining out rather than preparing meals at home. In general, a meal consumed in a restaurant consists of more food volume than one would consume at home. For example, many of us would not normally consume a high-calorie beverage, appetizer, salad, bread, entre, and dessert at home. Consumption of this type of meal several times per week is bound to add extra weight to most of us, especially those who lead sedentary lifestyles. The financial events of the past year have caused Americans to re-examine disposable income for food, and once again families and individuals have retreated to preparing meals at home rather than dining in a restaurant. The restaurant industry will almost certainly report losses with the downturn in the economy. Several nationwide restaurant chains have already filed for bankruptcy or closed their doors.

Cookbook sales have markedly increased in the past year, showing that consumers are interested in preparing meals at home (43). First Lady Michelle Obama has decided to grow a full vegetable garden on the White House grounds, the first since Eleanor Roosevelt's Victory Garden after World War II. She hopes to set an example by educating children in the importance of proper nutrition (44). We may even see more first-time home gardeners following the lead of the First Family by planting vegetables with veteran gardeners expanding their backyard gardens. Commercial growers may experience losses due to the popularity of home gardens.

We may find ourselves facing high food commodity prices if biofuel production begins to compete for grains. Inexpensive food may be a thing of the past, as food prices have increased noticeably.

It is premature to predict the long-term effects on nutrition as a result of the current economy. However, this may be a natural turn of events, a cycle turning toward better nutrition once again.

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