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**Examining Potential Changes in Nutrition
Recommendations and Implications for Specialty Crops in
California**

Report Prepared for the California Institute for the Study of Specialty Crops

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Introduction

Recent evidence reports that 65 percent of Americans are either overweight or obese, and this percentage rate is nearly double what it was in 1995 (Hedley et al. 2004). One effort to combat this epidemic has focused on the health benefits of including a greater share of foods derived from specialty crops—including fruits, vegetables, and in some cases tree nuts—in U.S. diets. Studies have shown that a higher consumption of selected specialty crops will reduce obesity and related ailments such as cancer, stroke, and heart disease (Block, Patterson, and Subar 1992). Considerable attention has been given to the economic impact that obesity has to consumers and to the government in the United States, and elsewhere. The annual cost of poor diets in the United States, with reference to health care costs, absenteeism, and early death has been estimated to be as high as \$10.6 billion per year (Frazao 1999).

Increased consumption of specialty crops will decrease the health costs associated with obesity, but it will also lead to benefits for producers of those healthy food products. Most diet recommendations advocate increased consumption of selected specialty crops and California's specialty crop growers stand to gain significantly if consumers follow the recommendations. Based on the current consumption patterns in the United States, we highlight the economic effects that compliance with seven different dietary plans would have for selected specialty crop markets in California agriculture.

Every five years, beginning in 1980, the Department of Health and Human Services and the USDA publish *Nutrition and Your Health: Dietary Guidelines for Americans* (DGA). Each edition of the DGA reviews the existing guidelines and proposes changes in light of the recent research in nutrition. Information from the DGA serves as the basis for the various food and

nutrition programs administered by the USDA, including the new USDA Food Guide or MyPyramid that was released in 2005.

The DGA is also used by nutritionists and other health experts in developing non-USDA food guides and recommended dietary plans. Quite often the recommendations from the non-USDA food guides differ significantly with respect to the consumption of foods such as olive oil, dairy products, fruits, vegetables, and even wine. Dietary plans offered as alternatives to the USDA regimes include the Harvard Model, the Mayo Clinic Model, the Traditional Mediterranean Diet Model, Atkins Diet, and the DASH diet, among others. Although the USDA food guides have been the most visible, others such as the Harvard Model and the Mayo Clinic Model are achieving greater public recognition. Furthermore, these alternative models are gaining credibility by the individuals that will be responsible for shaping the information that is used to develop the dietary guidelines in the United States, and elsewhere.

Motivation

A survey of the agricultural and food policy literature that examines topics related to nutrition policy shows three major bodies of work. The first examines the degree to which consumers respond to nutritional information and recommendations. Work done by Johnson (1999), Nayga (1999), Kim, Nayga, and Capps (2001), Nayga (2001), Drichoutis, Lazaridis, and Nayga (2004), He, Fletcher, and Rimal (2004) among others, exemplifies this branch of research. Much of this work shows that U.S. consumers do respond, although sometimes only marginally, to food recommendations. For example, Nayga (2001) showed that, in a given population, nutritional label use has reduced the intake of total fat by 7 percent and increased the intake of dietary fiber by 8 grams.

The second area has examined the relationship between observed phenomena, including government policies, and obesity in the United States and elsewhere. Alston, Sumner, and Vosti (2005) have examined the relationship between government subsidies and obesity rates in the United States, and find that U.S. subsidies for corn and soybeans have not had a significant impact on obesity rates. Loureiro and Nayga (2005) examined a dataset that spanned across several countries in an effort to find relationships between variables—including female labor force participation, urbanization, agricultural productivity, commuting miles (as a proxy for the level of physical activity), emission output, agricultural subsidies, physical activity, age, education, caloric intake, cigarette consumption, and income—and the growth of obese populations in selected countries. Their findings suggest that female labor force participation, caloric intake, and higher levels of income were the main drivers of the increased rate of obesity. This branch of research often provides public policy options that could be implemented to help curb the obesity epidemic in the United States, and elsewhere (*e.g.*, Haddad 2003).

The third broad area of research related to nutrition policy has examined implications for producers, and this is the focus of our research. Given some level of compliance with food and nutritional recommendations, researchers have asked a series of “what if” questions related to the implications for production agriculture in the United States if consumers followed food and nutrition recommendations. We will modify methodologies used in previous studies, and apply them to answer questions that are most pertinent to growers of specialty crops in California. Rather than focus on the implications for traditional and aggregate food groups, we analyze the implications for specific specialty crops by studying nutrient recommendations and nutrient composition.

O'Brien (1995) examined the relationship between greater compliance to the USDA Food Guide Pyramid (FGP) and production agriculture. He showed the per capita consumption rates for the major food groups, and selected subgroups, in the United States between 1960 and 1990. For these food groups, O'Brien characterized the effects that a shift towards compliance with the FGP would have. His findings focused on the direction and magnitude of changes rather than percent changes. In addition, O'Brien discussed the adjustments that would be required in the mix of food intake, namely the adjustments required away from fats, oils, and sweeteners and towards fruits and vegetables.

Young and Kantor (1999) followed O'Brien's idea, but developed a more rigorous economic approach to examine the question of compliance with the FGP and the implications for U.S. production agriculture. They provide the percent changes needed in production of the traditional food groups to comply with the FGP, and the corresponding changes required in acreages. For example, Young and Kantor's results show that the food group titled "Meat, poultry, fish, dry beans, eggs, and nuts" would need to increase by 5 percent, and the food group titled "Other Fruits" would need to increase by 114 percent. Furthermore, using the traditional food groups to aggregate, Young and Kantor show the direction that price, quantity supplied, quantity demanded, and quantity traded would take under compliance with the FGP.

Young and Kantor (1999) looked closely at the impacts within the meat sector, and examined how compliance with the FGP would affect beef, pork, poultry, and fish. This consideration has motivated us to consider other intra-food group implications. For example, how would greater compliance with the FGP (or other food recommendations) affect different types of fruits, vegetables, and tree nuts. As one example of this, the California Walnut

Commission has recently tried to understand what new nutritional recommendations will mean to the walnut industry (California Walnut Commission 2004).

Most recently, Jeter, Chalfant, and Sumner (2001, 2004) examined the impacts of compliance with fruit and vegetable recommendations outside of the FGP, namely a cancer prevention diet developed by the Cancer Prevention and Nutritional Services unit of the California Department of Health Services. The cancer prevention diet requires consumption of seven specific servings of fruit and vegetables per day. The authors also examine the implications of compliance with diets that included five and seven non-specific servings of fruits and vegetables per day. This research focused on the potential benefits for producers of fruits and vegetables in California. In examining the percent increases needed in consumption for compliance with the various diets, the authors decomposed the traditional food groups into subgroups. For example, vegetables were divided into starchy vegetables, salad, other vegetables, tomatoes, dark green and orange vegetables, cruciferous vegetables, and potatoes. Based on the changes in consumption required, an economic model calculated the percent changes in grower price, output, and revenue for thirty-seven fruit and vegetable commodities. Their findings indicate that full compliance with the unrestricted five-a-day fruit and vegetable diet would increase total net producer revenue to California's fruit and vegetable growers by \$316 million. Full compliance with the unrestricted seven-a-day fruit and vegetable diet would increase total net revenue by \$788 million, and full compliance with the seven-a-day fruit and vegetable cancer prevention diet would boost total net revenues to California's fruit and vegetable growers by \$836 million. Nation wide, full compliance with the seven-a-day fruit and vegetable cancer prevention diet would boost total U.S. net farm revenues by \$1.44 billion.

The studies reviewed thus far use traditional food groups, or subgroups of those, as the ‘markets’ in their analyses. As a result, findings are constant across a food group (or subgroup) and it is difficult to interpret crop specific implications. Therefore, to better understand the effects of food recommendations for specific crops, we have decided to interpret various food recommendations as nutrient recommendations, and assess the impact of greater compliance with nutrient recommendations. To do so, we have developed a model that examines the effects of compliance with various nutrient recommendations that will be applied to the 50 highest-value agricultural products in California, many of which are considered specialty crops.

Our analysis extracts nutrient recommendations from diet recommendations. Diet recommendations are broken down into 15 nutrient groups, specifically 9 macronutrients and 6 micronutrients, to help differentiate the nutrient recommendations found in alternative diet regimes. Certainly including more nutrient groups would strengthen the precision of our analysis, however, at some point additional nutrient groups would no longer provide valuable insight and would only unnecessarily complicate our model. We initially included 6 nutrient groups, slowly climbed up to 19 nutrient groups, and in the end decided to include 15 nutrient groups. We felt that the 15 groups would i) explain the major differences between the food recommendation models, and ii) provide a modeling framework that remains manageable. Of course, we may consider adding nutrient groups—including sub-nutrient groups for carbohydrates and key phytochemicals—in an extension to this work. The following list¹ includes the 9 macronutrients and 6 micronutrients used in our analysis.

List of Macronutrients

- 1) Protein
- 2) Carbohydrates (CHO)

¹ Abbreviations used in our study are placed in the parenthesis following the nutrient.

- 3) Fiber
- 4) Saturated Fats (SFA)
- 5) Monounsaturated Fats (MUFA)
- 6) Omega-3 Polyunsaturated Fats (Omega 3s)
- 7) Omega-6 Polyunsaturated Fats (Omega 6s)
- 8) Other Polyunsaturated Fats (Other PUFAs)
- 9) Cholesterol

List of Micronutrients

- 10) Vitamin A
- 11) Vitamin C
- 12) Vitamin E
- 13) Calcium
- 14) Iron
- 15) Sodium

Research Objectives

To examine the economic effects of compliance with seven dietary regimes for specialty crop growers in California, we have identified 8 research objectives.

- i) Identify the current per capita consumption rates for 15 selected nutrient groups in the United States.
- ii) In words, summarize the key similarities and differences among the seven dietary plans that will be considered in the analysis.
- iii) Calculate the average per capita consumption rates for the 15 nutrient groups under the seven alternative food guides, and compare to the current rates from Objective i) to assess the changes required for compliance.
- iv) Compute the share of nutrients in each of the 50 highest-value agricultural products in California.
- v) Understand the economic relationships between production and consumption of the 15 nutrient groups.
- vi) Develop a simulation model to examine how changes in consumption of the 15 nutrients (under compliance with the seven dietary regimes) would impact the gross revenues of the nutrients.

- vii) Combine the changes required in nutrient consumption from Objective iii), the nutrient shares in Objective iv), and the simulated changes in nutrient gross revenues from Objective vi) to assess changes in gross revenues for specific agricultural products.
- viii) Summarize the simulation results for an audience that may include economists, nutritionists, industry participants, and policy makers.

The first three objectives enable us to understand what type of changes in consumption would be required for compliance with each of the seven dietary regimes. Objective iv) is a two-step process. First the total weight of each agricultural product is broken down across the 15 nutrients. Second the nutrient weights are converted into nutrient shares. Objectives v), vi) and vii) summarize the economic modeling component of our analysis whereby we simulate how compliance would affect gross revenues across the 50 highest-value agricultural products in California. Finally, Objective viii) is included to remind us who our audience is, and to present our methodology and results in a way that is transparent and can be widely understood.

Examining the Alternatives

Recommendations for food intake have been made since the late 1800s. Upon establishing the USDA in 1862, the government mandated the dissemination of research-based information regarding nutrition to the public. The first set of food tables and dietary standards were published in 1894 by the first director of the Office of Experiment Stations in the USDA, namely W.O. Atwater. These tables presented food composition and dietary standards for protein, fat, carbohydrate, ash (minerals) and energy of foods commonly available at the time. As early as 1902, Atwater made the claim that unless Americans exercised care in consuming a balanced diet, “the evils” of over-consumption (*i.e.*, fats) would eventually appear in the form of chronic disease. Nutrition professionals are still engaged in discussions of chronic disease prevention

and treatment. Atwater's research formed the basis for ongoing dietary guidance themes of variety, balance, and moderation (Welsh et al. 1993).

Along with the dissemination of nutritional information, the USDA is also responsible for overseeing and promoting U.S. agriculture. This is oftentimes in conflict with the promotion of adequate and accurate nutritional information, and research continues to examine this relationship (see Alston, Sumner, and Vosti 2005). With that conflict in mind, many other professionals in the area of nutrition research have taken it upon themselves to review the research related to food intake and disease and develop their own dietary patterns or food guides. Several nutrition recommendations or diet regimes have been designed that mimic the pyramid shape of the USDA FGP, yet are less similar to the USDA FGP in terms of content. Next we will provide a description of the seven dietary regimes that are considered in our analysis.

The Traditional USDA Food Guide Pyramid

Creation of the traditional USDA FGP began in 1988 when the USDA contracted an independent marketing firm to develop an educational tool that would be used to promote the Dietary Guideline for Americans. The pyramid design was chosen to illustrate variety, proportionality, and moderation. The FGP was officially released in 1992 and did not undergo any significant changes until 2005 (Davies et al. 2001). Appendix A shows the illustration that is commonly associated with the USDA FGP.

The traditional FGP illustrates variety by including seven food groups, namely: i) breads, cereals, rice, and pasta; ii) vegetables; iii) fruit; iv) milk, yogurt, and cheese; v) meat, poultry, fish, dry beans, and nuts; and vi) fats, oils, and sweets. The illustration of proportionality comes from the shape of the pyramid. Breads, cereals, and grains form the base of the pyramid

followed by vegetables and fruits suggesting that the bulk of the diet should come primarily from plant-based foods. Moderation is suggested by the range of servings from each food group. The actual number of servings is dependent upon caloric intake. An obvious omission in this FGP, compared to other diet regimes, is physical activity.

Harvard Model

Faculty members in the Harvard School of Public Health, led by Walter C. Willett and Meir J. Stampfer, created the Healthy Eating Pyramid as an evidence-based guide for food intake. Willett and Stampfer have been investigators in very large scale epidemiological studies, spanning over 20 years, examining the dietary habits of men and women and the occurrence of chronic disease (*e.g.*, see Stampfer 1993). The results from these studies have shown a) positive associations between animal fat and red meat consumption and risk of colon cancer, and b) positive correlation between hydrogenated fat consumption and coronary heart disease. Results from these studies also showed that certain fats could decrease risk of coronary heart disease, namely monounsaturated and polyunsaturated fats (Hu et al. 1997; Fung et al. 2001; Hu et al. 2002). Likewise, evidence from these studies shows an inverse relationship between vitamin E consumption and risk of coronary heart disease (Rimm et al. 1993; Stampfer et al. 1993).

The results of these and many other diet and health related studies have formed the basis by which Willett, Stampfer, and other colleagues created the Healthy Eating Pyramid, a more evidence-based alternative to the USDA FGP. As shown in Appendix B, the Healthy Eating Pyramid resembles the USDA FGP but the content is much different. Distinction has been made between whole-grain carbohydrates and refined grains and sugars, and between red meat and poultry. Nuts and legumes, sources of plant-based proteins, and plant oils have been put in

categories of their own. These changes were due in part to results from several epidemiological studies showing the effects of specific foods on chronic disease risk. Although not diet in nature, another major difference is the inclusion of exercise as a component of the Healthy Eating Pyramid. Many studies show exercise is beneficial not only from a weight loss or weight maintenance standpoint, but also from the perspective of chronic disease risk. Population studies have indicated an inverse relationship between exercise and coronary artery disease, myocardial infarction, and diabetes in men and women (Manson et al. 1992; O'Connor et al. 1995; Manson et al. 1999; Tanasescu et al. 2002).

Mayo Clinic Model

The Mayo Clinic Healthy Weight Pyramid (Appendix C) was developed by physicians and dietitians at the Mayo Clinic. It is the first food intake guide to focus on weight loss or weight maintenance. Much of the research that was used to develop the model was conducted by obesity treatment experts at the Mayo Clinic in Rochester Minnesota, Pennsylvania State University, and the University of Alabama at Birmingham. Donald D. Hensrud, a primary force behind the Mayo Clinic Healthy Weight Pyramid, has substantial research experience in the area of obesity treatment, prevention, and the co-morbidities associated with excessive weight. In 2000, Hensrud edited a book titled "Mayo Clinic on Healthy Weight: Answers to Help You Achieve and Maintain the Weight That's Right for You" which uses the Mayo Clinic Healthy Weight Pyramid as a guide for diet planning.

At the base of the pyramid are fruits and vegetables, followed by whole grains and lean protein sources. Limitations are not made with respect to red meat consumption, however, it is recommended that protein comes from plant sources, as well as fish, poultry, and dairy products.

Unlimited consumption of fruits and vegetables are encouraged as are generous amounts of whole grains. This eating plan focuses on low-energy-density, high-fiber foods that provide satiety and adequate nutrition.

Mediterranean Model

The Mediterranean Food Guide Pyramid (Appendix D)—developed through collaboration between Harvard School of Public Health, a United Nations World Health Organization and Food and Agriculture Organization (WHO/FAO) Collaborating Center, and Oldways Preservation and Exchange Trust—represents the traditional dietary habits of Crete, Greece, and southern Italy in 1960. This design is based on the observed relationship between a very low rate of chronic disease and extended life expectancies for these populations at the time, in spite of limited medical services. More recent epidemiological studies have also revealed that chronic disease rates are still low in these traditional populations. Likewise, evidence from clinical studies on various components of the diet, such as olive oil or red wine, is consistent with the population data showing a lower incidence of heart disease and cancer.

The Mediterranean diet endorses an abundant consumption of fruits, vegetables, and whole grains. It also encourages consumption of fresh or minimally processed foods, olive oil, fish, and wine. As with several other diet regimes, physical activity is shown at the base of the pyramid.

Atkins Model

Robert C. Atkins wrote his first diet book in 1973 advocating a low-carbohydrate, high-protein diet for weight loss. Since then, dieting recommendations have changed many times and

recently many consumers have returned to Atkins' dietary recommendations. In 1994 Atkins published "Dr. Atkins' New Diet Revolution" which has caused an increase in the popularity of low-carbohydrate, high-protein diets. A food intake guide was created using a visual that is similar in appearance to, but nearly a reversal of the content shown in, the USDA FGP. A pictorial representation of the Atkins Diet Recommendation is shown in Appendix E.

The emphasis of the initial period of the diet is to deplete the body of glycogen (carbohydrate stores) and to initiate a state of ketosis (the body is breaking down body fat and protein). The primary way to do that is to limit carbohydrate intake and to increase protein and fat intake. This is evident in the visual food guide with protein sources at the base of the pyramid and carbohydrate sources (namely grains) at the peak. The Atkins regime also lists limitations for specific fruits and vegetables which are indicated in the visual.

Dietary Approaches to Stop Hypertension (DASH) Model

Dietary Approaches to Stop Hypertension (DASH) began as a multi-center clinical study funded by the National Heart, Lung, and Blood Institute (NHLBI) within the National Institutes of Health. The original study examined the effects of various components of the diet on blood pressure. The results of the study showed that elevated blood pressure levels could be lowered by consuming a diet low in total fat (notably saturated fat) and cholesterol, and rich in fruits, vegetables, and low-fat dairy products. This diet is naturally lower in sodium, higher in magnesium, calcium, and potassium, all of which have positive effects on blood pressure (NHLBI, 2003). Appendix F outlines the guidelines required under the DASH diet plan.

Several studies have examined the effectiveness of the DASH eating plan in improving health and reducing risk for chronic disease. The original intent was to develop an eating plan to

reduce blood pressure. While significant reductions in blood pressure have been seen in subjects following the DASH diet (Craddick et al. 2003), other health benefits have also been reported. Improvements in blood cholesterol and plasma homocysteine have been shown in subjects on the DASH diet (Craddick, et al. 2003; Harsha et al. 2004). High blood cholesterol and high plasma homocysteine are risk factors for cardiovascular disease. Doyle and Cashman (2004) reported that the DASH eating plan may reduce markers of bone turnover which could lead to improvement in bone density. In the long run, the DASH eating plan may prove to be beneficial in reducing the risk of many chronic diseases, in addition to hypertension.

The New USDA Food Guide: MyPyramid

On April 19, 2005, the new USDA Food Guide Pyramid, MyPyramid, was unveiled. MyPyramid places more emphasis on weight management, physical activity, optimal bone health, and balanced nutrition than did the USDA FGP. MyPyramid (Appendix G) is a visual representation of the DGA from 2005. MyPyramid includes an interactive component which allows individuals to customize their plan. The visual is less detailed than those in the past. Instead of the food groups displayed vertically in the pyramid, MyPyramid organizes the groups horizontally. Each section for each food group is of similar size, so proportionality is not obvious. The one exception is the section for oils. This is a much smaller section, suggesting one should limit intake of oils. The graphics along with the text emphasize healthy food choices, daily physical activity, and individuality. Subtle messages imbedded within the graphic are moderation, personalization, variety, and gradual improvement.

To get the full benefit of the information contained within MyPyramid, one must access the online version. Accessing *MyPyramid Plan* allows the individual to get diet specific

information for their gender, age, and physical activity level, expressed in servings of food groups per day or week. *Inside the Pyramid* allows users to click on each food group and get specific information including foods included in the group and nutrients found in foods within each group. There is information about the Dietary Guidelines for Americans, a link for *Tips and Resources*, information for professionals and children, and the *Pyramid Tracker*. *Pyramid Tracker* is an online dietary and physical activity assessment tool that is designed for individuals who are interested in keeping track of their physical activity and food and nutrient intake. This online program will save the information for up to one year, allowing an individual to see progress over time.

Methodology

Based on the current consumption patterns in the United States, we highlight the economic effects that compliance with each of seven dietary plans (USDA FGP, Harvard, Mayo Clinic, Mediterranean, Atkins, DASH, and My Pyramid) would have for the 50 highest-value markets in California agriculture, many of which are specialty crops.

Our economic model is designed to ask various ‘what-if’ questions related to the consumption of various nutrient groups, which are used to simulate the changes in the consumption of specialty crops. This is done by first simulating changes in consumer demand for nutrients to evaluate the effects on price, output, and revenues for each nutrient. Second, the simulated changes in revenues for nutrients are used to understand changes in revenues for specific crops using nutrient composition shares.

Changes in consumer demand can be assessed as a horizontal shift (H) or a vertical shift (V) of demand, and both are illustrated in Figure 1. Figure 1 shows the supply and demand in a

market for a nutrient. The initial point of equilibrium is found at their intersection, namely at P_0 and Q_0 . The initial gross revenue can be defined as the area under the market price and to the left of the market quantity, *i.e.*, $P_0 \cdot Q_0$. Initially, producers earn gross revenues of area (c+d) in Figure 1. A shift in demand, in this case whether it is a vertical or horizontal shift, increases the gross revenue to the area below the new market price of P_1 and to the left of the new market quantity of Q_1 . As a result, the new revenue amount is defined as area (a+b+c+d+e+f) in Figure 1, and the increase in profit is area (a+b+e+f). The objective of this research is to quantify the changes in prices, output levels, and revenues for the 15 nutrient markets from simulated changes in demand due to compliance with dietary recommendations. From that, we will use the simulated changes in nutrient revenues to calculate changes in gross revenues for the 50 highest-value agricultural products in California.

As illustrated in Figure 1, we can consider either a vertical shift (*V*) or a horizontal shift (*H*) of demand. Both shifts result in a new equilibrium point and although it is illustrated as the same point in Figure 1, the magnitude of these shifts is not necessarily the same. A vertical shift of demand (one in the price direction) indicates that, holding the initial quantity consumed constant, the consumers' willingness to pay has changed. Conversely, a horizontal shift of demand, or one that moves in the quantity direction, indicates that consumers will change the quantity consumed holding the price constant. Our research is examining potential changes in the demand for nutrients, and since these are changes in the quantity demanded given a price, they will be considered horizontal shifts in demand.

Our analysis is performed using a four-stage procedure. Step 1 examines the nutrient specifications of seven food recommendation regimes, namely the USDA FGP, Harvard, Mayo, Mediterranean, Atkins, DASH, and MyPyramid. Step 2 calculates the percent changes in

nutrient groups that would be needed to fully comply with each of the seven food guide recommendations. We recognize that full compliance with any of the selected food recommendations is not realistic, however, we do this to understand the relative implications across alternative diet plans. Step 3 determines the economic relationships between nutrient groups, namely the own- and cross-price elasticities of demand for the 15 selected nutrient groups. Step 3 is done to formally characterize how an increase (or decrease) in one nutrient group would affect the consumption patterns of other nutrient groups. Lastly, Step 4 will apply the simulation model that we have developed to examine several ‘what if’ scenarios. Scenarios will include, but are not limited to, examinations of the effects of moving from current nutrient intake to full compliance with each of the seven alternative food recommendation models (USDA FGP, Harvard, Mayo Clinic, Mediterranean, Atkins, DASH, and MyPyramid).

Step 1: Assessing the Nutrient Requirements under Alternative Diet Plans

In order to compare the nutrient composition of the seven diet regimes, actual menu plans were needed. Our nutrient breakdown for each of the diet regimes is based on average nutrient intakes across five days that follow a 2000-calorie diet. For the Harvard, Atkins, and DASH diet patterns, established menus were available and used to analyze their nutrient composition. Willett's book *Eat, Drink, and Be Healthy: The Harvard Medical School Guide to Healthy Eating* contains menu plans that follow the Healthy Eating Pyramid; Atkins' book *Dr. Atkins' New Diet Revolution* suggests sample menus; and the DASH eating plan is provided by the National Institutes of Health (NHLBI, 2003).

To assess the nutritional value of the remaining diet regimes (*i.e.*, USDA FGP, Mayo Clinic, Mediterranean, and MyPyramid) a five-day menu was created following the suggested

food servings from the diet regimes. Using Food Processor SQL 9.3.0 (ESHA Research, Salem, Oregon), five-day menus for each of the four diet regimes were analyzed based on a standard 2000-calorie diet. In order to standardize the analysis across food guides, only the USDA database was used to examine the nutrient contents of the various foods and diets.

The results of these analyses and calculations are presented in Table 1. Table 1 shows the quantities of nutrients required to meet the requirements of each the seven diet regimes. For example, compliance with the Mayo Clinic would require 82.9 grams of protein whereas the MyPyramid regimes requires 98.0 grams of protein.

Step 2: Calculating the Changes Needed for Compliance under Each Diet Plan

Using the information presented in Table 1, each diet plan was compared to the current nutrient intake of Americans based on Continuing Survey of Food Intake by Individuals (CSFII) 1996-1998, a nationwide survey conducted by the Agricultural Research Service of the USDA. This is the most recently completed dataset that describes current nutrient intake across our 15 selected nutrient groups. The per-capita consumption rates for the 15 selected nutrient groups in the United States is provided in the first column of Table 2. Column two in Table 2 shows the shares of macronutrients and micronutrients in the per-capita consumption rates. For example, the per-capita consumption rate of protein in the United States is 75.0 grams, and this comprises 17.4 percent of the total macronutrient intake.

Calculations were made to determine what changes were necessary in order to comply with each food recommendation plan. The changes in nutrient consumption needed to comply with the seven plans are presented as percentage increases or decreases from the current nutrient intakes shown in Table 3. For example, the percent change required to meet the Mayo Clinic

recommendation for protein would be 10.6 percent, and the percent change required to meet the MyPyramid recommendation would be 30.7 percent.

Step 3: Understanding the Economic Relationships Between Nutrient Groups

Many of the nutrient groups that we have included in our analysis will substitute, in some capacity, for other nutrient groups. Shifts in market conditions for one nutrient group will ultimately affect conditions in the markets for other nutrient groups. The purpose of Step 3 is to determine the degree to which nutrient groups substitute for each other. More formally, this is known as defining the economic relationships between goods or calculating the price elasticities of supply and demand.

The price elasticities of supply characterize how a change in the price of a product (nutrient) will affect the production of the same product (nutrient). The price elasticities of supply for all 15 nutrient groups have been set at 1.0 in our initial analysis for simplicity.

Own-price elasticities of demand characterize how a change in the price of a product (nutrient) will affect the consumption of the same product (nutrient). Cross-price elasticities characterize how a change in the price of a product (nutrient) will affect the consumption of related products (nutrients). Demand elasticities can be estimated, calculated, or borrowed from previous studies. Two pieces of recent research, namely Beatty and LaFrance (2005) and Richards and Patterson (2004), offer some insight for directly estimating nutrient demand elasticities, however, no previous estimates are available in the literature, and estimation requires a significant amount of data and expertise.

We have decided that it would be best to calculate a matrix of the own- and cross-price elasticities of demand for our 15 nutrient groups following an Armington-type specification (see

Armington, 1969). Piggott (1992) and Sumner, Alston, and Gray (1994) present an outline of the limitations of the Armington specification, as well as an overview of Armington-type models that have been used in earlier applications.

The calculation used to parameterize the Armington own-price elasticities of demand is shown below in Equation (1a) and the calculation used to parameterize the Armington cross-price elasticities of demand is shown in Equation (1b).

$$(1a) \quad \eta_{nn} = \zeta_n \eta - (1 - \zeta_n) \sigma \quad \text{where } n = (1, \dots, 15)$$

$$(1b) \quad \eta_{no} = \zeta_o (\eta + \sigma) \quad \text{where } n = (1, \dots, 15) \text{ } o = (1, \dots, 15), \text{ and } n \neq o$$

The own-price elasticity of demand for nutrient n is represented by η_{nn} , and η_{no} represents the cross-price elasticity of demand for nutrient n with respect to the price of another nutrient, o . The share of consumption for nutrient n is denoted as ζ_n , σ is the elasticity of substitution between the nutrients, and η is the overall elasticity of demand for nutrients. The elasticity of substitution (σ) is equal to zero when no substitution across products is possible, and increases as substitution possibilities increase. An estimate of the elasticity of substitution between the nutrient groups (η) is not available, however, one could be based on parameters used in other studies, for example George and King (1971), Huang (1985), and Sumner, Alston, and Gray (1994).

Information on consumption shares of nutrients, defined as ζ_n in the equations above, is typically built up using information from industry sources, and where applicable, from national consumption data. This method would be ideal in considering the caloric nutrient groups, but becomes less ideal once non-caloric nutrient groups are considered. For example, the nutrient share for cholesterol, vitamin A, vitamin C, vitamin E, sodium, iron, and calcium would be significantly less than 1 percent, and the results would be driven solely by the nutrient shares for

fats, carbohydrates, and protein. Therefore, we consider the macronutrients to be a separate group from the micronutrients and calculate the elasticity parameters for each group using Equation (2) for the macronutrients and Equation (3) for the micronutrients. In Equation (2) the subscripts a and b are used to denote different macronutrients. In Equation (3) the subscripts i and j are used to denote different micronutrients. Now ζ_a (or ζ_b) is used to denote the consumption share of the specific macronutrient a (or b) from the 9 selected macronutrients. Likewise, ζ_i (or ζ_j) is used to denote the consumption share of the specific micronutrient i (or j) from the 6 selected micronutrients.

$$(2a) \quad \eta_{aa} = \zeta_a \eta - (1 - \zeta_a) \sigma \quad \text{where } a = (1, \dots, 9)$$

$$(2b) \quad \eta_{ab} = \zeta_b (\eta + \sigma) \quad \text{where } a = (1, \dots, 9), b = (1, \dots, 9), \text{ and } a \neq b$$

$$(3a) \quad \eta_{ii} = \zeta_i \eta - (1 - \zeta_i) \sigma \quad \text{where } i = (10, \dots, 15)$$

$$(3b) \quad \eta_{ij} = \zeta_j (\eta + \sigma) \quad \text{where } i = (10, \dots, 15), j = (10, \dots, 15), \text{ and } i \neq j$$

Appendices H provides the matrix of own- and cross- price elasticities for the 9 macronutrients. The value in the top left-hand corner in Appendix H, -0.91 , describes the own-price elasticity of demand for protein. This indicates that a one percent increase in the price of protein will decrease the consumption of protein by 0.91 percent. The value directly below the own-price elasticity of demand for protein, namely 0.29 , describes the cross-price elasticity of demand for protein with respect to the price of the carbohydrate group. This indicates that a one percent increase in the price of carbohydrates will increase the consumption of protein by 0.29 percent. Appendix I provides the matrix of own- and cross- price elasticities for the 6 micronutrients used in our analysis.

Step 4: The Economic Simulation Model

The effects of compliance with the seven dietary recommendation plans will be understood by simulating changes in demand, and calculating changes in revenue, for selected nutrient groups. Simulated changes in revenue for selected nutrient groups will subsequently be used to calculate changes in revenue for the 50 highest-value agricultural products in California. To assess these effects we will follow a class of models that are often referred to as equilibrium displacement models. Agricultural economists have adopted this type of model to study a wide range of research topics, most notably in studies that examine the potential effects of relatively small changes in supply and demand conditions. These models can be readily explicated and understood, and therefore ideal for disseminating the results to both agricultural economists and an audience with a general interest in nutrition policy.

A set of basic equations is used to describe the supply and demand for a given market, here a market for a nutrient group. Totally differentiating these equations and converting them to elasticity form yields a system of linear (logarithmic differential) approximations, or a linear elasticity model. The equations are solved for proportional changes in quantity and prices as functions of various elasticity and share parameters.

The basic structure of the model is given in Equations (4a), (4b), and (4c). The term Q is used to denote a quantity and P denotes a price. The subscript n is used to denote a nutrient group, where $n = (1, \dots, 15)$. Equation (4a) represents the supply of nutrient group n ; it depends only on its price and exogenous supply shifters (B_n). Equation (4b) represents demand for a subset of nutrients, namely the nine macronutrients, and demand for a macronutrient, denoted a where $a = (1, \dots, 9)$, is a function of all macronutrient prices, and exogenous demand shifters (A_a). Equation (4c) represents demand for the six remaining nutrients, namely the micronutrient

groups, demand for micronutrients, denoted i where $i = (10, \dots, 15)$ is a function of all micronutrient prices, and exogenous demand shifters (A_i).

$$(4a) \quad Q_n = f_n(P_n; B_n) \quad \text{Supply, } n = (1, \dots, 15)$$

$$(4b) \quad Q_a = g_a(P_a, P_b; A_a) \quad \text{Demand, } a = (1, \dots, 9), b = (1, \dots, 9), \text{ and } a \neq b$$

$$(4c) \quad Q_i = g_i(P_i, P_j; A_i) \quad \text{Demand, } i = (10, \dots, 15), j = (10, \dots, 15), \text{ and } i \neq j$$

Totally differentiating Equations (4a), (4b), and (4c) and converting to elasticity form yields the linear elasticity model in Equations (5a), (5b), and (5c). These equations do not involve any explicit or implicit assumptions about the functional forms used, and it is not necessarily assumed that the elasticities are constant. However, it is assumed that the supply-and-demand functions are approximately linear at the initial point of market equilibrium (Alston, Norton, and Pardey 1995). Equilibrium adjustments can be simulated by exogenously specifying supply and demand changes. Values for elasticity and share parameters are held constant as exogenous changes to supply and demand are applied. Therefore, the linear elasticity model is best suited for local adjustments around the initial long-run equilibrium.

In the simulation model that follows, a vertical shift of demand would be incorporated as $E(Q) = \eta[E(P) - \alpha]$ in Equations (5b) and (5c). A horizontal shift of demand would be incorporated as $[E(Q) - \alpha] = \eta[E(P)]$, or equivalently $E(Q) = \{\eta[E(P)] + \alpha\}$ in Equations (5b) and (5c). Since our research is examining potential changes in the demand for specialty crops for a given price, they will be considered horizontal shifts in demand.

In the following equations, for any variable X , $E(X)$ represents the relative change in X , that is, $E(X)$ represents dX/X where d refers to a total differential.

$$(5a) \quad E(Q_n) = \varepsilon_n [E(P_n) + \beta_n]$$

$$(5b) \quad E(Q_a) = \eta_{aa}[E(P_a) - \alpha_a] + \sum_b \eta_{ab} [E(P_b) - \alpha_a]$$

$$(5c) \quad E(Q_i) = \eta_{ii}[E(P_i) - \alpha_i] + \sum_j \eta_{ij}[E(P_j) - \alpha_i]$$

The own-price elasticity of supply for nutrient n is represented by ε_n . The price elasticity of demand for the macronutrient a with respect to the price of another macronutrient b , is represented by η_{ab} . Similarly, the price elasticity of demand for the micronutrient i with respect to the price of another macronutrient j , is represented by η_{ij} . A relative increase in the supply of a nutrient, (a vertical shift up) is denoted β_n , a relative increase in the demand for a macronutrient (a vertical shift up) is denoted α_a , and a relative increase in the demand for a micronutrient (a vertical shift up) is denoted α_i . The fully specified model for the 15 nutrient groups yields a system of forty-five equations.

Simulated changes in demand for nutrient groups due to compliance with food recommendations yield changes in prices and output for the 15 nutrient groups. The simulated changes in prices and output of nutrient groups can then be used to calculate the changes in the gross revenues for the 9 macronutrients as shown in Equation (6), and gross revenues for the 6 micronutrients as shown in Equation (7). The percent change in gross revenue for a nutrient group is approximated as the sum of the percent changes in price and quantity. This approximation serves our purpose well as we are mostly concerned with a comparison of the change in gross revenue across the seven diet regimes.

$$(6) \quad E(TR_a) \approx E(P_a) + E(Q_a) \quad \text{where } a = (1, \dots, 9)$$

$$(7) \quad E(TR_i) \approx E(P_i) + E(Q_i) \quad \text{where } i = (10, \dots, 15)$$

Changes in the gross revenues of specific crops follow a weighted share calculation. The calculation combines the simulated changes in gross revenues for the 15 nutrients and nutrient composition shares for specific crops. Table 4 details the nutrient composition of California's top 50 agricultural products (California Department of Food and Agriculture 2003), many of

which are specialty crops. Standard serving sizes of each of the top 50 commodities were analyzed using Food Processor SQL (ESHA Research, Salem, Oregon) for nutrient content. For consistency, the USDA database was selected for each of the items analyzed on the diet analysis program.

Based on the information in Table 4 we calculate the nutrient composition shares for our 15 nutrient groups. Table 5 shows the nutrient composition shares for the macronutrients and Table 6 shows the nutrient composition shares for the micronutrients. Nutrient composite shares will not simply be based on mass. This is because a subset of the 15 nutrient groups—namely the caloric nutrient groups including fats, carbohydrates, and protein—comprise the vast majority of the total weight in any food item. Since macronutrients are typically measured in grams and micronutrients are typically measured in milligrams, any weight-based share across nutrients would favor the macronutrients. Instead, we assign additional weight to the non-caloric nutrient groups, *i.e.*, the micronutrients. We do this to better incorporate the changes in micronutrient recommendations across the diet regimes in our analysis.

The final calculation in *Step 4* is to calculate the percent change in gross revenue for a specific crop due to changes in demand for nutrient groups based on compliance with the seven dietary regimes and their nutrient recommendations. In the notation below, NCS_a^C refers to the Nutrient Composition Share for macronutrient a and NCS_i^C refers to the Nutrient Composition Share for macronutrient i , in specialty crop C . Equation (8) describes the calculation used to find the percent change in gross revenue for a specific crop, denoted $E(TR^C)$, due to changes in demand for nutrient groups from compliance with the seven dietary recommendations.

$$(8) \quad E(TR^C) = (0.95) * \sum_a [(E(TR_a) * NCS_a^C)] + (0.05) * \sum_i [(E(TR_i) * NCS_i^C)]$$

Changes in gross revenues of nutrient groups and the nutrient composition shares are used to calculate the change in gross revenue for a specific crop in Equation (8). We have considered allocating different weights to the macronutrient group. Based on mass, the allocation to macronutrients would be greater than 99.5 percent and we wanted our results to also reflect the recommended changes in micronutrients to some degree. In the results presented below, we allocate 95 percent of the weight to the macronutrients and 5 percent to the micronutrients. Overall, we found that our results were robust across weight allocations of between 85 and 98 percent for the macronutrient group.

Results

Our methodology included four steps and a summary of the results for the first three steps have been provided above. Therefore, we will turn our attention here to the results from our final step, namely the results from our simulation model. The simulation model is developed and used to examine how compliance with the seven diet regimes would impact revenues for the 50 highest-value agricultural products in California.

Based on the information in Tables 1 and 2, we calculated the percent changes in consumption of nutrients required to comply with the seven dietary regimes in Table 3. The calculated quantities of nutrients per serving for the 50 highest-value agricultural products in California are provided in Table 4. Table 5 shows the relative share of each macronutrient and Table 6 shows the relative share of each micronutrient for each agricultural product. The simulation model as outlined in Equation (5) combines changes required for compliance with the various diet plans in Table 3, the calculated elasticity parameters shown in Appendix H and Appendix I, and the nutrient composition shares provided in Tables 5 and 6. The simulation

model allows us to examine how compliance with each diet regime would affect gross revenues for the 15 nutrient groups and ultimately gross revenues for each of the 50 highest-value agricultural products in California.

Table 7 shows the percent changes in gross revenues for the 15 nutrients across the seven diet regimes. The model used to calculate the results in Table 7 assumes full consumer compliance with the dietary regimes and that some substitution is possible across nutrient groups. For example, Table 7 shows that gross revenue for protein would increase by 13.6 percent if consumers complied with the USDA FGP, whereas gross revenue would increase by 35.4 percent if consumers complied with the Mediterranean regime. For most diet regimes, gross revenue would increase for protein, carbohydrates, fiber, Omega 3 and Omega 6 polyunsaturated fats, vitamin C, vitamin E, calcium, and iron. It will be the differences in the proportions of nutrient groups, and the nutrient composition shares for specialty crops, that will drive our results. Consumer compliance with many of these diets would increase the demand for nutrient groups that are commonly found in many of California's specialty crops. Calculating the changes in revenue for nutrient groups is done as a step towards what we are ultimately concerned with—calculating the changes in gross revenues for specialty crop markets in California.

Table 8 shows the changes in revenues for the 50 highest-value agricultural products² in California given compliance with each of the seven dietary regimes. The most important result is that compliance with all diet regimes, with the exception of Atkins, would increase gross revenue for nearly all of the agricultural products listed in Table 8. For 38 of the agricultural products listed in Table 8, compliance with the Harvard diet regime would generate the greatest

² Table 8 includes two milk products and therefore 51 agricultural products are listed.

gross revenue gain. However, for certain specialty crops, compliance with the Mediterranean, Atkins, and MyPyramid diet regimes would provide the greatest increase in gross revenues. In many cases, the Harvard, Mayo Clinic, and Mediterranean diet regimes would all increase gross revenues by 20 percent, or more.

In addition to our comparisons across the seven diet regimes, the differences between the two USDA regimes should be noted. The results between the 1992 USDA FGP and the 2005 USDA MyPyramid are often similar, however, compliance with one of the USDA diet regimes is not always best across all agricultural products. Compliance with the USDA FGP would generate a slightly higher increase in gross revenue for citrus products, stone fruits, and several vegetable products whereas the USDA MyPyramid would be best for leafy green vegetables, olives, and tree nuts.

We assessed how seven dietary regimes would affect the gross revenue for 15 nutrient groups, and used the results to calculate nutrient-weighted changes in gross revenue for agricultural products. Previous work in this area provided results for aggregated food groups. Our research has focused on understanding what the dietary regimes are recommending in terms of nutrients. This was done to give a disaggregated set of results that would be directly applicable to specific agricultural products. One example of the benefits of disaggregation in our results is within the tree nut category. Earlier work aggregated tree nuts with other sources of protein such as meat, poultry, eggs, and beans. Our results show the additional revenue that would be generated from compliance with the various diet regimes across the protein sources is different. Within the tree nut category alone, *i.e.*, almonds, pistachios, and walnuts, the results do not indicate that the same dietary regime would be best. The Harvard regime would be best for almonds and pistachios while the USDA MyPyramid regime would be best for walnuts.

Although many agricultural products share similar nutrient profiles, all products are different. Understanding the changes in gross revenue for agricultural products considering nutrient composition enriches the analysis, and allows us to provide a set of results that are specific to an agricultural product rather than to a group of agricultural products that share some similar characteristics. As a result, our findings are much more applicable to growers of, and policy makers concerned with the benefits of consuming, specialty crops.

Sensitivity Analysis

The results presented in Tables 7 and 8 were calculated assuming that there was some substitutability between micronutrients ($\sigma_a = 1.0$) and also some substitutability between macronutrients ($\sigma_i = 0.75$). The degree of substitutability is incorporated into the calculations of the own- and cross-price elasticities of demand, and ultimately affects the results for revenue changes among the 50 crops. To understand how robust our results in Table 7 and Table 8 are to changes in this key assumption, we will undertake a sensitivity analysis under the assumption of little substitutability between the 9 macronutrients ($\sigma_a = 0.1$) and the 6 micronutrients ($\sigma_i = 0.1$). Table 9 is set up following the format in Table 7 and Table 10 is set up following the format in Table 8. However, the changes in gross revenues in Tables 9 and 10 are different because we assume that there is less substitution between the nutrients.

Table 9 documents the changes in gross revenues for the 15 nutrient groups under the assumption that there is little substitution between nutrient groups. For example, Table 9 indicates that the compliance with the USDA FGP would increase gross revenue for protein by 19.5 percent. Table 10 incorporates the nutrient composition shares from Tables 5 and 6 and the percent changes in gross revenues for the nutrient groups from Table 9 to calculate the changes

in gross revenue for the agricultural products under the assumption that there is little substitution between the nutrient groups.

Overall, Table 10 shows that as the substitutability of nutrients decreases, the revenue impacts from compliance with the various dietary recommendations are larger for most crops. The crops that previously saw an increase in gross revenue in Table 9 will see a greater increase in gross revenue in Table 10, and crops that previously saw a decrease in gross revenue in Table 9 will see a greater decrease in gross revenue in Table 10. For example, Table 8 reported that compliance with the Harvard regime would increase gross revenue for romaine lettuce by 67.3 percent and in Table 10 gross revenue would increase by 113.9 percent. For 38 of the agricultural products gross revenue would increase the most under compliance with the Harvard regime, and again, six of the seven diet regimes would increase gross revenues for nearly all of California's specialty crops. The order of the rankings changes slightly from Table 9, and the diet regime that is best for almonds and honey changes in Table 10. Almond revenue would see the greatest increase under compliance with the Atkins regime followed by the Mediterranean regime, and honey revenue would see the greatest increase under compliance with the 1992 USDA FGP.

Research Extensions

This study examined how various food recommendation models affect the demand for nutrients rather than food groups, and this itself is an extension of earlier research in this field. Two related research areas that deserve additional work are: i) consideration of additional sub-nutrient groups in the analysis, and ii) calculating the amount of key phytochemicals in agricultural products and understanding the role of phytochemicals in various dietary regimes.

Both research extensions would expand upon our list of 15 nutrients to assess how adding, or further disaggregating, macronutrients and micronutrients would affect our results.

Examining sub-nutrients in the carbohydrate category might shed some light on the different recommendations for simple and complex sugars, and help to further distinguish between agricultural products. The presence of phytochemicals naturally found in many specialty crops is something that is generating much interest (see Debusk et al. 2005).

Recommendations for increased consumption of phytochemicals has the potential to increase the demand for specialty crops rich in phytochemicals. Incorporating existing or potential recommendations concerning phytochemicals is a natural extension of our analysis. We expect that further increases in consumption of agricultural products containing phytochemicals would increase the demand for many of California's specialty crops.

An Extension to Consider Additional Sub-Nutrient Groups

At the onset of this project, our intent was to break each macronutrient group down into its most basic components. The carbohydrates category can be broken down into monosaccharides, disaccharides, starch, and fiber, with the fiber category being broken down further into soluble fiber and insoluble fiber. Ideally, we would have had information for all sub-nutrient groups. However, once we started collecting nutrient information for the 50 commodities, specific nutrient data for sub-nutrients within the carbohydrate group were missing in the USDA National Nutrient Database for Standard Reference.

Data on the nutrient content of all foods within the USDA database are limiting with respect to monosaccharides, disaccharides, and total starch content. For some agricultural products, complete data were available, but not for all. Likewise, the programs used to evaluate

the nutrient content of the various diets were not consistent with the USDA database. Because of these complications, we were not able to further subdivide the carbohydrates category.

Similarly, there was inadequate information on the types of dietary fibers in every food item within the USDA database. Dietary fiber can be classified into soluble fiber and insoluble fiber. Each type of fiber carries out specific functions in the intestinal track and imparts certain health benefits. Many fiber-rich foods contain both types of fiber, but are generally regarded as a good source for one or the other. Presently, nutrition professionals are moving away from distinguishing fiber according to solubility and do not make specific recommendations as to how much of each type of fiber is considered healthy. To be consistent with current practices among nutrition professionals and because of the limitation of the USDA nutrient database, we included only total dietary fiber and did not subdivide this group. These complications left us with a total carbohydrate category and a total fiber category.

With better information available, our research could be extended to examine how the seven diet regimes would change the demand for specific types of carbohydrates. There is reason to consider sub-nutrient groups within the carbohydrate group as research has suggested that consumption of simple sugars, specifically consumption of fructose and high fructose corn syrup, is associated with health risks such as obesity, aging, diabetes, and hypertriglyceridemia (Bray 2004; Bray, Nielsen, and Popkin 2004; Gaby 2005). Simple sugars include monosaccharides and disaccharides and are found in fresh and processed fruits, snack foods, and sweeteners. The simple sugars in fresh fruits are not usually associated with any health problems, however, processed foods that contain sweeteners are typically discouraged under most healthy eating plans.

Our analysis examined saturated fats, monounsaturated fats, Omega 3 and Omega 6 polyunsaturated fats, and other polyunsaturated fats but not trans-fats. Trans-fats come primarily from foods that are made with hydrogenated vegetable oils and are associated with chronic diseases such as heart disease and possibly cancer. As of January 1, 2006, the Food and Drug Administration has mandated that all food companies include trans-fats in their nutritional labeling. Because of this, many food companies have made the necessary modifications to their products to get the hydrogenated fat, and therefore the trans-fats, out of their products. Labeling of trans-fats has made consumers more aware of the health risks associated with consumption of trans-fats, and there have been signs that some consumers have begun to modify their diets to avoid foods high in trans-fat.

An Extension to Consider Phytochemicals

One of the most interesting and dynamic areas of research in nutrition is in the area of phytochemicals. Phytochemicals are non-nutritive plant compounds which confer health benefits in humans. These chemicals offer protection to the plants themselves, and many offer protection against chronic diseases in humans as well. There are over a thousand phytochemicals, each with specific actions. Phytochemicals have been characterized as antioxidants and include many positive effects for human health including stimulation of enzymes, hormonal action, interference with DNA, and antibacterial action.

While there presently are no recommendations for specific levels of phytochemicals in the diet, consuming a diet that meets the recommendations for fruits, vegetables, and whole grains would certainly include significant amounts of these compounds. With vast research in this area and in the area of biotechnology, we may see agricultural products engineered to

contain higher levels of specific phytochemicals in the future (Hausler 1998; American Dietetic Association 1999; Milner 2002; Debusk et al. 2005).

Another provocative area of nutrition research is in nutritional genomics. This is the study of how nutrition, or specific components of the diet, can affect gene expression and thus affect disease risk. Most chronic diseases have a genetic component as well as an environmental component to their risk profiles. It is plausible that in the future we will see foods developed that will have more or less of a particular compound (such as a specific phytochemical) and marketed to people from a nutritional genomics platform (Debusk et al. 2005).

Consistent with the present study, it would be of interest to incorporate phytochemical information to understand how consumer compliance with phytochemical recommendations would affect specialty crop markets in California. As a beginning, we could start with some of the phytochemicals for which there is substantial research on health-related benefits such as those listed in Table 6, namely β -Carotene, flavonoids, isoflavones, lutein, lycopene, isothiocyanates, zeaxanthin, ellagic acid, limonoids, and allyl sulfides.

Food sources for many phytochemicals have been identified, however, content of all food sources have not been quantified. The USDA has databases on the β -Carotene content and the flavonoid content of selected foods, but these are not complete. Data does not exist on the phytochemical content of all foods. For these reasons, it was not possible for us to do this type of analysis in the present study. Table 6 indicates with asterisks the agricultural commodities that contain specific quantities of 10 selected phytochemicals. These lists are not all inclusive, but represent foods that are known to be good sources of each of the compounds.

Industry and Policy Implications

The purpose of this study was threefold: i) to review and assess various food recommendation models (or dietary regimes) in terms of their nutrient recommendations, ii) to develop a framework for evaluating the implications that consumer compliance with each diet would have for selected nutrient groups, and iii) to understand how consumer compliance with the diet regimes would affect gross revenues for the 50 highest-value agricultural products (many of which are specialty crops) in California. This research was designed, and its intent was, to answer questions that would be relevant to both growers of specialty crops and policy makers interested in the potential benefits of increased compliance with nutritional recommendations.

Our results show that consumer compliance with six of the seven diet regimes, all except the Atkins regime, would generate additional revenue for most of the specialty crops grown in California. For 38 of the 50 agricultural products analyzed it was compliance with the Harvard regime that would generate the most additional revenue. However, compliance with two USDA regimes, the Mayo Clinic regime, the Mediterranean regime, and the DASH regime showed results that closely trailed those for the Harvard regime.

This research makes two important contributions to our understanding of the implications of better compliance with nutritional recommendations for specialty crop producers. First, we consider the economic effects of compliance with seven dietary regimes that have been widely promoted in the United States. Prior research examined only compliance with the USDA FGP, a cancer prevention diet, diets that included 5 and 7 servings of fruit and vegetables per day, and a WHO-based diet. Second, given consumer compliance with nutritional recommendations, we assessed the changes in gross revenues for agricultural products considering the nutrient composition of those products. This approach has not been used previously in this area of

research, and it is a novel way of evaluating the economic implications for specific agricultural products that had previously been aggregated into food groups.

U.S. consumers have become more aware of the ingredients in food products and the nutrient composition of agricultural products. Our work follows this lead, and shows how consumer compliance with seven different nutritional recommendations would affect the gross revenue for producers of specialty crops in California. The modeling approach and the results are outlined such that they can be understood by a wide audience, and therefore we anticipate that our research will be of immediate interest to both industry stakeholders and policy makers in California, and elsewhere.

Figure 1: An Illustration of How Shifts in Demand Affect Producer Revenue

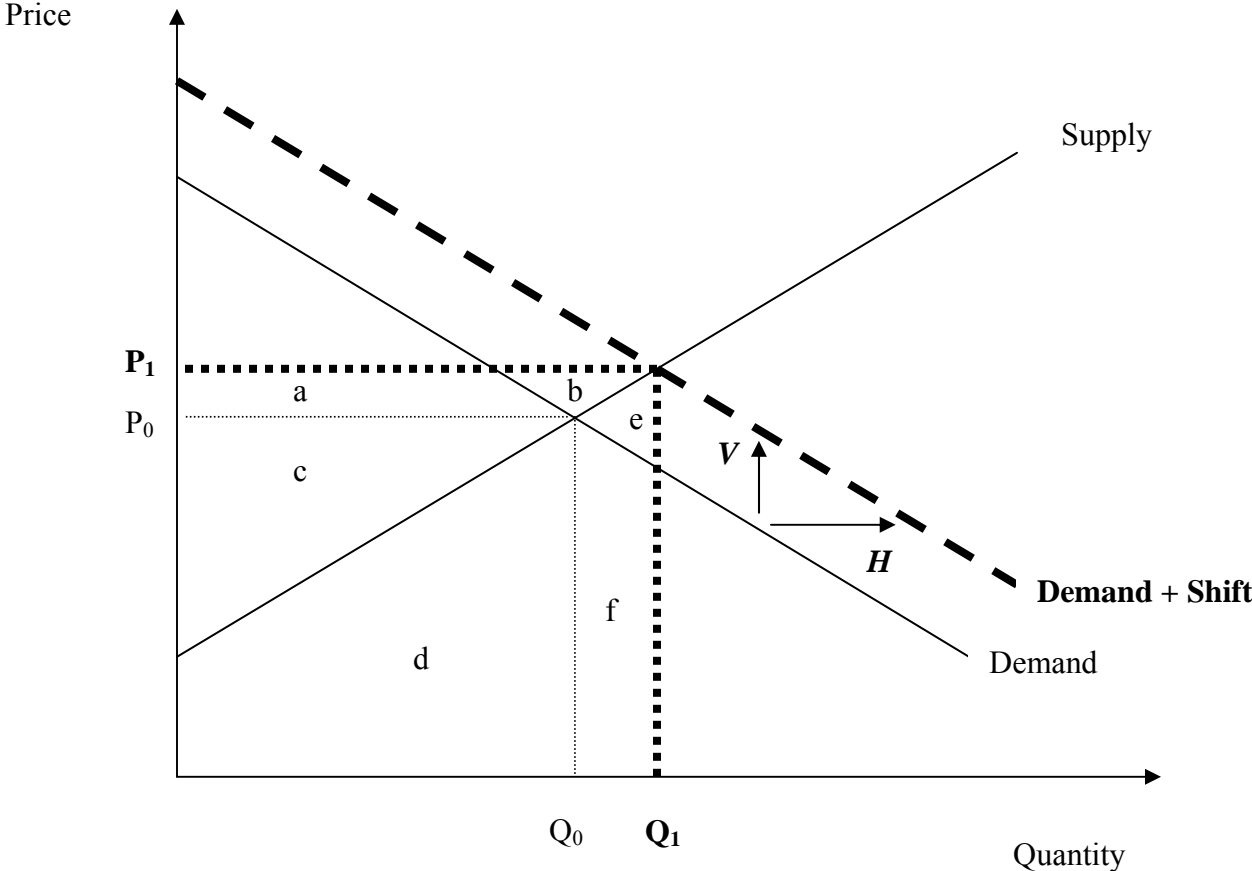


Table 1: Comparison of Nutrient Content of Various Recommended Diet Patterns

Nutrients^a		USDA FGP 1992	Harvard	Mayo Clinic	Mediterranean	Atkins	DASH	My Pyramid 2005
Macronutrients								
Protein	g	92.9	94.6	82.9	123.6	131.2	104.5	98.0
CHO	g	291.3	281.5	281.1	294.6	45.2	287.1	264.0
Fiber	g	28.8	57.4	42.8	39.6	13.0	30.6	31.0
SFA	g	16.6	10.4	16.8	15.2	36.9	13.7	16.0
MUFA	g	22.3	22.7	30.6	21.7	53.7	21.9	23.0
Omega 3s	g	1.6	1.5	1.6	0.9	0.5	0.6	1.1
Omega 6s	g	16.1	11.3	9.8	8.4	6.3	9.4	21.0
Other PUFA ^b	g	0.4	1.2	2.0	1.1	8.3	1.4	0.9
Cholesterol	mg	223.8	38.5	118.1	150.9	856.6	188.0	207.0
Micronutrients								
Vitamin A	mcg RE	1321.3	2997.0	2979.3	1245.3	906.5	1231.4	1430.0
Vitamin C	mg	163.7	273.8	303.8	196.7	61.0	166.2	190.0
Vitamin E	mg TE	8.3	9.7	13.2	9.0	8.1	12.8	18.9
Calcium	mg	1159.3	846.4	1015.7	1291.0	650.7	1047.5	1389.0
Iron	mg	19.4	27.9	17.3	19.4	14.5	17.9	21.0
Sodium	mg	2086.4	1843.9	2099.2	2328.9	2771.0	2324.3	1948.0

^a CHO denotes carbohydrates; SFA denotes saturated fatty acids; MUFA denotes monounsaturated fatty acids; Omega 3s denotes omega 3 fatty acids; Omega 6s denotes omega 6 fatty acids; PUFA denotes polyunsaturated fatty acids.

^b Other PUFA= (Total PUFA – Omega 3s – Omega 6s)

Table 2: Current Consumption Patterns and Shares for Selected Nutrients

Nutrients ^a		Current Consumption Patterns ^b	Consumption Shares (%)
<i>Micronutrients</i>			
Protein	g	75.0	17.4
CHO	g	255.0	59.3
Fiber	g	15.4	3.6
SFA	g	26.0	6.1
MUFA	g	29.0	6.7
Omega 3s	g	1.3	0.3
Omega 6s	g	12.9	3.0
Other PUFA ^c	g	15.0	3.5
Cholesterol	mg	256.0	0.1
<i>Macronutrients</i>			
Vitamin A	mcg RE	1445.0	19.7
Vitamin C	mg	100.0	13.7
Vitamin E	mg TE	8.0	6.5
Calcium	mg	801.0	9.8
Iron	mg	15.4	23.6
Sodium	mg	3271.0	26.7

^a CHO denotes carbohydrates; SFA denotes saturated fatty acids; MUFA denotes monounsaturated fatty acids; Omega 3s denotes omega 3 fatty acids; Omega 6s denotes omega 6 fatty acids; PUFA denotes polyunsaturated fatty acids.

^b Consumption patterns were taken from the Continuing Survey of Food Intake by Individuals (CSFII) 1996-1998, a nationwide survey conducted by the Agricultural Research Service of the United States Department of Agriculture in 1997.

^c Other PUFA= (Total PUFA – Omega 3s – Omega 6s)

Table 3: Percent Change from Current Consumption Patterns to Meet Proposed Diet Recommendations

Nutrients^a	USDA FGP 1992	Harvard	Mayo Clinic	Mediterranean	Atkins	DASH	My Pyramid 2005
<i>—Percent Change Required in Consumption—</i>							
Macronutrients							
Protein	23.9	26.1	10.6	64.8	74.9	39.3	30.7
CHO	14.2	10.4	10.3	15.5	-82.3	12.6	3.5
Fiber	86.7	272.7	178.1	157.1	-16.2	98.5	101.3
SFA	-36.3	-59.9	-35.4	-41.4	42.2	-47.1	-38.5
MUFA	-23.2	-21.8	5.7	-25.2	85.2	-24.4	-20.7
Omega 3s	22.3	12.3	21.5	-30.8	-61.5	-52.3	-15.4
Omega 6s	24.4	-12.6	-23.7	-34.9	-51.2	-27.2	62.8
Other PUFA ^b	-97.7	-91.9	-86.7	-92.7	-44.9	-90.7	-94.0
Cholesterol	-12.6	-84.7	-53.9	-41.1	234.6	-26.6	-19.1
Micronutrients							
Vitamin A	-8.6	107.4	106.2	-13.8	-37.3	-14.8	-1.0
Vitamin C	63.7	173.8	203.8	96.7	-38.9	66.2	90.0
Vitamin E	3.1	21.0	65.5	12.5	1.5	60.6	136.3
Calcium	44.7	5.7	26.8	61.2	-18.8	30.8	73.4
Iron	26.1	81.4	12.0	25.9	-6.0	16.4	36.4
Sodium	-36.2	-43.6	-35.8	-28.8	-15.3	-28.9	-40.5

^a CHO denotes carbohydrates; SFA denotes saturated fatty acids; MUFA denotes monounsaturated fatty acids; Omega 3s denotes omega 3 fatty acids; Omega 6s denotes omega 6 fatty acids; PUFA denotes polyunsaturated fatty acids.

^b Other PUFA= (Total PUFA – Omega 3s – Omega 6s)

Table 4a: Nutrient Content^a of the Top 50 Commodities in California by Serving Size

		Milk		Grapes	Beef	Romaine Lettuce	Almonds	Oranges	Strawberries	Canned Tomatoes	Rice	Broccoli
		Fat-Free	Whole									
<i>Ranking^b</i>		<i>1</i>	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>	<i>7</i>	<i>8</i>	<i>9</i>	<i>10</i>
Quantity		8	8	0.5	4	1	1	1	1	0.5	0.25	0.5
Measure		ounce	ounce	cup	ounce	cup	ounce	each	cup	cup	cup	cup
Nutrients^c												
Protein	g	8.3	8.0	0.6	17.8	0.7	6.0	1.3	0.9	0.9	3.3	1.2
CHO	g	12.2	12.0	14.5	0.0	1.8	5.7	17.6	11.1	4.7	36.9	2.9
Fiber	g	0	0	0.7	0.0	1.2	3.5	3.1	2.9	1.1	0.6	1.1
SFA	g	0.3	4.6	0.04	10.7	0.02	1.1	0.02	0.02	0.02	0.1	0.01
MUFA	g	0.1	2.0	0.01	12.4	0.01	9.1	0.04	0.1	0.02	0.1	0
Omega 3s	g	0.01	0.3	0.01	0.6	0.1	0	0.01	0.1	0	0.01	0.01
Omega 6s	g	0.01	0.3	0.03	0.1	0.03	3.3	0.03	0.1	0.1	0.1	0.01
Other PUFA ^d	g	0.01	0	0	0.7	0	0	0	0.01	0.01	0.1	0
Cholesterol	mg	5.0	24.0	0	85.0	0	0	0	0	0	0	0
Vitamin A	mcg RE	149.0	60.0	4.8	0	324.8	0	33.6	2.9	35.4	0	15.0
Vitamin C	mg	0	1.2	8.6	0	13.4	0	82.7	84.7	4.7	0	39.0
Vitamin E	mg TE	0.02	0.2	0.2	0.5	0.07	7.3	0.2	0.4	0.3	0.1	0.3
Calcium	mg	306.0	276.0	8.0	24.0	18.5	70.0	60.2	23.0	17.2	13.0	21.0
Iron	mg	0.1	0	0.3	2.0	0.5	1.2	0.2	0.6	0.7	0.4	0.3
Sodium	mg	103.1	98.0	1.6	76.0	4.5	0	1.4	1.4	66.7	2.0	15.0

^a USDA National Nutrient Database for Standard Reference, 2004.

^b CDFA Summary of County Agricultural Commissioners' Reports.

^c CHO denotes carbohydrates; SFA denotes saturated fatty acids; MUFA denotes monounsaturated fatty acids; Omega 3s denotes omega 3 fatty acids; Omega 6s denotes omega 6 fatty acids; PUFA denotes polyunsaturated fatty acids.

^d Other PUFA= (Total PUFA – Omega 3s – Omega 6s)

Table 4b: Nutrient Content^a of the Top 50 Commodities in California by Serving Size

		Salad Greens	Peaches	Chicken	Avocados	Pistachios	Walnuts	Lemons	Celery	Egg	Plums
<i>Ranking^b</i>		11	12	13	14	15	16	17	18	19	20
Quantity		1	1	4	1	1	1	1	1	1	1
Measure		cup	each	ounce	each	ounce	ounce	each	each	each	each
Nutrients^c											
Protein	g	0.9	1.4	26.2	3.4	5.8	4.3	0.9	0.3	6.3	0.5
CHO	g	1.6	15.0	0	14.9	7.9	3.9	7.8	1.2	0.4	7.5
Fiber	g	1.2	2.4	0	11.8	2.9	1.9	2.4	0.1	0	0.9
SFA	g	0.02	0.03	0.4	3.7	1.5	1.7	0.03	0.02	1.6	0.01
MUFA	g	0	0.1	0.3	16.9	6.6	2.5	0.01	0.01	1.9	0.1
Omega 3s	g	0.04	0	0.03	0.2	0.1	2.6	0.02	0	0.04	0
Omega 6s	g	0.02	0.1	0.2	2.9	3.7	10.8	0.1	0.03	0.6	0.03
Other PUFA ^d	g	0.01	0.01	0.1	0.4	0	0	0	0	0	0
Cholesterol	mg	0	0	65.8	0	0	0	0	0	211.5	0
Vitamin A	mcg RE	149.6	50.2	6.8	24.2	15.9	0.6	1.7	17.6	70.5	22.4
Vitamin C	mg	8.9	10.4	1.4	15.2	1.4	0.4	44.5	1.2	0	6.3
Vitamin E	mg TE	0.4	1.2	0.2	3.4	0.7	0.2	0.1	0.1	0.5	0.2
Calcium	mg	30.1	9.4	12.5	22.5	30.3	27.8	21.8	16.0	26.5	3.9
Iron	mg	0.7	0.4	0.8	1.1	1.2	0.8	0.5	0.1	0.9	0.1
Sodium	mg	14.0	0	73.7	13.8	0.3	0.6	1.7	32.0	70.0	0

^a USDA National Nutrient Database for Standard Reference, 2004.

^b CDFA Summary of County Agricultural Commissioners' Reports.

^c CHO denotes carbohydrates; SFA denotes saturated fatty acids; MUFA denotes monounsaturated fatty acids; Omega 3s denotes omega 3 fatty acids; Omega 6s denotes omega 6 fatty acids; PUFA denotes polyunsaturated fatty acids.

^d Other PUFA= (Total PUFA – Omega 3s – Omega 6s)

Table 4c: Nutrient Content^a of the Top 50 Commodities in California by Serving Size

		Nectarines	Onions	Potatoes	Tomatoes	Bell Peppers	Cauliflower	Spinach	Wheat	Turkey	Garlic
<i>Ranking^b</i>		21	22	23	24	25	26	27	28	29	30
Quantity		1	0.5	1	0.5	0.5	0.5	1	0.25	4	1
Measure		each	cup	each	each	each	cup	cup	cup	ounce	each
Nutrients^c											
Protein	g	1.4	0.7	4.3	0.8	0.7	1.0	0.9	6.1	22.8	0.2
CHO	g	14.4	8.1	37.2	3.6	3.8	2.7	1.1	34.2	0	1.0
Fiber	g	2.3	1.1	4.7	1.1	1.4	1.3	0.7	5.9	0	0.1
SFA	g	0.03	0.01	0.1	0.04	0.1	0.01	0.02	0.1	1.7	0
MUFA	g	0.1	0.01	0	0.04	0.01	0	0	0.1	1.1	0
Omega 3s	g	0	0	0.02	0	0.01	0.04	0.04	0.01	0.1	0
Omega 6s	g	0.2	0	0.1	0.1	0.04	0.01	0.01	0.3	1.4	0.01
Other PUFA ^d	g	0	0.04	0	0	0	0	0	0	0.03	0
Cholesterol	mg	0	0	0	0	0	0	0	0	78.2	0
Vitamin A	mcg RE	46.2	0.2	0.4	76.4	29.5	1.0	281.4	0.4	0	0
Vitamin C	mg	7.3	5.1	41.9	11.6	65.9	23.2	8.4	0	0	0.9
Vitamin E	mg TE	1.1	0.02	0.02	0.5	0.3	0.04	0.6	0.5	0.8	0
Calcium	mg	8.2	17.6	25.6	9.1	8.2	11.0	29.7	13.9	19.3	5.4
Iron	mg	0.4	0.2	1.7	0.3	0.3	0.2	0.8	1.5	2.0	0.1
Sodium	mg	0	2.4	12.8	4.6	2.5	15.0	23.7	0.9	87.3	0.5

^a USDA National Nutrient Database for Standard Reference, 2004.

^b CDFA Summary of County Agricultural Commissioners' Reports.

^c CHO denotes carbohydrates; SFA denotes saturated fatty acids; MUFA denotes monounsaturated fatty acids; Omega 3s denotes omega 3 fatty acids; Omega 6s denotes omega 6 fatty acids; PUFA denotes polyunsaturated fatty acids.

^d Other PUFA= (Total PUFA – Omega 3s – Omega 6s)

Table 4d: Nutrient Content^a of the Top 50 Commodities in California by Serving Size

		Cherries	Cantaloupe	Mushrooms	Dried Plums	Apples	Carrots	Pears	Asparagus	Pink Beans	Sweet Potatoes
<i>Ranking^b</i>		31	32	33	34	35	36	37	38	39	40
Quantity		0.5	1	0.5	1	1	1	1	0.5	0.25	1
Measure		cup	cup	cup	each	each	each	each	cup	cup	each
Nutrients^c											
Protein	g	0.8	1.3	1.5	0.5	0.4	0.7	0.6	1.5	11.0	2.0
CHO	g	11.6	13.1	1.6	24.9	19.1	6.9	25.7	2.6	33.7	22.9
Fiber	g	1.5	1.4	0.6	4.9	3.3	2.2	5.2	1.4	6.7	3.9
SFA	g	0.03	0.1	0.02	0.1	0.04	0.02	0.01	0.03	0.2	0.02
MUFA	g	0.03	0	0	0.1	0.01	0.01	0.04	0	0.1	0
Omega 3s	g	0.02	0.1	0	0	0.01	0	0	0.01	0.1	0
Omega 6s	g	0.02	0.1	0.1	0.1	0.1	0.1	0.1	0.03	0.1	0.02
Other PUFA ^d	g	0	0	0.01	0.01	0	0	0	0.01	0	0
Cholesterol	mg	0	0	0	0	0	0	0	0	0	0
Vitamin A	mcg RE	4.4	540.8	0	25.8	8.3	866.9	3.3	50.9	0	1890.0
Vitamin C	mg	5.1	58.7	1.2	0	6.4	4.3	7.0	3.8	0	29.5
Vitamin E	mg TE	0.1	0.1	0	0.3	0.3	0.5	0.2	0.8	0.1	0.3
Calcium	mg	9.4	14.4	1.4	8.5	8.3	23.8	14.9	16.1	68.3	39.0
Iron	mg	0.3	0.3	0.3	0.3	0.2	0.2	0.3	1.4	3.6	0.8
Sodium	mg	0	25.6	1.9	0.7	1.4	49.7	1.7	1.3	4.2	16.9

^a USDA National Nutrient Database for Standard Reference, 2004.

^b CDFA Summary of County Agricultural Commissioners' Reports.

^c CHO denotes carbohydrates; SFA denotes saturated fatty acids; MUFA denotes monounsaturated fatty acids; Omega 3s denotes omega 3 fatty acids; Omega 6s denotes omega 6 fatty acids; PUFA denotes polyunsaturated fatty acids.

^d Other PUFA= (Total PUFA – Omega 3s – Omega 6s)

Table 4e: Nutrient Content^a of the Top 50 Commodities in California by Serving Size

		Corn	Olives	Dates	Watermelon	Lamb	Apricots	Honey	Grapefruit	Honeydew	Artichokes
<i>Ranking^b</i>		41	42	43	44	45	46	47	48	49	50
Quantity		1	0.25	0.5	1	4	1	1	1	1	1
Measure		ear	cup	cup	cup	ounce	each	Tbsp	each	cup	each
Nutrients^c											
Protein	g	4.6	0.3	2.2	0.9	23.7	0.5	0.1	1.9	0.9	5.3
CHO	g	27.2	2.1	66.8	11.5	0	3.9	17.5	26.2	15.5	17.0
Fiber	g	3.9	1.1	7.1	0.6	0	0.7	0.04	3.9	1.4	8.8
SFA	g	0.3	0.5	0.03	0.02	2.4	0.01	0	0.03	0.1	0.06
MUFA	g	0.5	2.7	0.03	0.1	2.7	0.1	0	0.03	0.01	0.01
Omega 3s	g	0.02	0.02	0	0	0.1	0	0	0.01	0.1	0.03
Omega 6s	g	0.8	0.3	0.01	0.1	0.5	0.03	0	0.1	0.04	0.1
Other PUFA ^d	g	0	0.01	0.01	0	0	0	0	0	0	0
Cholesterol	mg	0	0	0	0	74.8	0	0	0	0	0
Vitamin A	mcg RE	28.6	13.4	0.9	85.1	0	67.2	0	63.9	10.2	0
Vitamin C	mg	9.7	0.3	0.4	12.3	0	3.5	0.1	93.7	30.6	18.9
Vitamin E	mg TE	0.1	0.6	0.04	0.1	0.2	0.3	0	0.6	0.03	0.3
Calcium	mg	2.9	29.6	34.7	10.6	13.6	4.6	1.3	27.1	10.2	71.1
Iron	mg	0.7	1.1	0.9	0.4	2.2	0.1	0.1	0.2	0.3	2.1
Sodium	mg	21.5	293.0	1.8	1.5	77.1	0.4	0.9	2.5	30.6	152.3

^a USDA National Nutrient Database for Standard Reference, 2004.

^b CDFA Summary of County Agricultural Commissioners' Reports.

^c CHO denotes carbohydrates; SFA denotes saturated fatty acids; MUFA denotes monounsaturated fatty acids; Omega 3s denotes omega 3 fatty acids; Omega 6s denotes omega 6 fatty acids; PUFA denotes polyunsaturated fatty acids.

^d Other PUFA= (Total PUFA – Omega 3s – Omega 6s)

Table 5a: Macronutrient Shares of the Top 50 Commodities in California

	Milk		Grapes	Beef	Romaine Lettuce	Almonds	Oranges	Strawberries	Canned Tomatoes	Rice	Broccoli
	Fat-Free	Whole									
<i>Ranking^a</i>	<i>1</i>	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>	<i>7</i>	<i>8</i>	<i>9</i>	<i>10</i>
Macronutrients^b	— Shares (%) —										
Protein	39.6	29.4	3.8	42.2	25.9	24.0	6.7	7.8	18.4	8.1	32.2
CHO	58.3	44.1	90.8	0.0	25.2	7.9	76.5	66.3	58.7	89.6	38.4
Fiber	0	0.0	4.8	0.0	44.4	14.0	16.3	23.4	21.0	1.5	28.6
SFA	1.4	16.7	0.3	25.4	0.8	4.4	0.1	0.2	0.4	0.2	0.3
MUFA	0.6	7.4	0.1	29.3	0.4	36.5	0.2	0.5	0.4	0.2	0
Omega 3s	0	1.2	0.1	1.3	2.3	0	0.1	0.7	0	0.0	0.3
Omega 6s	0	1.1	0.2	0.2	1.1	13.2	0.2	1.1	1.0	0.2	0.3
Other PUFA ^c	0	0	0	1.6	0	0	0	0.1	0.2	0.2	0
Cholesterol	0	0.1	0	0.2	0	0	0	0	0	0	0

^a CDFA Summary of County Agricultural Commissioners’ Reports.

^b CHO denotes carbohydrates; SFA denotes saturated fatty acids; MUFA denotes monounsaturated fatty acids; Omega 3s denotes omega 3 fatty acids; Omega 6s denotes omega 6 fatty acids; PUFA denotes polyunsaturated fatty acids.

^c Other PUFA= (Total PUFA – Omega 3s – Omega 6s)

Table 5b: Macronutrient Shares of the Top 50 Commodities in California

	Salad Greens	Peaches	Chicken	Avocados	Pistachios	Walnuts	Lemons	Celery	Egg	Plums
<i>Ranking^a</i>	11	12	13	14	15	16	17	18	19	20
Macronutrients^b	— Shares (%) —									
Protein	33.7	8.3	96.0	8.0	22.7	16.7	10.4	24.3	57.0	5.7
CHO	17.2	76.2	0	7.5	19.4	7.7	61.9	65.2	3.5	81.4
Fiber	45.6	13.9	0	27.7	11.4	7.4	26.5	5.2	0.0	11.3
SFA	0.8	0.2	1.4	8.7	6.0	6.7	0.3	1.7	14.1	0.1
MUFA	0	0.6	1.2	39.9	25.7	9.8	0.1	0.9	17.3	1.1
Omega 3s	1.5	0	0.1	0.5	0.3	9.9	0.2	0	0.4	0
Omega 6s	0.8	0.8	0.9	6.8	14.5	41.8	0.6	2.6	5.8	0.4
Other PUFA ^c	0.4	0.1	0.2	0.8	0	0	0	0	0	0
Cholesterol	0	0	0.2	0	0	0	0	0	1.9	0

^a CDFA Summary of County Agricultural Commissioners' Reports.

^b CHO denotes carbohydrates; SFA denotes saturated fatty acids; MUFA denotes monounsaturated fatty acids; Omega 3s denotes omega 3 fatty acids; Omega 6s denotes omega 6 fatty acids; PUFA denotes polyunsaturated fatty acids.

^c Other PUFA= (Total PUFA – Omega 3s – Omega 6s)

Table 5c: Macronutrient Shares of the Top 50 Commodities in California

	Nectarines	Onions	Potatoes	Tomatoes	Bell Peppers	Cauliflower	Spinach	Wheat	Turkey	Garlic
<i>Ranking^a</i>	21	22	23	24	25	26	27	28	29	30
<i>Macronutrients^b</i>	— Shares (%) —									
Protein	9.0	8.3	10.3	17.5	15.4	26.8	42.8	14.8	84.0	16.0
CHO	74.8	78.4	78.1	54.2	52.2	37.8	20.9	69.5	0	78.2
Fiber	14.4	12.6	11.3	23.9	30.1	33.8	32.8	14.4	0	5.0
SFA	0.2	0.1	0.1	0.9	1.1	0.3	1.0	0.3	6.2	0
MUFA	0.7	0.1	0	0.9	0.2	0	0	0.2	4.1	0
Omega 3s	0	0	0	0	0.2	1.1	2.0	0.0	0.3	0
Omega 6s	0.9	0	0.2	2.6	0.9	0.3	0.5	0.7	5.1	0.8
Other PUFA ^c	0	0.5	0	0	0	0	0	0	0.1	0
Cholesterol	0	0	0	0	0	0	0	0	0.3	0

^a CDFA Summary of County Agricultural Commissioners' Reports.

^b CHO denotes carbohydrates; SFA denotes saturated fatty acids; MUFA denotes monounsaturated fatty acids; Omega 3s denotes omega 3 fatty acids; Omega 6s denotes omega 6 fatty acids; PUFA denotes polyunsaturated fatty acids.

^c Other PUFA= (Total PUFA – Omega 3s – Omega 6s)

Table 5d: Macronutrient Shares of the Top 50 Commodities in California

	Cherries	Cantaloupe	Mushrooms	Dried Plums	Apples	Carrots	Pears	Asparagus	Pink Beans	Sweet Potatoes
<i>Ranking^a</i>	31	32	33	34	35	36	37	38	39	40
Macronutrients^b	— Shares (%) —									
Protein	6.2	8.4	47.5	1.8	1.8	8.7	2.4	34.9	24.4	8.2
CHO	80.9	81.6	31.2	78.3	80.6	61.8	77.7	29.9	59.9	76.1
Fiber	12.2	8.7	18.5	19.3	16.9	28.2	19.5	33.3	14.8	15.6
SFA	0.2	0.5	0.6	0.2	0.2	0.3	0	0.7	0.3	0.1
MUFA	0.2	0	0	0.2	0.1	0.1	0.2	0	0.1	0
Omega 3s	0.2	0.4	0	0	0.1	0.0	0	0.2	0.3	0
Omega 6s	0.2	0.4	1.9	0.2	0.3	0.9	0.2	0.7	0.3	0.1
Other PUFA ^c	0	0	0.3	0	0	0	0	0.2	0	0
Cholesterol	0	0	0	0	0	0	0	0	0	0

^a CDFA Summary of County Agricultural Commissioners’ Reports.

^b CHO denotes carbohydrates; SFA denotes saturated fatty acids; MUFA denotes monounsaturated fatty acids; Omega 3s denotes omega 3 fatty acids; Omega 6s denotes omega 6 fatty acids; PUFA denotes polyunsaturated fatty acids.

^c Other PUFA= (Total PUFA – Omega 3s – Omega 6s)

Table 5e: Macronutrient Shares of the Top 50 Commodities in California

	Corn	Olives	Dates	Watermelon	Lamb	Apricots	Honey	Grapefruit	Honeydew	Artichokes
<i>Ranking^a</i>	41	42	43	44	45	46	47	48	49	50
<i>Macronutrients^b</i>	— Shares (%) —									
Protein	13.8	4.8	3.2	7.4	80.3	9.5	0.3	8.3	5.6	23.6
CHO	70.0	17.7	86.4	86.5	0	75.1	99.4	74.1	85.2	36.8
Fiber	11.6	18.5	10.3	4.9	0	13.5	0.2	17.1	8.2	38.9
SFA	0.8	8.2	0	0.2	8.2	0.2	0	0.1	0.4	0.3
MUFA	1.5	45.5	0	0.5	9.2	1.2	0	0.1	0.1	0
Omega 3s	0.1	0.3	0	0	0.3	0	0	0	0.4	0.1
Omega 6s	2.3	4.8	0	0.6	1.8	0.6	0	0.2	0.2	0.3
Other PUFA ^c	0	0.2	0	0	0	0	0	0	0	0
Cholesterol	0	0	0	0	0.3	0	0	0	0	0

^a CDFA Summary of County Agricultural Commissioners' Reports.

^b CHO denotes carbohydrates; SFA denotes saturated fatty acids; MUFA denotes monounsaturated fatty acids; Omega 3s denotes omega 3 fatty acids; Omega 6s denotes omega 6 fatty acids; PUFA denotes polyunsaturated fatty acids.

^c Other PUFA= (Total PUFA – Omega 3s – Omega 6s)

Table 6a: Micronutrient Shares^a and Phytochemical^b Content of the Top 50 Commodities in California

	Milk		Grapes	Beef	Romaine Lettuce	Almonds	Oranges	Strawberries	Canned Tomatoes	Rice	Broccoli
	Fat-Free	Whole									
<i>Ranking^c</i>	<i>1</i>	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>	<i>7</i>	<i>8</i>	<i>9</i>	<i>10</i>
<i>Micronutrients</i>	— Shares (%) —										
Vitamin A	30.1	16.1	3.4	0.0	59.8	0	3.5	0.3	15.5	0	5.7
Vitamin C	0	3.2	61.3	0.0	24.7	0	87.2	87.8	20.4	4.5	77.6
Vitamin E	0.2	0	6.4	9.4	0.8	68.7	1.3	2.6	7.1	0	4.1
Calcium	55.6	60.5	5.1	6.6	3.1	9.8	5.7	2.2	6.8	10.3	3.7
Iron	1.6	0	23.1	69.9	11.2	21.4	2.1	7.0	32.6	80.3	7.2
Sodium	12.5	20.2	0.7	14.0	0.5	0	0.1	0.1	17.6	4.9	1.7
<i>Phytochemicals</i>											
β-Carotene											
Flavonoids			*								*
Isoflavones											
Lutein											*
Lycopene									*		
Isothiocyanates											*
Zeaxanthin											
Ellagic Acid								*			
Limonoids							*				
Allyl Sulfides											

^a Using the Dietary Reference Intake (DRI) for each micronutrient, the shares represent the micronutrient content per serving. DRI information was taken from the Institute of Medicine of the National Academies of Sciences, National Academy Press.

^b Presence of phytochemicals in selected commodities is denoted with an asterisk.

^c CDFA Summary of County Agricultural Commissioners' Reports.

Table 6b: Micronutrient Shares^a and Phytochemical^b Content of the Top 50 Commodities in California

	Salad Greens	Peaches	Chicken	Avocados	Pistachios	Walnuts	Lemons	Celery	Egg	Plums
<i>Ranking^c</i>	11	12	13	14	15	16	17	18	19	20
<i>Micronutrients</i>	— Shares (%) —									
Vitamin A	39.6	18.3	3.8	4.6	6.9	0.4	0.3	22.2	26.4	20.2
Vitamin C	23.5	37.7	7.7	28.8	6.2	2.8	83.8	15.7	0	56.3
Vitamin E	6.0	25.1	5.1	38.7	17.0	9.0	1.5	8.3	10.8	9.2
Calcium	7.2	3.1	6.3	3.8	11.9	18.7	3.7	18.2	8.9	3.2
Iron	21.5	15.9	52.1	22.6	57.9	68.9	10.6	11.4	38.3	11.1
Sodium	2.2	0	25.0	1.6	0.1	0.3	0.2	24.2	15.7	0
<i>Phytochemicals</i>										
β-Carotene		*								
Flavonoids										
Isoflavones										
Lutein										
Lycopene										
Isothiocyanates										
Zeaxanthin	*									
Ellagic Acid						*				
Limonoids							*			
Allyl Sulfides										

^a Using the Dietary Reference Intake (DRI) for each micronutrient, the shares represent the micronutrient content per serving. DRI information was taken from the Institute of Medicine of the National Academies of Sciences, National Academy Press.

^b Presence of phytochemicals in selected commodities is denoted with an asterisk.

^c CDFA Summary of County Agricultural Commissioners' Reports.

Table 6c: Micronutrient Shares^a and Phytochemical^b Content of the Top 50 Commodities in California

	Nectarines	Onions	Potatoes	Tomatoes	Bell Peppers	Cauliflower	Spinach	Wheat	Turkey	Garlic
<i>Ranking^c</i>	21	22	23	24	25	26	27	28	29	30
<i>Micronutrients</i>	— Shares (%) —									
Vitamin A	19.9	0.2	0.1	29.4	3.9	0.4	52.7	0.2	0	0
Vitamin C	31.5	59.0	65.7	44.4	88.2	83.1	15.8	0	0	46.5
Vitamin E	27.1	1.4	0.2	11.3	2.4	0.9	6.9	13.4	14.3	0
Calcium	3.2	18.3	3.6	3.1	1.0	3.6	5.0	5.8	5.1	24.2
Iron	18.4	19.5	29.2	10.8	4.2	8.9	17.1	80.3	65.3	27.8
Sodium	0	1.7	1.2	1.1	0.2	3.2	2.7	0.3	15.4	1.5
<i>Phytochemicals</i>										
β-Carotene	*						*			
Flavonoids		*								
Isoflavones										
Lutein							*			
Lycopene				*						
Isothiocyanates						*				
Zeaxanthin							*			
Ellagic Acid										
Limonoids										
Allyl Sulfides		*								*

^a Using the Dietary Reference Intake (DRI) for each micronutrient, the shares represent the micronutrient content per serving. DRI information was taken from the Institute of Medicine of the National Academies of Sciences, National Academy Press.

^b Presence of phytochemicals in selected commodities is denoted with an asterisk.

^c CDFA Summary of County Agricultural Commissioners' Reports.

Table 6d: Micronutrient Shares^a and Phytochemical^b Content of the Top 50 Commodities in California

	Cherries	Cantaloupe	Mushrooms	Dried Plums	Apples	Carrots	Pears	Asparagus	Pink Beans	Sweet Potatoes
<i>Ranking^c</i>	31	32	33	34	35	36	37	38	39	40
<i>Micronutrients</i>	— Shares (%) —									
Vitamin A	4.5	45.1	0	31.4	7.3	85.5	2.5	16.4	0	80.8
Vitamin C	52.9	48.9	27.3	0	55.6	4.2	53.2	12.1	0	12.6
Vitamin E	3.1	0.4	0	24.8	13.1	2.8	9.2	14.7	1.5	0.9
Calcium	8.9	1.1	3.1	9.3	6.5	2.1	10.3	4.7	13.1	1.5
Iron	30.5	3.2	66.9	34.1	16.7	2.4	24.1	51.9	84.9	3.8
Sodium	0	1.3	2.7	0.5	0.7	2.9	0.8	0.3	0.5	0.4
<i>Phytochemicals</i>										
β-Carotene		*				*				*
Flavonoids	*				*					
Isoflavones									*	
Lutein										
Lycopene										
Isothiocyanates										
Zeaxanthin										
Ellagic Acid										
Limonoids										
Allyl Sulfides										

^a Using the Dietary Reference Intake (DRI) for each micronutrient, the shares represent the micronutrient content per serving. DRI information was taken from the Institute of Medicine of the National Academies of Sciences, National Academy Press.

^b Presence of phytochemicals in selected commodities is denoted with an asterisk.

^c CDFA Summary of County Agricultural Commissioners' Reports.

Table 6e: Micronutrient Shares^a and Phytochemical^b Content of the Top 50 Commodities in California

	Corn	Olives	Dates	Watermelon	Lamb	Apricots	Honey	Grapefruit	Honeydew	Artichokes
<i>Ranking^c</i>	41	42	43	44	45	46	47	48	49	50
<i>Micronutrients</i>	— Shares (%) —									
Vitamin A	12.4	3.6	0.6	32.2	0	47.7	0	5.9	2.7	0
Vitamin C	42.2	0.8	2.5	46.6	0	24.9	8.5	86.3	80.9	31.8
Vitamin E	2.6	8.8	1.7	1.8	4.2	13.2	0	3.4	0.5	3.1
Calcium	1.1	7.1	22.1	3.6	3.9	2.9	8.9	2.2	2.4	10.8
Iron	36.1	33.2	72.3	15.3	77.3	11.2	78.6	2.1	8.6	39.0
Sodium	5.6	46.7	0.8	0.4	14.7	0.2	3.9	0.1	4.9	15.3
<i>Phytochemicals</i>										
β-Carotene						*				
Flavonoids										
Isoflavones										
Lutein										
Lycopene				*		*				
Isothiocyanates										
Zeaxanthin	*									
Ellagic Acid										
Limonoids								*		
Allyl Sulfides										

^a Using the Dietary Reference Intake (DRI) for each micronutrient, the shares represent the micronutrient content per serving. DRI information was taken from the Institute of Medicine of the National Academies of Sciences, National Academy Press.

^b Presence of phytochemicals in selected commodities is denoted with an asterisk.

^c CDFA Summary of County Agricultural Commissioners' Reports.

Table 7: Percent Change in Nutrient Revenues under Alternative Diet Recommendations (Some Nutrient Substitution)

Nutrients ^a	USDA FGP 1992	Harvard	Mayo Clinic	Mediterranean	Atkins	DASH	My Pyramid 2005
	—Percent change in gross revenue—						
Macronutrients							
Protein	13.6	15.0	6.8	35.4	32.3	21.2	16.4
CHO	8.7	7.2	6.6	10.7	-46.4	7.8	2.8
Fiber	45.0	138.6	90.7	81.7	-13.3	50.9	51.7
SFA	-16.6	-28.0	-16.2	-17.8	16.0	-22.1	-18.3
MUFA	-10.1	-9.0	4.3	-9.7	37.5	-10.7	-9.4
Omega 3s	12.7	8.1	12.3	-12.5	-36.0	-24.7	-6.7
Omega 6s	13.8	-4.3	-10.4	-14.5	-30.8	-12.1	32.4
Other PUFA ^b	-47.4	-44.1	-41.9	-43.5	-27.7	-43.9	-46.1
Cholesterol	-4.7	-40.6	-25.5	-17.6	112.3	-11.8	-8.6
Micronutrients							
Vitamin A	-4.1	66.6	65.4	-6.4	-23.2	-7.6	1.9
Vitamin C	37.2	104.5	121.2	56.8	-24.2	38.7	53.9
Vitamin E	2.6	17.2	42.1	8.6	-1.0	35.5	80.4
Calcium	26.3	8.4	20.0	36.5	-12.6	18.5	44.4
Iron	15.7	51.7	11.5	16.3	-5.3	10.2	23.3
Sodium	-19.9	-19.8	-15.8	-15.0	-10.6	-15.7	-20.7

^a CHO denotes carbohydrates; SFA denotes saturated fatty acids; MUFA denotes monounsaturated fatty acids; Omega 3s denotes omega 3 fatty acids; Omega 6s denotes omega 6 fatty acids; PUFA denotes polyunsaturated fatty acids.

^b Other PUFA= (Total PUFA – Omega 3s – Omega 6s)

Table 8a: Percent Change in Crop Revenues under Alternative Diet Recommendations (Some Nutrient Substitution)

Selected Crops Ranked by Value (1 to 25)	USDA FGP 1992	Harvard	Mayo Clinic	Mediterranean	Atkins	DASH	My Pyramid 2005
	<i>—Percent change in gross revenue—</i>						
Fat-Free Milk	10.2	10.4	7.5	19.8	-13.9	12.3	8.6
Whole Milk	5.0	2.9	3.6	11.6	-6.6	4.9	3.7
Grapes	11.4	16.9	14.1	16.2	-40.4	11.1	7.6
Beef	-1.4	-2.1	0.0	6.9	26.2	-0.4	0.0
Romaine Lettuce	25.1	67.3	45.1	45.8	-10.6	28.0	27.5
Almonds	7.7	18.7	15.3	14.5	11.8	7.5	14.1
Oranges	15.8	32.3	24.7	25.2	-34.8	16.6	13.6
Strawberries	18.3	41.1	30.2	29.8	-31.3	19.2	17.2
Canned Tomatoes	16.7	36.4	24.8	29.0	-23.7	18.5	16.1
Rice	9.8	11.4	8.1	13.8	-37.5	9.4	5.5
Broccoli	21.1	49.2	34.1	39.1	-11.9	24.6	22.5
Salad Greens	25.9	68.9	45.4	48.8	-4.6	29.9	29.2
Peaches	14.2	27.7	20.7	22.4	-33.5	15.0	12.6
Chicken	12.5	14.7	6.7	32.3	29.6	19.0	15.7
Avocados	9.7	34.4	27.1	19.7	8.3	9.8	14.3
Pistachios	8.7	17.4	12.6	13.9	2.3	6.7	12.5
Walnuts	11.5	11.1	5.2	4.1	-10.7	-1.3	18.3
Lemons	19.5	45.2	32.5	32.7	-28.6	21.0	18.9
Celery	11.1	15.9	11.6	18.8	-22.8	11.9	9.6
Eggs	4.7	4.0	2.7	14.7	23.9	6.3	7.5
Plums	13.4	25.1	19.6	20.5	-36.3	13.7	10.7
Nectarines	14.3	28.2	20.8	22.7	-32.7	15.2	12.9
Onions	14.2	26.6	20.0	22.5	-34.6	14.8	11.6
Potatoes	14.1	25.8	19.4	22.2	-33.6	14.7	11.4
Fresh Tomatoes	18.0	40.9	28.7	30.7	-22.8	19.6	18.4
Bell Peppers	20.8	49.9	35.5	36.0	-23.3	22.9	21.2

Table 8b: Percent Change in Crop Revenues under Alternative Diet Recommendations (Some Nutrient Substitution)

Selected Crops Ranked by Value (26 to 50)	USDA FGP 1992	Harvard	Mayo Clinic	Mediterranean	Atkins	DASH	My Pyramid 2005
	<i>—Percent change in gross revenue—</i>						
Cauliflower	22.8	55.5	38.4	41.3	-14.2	25.9	24.2
Spinach	21.8	53.7	35.3	42.0	-1.8	25.6	24.2
Wheat	14.6	27.9	18.4	23.9	-28.2	15.6	13.0
Turkey	10.6	11.3	4.7	26.6	26.6	15.0	14.4
Garlic	12.2	17.5	13.4	19.1	-31.2	12.6	9.4
Cherries	14.0	26.1	19.6	21.6	-36.1	14.3	11.2
Cantaloupe	12.4	22.3	17.6	19.0	-35.8	12.5	9.2
Mushrooms	17.7	36.0	22.6	34.3	-2.6	21.2	19.2
Dried Plums	15.2	33.0	23.4	23.9	-36.9	15.9	13.4
Apples	15.4	31.7	23.8	23.7	-38.0	15.9	13.2
Carrots	18.3	45.6	31.7	30.8	-29.4	19.6	17.4
Pears	16.4	34.9	25.6	25.7	-36.8	17.0	14.4
Asparagus	21.8	53.2	34.5	41.1	-7.4	25.7	24.2
Pink Beans	15.3	29.2	18.7	26.5	-21.2	16.9	14.0
Sweet Potatoes	14.1	30.4	22.2	22.7	-34.1	14.8	11.5
Corn, Ear	13.6	25.1	18.2	21.6	-28.9	13.9	11.8
Olives	4.8	20.6	17.7	11.5	6.8	4.2	6.6
Dates	12.8	22.0	15.3	18.9	-38.8	12.6	9.3
Watermelon	11.2	17.2	14.1	16.3	-37.5	11.0	7.6
Lamb	9.0	10.2	4.6	25.1	28.5	13.6	11.8
Apricots	13.6	27.4	20.4	21.8	-32.5	14.4	11.6
Honey	9.2	9.6	7.5	11.4	-44.1	8.2	4.1
Grapefruit	16.1	33.5	25.4	26.0	-33.4	17.1	14.2
Honeydew	12.8	21.9	17.8	19.1	-38.1	12.8	9.5
Artichokes	23.6	59.6	39.5	43.1	-14.6	27.0	25.3

Table 9: Percent Change in Nutrient Revenues under Alternative Diet Recommendations (Little Nutrient Substitution)

Nutrients ^a	USDA FGP 1992	Harvard	Mayo Clinic	Mediterranean	Atkins	DASH	My Pyramid 2005
	—Percent change in gross revenue—						
<i>Macronutrients</i>							
Protein	19.5	20.8	7.4	54.6	75.5	33.5	26.4
CHO	10.7	6.6	7.2	9.9	-67.2	9.2	1.8
Fiber	76.4	244.6	159.5	138.4	-7.2	87.2	90.5
SFA	-35.2	-57.2	-34.2	-41.8	45.8	-45.0	-36.3
MUFA	-23.3	-22.7	3.0	-27.1	84.9	-24.4	-20.2
Omega 3s	18.0	8.3	17.4	-32.2	-48.3	-49.7	-15.4
Omega 6s	20.0	-14.3	-23.7	-35.9	-38.9	-26.9	55.6
Other PUFA ^b	-90.9	-86.3	-80.8	-88.4	-33.3	-84.5	-86.7
Cholesterol	-13.7	-80.0	-51.0	-41.5	220.4	-26.3	-18.8
<i>Micronutrients</i>							
Vitamin A	-9.7	84.4	84.6	-16.4	-29.0	-15.7	-7.2
Vitamin C	55.9	144.7	173.3	84.0	-30.6	57.9	75.5
Vitamin E	0.9	5.9	47.7	7.6	6.2	52.8	117.5
Calcium	38.7	-8.0	12.5	51.8	-12.2	25.7	60.4
Iron	21.8	60.8	-0.9	19.8	-0.7	12.6	26.8
Sodium	-34.9	-52.8	-44.4	-30.0	-9.1	-28.5	-43.0

^a CHO denotes carbohydrates; SFA denotes saturated fatty acids; MUFA denotes monounsaturated fatty acids; Omega 3s denotes omega 3 fatty acids; Omega 6s denotes omega 6 fatty acids; PUFA denotes polyunsaturated fatty acids.

^b Other PUFA= (Total PUFA – Omega 3s – Omega 6s)

Table 10a: Percent Change in Crop Revenues under Alternative Diet Recommendations (Little Nutrient Substitution)

Selected Crops Ranked by Value (1 to 25)	USDA FGP 1992	Harvard	Mayo Clinic	Mediterranean	Atkins	DASH	My Pyramid 2005
	<i>—Percent change in gross revenue—</i>						
Fat-Free Milk	13.4	11.4	7.7	26.3	-8.6	17.3	11.7
Whole Milk	3.9	-2.1	0.7	11.4	4.6	4.0	2.8
Grapes	15.4	22.6	19.2	19.5	-56.5	15.0	9.7
Beef	-7.7	-11.4	-5.7	3.0	64.0	-5.7	-3.9
Romaine Lettuce	40.4	113.9	75.3	73.4	-2.6	45.8	46.0
Almonds	8.8	26.5	21.7	16.7	37.8	8.3	21.3
Oranges	23.3	50.3	38.1	35.7	-46.4	24.8	20.5
Strawberries	27.8	66.2	48.0	44.0	-40.0	29.4	27.0
Canned Tomatoes	25.1	58.3	38.9	43.0	-26.3	28.4	25.2
Rice	12.5	12.9	9.0	15.4	-51.5	12.0	6.1
Broccoli	32.9	81.0	55.1	61.0	-4.8	39.4	36.6
Salad Greens	41.7	116.9	76.0	78.8	8.3	49.2	49.1
Peaches	20.5	42.3	31.2	30.9	-44.2	22.1	18.6
Chicken	17.5	19.1	6.3	49.0	70.2	29.6	24.5
Avocados	12.4	54.5	42.9	26.0	31.6	12.5	21.9
Pistachios	10.5	23.8	17.0	15.6	20.7	7.1	18.8
Walnuts	15.6	12.5	3.7	-2.1	-2.8	-7.5	29.2
Lemons	30.0	73.7	52.3	49.4	-35.2	32.8	30.1
Celery	15.0	21.3	15.0	24.5	-24.8	16.6	13.5
Eggs	3.5	-0.2	-0.9	17.2	59.9	6.5	9.8
Plums	19.0	37.4	29.0	27.4	-49.0	19.7	15.3
Nectarines	20.7	43.2	31.5	31.5	-42.7	22.4	19.2
Onions	20.4	40.1	29.9	30.9	-46.0	21.6	16.9
Potatoes	20.2	38.6	28.7	30.5	-44.3	21.4	16.6
Fresh Tomatoes	27.4	66.2	45.7	46.0	-24.6	30.3	29.2
Bell Peppers	32.3	82.2	57.6	55.3	-25.5	36.2	34.2

Table 10b: Percent Change in Crop Revenues under Alternative Diet Recommendations (Little Nutrient Substitution)

Selected Crops Ranked by Value (26 to 50)	USDA FGP 1992	Harvard	Mayo Clinic	Mediterranean	Atkins	DASH	My Pyramid 2005
<i>—Percent change in gross revenue—</i>							
Cauliflower	35.9	92.3	62.9	65.0	-9.1	41.6	39.6
Spinach	34.4	89.4	57.8	66.7	13.4	41.5	40.1
Wheat	21.2	42.8	27.7	33.7	-34.7	23.3	19.5
Turkey	14.0	13.0	2.7	38.6	64.8	22.2	22.2
Garlic	16.8	23.7	18.1	24.8	-40.0	17.7	12.9
Cherries	20.1	39.3	29.2	29.3	-48.8	20.7	16.2
Cantaloupe	17.4	32.3	25.4	24.8	-48.2	17.6	12.7
Mushrooms	26.7	57.3	34.9	52.5	11.8	33.3	30.8
Dried Plums	22.5	52.2	36.5	33.8	-50.2	23.9	20.4
Apples	22.6	49.5	36.6	33.2	-52.3	23.5	19.7
Carrots	28.1	74.7	51.2	46.4	-36.6	30.7	27.9
Pears	24.4	55.3	40.0	36.8	-50.1	25.6	21.9
Asparagus	34.3	88.6	56.4	64.9	3.1	41.5	39.9
Pink Beans	22.5	45.2	28.1	38.5	-21.9	25.6	21.4
Sweet Potatoes	20.6	47.0	33.9	31.8	-45.1	21.9	17.1
Corn, Ear	19.4	37.5	26.7	29.4	-35.8	20.1	17.4
Olives	3.8	30.0	26.5	11.5	28.9	2.7	8.4
Dates	18.1	32.3	22.1	24.7	-53.8	17.9	12.9
Watermelon	15.0	23.1	19.1	19.9	-51.2	14.9	9.8
Lamb	11.1	11.0	2.5	35.9	68.2	19.7	17.5
Apricots	19.6	41.7	30.6	30.1	-42.3	21.1	17.1
Honey	11.5	9.7	7.8	11.1	-63.5	9.8	3.5
Grapefruit	23.9	52.4	39.2	37.2	-43.9	25.7	21.6
Honeydew	17.9	31.4	25.6	24.8	-52.3	18.0	13.0
Artichokes	37.6	100.2	65.5	68.3	-9.9	43.8	41.9

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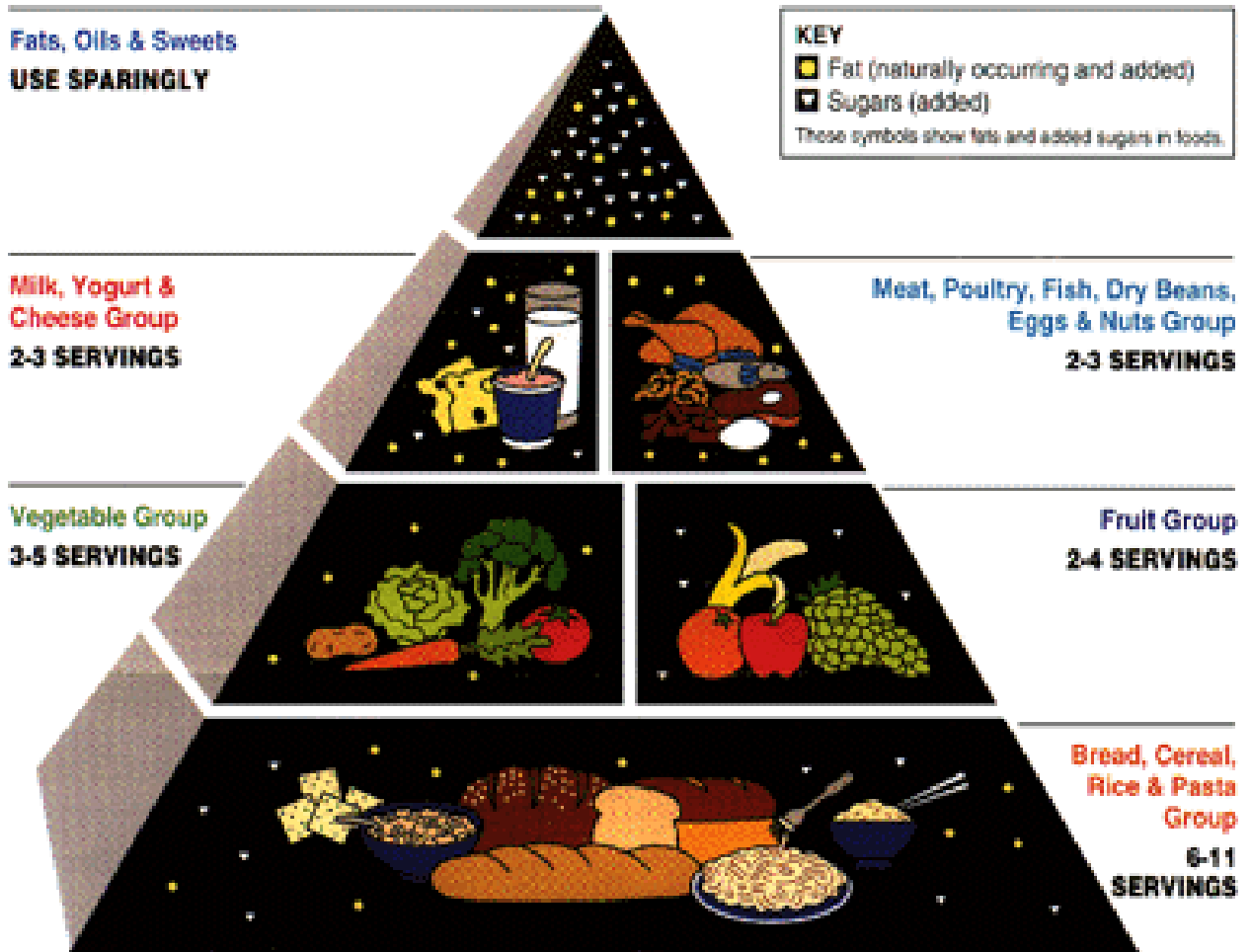
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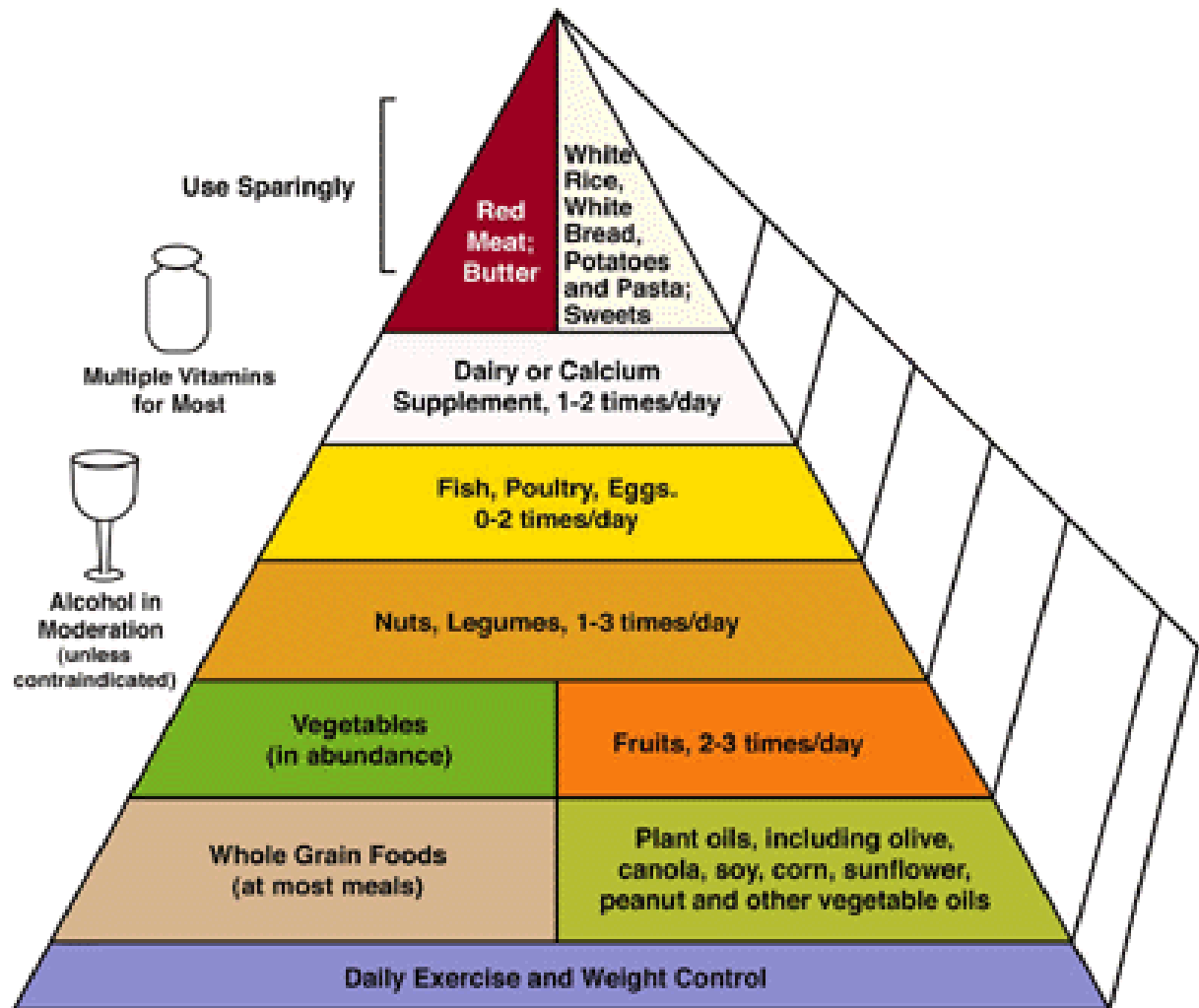
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Appendix A: The USDA Food Guide Pyramid (1992)



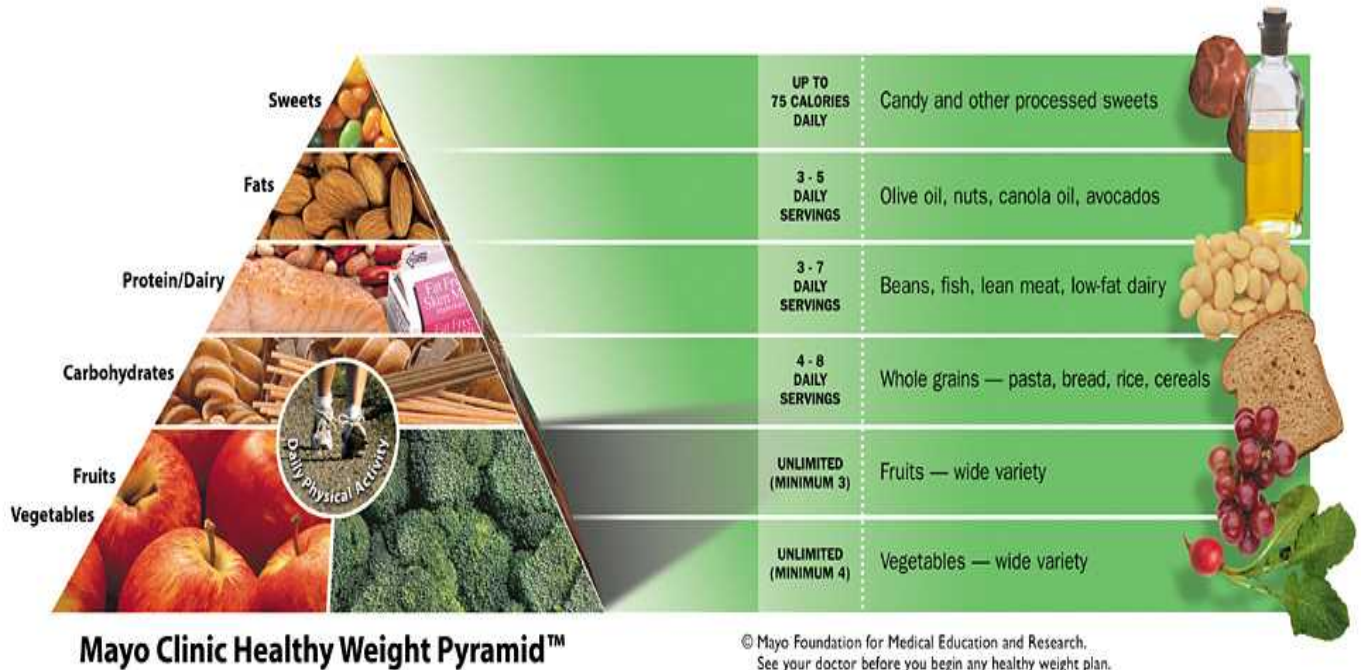
Source: U.S. Department of Agriculture and the U.S. Department of Health and Human Services

Appendix B: Harvard Food Guide Pyramid



Source: EAT, DRINK, AND BE HEALTHY by Walter C. Willett, MD copyright Simon & Schuster 2001.

Appendix C: Mayo Clinic Food Guide Pyramid



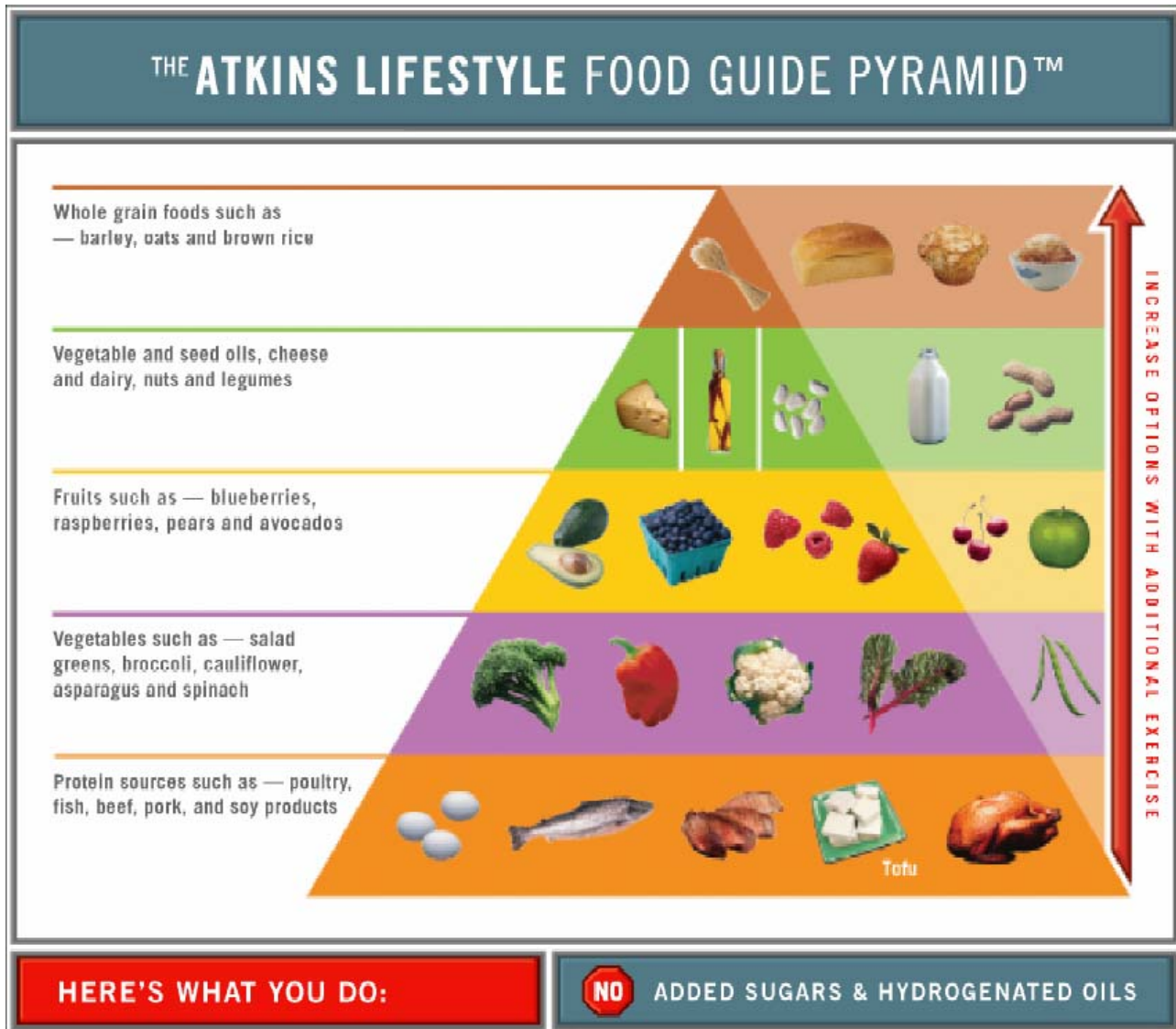
Source: <http://www.mayoclinic.org/news2000-av/pyramid1.jpg>

Appendix D: Mediterranean Food Guide Pyramid



Source: K. Dun Gifford, Oldways Preservation & Exchange Trust
http://www.oldwayspt.org/pyramids/med/p_med.html

Appendix E: Atkins Food Guide Pyramid



Source: <http://atkins.com/Archive/2004/2/10-121449.html>

Appendix F: The DASH Eating Plan

Food Group	Daily Servings (except as noted)	Serving Sizes
<i>Grains & grain products</i>	7-8	1 slice bread 1 cup ready-to-eat cereal ^a ½cup cooked rice, pasta, or cereal
<i>Vegetables</i>	4-5	1 cup raw leafy vegetable ½cup cooked vegetable 6 ounces vegetable juice
<i>Fruits</i>	4-5	1 medium fruit ¼cup dried fruit ½cup fresh, frozen, or canned fruit 6 ounces fruit juice
<i>Lowfat or fat free dairy foods</i>	2-3	8 ounces milk 1 cup yogurt 1 ½ounces cheese
<i>Lean meats, poultry, and fish</i>	2 or less	3 ounces cooked lean meats, skinless poultry, or fish
<i>Nuts, seeds, and dry beans</i>	4-5 per week	⅓ cup or 1 ½ounces nuts 1 tablespoon or ½ounce seeds ½cup cooked dry beans
<i>Fats & oils^b</i>	2-3	1 teaspoon soft margarine 1 tablespoon lowfat mayonnaise 2 tablespoons light salad dressing 1 teaspoon vegetable oil
<i>Sweets</i>	5 per week	1 tablespoon sugar 1 tablespoon jelly or jam ½ounce jelly beans 8 ounces lemonade

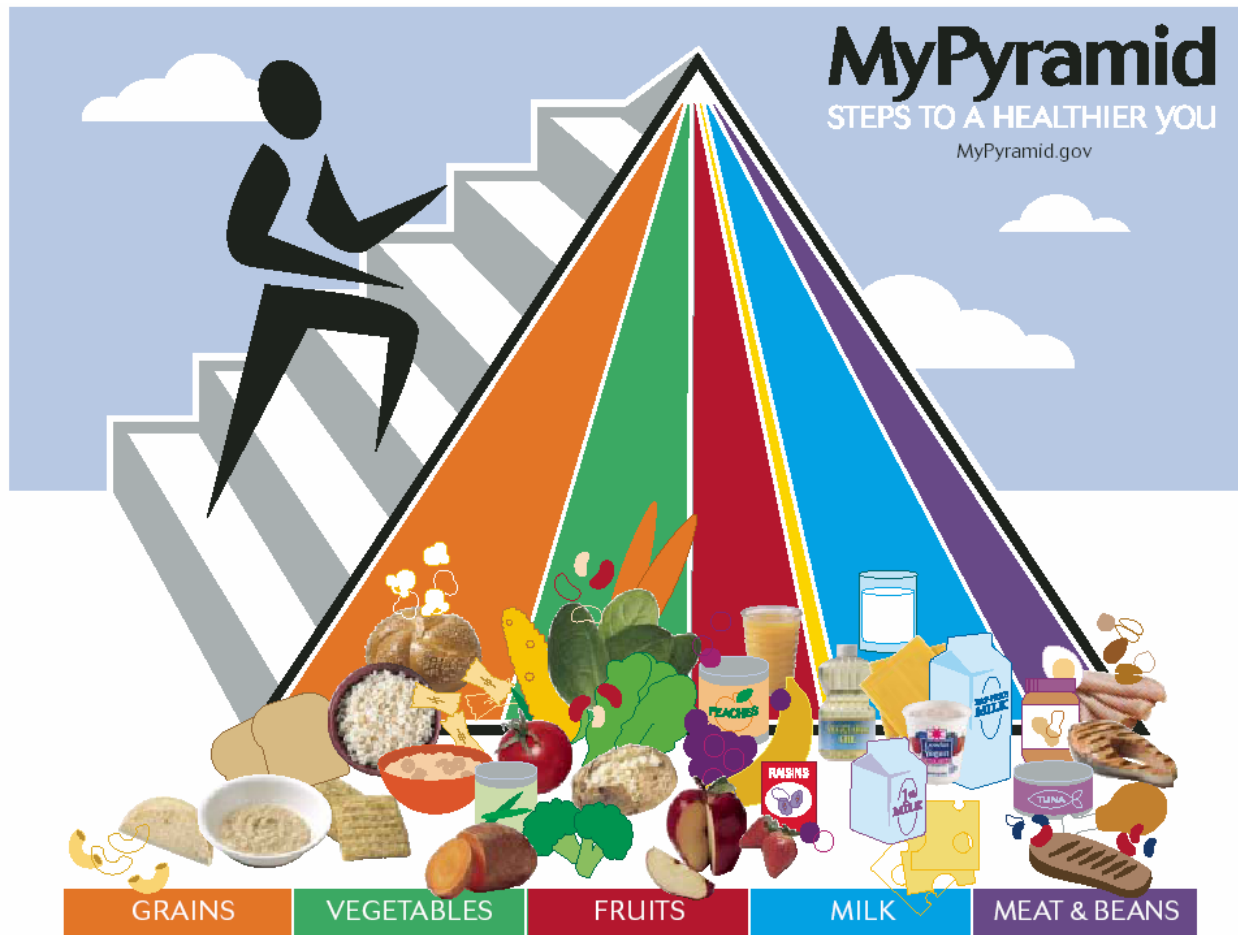
^a Serving sizes vary between ½ cup and 1¼ cups. Check the product's nutrition label.

^b Fat content changes serving counts for fats and oils. For example: 1 tablespoon of regular salad dressing equals 1 serving; 1 tablespoon of a low-fat dressing equals ½ serving; 1 tablespoon of a fat-free dressing equals 0 servings.

Source: National Heart Lung Blood Institute

http://www.nhlbi.nih.gov/hbp/prevent/h_eating/h_e_dash.htm

Appendix G: USDA's MyPyramid.gov (2005)



Source: MyPyramid.gov, United States Department of Agriculture.
<http://www.mypyramid.gov/>

Appendix H: Armington Matrix of Own- and Cross- Price Elasticities^a for Selected Macronutrients

Selected Macronutrients	Consumption Share (%)	Protein	CHO	Fiber	SFA	MUFA	Omega 3s	Omega 6s	Other PUFA	Cholesterol
		<i>Demand Elasticity with Respect to the Price of:</i>								
Protein	17.4	-0.91	0.09	0.91	0.91	0.91	0.91	0.91	0.91	0.91
CHO	59.2	0.29	-0.70	0.29	0.29	0.29	0.29	0.29	0.29	0.29
Fiber	3.6	0.02	0.02	-0.98	0.02	0.02	0.02	0.02	0.02	0.02
SFA	6.0	0.03	0.03	0.03	-0.97	0.03	0.03	0.03	0.03	0.03
MUFA	6.7	0.03	0.03	0.03	0.03	-0.97	0.03	0.03	0.03	0.03
Other PUFA	0.3	0	0	0	0	0	-1.00	0	0	0
Omega 3s	3.0	0.02	0.02	0.02	0.02	0.02	0.02	-0.99	0.02	0.02
Omega 6s	3.5	0.02	0.02	0.02	0.02	0.02	0.02	0.02	-0.98	0.02
Cholesterol	0.1	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	-1.00

^a Appendix H provides the baseline elasticities that were used to calculate the results in Table 7 where some substitution between nutrient groups was allowed.

Appendix I: Armington Matrix of Own- and Cross- Price Elasticities^a for Selected Micronutrients

Selected Micronutrients	Consumption Share (%)	Vitamin A	Vitamin C	Vitamin E	Calcium	Iron	Sodium
		<i>Demand Elasticity with Respect to the Price of:</i>					
Vitamin A	19.7	-0.70	0.05	0.05	0.05	0.05	0.05
Vitamin C	13.6	0.03	-0.72	0.03	0.03	0.03	0.03
Vitamin E	6.5	0.02	0.02	-0.73	0.02	0.02	0.02
Calcium	9.8	0.02	0.02	0.02	-0.73	0.02	0.02
Iron	23.6	0.06	0.06	0.06	0.06	-0.69	0.06
Sodium	26.7	0.07	0.07	0.07	0.07	0.07	-0.68

^a Appendix I provides the baseline elasticities that were used to calculate the results in Table 7 where some substitution between nutrient groups was allowed.