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Possible Implications for U.S. Agriculture From Adoption of Select Dietary Guidelines

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Possible Implications for U.S. Agriculture From Adoption of Select Dietary Guidelines

Jean C. Buzby, Hodan Farah Wells, and Gary Vocke

Abstract

To help Americans meet nutritional requirements while staying within caloric recommendations, the 2005 *Dietary Guidelines for Americans* encourage consumption of fruits, vegetables, whole-grain products, and fat-free or low-fat milk or milk products. This report provides one view of the potential implications for U.S. agriculture if Americans changed their current consumption patterns to meet some of those guidelines. For Americans to meet the fruit, vegetable, and whole-grain recommendations, domestic crop acreage would need to increase by an estimated 7.4 million harvested acres, or 1.7 percent of total U.S. cropland in 2002. To meet the dairy guidelines, consumption of milk and milk products would have to increase by 66 percent; an increase of that magnitude would likely require an increase in the number of dairy cows as well as increased feed grains and, possibly, increased acreage devoted to dairy production.

Keywords

Agriculture, dairy, *Dietary Guidelines for Americans,* dietary recommendations, food, food consumption, food production, fruit, MyPyramid Food Guidance System, vegetables, whole grains.

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Contents

Summary iii

Introduction 1

Methodology 3

How Much Would U.S. Agriculture Have To Adjust? 9

- **Fruit** 9
- **Vegetables** 12
- **Milk** 15
- **Whole Grains** 19

Discussion 25

References 27

Summary

The latest *Dietary Guidelines for Americans* was released in January 2005. In April 2005, the *Guidelines*' companion MyPyramid Food Guidance System was released and replaced the 1992 Food Guide Pyramid. A major focus of the new *Guidelines* is to encourage Americans to consume fruit, vegetables, dairy products (particularly fat-free or low-fat milk products), and whole-grain products, while staying within caloric recommendations.

What Is the Issue?

Currently, the average American diet falls short of the daily recommendations for fruit, vegetables, whole grains, and milk and milk products in the 2005 *Dietary Guidelines for Americans* and in the supporting MyPyramid Food Guidance System. If Americans were to bring their diets fully in line with these recommendations, changes in the mix and quantity of foods produced in the United States would undergo some major shifts.

What Did This Study Find?

If Americans were to fully meet the *Guidelines'* recommendations for fruits, vegetables, total grains, and whole grains, U.S. agriculture would need to harvest 7.4 million additional acres of cropland per year, an increase of 1.7 percent of total U.S. cropland in 2002. Additionally, U.S. dairy farmers would need to raise annual production of milk and milk products by an estimated 108 million pounds (about a 65-percent increase) for Americans to meet recommendations for dairy consumption. Such an increase in dairy demand would likely require an increase in the number of dairy cows, an increase in the volume of feed grains needed, and, possibly, an increase in the acreage devoted to dairy production.

Fruit. Americans would need to increase daily fruit consumption by 132 percent to meet the new dietary recommendations. The additional demand could require U.S. producers to more than double harvested fruit acreage to 7.6 million acres (from 3.5 million). U.S. fruit production is constrained by land, labor, and climate, making it likely that imports would continue to increase as a share of the total U.S. fruit supply.

Vegetables. To meet the new recommendations for vegetables, Americans' daily vegetable consumption would need to rise by about 31 percent and the mix of vegetables consumed would need to change. For example, consumption of legumes would have to increase by 431 percent, and consumption of starchy vegetables would have to decline by 35 percent. To meet this increased demand, the area harvested for vegetables in the United States would need to increase by about 137 percent from 6.5 million acres to 15.3 million acres.

Milk and milk products. Americans would need to increase their consumption of dairy products, including fat-free or low-fat milks and equivalent milk products (e.g., nonfat yogurt), by 66 percent (requiring an additional 111 billion pounds of milk per year) to meet the new dietary recommendations. Domestic production could account for 108 billion pounds of that

increase, most likely by expanding dairy cow inventories, an action counter to long-term industry trends.

Whole grains. To meet the dietary recommendations, Americans would need to increase their daily consumption of whole grains by an estimated 248 percent and reduce their consumption of total grains by about 27 percent. Because it takes less raw wheat to produce a whole-grain product than a similar refined-grain product and because of the decline in total-grain intake, the overall drop in demand could translate to producers' harvesting about 5.6 million fewer acres of wheat each year.

How Was the Study Conducted?

The authors used both the ERS Food Availability data and the ERS Food Guide Pyramid Servings data, which are the ERS Food Availability data adjusted for plate waste and other food losses and converted to daily per capita servings. These data series are proxies for actual food consumption. The authors assumed a consumption level of 2,000 calories per day for the average American, which corresponds with the level used throughout the examples in the *Dietary Guidelines* and which is consistent with the level on the Nutrition Facts labels that the Food and Drug Administration requires on most packaged foods.

The analysis is a straightforward extrapolation from the data, not an equilibrium model. For each food group covered here, the authors calculated the percent change in per capita daily consumption needed to meet the dietary recommendation and then multiplied this percent change in consumption by the *total availability* of that food group in the United States to estimate the new level of food needed. Within each food group, the authors then calculated the change in U.S. production needed to meet the new recommendations using the consumption change estimates and calculated the domestic acreage needed to meet the new production levels. For these calculations, the authors (1) fixed the consumption mix of individual foods at 2003 levels (i.e., no substitution), (2) held exports constant at the average of 1999-2003 levels, and (3) fixed relative shares of production and imports at the average of 1999-2003 levels.

The analysis did not analyze the decreases in meat, added fats and oils, and caloric sweetener consumption needed for Americans to meet the *Guidelines*' recommendations. Had these food groups been incorporated in this analysis, their impacts may have offset the increases in consumption and production noted here, but, without explicit analysis, the net effect is uncertain.

Introduction

The U.S. Department of Agriculture released the latest *Dietary Guidelines for Americans* in January 2005. In April 2005, the *Guidelines*' companion MyPyramid Food Guidance System was released and replaced the 1992 Food Guide Pyramid. A major focus of the new *Guidelines* is to encourage consumption of foods that provide substantial amounts of vitamins and minerals, yet are relatively low in calories, cholesterol, saturated fat, trans fats, and added sugars and salt so that Americans can meet their nutritional requirements "while staying within energy needs." In particular, a chapter in the *Guidelines* is devoted to encouraging consumption of fruits, vegetables, dairy products—particularly fat-free or low-fat milk or milk products (e.g., nonfat yogurt and lower fat cheese)—and whole-grain products (a subgroup of the grains group).

If Americans adopt diets that follow the new dietary recommendations, there will be implications for U.S. agriculture. This study aims to estimate how big those impacts on agriculture might be if consumers were to fully meet the dietary recommendations for fruits, vegetables, whole grains, and milk products. Although we recognize that it is unrealistic to assume that Americans will fully meet the new dietary recommendations, they could make dietary changes to move closer to the *Dietary Guidelines'* recommended intake levels. Therefore, the estimated implications for agriculture may be realized to some extent. The findings in this report can add insight to the potential effect of these dietary changes on agricultural producers and the likelihood of U.S. agriculture's meeting the challenge to produce more of certain foods.

This report updates portions of Young and Kantor (1999), which examined the potential implications for agriculture if Americans met dietary recommendations in an earlier version of the *Guidelines*. They projected a net increase in crop acreage of about 2 percent of total cropland in 1991-95 due to the changes in consumption patterns. Young and Kantor looked at the impacts on all food groups, whereas this report examines only the impacts of the recommendations for fruits, vegetables, grain, and dairy consumption. We did not update estimates for the meat group, added fats and oils, and caloric sweeteners.[1]

For each food group covered here, we tried to answer the following questions:

(1) What level of domestic production would be needed to fully meet the Guidelines' recommendations?

(2) What does this suggest for U.S. production acreage and regions?

(3) Are there any anticipated changes in exports or the proportion or mix of products produced domestically or imported if we relax our assumptions?

(4) Are there any interesting potential substitution effects or dietary challenges?

[1] The ERS food consumption data for added fats and oils are not appropriate for this analysis. The number of firms reporting vegetable oil production in U.S. Census Bureau data increased in 2000, causing a jump in per capita estimates in 2000, which is in the middle of the time frame for this analysis. Updating the meats group would require a more sophisticated model to fully capture the impact on meats from the new *Dietary Guidelines*. In particular, neither the simple technique employed here nor any existing ERS model can simulate the demand and supply for different quality cuts of meat (e.g., with different degrees of trimmed fat). Meat quality would undoubtedly be an issue if Americans strive to reduce fat intake. Therefore, this analysis omits meats. Given the remaining food groups, it seemed logical to focus on food groups that the *Dietary Guidelines* wanted to "encourage" and to exclude caloric sweeteners.

Understanding the full extent of the impacts requires a sophisticated dynamic model, capable of modeling complex supply and demand responses as well as the interactions across food groups and within each food group. For example, the model could incorporate offsetting shifts in trade, production, nonfood uses, and substitute foods. This study is not dynamic but rather partitions food sectors into segments that preclude interaction and ignores price effects. A more sophisticated analysis may show large price effects.

In general, for U.S. consumers to substantially increase consumption of foods in a certain food group, imports may be increased, exports may be diverted to domestic consumption, and domestic production may be expanded where possible. In this analysis, however, as discussed more fully in the methodology section, we kept the ratio between production and imports constant and held exports constant for each food group at 1999-2003 average levels. As demand for these products increases, domestic prices would likely increase as well, perhaps substantially in cases where consumption significantly increases, and maintaining constant exports would be highly unlikely. A more sophisticated analysis could use an almost infinite combination of imports, exports, and domestic production levels to move American diets closer to the new dietary recommendations.[2] Nevertheless, the straightforward extrapolations in this report offer a first glance of the possible implications for agriculture, which could be substantial.

[2] See Young and Kantor (1999) for more details on supply and demand adjustments.

Methodology

To answer the research questions, we followed several steps for each food group:

Step 1: Identify the new Dietary Guidelines' recommendations relevant for this analysis

USDA's Food Guide in Appendix A-2 of the 2005 *Dietary Guidelines for Americans* specifies new daily recommendations for intake levels of each food group (p. 53). These recommendations are broken into 12 calorie levels ranging from 1,000 to 3,200 calories a day, depending on a person's age, gender, and physical activity. In particular, the Food Guide (table 1) provides:

> "the suggested amounts of food to consume from the basic food groups, subgroups, and oils to meet recommended nutrient intakes at 12 different calorie levels. Nutrient and energy contributions from each group are calculated according to the nutrient-dense forms of foods in each group (e.g., lean meats and fat-free milk). The table also shows the discretionary calorie allowance that can be accommodated within each calorie level, in addition to the suggested amounts of nutrient-dense forms of foods in each group."

For some food groups, the *Guidelines* implicitly suggest greater moderation in daily "servings" (i.e., cups or 1 ounce-equivalents (oz-eq) per day), while for other groups, they recommend increased consumption. In this report, we focused on the food groups for which the *Guidelines* encourage Americans to increase consumption to meet nutritional requirements "while staying within energy needs": fruits, vegetables, milk products—particularly fat-free or low-fat milk or dairy products (e.g., nonfat yogurt and lower fat cheese)—and whole-grain products. We also examined refined-grain and total grain intake as part of our whole-grain analysis.

We used a 2,000-calorie-per-day reference level in our analysis, which is consistent with that used throughout the *Guidelines* in the USDA Food Guide and the DASH eating plan examples.[3] The 2,000-calorie level is also used on all Nutrition Facts labels found on packaged foods. Recommended calorie intakes vary among individuals, depending on gender, age, and activity level; however, data do not exist on the distribution of all U.S. consumers with respect to the 12 calorie levels in the USDA Food Guide,[4] thus hindering a more sophisticated analysis by calorie level.

The *Guidelines* recommend that Americans on a 2,000-calorie-per-day diet should consume 2 cups of fruit, 2.5 cups of vegetables, 3 cups of milk products, and 6 oz-eq of total grains daily. Half of the grain servings should be whole grain. The grains group includes all foods made from wheat, rice, oats, cornmeal, and barley, such as bread, pasta, oatmeal, breakfast cereals, tortillas, and grits. In general, 1 slice of bread, 1 small muffin, 1 cup of ready-to-eat cereal, 1 ounce of dry pasta or rice, or 1/2 cup of cooked rice,

[3] The Dietary Approaches to Stop Hypertension (DASH) diet eating plan was sponsored by the National Institutes of Health and involves eating more low-fat or nonfat dairy and fruits and vegetables.

[4] In the USDA Food Guide, the 2,000-calorie level is appropriate for many sedentary females age 19 to 30, many sedentary males age 51 to 70, and for some other age/gender groups who are more physically active (DGA, 2005, p. 10, footnote B).

pasta, or cooked cereal can be considered as 1 oz-eq from the grains group (DGA, 2005, p. 54).

The *Guidelines* encourage Americans to choose a variety of fruits and vegetables each day. In particular, they encourage Americans to select from all five vegetable subgroups several times a week because each subgroup provides a somewhat different array of nutrients (table 2). Recommended weekly intakes of vegetables for persons on a 2,000-calorie per day diet include the following: dark-green vegetables (3 cups), orange vegetables (2 cups), legumes (i.e., dry beans, peas, and lentils) (3 cups), starchy vegetables (3 cups), and other vegetables (6.5 cups).

Table 1

Daily amount of food from each group as recommended by the USDA Food Guide in the 2005 *Dietary Guidelines for Americans*

	Daily calorie level[1]											
Food group	1,000	1,200	1,400	1,600	1,800	2,000[2]	2,200	2,400	2,600	2,800	3,000	3,200
	Servings											
Fruit[3] (cups)	1.0	1.0	1.5	1.5	1.5	2.0	2.0	2.0	2.0	2.5	2.5	2.5
Vegetables[4] (cups)	1.0	1.5	1.5	2.0	2.5	2.5	3.0	3.0	3.5	3.5	4.0	4.0
Grains[5]	3.0	4.0	5.0	5.0	6.0	6.0	7.0	8.0	9.0	10.0	10.0	10.0
Whole-grain portion (oz-eq)	1.5	2.0	2.5	3.0	3.0	3.0	3.5	4.0	4.5	5.0	5.0	5.0
Meat and beans[6] (oz-eq)	2.0	3.0	4.0	5.0	5.0	5.5	6.0	6.5	6.5	7.0	7.0	7.0
Milk[7] (cups)	2.0	2.0	2.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Oils[8] (tsp)	3.0	4.0	4.0	5.0	5.0	6.0	6.0	7.0	8.0	8.0	10.0	11.0
Discretionary calorie allowance[9]	165	171	171	132	195	267	290	362	410	426	512	648

Note: oz-eq = ounce equivalent. [1]Calorie levels are set across a wide range to accommodate the needs of different individuals. This table can be used to help assign individuals to the food intake pattern at a particular calorie level. [2]A 2,000-calorie level is used in this report to be consistent with the Nutrition Facts labels found on packaged foods. [3]Fruit group includes all fresh, frozen, canned, and dried fruit and fruit juices. In general, 1 cup of fruit or 100 percent fruit juice, or 1/2 cup of dried fruit can be considered as 1 cup from the fruit group. [4]Vegetable group includes all fresh, frozen, canned, and dried vegetables and vegetable juices. In general, 1 cup of raw or cooked vegetables or vegetable juice, or 2 cups of raw leafy greens can be considered as 1 cup from the vegetable group. According to the MyPyramid Plan, 1 cup of whole, mashed, or cooked dry legumes or 1 cup of 1/2 inch cubes of tofu count as 1 cup from the vegetable group. [5]Grains group includes all foods made from wheat, rice, oats, cornmeal, and barley, such as bread, pasta, oatmeal, breakfast cereals, tortillas, and grits. In general, 1 slice of bread, 1 cup of ready-to-eat cereal, or 1/2 cup of cooked rice, pasta, or cooked cereal can be considered as 1 ounce equivalent from the grains group. At least half of all grains consumed should be whole grains. [6]Meat and beans group includes, in general, 1 ounce of lean meat, poultry, or fish, 1 egg, 1 tablespoon of peanut butter, 1/4 cup of cooked dry beans, or 1/2 ounce of nuts or seeds can be considered as 1-ounce equivalent from the meat and beans group. [7]Milk group includes all fluid milk products and foods made from milk that retain their calcium content, such as yogurt and cheese. Foods made from milk that have little to no calcium, such as cream cheese, cream, and butter, are not part of the group. Most milk group choices should be fat free or low fat. In general, 1 cup of milk or yogurt, 1½ ounces of natural cheese, or 2 ounces of processed cheese can be considered as 1 cup from the milk group. [8]Oils include fats from many different plants and fish that are liquid at room temperature, such as canola, corn, olive, soybean, and sunflower oil. Some foods are naturally high in oils, such as nuts, olives, some fish, and avocados. Foods that are mainly oil include mayonnaise, certain salad dressings, and soft margarine. [9]Discretionary calorie allowance is the remaining amount of calories in a food intake pattern after accounting for the calories needed for all food groups, using forms of foods that are fat-free or low-fat and with no added sugars.

Source: Prepared by USDA, Economic Research Service using data from *Dietary Guidelines for Americans*, 2005, Appendix A-2 "USDA Food Guide."

In the *Guidelines* (p. 36), legumes are considered "part of both the vegetable group and the meat and beans group as they contain nutrients found in each of these groups" but should be counted in only one group (p. 54).[5] Here, we count legumes in the vegetable group, which is consistent with their placement in the ERS Food Guide Pyramid Servings data. According to the MyPyramid Food Guidance System, 1 cup of whole, mashed, or cooked dry legumes or 1 cup of ½-inch cubes of tofu counts as 1 cup from the vegetable group.

[5] In the USDA Food Guide, ¼ cup of cooked dry beans or tofu is equivalent to 1 ounce of lean fish, meat, or poultry (DGA, 2005).

Step 2: Use ERS Food Guide Pyramid Servings data to calculate the percent change in per capita daily consumption needed to meet the dietary recommendation

We used the ERS Food Guide Pyramid Servings data to calculate the increase in per capita daily consumption needed to meet the new recommendations in the *Dietary Guidelines*. This data series comprises the ERS Food Availability data adjusted for nonedible food parts and food lost through spoilage, plate waste, and other losses in the home and marketing system and converted into daily per capita servings as defined by the new recommendations.[6] It does not measure actual food intake. ERS compiles the Food Availability data annually to reflect the amount of food available for human consumption in the United States. This historical series measures the national food supply of several hundred foods, and it is the only source of time series data on food availability in the country. It extends back to 1909 for many commodities. ERS's Food Availability data are normally calculated as the residual of a commodity's total annual available supply after subtracting measurable uses, such as farm inputs (feed and seed), exports, ending stocks, and industrial uses. As these data represent the disappearance of food into the U.S. food marketing system, they are often referred to as food disappearance data. The annual data series also includes per capita food consumption estimates, which serve as a proxy for actual food intake and are useful for studying food consumption trends. In the mid-1990s, ERS developed new methods to adjust the Food Availability data for losses and express the data in terms of Food Guide Pyramid-based servings.

[6] See www.ers.usda.gov/data/foodconsumption/ for detailed documentation of the data.

Table 2

Vegetable subgroup amounts per week as recommended by the USDA Food Guide in the 2005 *Dietary Guidelines*[1]

Vegetable subgroup	Daily calorie level											
	1,000	1,200	1,400	1,600	1,800	2,000[2]	2,200	2,400	2,600	2,800	3,000	3,200
	Cups per week											
Dark green	1.0	1.5	1.5	2.0	3.0	3.0	3	3	3.0	3.0	3.0	3.0
Orange	.5	1.0	1.0	1.5	2.0	2.0	2	2	2.5	2.5	2.5	2.5
Legumes	.5	1.0	1.0	2.5	3.0	3.0	3	3	3.5	3.5	3.5	3.5
Starchy	1.5	2.5	2.5	2.5	3.0	3.0	6	6	7.0	7.0	9.0	9.0
Other	3.5	4.5	4.5	5.5	6.5	6.5	7	7	8.5	8.5	10.0	10.0

[1]Vegetable subgroups include all fresh, frozen, canned, and dried vegetables and vegetable juices. In general, 1 cup of raw or cooked vegetables or vegetable juice, or 2 cups of raw leafy greens can be considered as 1 cup from the vegetable group. [2]A 2,000-calorie level is used in this report to be consistent with the Nutrition Facts labels found on packaged foods.

Source: Prepared by USDA, Economic Research Service using data from *Dietary Guidelines for Americans*, 2005, Appendix A-2 "USDA Food Guide."

To analyze the impact on agriculture from the new dietary recommendations, we first assessed and updated all of the conversion rates and assumptions for the serving sizes in the ERS Food Guide Pyramid Servings data, which had been previously based on the Food Guide Pyramid Bulletin (revised 1996). Prior to the release of the 2005 *Guidelines* and MyPyramid Food Guidance System, units of food were measured in *servings*. Now, the units are measured in cups for the fruit, vegetable, and milk groups, and *ounce-equivalents* for grains and meats. Because of the significant changes in conversion rates and assumptions as well as in daily intake recommendations, any dietary shortfalls and excesses quantified in this study are not comparable with those in previous analyses. For example, in the earlier recommendations, a "serving" of raw-leafy vegetables equaled 1 cup; now, 2 cups of raw-leafy vegetables equal 1 cup from the vegetable group.

Within each group, we assumed that the mix of foods was held constant at 2003 levels when estimating new levels of production and imports needed to meet the new dietary recommendations.[7] For example, we assumed constant relative shares of apples, bananas, cranberries, etc., in the fruit group. Additionally, in the vegetable group, we fixed consumption of the five vegetable subgroups at levels recommended in the *Guidelines* and fixed the mix of foods within each vegetable subgroup (e.g., spinach, kale, and broccoli in the dark-green vegetable category). As explained further in the grains section, our analysis for whole grains focuses on whole-wheat flour and whole-wheat flour products. We assumed the current mix of these products remains constant (e.g., relative shares of bread, pasta, and other products). Due to data limitations, we looked at the milk group as a whole and did not make adjustments to the share of the different fat-content versions for each product (i.e., fat-free, low-fat, etc.). This limitation should be noted because the *Guidelines* and supporting guidance documents suggest that consumers should choose fat-free and low-fat options most often.

[7] At the time of this report, 2003 was the latest year for which we had Food Guide Pyramid Servings data.

Our assumption that the mix of foods within a food group (e.g., strawberries and tangerines in the fruit group) is fixed could be relaxed in a more rigorous analysis. In reality, the mix of foods within a group is constantly changing in response to changes in supply (e.g., sudden supply shocks due to severe weather or widespread pest infestation) and consumer demand. For example, consumers might change the mix of foods they consume in response to relative prices and recommendations from popular fad diets (e.g., blueberries recommended by some diets for their antioxidant properties). The mix of foods in each food group will also continue to change as the U.S. population becomes more culturally diverse, as disposable incomes rise, and as a wider range of fresh and processed food options becomes available year-round (e.g., ready-to-eat carrots and precut fruit). We have seen notable evidence of some demographic changes that have affected consumption trends. For example, population changes, such as the increase in the Hispanic population during the 1990s, boosted black bean consumption in Tex-Mex and Mexican cuisines (Lucier and Jerardo, August 2005). More recently, the popularity of other cuisines nationwide, such as Thai, have increased demand for a different mix of vegetables.

Next, we calculated changes needed to meet the daily dietary recommendations at the 2,000-calorie level as the difference between the new *Guidelines*' recommendations and the current consumption estimates as

measured by the ERS Food Guide Pyramid Servings data for fruit, vegetables, milk products, and total- and whole-grain products in 2003. To meet the *Guidelines*, we calculate that Americans would need to increase daily consumption of fruit by 132 percent and vegetables by 31 percent (table 3). Additionally, consumers would need to alter the mix of vegetables. This change would include the consumption of more legumes, dark-green vegetables, and orange vegetables and less starchy vegetables. To meet the new recommendations, the average American would also need to increase daily consumption of milk and milk products by 66 percent. ERS servings data also imply that Americans would need to decrease total grain consumption by 27 percent and increase consumption of whole grains by 248 percent to meet the *Guidelines'* recommended number of grain servings.

Step 3: Multiply the percent change in consumption by the total availability of food in that food group in the United States to estimate the new level of food needed

We estimated the new level of food needed if all Americans fully meet the *Guidelines'* recommendations by multiplying the estimated percent change in consumption (table 3) by the *total availability* of that food group in the United States. As previously mentioned, total availability is a proxy for total U.S. consumption and is calculated here as domestic production plus imports minus exports.[8] We used estimated average production, imports, and exports of food for 1999-2003.

[8] Beginning and ending stocks and nonfood uses were not considered in this analysis.

Table 3
Daily ERS loss-adjusted food guide pyramid servings in 2003, compared with the recommendations from the 2005 *Dietary Guidelines for Americans*

Food group	*Dietary Guidelines* recommendations for a 2,000-calorie diet	2003 ERS Food Guide Pyramid Servings[1]	Change needed to meet *Guidelines'* recommendations[2]	
	Number per day	*Number per day*	*Number*	*Percent*
Fruit	2.0 cups	.9 cups	1.1 cups	132
Vegetables:	2.5 cups	1.9 cups	.6 cups	31
Dark green	.4 cups	.2 cups	.3 cups	175
Orange	.3 cups	.1 cups	.2 cups	183
Legumes	.4 cups	.1 cups	.3 cups	431
Starchy	.4 cups	.7 cups	-.2 cups	-35
Other	.9 cups	.9 cups	-- cups	2
Milk	3.0 cups	1.8 cups	1.2 cups	66
Total grains[3]	6.0 oz-eq	8.2 oz-eq	-2.2 oz-eq	-27
Whole grains	3.0 oz-eq	.9 oz-eq	2.1 oz-eq	248

Note: oz-eq = ounce equivalent. -- means less than .1 cup. [1]The ERS estimate of .9 oz.-eq. for the whole-grain subset of total grains is the sum of the ERS-estimated whole-grain share of wheat flour (5 percent of the 5.22 oz-eq of wheat flour available per capita or 0.261 oz-eq.) plus an estimated 0.6 oz-eq. missing from the ERS Food Guide Pyramid Servings data from Putnam et al. (2002), which includes foods, such as popcorn. [2]Computed from unrounded numbers. [3]The ERS estimate of 8.2 oz-eq. includes 7.6 oz. eq. from the ERS Food Guide Pyramid Servings data plus the 0.6 oz-eq. missing whole-grain estimate by Putnam et al. (2002). In general, 1 slice of bread, 1 cup of ready-to-eat cereal, or 1/2 cup of cooked rice, pasta, or cooked cereal can be considered as 1-oz-eq. from the grains group.
Source: Prepared by USDA, Economic Research Service using data from *Dietary Guidelines for Americans*, 2005, Appendix A-2 "USDA Food Guide" and ERS food consumption (per capita) data system, Food Guide Pyramid Servings, www.ers.usda.gov/data/foodconsumption/

Step 4: Calculate change in U.S. production using consumption change estimates

We next estimated the levels of domestic production and imports needed to meet the new levels of food consumption calculated in step 3. To do so, we made two simplifying assumptions: we held exports constant at the average level for 1999-2003, and of the remaining food availability, we fixed the relative shares of domestic production and imports at the average of 1999-2003 levels.

The *Guidelines* encourage increased consumption of all food groups covered here (fruit, vegetables, dairy, and whole grains). Therefore, if Americans fully meet all of the recommendations, the demand for these foods would increase. As a result, prices of these foods would increase, making it more likely that imports and domestic production would increase and that exports would decrease. For simplicity, we assumed exports remain constant because some exports would still occur and exports of certain byproducts may even increase. For example, American cheeses are popular in some foreign countries, and fruit and vegetables produced here might complement seasonal production gaps in other countries. Additionally, if Americans switch to low-fat or nonfat milk and milk products, greater quantities of milkfat and products high in milkfat may be exported.

Step 5: Calculate domestic acreage needed to meet new production levels

In calculating the change in net acreage in the United States needed for Americans to meet the 2005 dietary recommendations for fruit, vegetables, and whole grains, we assumed that average yields per acre remained constant at the average of 1999-2003 levels. In particular, we assumed that the ratio between the average U.S. acreage for a particular crop during 1999-2003 and the average production from that acreage remained the same. We used harvested instead of planted acres due to data availability. Data limitations prevent estimates of changes in farmland devoted to dairy production or cropland adjustments needed to feed more dairy cattle.

How Much Would U.S. Agriculture Have To Adjust?

If Americans were to fully meet the recommendations from the 2005 *Dietary Guidelines* for fruits, vegetables, and whole grains, we estimate the increased demand would require U.S. agriculture to harvest a maximum of 7.4 million acres of additional cropland per year (table 4). This 1.7-percent increase is relatively small, given the total U.S. cropland of 433.5 million acres in the 2002 Census of Agriculture.

As shown in the table, the changes would affect some agricultural sectors more than others. The effects would also vary by production region. For example, domestic bananas are grown only in Hawaii, and most U.S. bananas are imported. Therefore, any expansion in domestic banana production resulting from increased demand would likely be limited to Hawaii. At the other extreme, dairy production occurs in all 50 States, meaning that the effects of increased dairy demand would not be limited to a particular area or region.

Table 4

Maximum crop acreage adjustments implied by full adoption of select recommendations from the 2005 *Dietary Guidelines for Americans*[1]

Crop	Average harvested area, 1999-2003	Adjustments in acreage	Acreage needed to meet *Guidelines*
		Million acres	
Fruit	3.5	4.1	7.6
Vegetables:	6.5	8.9	15.3
Dark green	0.3	0.5	0.8
Orange	0.2	0.4	0.6
Legumes	2.0	8.8	10.8
Starchy	2.3	-0.8	1.5
Other	1.7	--	1.7
Wheat (example for whole grains)	22.6	-5.6[2]	17.04
Dairy[3]	NA	NA	NA
Total[4]	32.6	7.4	39.9

Note: -- means less than 0.1 million acres. [1]Maximum estimate assumes that all adjustments occur in domestic production with no offsetting changes in trade or other uses. Estimates may not total due to rounding. [2]This is the total acreage adjustment needed to meet both the whole-grain and the total-grain recommendations. [3]Not applicable—dairy is not measured in terms of crop acreage. [4]This analysis did not cover meat, added fats and oils, and caloric sweeteners.

Source: USDA, Economic Research Service.

Fruit

To meet the *Dietary Guidelines'* recommendations, Americans on a 2,000-calorie diet would need to increase fruit consumption by 132 percent.[9] Average domestic production of fruit during 1999-2003 was 72,823 million pounds per year. After accounting for imports (add 29,135 million pounds) and exports (subtract 11,698 million pounds), total fruit available for annual U.S. consumption was estimated at 90,259 million pounds (farm weight) (table 5). For Americans to increase fruit consumption by 132 percent, we

[9] The fruit group includes all fresh, frozen, canned, and dried fruits and fruit juices. In general, 1 cup of cut-up, raw, or cooked fruit, 1 cup of 100 percent fruit juice, or 1/2 cup of dried fruit can be considered as 1 cup from the fruit group. The 2005 *Dietary Guidelines* no longer has specific recommendations for the "citrus, melon, and berries" and "other" fruit categories so they are not analyzed separately here.

estimated that U.S. production would need to rise 117 percent to 157,669 million pounds and imports would need to rise to 63,080 million pounds.

To meet the higher level of fruit consumption demanded in the new dietary recommendations, U.S. agriculture would need to harvest an estimated 7.6 million acres, an increase of 4.1 million acres. Additional acreage devoted to U.S. fruit production would likely come from current high-production areas or contiguous areas that have similar production characteristics, such as favorable climate, water availability, and arable land (fig. 1).

Currently, California accounts for half of all U.S. fruit acreage, Florida accounts for a fourth, and Washington accounts for almost a tenth (Perez and Pollack, 2004a). With the exception of domestically grown tropical fruit, such as bananas and pineapple, domestic citrus fruit faces more constraints in terms of suitable land for growing than other U.S. fruit crops. Citrus production primarily occurs in areas of Florida, California, Arizona, and Texas that have subtropical climates.

Because of the time required for citrus and tree fruit (e.g., plums, peaches, pears, and apples) plantings to mature and bear fruit, increased domestic production of these crops could lag behind production increases in other commodities. Substantial increases in U.S. fruit production would also increase demand for farm labor, as many fruit crops are labor intensive. Higher costs for labor and land and, in some cases, higher costs for transportation and irrigation would likely be passed on to consumers in the form of higher fruit prices.

Our estimated increase in fruit acreage needed to meet the 2005 *Guideline*s would be an upper-bound estimate because current trends suggest that imports will continue to increase as a share of the total U.S. fruit supply despite the adoption of new management techniques and high-yield fruit varieties by U.S. agriculture (fig. 2). U.S. fresh fruit imports, excluding bananas, increased at an annual average rate of 8 percent between 1996 and 2004 (Perez, 2005). Fresh fruit imports as a share of consumption (excluding bananas) rose from about 16 percent in 1996 to 25 percent in

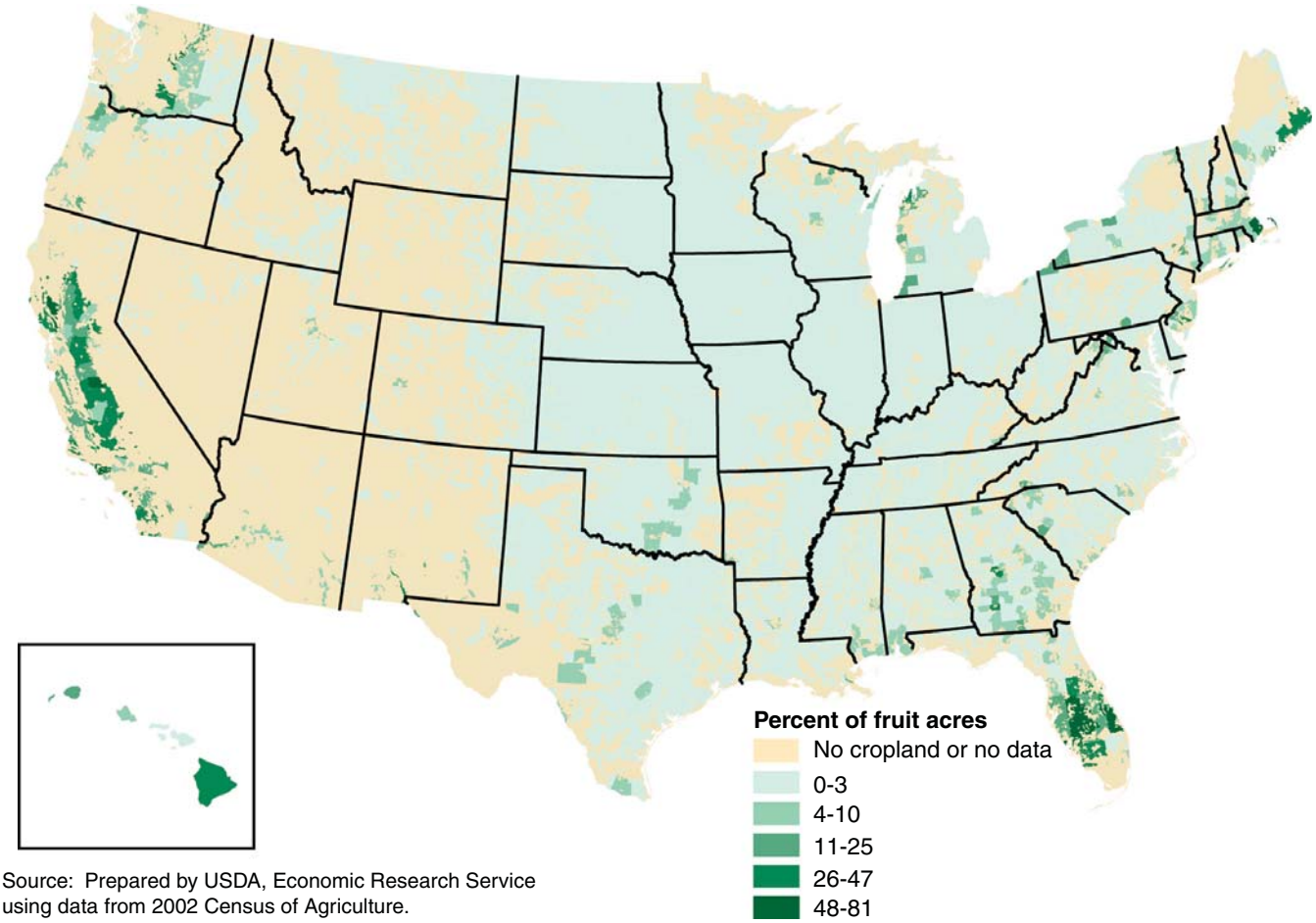
Table 5
Estimated U.S. fruit production to meet the 2005 *Dietary Guidelines for Americans*[1]

Item	Average fruit production in 1999-2003	Fruit production needed to meet *Guidelines*
	Million pounds	
Production	72,823	157,669
Imports	29,135	63,080
Exports	11,698	11,698
Total availability[2]	90,259	209,051
	1,000 acres	
Harvested acres	3,508	7,595

[1]Production is measured in farm weight.
[2]Total availability is production plus imports and minus exports.
Source: USDA, Economic Research Service.

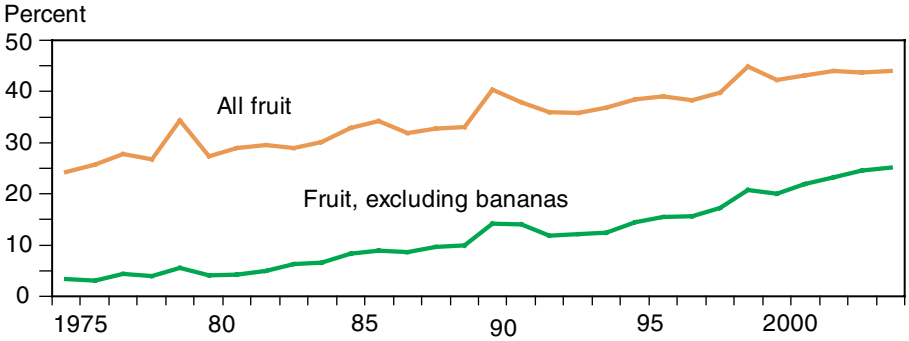
2004. Bananas account for over 60 percent of the volume of fresh fruit imports and have the third highest per capita consumption of all fresh fruit in the United States (Perez and Pollack, 2004a). Additionally, if the demand for fruit rises, the export share of U.S. production would likely decline because fruit wholesalers and retailers tend to prefer to source fruit domestically, where possible.

Figure 1
Fruit harvested acres as a share of total cropland, by county



Source: Prepared by USDA, Economic Research Service using data from 2002 Census of Agriculture.

Figure 2
Imports as a share of U.S. fresh fruit consumption



Source: USDA, Economic Research Service and U.S. Department of Commerce, Bureau of Census.

Vegetables

To meet the *Dietary Guidelines'* recommendations, Americans on a 2,000-calorie-per-day diet would need to increase daily consumption of vegetables by 31 percent.[10] However, when considering the five vegetable subgroups in the *Guidelines*, Americans would need to substantially increase vegetable consumption in three of the subgroups (legumes by 431 percent, orange vegetables by 183 percent, and dark-green vegetables by 175 percent) and decrease consumption of starchy vegetables by 35 percent (see table 3) (fig. 3).

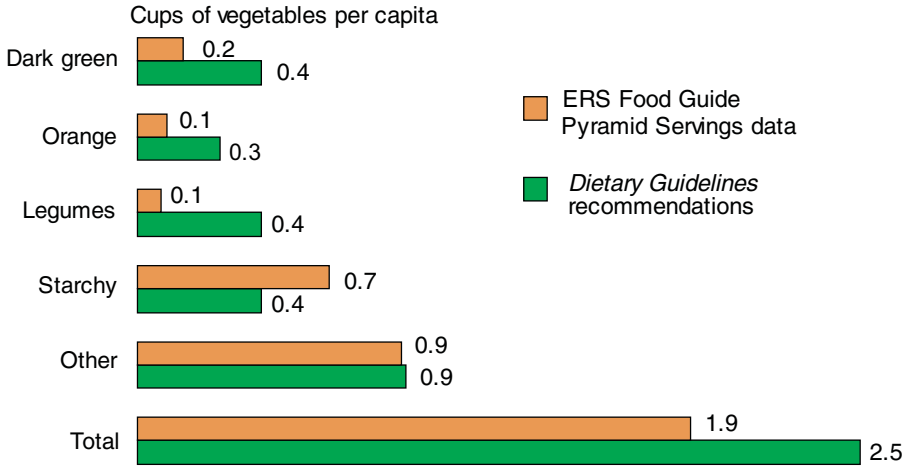
We estimate that U.S. agriculture would need to produce 128.2 billion pounds (farm weight) of vegetables each year for Americans to raise their vegetable intake to 2.5 cups per day (table 6). This represents an increase in production of 19.4 billion pounds (18 percent) per year over 1999-2003 levels. In particular, we estimate annual domestic production of some vegetables would have to increase substantially (i.e., dark-green vegetables by 10.7 billion pounds (175 percent), orange vegetables by 11.1 billion pounds (183 percent), and legumes by 14.4 billion pounds (432 percent)) while domestic production of starchy vegetables would have to decrease by 17.6 billion pounds (35 percent).

We estimate that U.S. farmers would need to harvest 15.3 million acres of vegetables per year for Americans to meet the higher level of consumption recommended in the 2005 *Dietary Guidelines,* an increase of 137 percent (8.9 million harvested acres) over 1999-2003 levels. This change includes increased acreage for legumes (8.8 million acres), dark-green vegetables (0.5 million acres), and orange vegetables (0.4 million acres) and decreased acreage for starchy vegetables (0.8 million acres).

California, Idaho, Washington, Wisconsin, and Florida are the top vegetable-producing States (fig. 4). In general, the availability of suitable land is not a constraint for vegetable production—if the demand for vegetables increases

[10] Vegetables include all fresh, frozen, canned, and dehydrated vegetables and vegetable juices. In general, 1 cup of raw or cooked vegetables or vegetable juice or 2 cups of raw leafy greens can be considered as 1 cup from the vegetable group.

Figure 3
Loss-adjusted food availability data compared with 2005 *Dietary Guidelines* recommendations for a 2,000-calorie diet



Source: USDA, Economic Research Service.

and vegetable prices rise in response, U.S. production will increase (Lucier, 2005a). For example, acreage in dry peas and lentils has increased over time in response to growing demand. Water availability, however, constrains vegetable production in some regions.

Actual changes in the demand for labor and land as a result of Americans' moving closer to the dietary recommendations for vegetables will vary by crop. For example, the legume industry is relatively efficient and mechanized, compared with the fresh asparagus industry. And, some vegetable crops, such as tomatoes, are commercially grown in many States while other crops, such as artichokes, are produced in just a few States.

Table 6

Estimated U.S. vegetable production needed to meet the 2005 *Dietary Guidelines for Americans*[1]

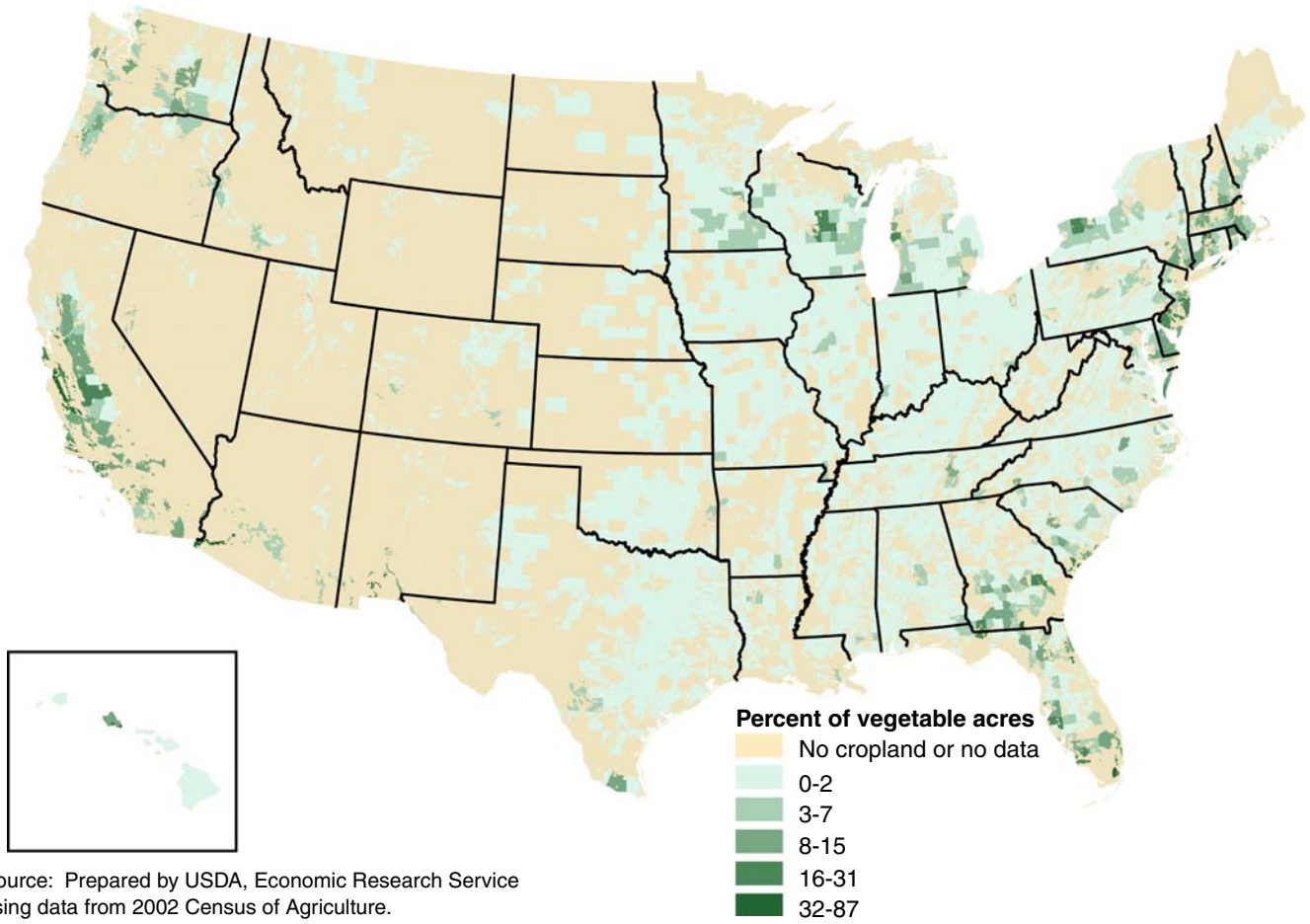
Vegetables	Average vegetable production in 1999-2003	Vegetable production needed to meet *Guidelines*
	Million pounds	
Production		
Dark-green leafy	6,098	16,767
Orange	6,077	17,171
Legumes	3,348	17,796
Starchy	49,726	32,083
Other	43,519	44,353
Subtotal	108,767	128,170
Imports		
Dark-green leafy	710	1,952
Orange	243	687
Legumes	234	1,245
Starchy	4,070	2,626
Other	8,638	8,804
Subtotal	13,896	15,314
Exports		
Dark-green leafy	710	710
Orange	370	370
Legumes	1,131	1,131
Starchy	5,982	5,982
Other	4,100	4,100
Subtotal	12,293	12,293
Total availability[2]	110,370	131,190
	1,000 acres	
Harvested acres		
Dark-green leafy	291	799
Orange	202	571
Legumes	2,030	10,788
Starchy	2,261	1,459
Other	1,697	1,730
Subtotal	6,480	15,346

[1]Vegetable production is measured in farm weight.
[2] Total availability is production plus imports and minus exports.
Source: USDA, Economic Research Service.

Due to lower transportation costs and low or zero tariffs in accordance with the North American Free Trade Agreement, 88 percent of U.S. fresh vegetable imports by volume in the first half of 2005 came from Mexico and Canada (Lucier and Jerardo, August 2005). Mexico and Canada are also the largest markets for U.S. vegetable exports. Despite recent declines in the dollar, total U.S. vegetable exports are, in general, growing more slowly than imports because of slow economic growth and high tariffs in many importing countries (Krissoff and Wainio, 2005).

Americans would need to adjust their consumption of legumes more than that of any of the other four vegetable subgroups to meet the recommendations in the *Guidelines*. The United States is the sixth-leading producer of legumes (Lucier, 2005b), yet domestic production of the crop would have to increase significantly to meet the 431-percent increase in demand associated with the change in consumption. Additionally, legume exports currently account for less than 20 percent of U.S. production; some of these exports would likely be diverted to domestic consumption if demand and, consequently, legume prices were to rise.

Figure 4
Vegetable harvested acres as a share of total cropland, by county



Source: Prepared by USDA, Economic Research Service using data from 2002 Census of Agriculture.

Milk

According to the 2005 *Dietary Guidelines* (p. 24), Americans on a 2,000-calorie-per-day diet should consume 3 cups of fat-free or low-fat milk or equivalent milk products daily. These recommendations do not perfectly align with the recommendations in the companion USDA *Food Guide* in Appendix A-2 of the *Guidelines* (p. 54) or the more recently released MyPyramid Food Guidance System recommendations for the milk group.[11] In these companion documents, the milk group contains all milks, yogurts, frozen yogurts, dairy desserts, and cheeses (except cream cheese), including lactose-free and lactose-reduced products (DGA, 2005, p. 54). These companion documents recommend consumption of 3 cups from the milk group per day for Americans on a 2,000-calorie diet and recommend that "most choices should be fat-free or low-fat" (p. 54, footnote 1). However, the food patterns in these documents were developed using *only* fat-free milk. Consumption of milk in any dairy product must be counted as part of consumers' discretionary dietary allowance.

[11] In general, 1 cup of milk or yogurt, 1½ ounces of natural cheese, such as Cheddar cheese, or 2 ounces of processed cheese can be considered as 1 cup from the milk group (DGA, 2005, p. 54).

The ERS Food Availability data and ERS Food Guide Pyramid Servings data provide per capita consumption data on numerous dairy products. However, for most dairy products, including the many cheese varieties, the data do not provide sufficient detail for researchers to ascertain the share or quantity consumed that is fat free or low fat. The exceptions are milk and cottage cheese. Because of these and other data limitations, we analyzed the milk group as a whole and did not make adjustments to the share of the different fat versions for each product (i.e., fat-free, low-fat, high-fat, etc.).[12]

[12] Fat-free milk is also called nonfat and skim milk. Low-fat milk is 1 percent fat by weight, and high-fat milk has 2 percent or more milkfat. High-fat versions of dairy products, such as cream cheese, heavy cream, and butter, also have 2 percent or more milkfat by weight.

To meet the 2005 *Dietary Guidelines'* recommendations for the milk group, Americans would need to increase their daily consumption of milk and milk products by 66 percent. To meet this considerable increase in demand, total availability of farm milk would have to increase by 111 billion pounds, from 169 billion pounds to 280 billion pounds (table 7). This change means that total annual U.S. production of farm milk would have to increase to 274 billion pounds to make the wide array of milk and milk products currently available—a substantial increase of roughly 108 billion pounds per year.

Table 7

Estimated U.S. farm milk production to meet the 2005 *Dietary Guidelines for Americans*[1]

Item	Average dairy production in 1999-2003	Dairy production needed to meet *Guidelines*
	Million pounds	
Production	165,882	273,617
Imports	4,973	8,203
Exports	1,629	1,629
Total availability[2]	169,226	280,191

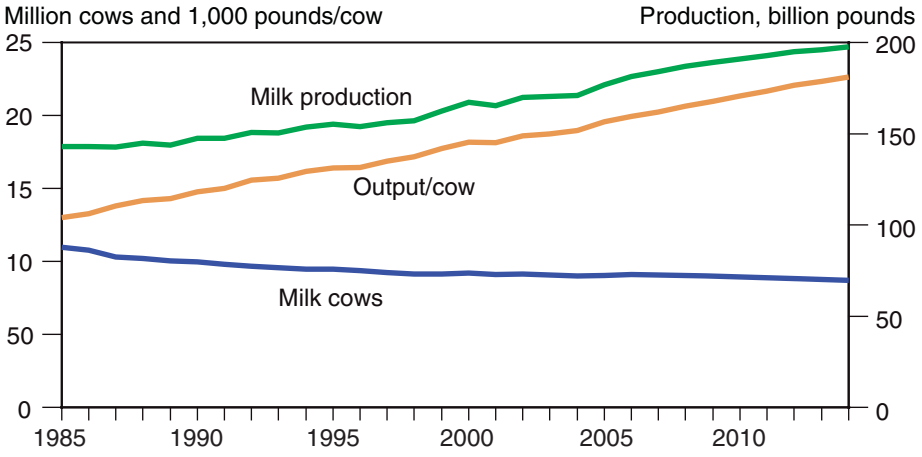
[1]Foods made from milk that have little to no calcium and are relatively high in milkfat, such as cream cheese, heavy cream, and butter, are not part of the milk group but can be counted as part of consumers' discretionary dietary allowance in the USDA's Food Guide and the MyPyramid Food Guidance System.
[2]Total availability is production plus imports and minus exports.
Source: USDA, Economic Research Service.

Part of the reason for this two-thirds increase is that the 2005 *Guidelines* call for 3 cups per day from the milk group for a 2,000-calorie diet whereas the previous version recommended consumption of only 2.2 cups per day. The 111 billion additional pounds may be an overestimate because 30 to 50 million Americans (roughly 10 percent of the population) are lactose intolerant (NIDDK, 2006) and, therefore, may seek alternate sources for calcium and other nutrients found in milk. Consumers can, however, minimize the problem of lactose intolerance by choosing lactose-free milk or by consuming the enzyme lactase prior to consuming milk products. Therefore, it is inaccurate to assume that 10 percent of Americans would entirely avoid milk products. Nevertheless, even if the 111 billion pounds is reduced by 10 percent to roughly 99.9 billion pounds, the additional demand for milk and milk products would be substantial.

Output per cow has increased gradually over time (fig. 5), but this new requirement outstrips even conceivable potential milk-production rates, leaving increases in imports and substantial herd expansion as the remaining options to raise production to the necessary levels. Most dairy products consumed in the United States are domestically produced rather than imported for myriad reasons, including perishability, high transportation costs (e.g., milk is bulky), and natural fluctuations in milk production due to weather and feed conditions as well as daily or seasonal fluctuations in milk and milk-product consumption (e.g., high consumption of ice cream in the summer) (Miller, 2004). For the same reasons, the export share of dairy products is low. Imports account for roughly 3 percent of all U.S. dairy product consumption, and most of these imports are specialty cheeses.

Since it is unlikely that imports would significantly reduce the domestic milk production needed to help Americans meet the recommended intake levels in the new *Guidelines*, any increase in domestic consumption would likely have to come from domestic production. In short, U.S. dairy producers would need to substantially expand the number of dairy cows, an action counter to long-term industry trends. California, Wisconsin, and New York are currently the top dairy-producing States (fig. 6).

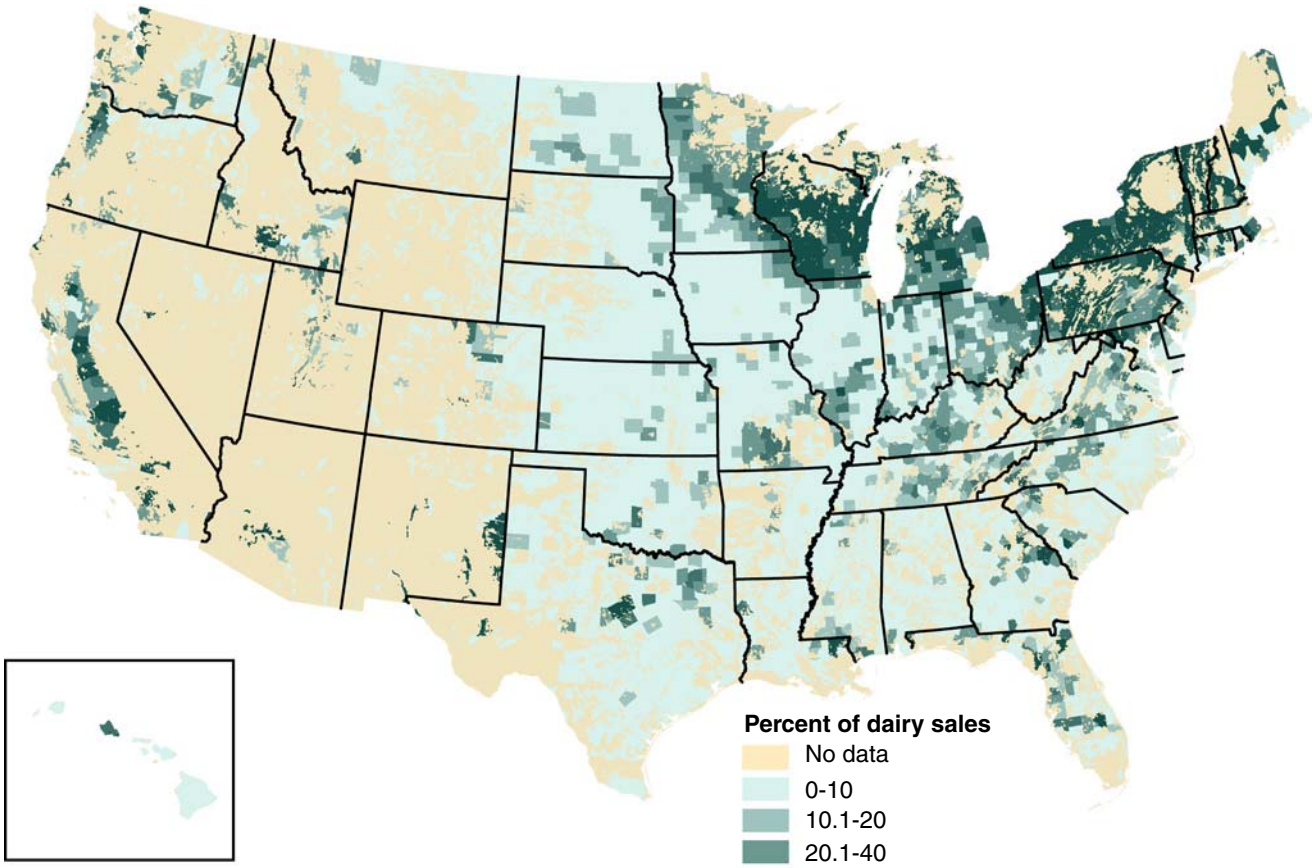
Figure 5
Milk production and dairy herd



Source: USDA's Economic Research Service, *USDA Agricultural Baseline Projections to 2014*, February 2005.

As previously mentioned, one shortcoming of this analysis is that our data are limited, precluding us from undertaking a full analysis of the milk and milk product group between regular and fat-free or low-fat products whereas the *Guidelines* and their supporting materials suggest that consumers should choose fat-free and low-fat options most often. If our analysis had incorporated the recommendation that "most choices should be fat-free or low-fat," findings suggest that increases in the production of raw fluid milk would need to be even higher to offset the removal of fat from the total poundage. Raw milk at the farm level is a joint product. The proportions of the components in milk depend on the type of cow and the feed and forage used in production. For example, milk from Holstein dairy cows generally comprises 3.7 percent milkfat, 8.6 percent skim solids, and 87.7 percent water (Miller, 2004). If Americans were to meet the new *Dietary Guidelines* by increasing their consumption of milk and milk products, particularly nonfat and low-fat versions, the effect might be a large increase in milkfat available for other uses. Manufacturers might use this milkfat to produce more cream cheese, heavy cream, butter, and higher fat cheeses for domestic consumption or export. Recent trends show that low-fat milk consumption has increased, but average U.S. per capita consumption of cheese, both low-fat and high-fat, nearly tripled between 1970 and 2003, from 11 to 31 pounds per year, and shows no sign of leveling off (Buzby, 2005). During

Figure 6
Milk and dairy sales as a share of all livestock product sales, by county



Source: Prepared by USDA, Economic Research Service using data from 2002 Census of Agriculture.

this same time period, per capita butter consumption has been fairly constant at around 4.6 pounds per year while cream consumption rose from 4.0 pounds to 7.4 pounds. Cream and Neufchâtel cheese consumption rose from 0.61 pound per capita per year in 1971 to 2.4 pounds in 2003.

In the event of a glut in milkfat, milkfat's price and the price of products derived from milkfat would fall sharply. In this case, the United States might even emerge as the leading exporter of milkfat-based products. And if Americans were to choose fat-free or low-fat milk and milk products "most often" as recommended in the new MyPyramid Food Guidance System, current U.S. dairy imports, which primarily comprise value-added cheeses, might decline. Moreover, current U.S. exports of whey products and skim milk powder might also decline.

The response by U.S dairy producers could also be influenced by changes in the demand for beef and beef products. Although we did not analyze the effects of the *Guidelines* on consumption of meat, the new dietary recommendation for Americans on a 2,000-calorie diet is to consume 5.5 oz-eq of meat per day (see table 1). This intake level is lower than the 6.1-oz-eq estimate for 2003 consumption in the meat group (here meat, poultry, and seafood) from the ERS Food Guide Pyramid Servings data. In particular, if Americans were to consume less beef in accordance with the *Guidelines*, U.S. beef production would likely decline as a result. And, if this effect were matched with a potentially huge increase in dairy production, we might also see a greater supply of utility beef from slaughtered dairy herds, aggravating any declines in the market for meat from beef cattle.

Repercussions would also spread to grain production, as the increase in dairy cattle would require dairy producers to claim a larger share of the U.S. corn crop as well as greater quantities of soybeans and forage. Perhaps some of these feedstuffs could be shifted from beef production if that market declines. On the other hand, a huge glut in milkfat and associated falling milkfat prices might lessen the pressure on expanding dairy herds and the need for substantial increases in grain feeding. Balancing all of the complex and numerous interactions raised in this analysis would require a more sophisticated model to better estimate any eventual outcomes.

Whole Grains

Compared with the *Dietary Guidelines* recommendations, the average American is eating too much grain-based food (i.e., food made with refined and/or whole grains). We estimate that 8.2 grain servings per day are available for consumption, compared with the *Guidelines*' recommendation of 6 servings for a 2,000-calorie diet (see table 3).[13] Accordingly, Americans would need to decrease total grain intake by 2.2 servings, or 27 percent, to meet the *Guidelines*. Our estimate of 8.2 grain servings per day is the sum of 7.6 grain servings from the ERS Food Guide Pyramid Servings and 0.6 whole-grain serving that is missing from the ERS servings data (e.g., popcorn) (see boxes on "Whole-Grain Foods" and "Whole-Grain Data Limitations"). An earlier ERS report analyzed consumption of whole-grain foods missing from the Food Guide Pyramid Servings data and estimated that Americans were eating at least an additional 0.6 whole-grain servings per capita per day in 2000 (Putnam et al., 2002).

For the first time, the *Dietary Guidelines* have specific recommendations for whole-grain consumption separate from those for total or refined grains. The goal of the recommendation is to encourage Americans to eat more whole grains by raising awareness of whole grains and their role in nutritious diets. For Americans on a 2,000-calorie diet, the *Guidelines* recommend consumption of at least three 1 oz-eq of whole grains each day, or half of their recommended total-grain intake. The new whole-grain recommendation is ambitious given that Americans currently eat relatively few whole grains. We estimate that the average American consumes 0.9 oz.-eq of whole grains each day. This ERS estimate for whole-grain consumption is the sum of the 0.6 oz-eq missing from the ERS Food Guide Pyramid Servings database (Putnam et al., 2002) and an estimated 0.261 oz-eq of whole-wheat flour and whole-wheat flour products. ERS estimated this latter amount using the estimated per capita consumption of 5.22 oz-eq of wheat flour per person (table 8) and the 5-percent industry estimate of whole-wheat flour as a share of domestically milled wheat. A comparison of this estimate with the new *Dietary Guidelines* recommendation for intake of whole grains for a 2,000-calorie diet shows that Americans would need to increase daily consumption of whole grains by roughly 2.1 oz-eq, or 248 percent (see table 3).

Because of gaps in data on whole-grain consumption, wheat is the focal point of our grain analysis. Wheat accounted for 71 percent of all U.S. grain available for consumption in terms of pounds per capita in 2003 (fig. 7). Corn and rice are the second and third most available food grains (table 8).[14] We do not have reliable estimates of the whole-grain share of corn or rice consumption to use as a starting point for this analysis so these grains are not included here. Food availability data from 2001-02 suggest that consumption of brown rice, which is a whole grain, makes up less one-half of 1 percent of total U.S. rice available for consumption.[15] Additionally, we do not have data on consumption of other types of whole-grain rice (e.g., long-grain wild rice). Although most oat consumption can be counted as whole-grain consumption, oats accounted for only 1.4 percent of total grain servings in 2003.

[13] The MyPyramid Food Guidance System defines a serving as 1 oz-eq of grain or grain-based foods.

[14] Note that sweet corn is in the vegetable group whereas corn products considered here are in the grains group. Corn products include corn flour, meal, and grits made from field corn for human consumption.

[15] Data on brown rice have been discontinued.

Our analysis focuses on wheat milled to make wheat flour and wheat-flour products for human food use in the United States and, therefore, does not include wheat used for exports, stocks, and nonfood uses, such as animal feed. Between 1999 and 2003, the United States produced an annual average of 40,573 million pounds of wheat flour (both whole-wheat and refined), imported 1,032 million pounds of wheat flour and flour products, and exported 1,413 million pounds of wheat flour and flour products. Based on ERS's formula for total wheat availability (i.e., production plus imports

Table 8. Daily per capita availability of select grains in the United States, 2003[1]

Grain	1-ounce equivalent servings	Share of total grain servings
	Number	*Percent*
Wheat flour	5.22	69.2
Corn products[2]	1.56	20.6
Rice	0.63	8.3
Oat products	0.11	1.4
Rye flour	0.02	0.3
Barley products	0.02	0.2
Total	7.55	100

[1]Numbers may not total due to rounding. [2]Note that sweet corn is a vegetable whereas corn products considered here in the grains group include corn flour, meal, and grits made from field corn for human consumption.
Source: ERS Food Guide Pyramid Servings data, November 2006.

Whole-Grain Foods

In February 2006, the U.S. Food and Drug Administration (FDA) issued draft guidance on the term "whole grain" for food labels. The agency defined whole grain to "include cereal grains that consist of the intact, ground, cracked, or flaked fruit of the grains whose principal components—the starchy endosperm, germ, and bran—are present in the same relative proportions as they exist in the intact grain." FDA requires foods that bear the whole-grain health claim to (1) contain 51 percent or more whole-grain ingredients by weight per reference amount and (2) be low in fat.

Whole grains can be consumed either as a single food, such as wild rice and popcorn, or as a food ingredient, as in some multigrain breads. Whole grains are good sources of fiber and other nutrients, such as calcium, magnesium, and potassium. Consumption of at least 3 or more ounce-equivalents of whole grains per day may help an individual with weight control and can reduce the risk of several chronic diseases, such as coronary heart disease and some kinds of cancer. Refined grains are the product of a process that removes most of the bran and some of the germ. Refining also removes some dietary fiber, vitamins, minerals, and other natural plant compounds.

Almost all refined grains are enriched before being further processed into foods, a step taken by many grain companies since the 1940s. To conform to FDA's standards of identity—which define a given food, its name, and its ingredients—enriched foods were required to be fortified with thiamine, riboflavin, niacin, and iron. In 1998, the FDA required that folic acid be added to the enrichment mixture. Currently, enrichment is not required for whole-grain foods because these foods naturally contain many of the vitamins and minerals that are stripped out of refined grains during processing.

Examples of whole grains:

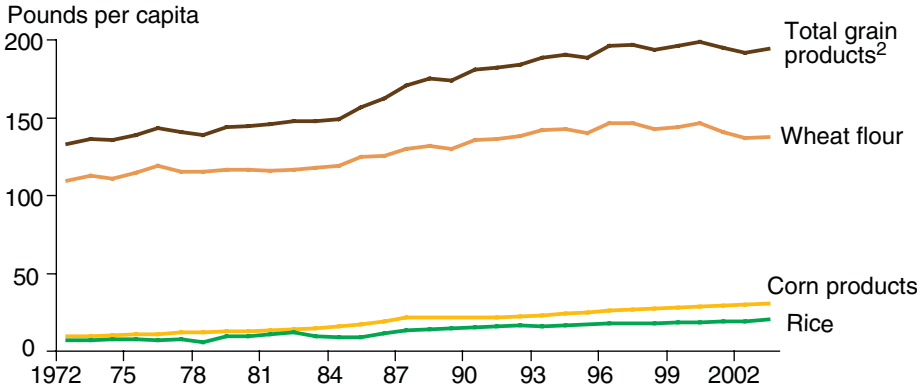
Brown rice	Buckwheat
Bulgur (cracked wheat)	Millet
Popcorn	Quinoa
Sorghum	Triticale
Whole-grain barley	Whole-grain corn
Whole oats/oatmeal	Whole rye
Whole wheat	Wild rice

Source: *Dietary Guidelines for Americans*, jointly issued by USDA and DHHS, January 2005, www.cnpp.usda.gov/DG2005/index.html/

minus exports), wheat flour and flour products available in the U.S. food supply averaged 40,192 million pounds per year during the period.

According to industry estimates, annual production of whole-wheat flour was 5 percent of all domestically milled wheat. Therefore, we estimate that the production of whole-wheat flour is 2,029 million pounds (table 9). We also assumed that 5 percent of all wheat-flour imports, exports, and total availability is attributed to whole-wheat flour and whole-wheat flour products. The remaining share (95 percent) of domestically milled wheat goes to refined-wheat flour and associated products (not shown in table 9).

Figure 7
Total food grain availability in 2003 [1]



[1]These data are not adjusted for plate waste and other food losses in the food marketing and consumption chain. [2] Total includes oat, barley, and rye products.
Source: USDA's Economic Research Service.

Whole-Grain Data Limitations

Accurately tracking consumption of whole grains is a difficult task due to the lack of comprehensive, publicly available data. For example, except for data on rye flour and oat and barley products, which are mainly whole grains, ERS's food availability data do not include a comprehensive estimate of the per capita intake of whole grains or the whole-grain share of the available grain supply. The database has some significant data gaps for whole grains, such as for popcorn, nonmilled wheat products, and less frequently consumed grains, such as buckwheat and quinoa. In an attempt to estimate the size of this data gap, Putnam et al. (2002) estimated that Americans were eating at least 0.6 whole-grain servings per capita per day in 2000.

Other food consumption data series also fall short in reporting whole-grain consumption for various reasons. Many do not distinguish between whole and refined grains. Others are not nationally representative or provide only single point-in-time estimates. Data that rely on self-reported consumer recall, such as USDA's Continuing Survey of Food Intake by Individuals (CSFII), may differ from actual intake data, particularly for whole grains, because consumers have difficulty identifying whole grains. According to the 1994-96 CSFII, two-thirds of Americans over age 2 consumed less than one serving of whole grains a day.

Identifying whole-grain foods by existing labels may be difficult for some consumers. Labels like "wheat bread," "stone-ground," and "seven-grain bread" do not guarantee that the food contains whole grains. Color is not a good indicator of whole grains either because foods may be darker simply because of added molasses.

Without comprehensive data, it is difficult to accurately assess the extent of whole-grain consumption in any given year, or develop any short- or long-term consumption trends. Obtaining such data will likely require a concerted effort and cooperation between industry and government.

Table 9

Estimated U.S. whole-wheat flour and whole-wheat products needed to meet the 2005 *Dietary Guidelines* recommendations for total grains and whole-grains, 1999-2003[1]

Item	Average whole-wheat flour and whole-wheat flour products in 1999-2003[2]	Whole-wheat flour and whole-wheat flour products needed to meet *Guidelines*
	Million pounds	
Production	2,029	14,268
Imports	52	366
Exports	71	71
Total availability	2,010	14,704
	Million acres	
Harvested acres	22.6[3]	17.0[4]

[1]Numbers may not total due to rounding. [2]On average, between 1999 and 2003, the United States produced 40,573 million pounds of wheat flour, imported 1,032 million pounds of wheat flour and wheat flour products, and exported 1,413 million pounds of wheat flour and wheat flour products. Total availability (40,192 million pounds) is estimated as production plus imports and minus exports. To calculate estimates for whole-wheat flour, these figures are multiplied by the 5-percent industry estimate of whole-wheat flour as a share of all domestically milled wheat. [3]During 1999-2003, an annual average of 50.8 million acres of wheat was grown in the United States. On average, domestic food use accounted for 44.5 percent of these acres, or 22.6 million acres. [4]This meets both the whole-grain and total-grain recommendations, using ERS data.

Source: USDA, Economic Research Service.

The *Guidelines* and the MyPyramid Food Guidance System do not call for a reduction in grain intake. Instead, they specify the number of 1-oz-eq servings that Americans should get from whole grains and other (i.e., refined) grains and emphasize that half of total grain servings should be whole grains. Compared with these dietary recommendations, the ERS servings data imply that U.S. consumers need to both reduce total grain intake and shift their intake mix of whole and refined grains. If Americans were to reduce consumption of total grains by 27 percent and increase consumption of whole-wheat flour and flour products from 5 to 50 percent of domestic production to fully meet the *Guidelines'* recommendations, total annual availability would have to increase to 14,704 million pounds of whole-wheat flour and whole-wheat flour products (right column in table 9).[16] Accordingly, the United States would need to produce 14,268 million pounds of whole-wheat flour and whole-wheat products per year and import 366 million pounds.[17]

The acreage calculations for wheat are more complex than those for fruits and vegetables because the demand for wheat and the acreage needed to produce this wheat would actually decline. In general, manufacturers require less raw grain to produce a whole-grain product than a similar refined-grain product. Whole-grain products use all of the grain kernel (i.e., bran, germ, and endosperm), while refined-grain products lack most of the bran. The remaining byproducts from refined-flour milling (i.e., "mill grind") are diverted to secondary uses. Bran, for example, is used as an ingredient in food products and livestock feed. A shift in U.S. consumption from refined-grain to whole-grain products could reduce the quantity of grain milled and supplies of byproducts for secondary markets.

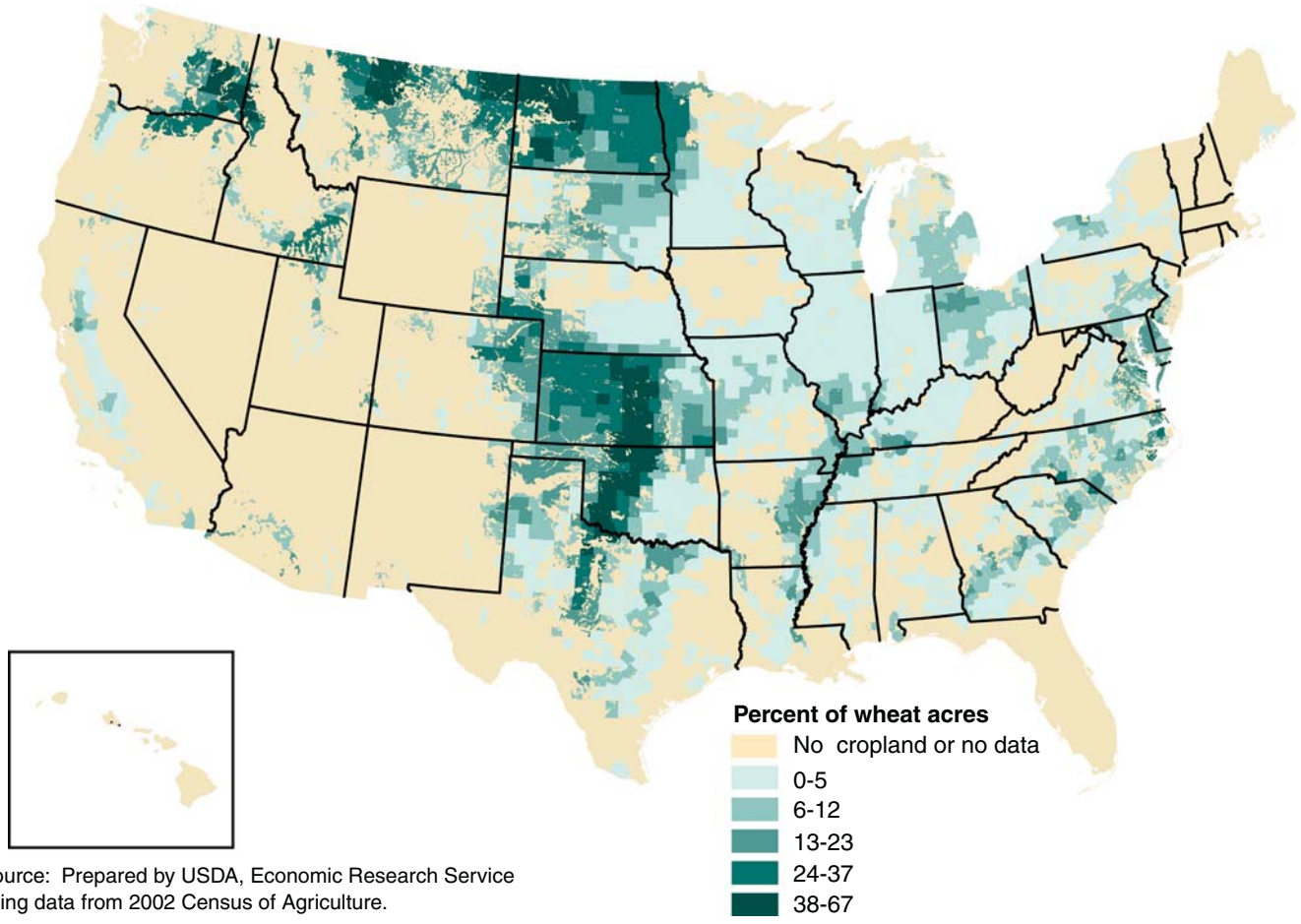
[16] We took the total availability of whole-wheat flour and associated products (i.e., 2,010 million pounds) and (1) decreased it by 27 percent to meet the total-grain intake recommendation, and (2) increased it tenfold to meet the whole-grain recommendation. This tenfold increase is to raise the whole-wheat flour share of all domestically milled wheat flour from the current level of 5 to 50 percent (i.e., half of the recommended total-grain intake). Note that we did not use the 248-percent increase in total whole-grain consumption needed to meet the *Guidelines* in table 3 because that estimate is for the sum of all types of whole grains consumed by Americans (e.g., oats, rice, wheat) and we focused on wheat only.

[17] After we calculated the new total availability, we added exports back in, which we kept fixed at 71 million pounds, and then divided the balance among U.S. production and imports in fixed proportions as our whole-wheat flour and products' baseline for 1999-2003 (97.5 percent domestic production and 2.5 percent imports).

One pound of wheat makes 0.98 pounds of whole-wheat flour but only 0.74 pounds of refined flour (USDA/ERS, 1992). If Americans were to reduce their consumption of total grains by 27 percent and increase their consumption of whole-wheat flour from 5 percent of flour production (estimated amount in 2003) to the *Guidelines'* recommendation of 50 percent, manufacturers would require only 670.7 million bushels of wheat—versus 912 million bushels in 2003. Unless secondary demand increased to make up some or all of the difference, demand for wheat for domestic-flour production would drop by 241.3 million bushels, or around 36 percent. This decrease would put downward pressure on wheat prices; however, since less than a third of the wheat supply is used for domestic food consumption, the price effect is likely to be limited.

A drop in wheat demand could trigger a change in land allocation. If total wheat intake were reduced by 27 percent and if half of all wheat flour were milled as whole-wheat flour, U.S. agriculture would need to harvest 5.6 million fewer acres of wheat per year (based on the marketing year 2004/05 yield of 43.2 bushels per acre). To put this acreage drop into perspective, producers harvested an estimated 50.8 million acres of wheat each year, on average, during 1999-2003—these estimates account for all uses, including food, nonfood, stocks, and exports (fig. 8). We calculated that roughly 44.5

Figure 8
Wheat harvested acres as a share of total cropland, by county



Source: Prepared by USDA, Economic Research Service using data from 2002 Census of Agriculture.

percent of the U.S. harvested wheat acres, or 22.6 million acres, went to domestic food use. Decreasing this amount of cropland by 5.6 million acres to account for the effects of both the total grain intake and whole-grain intake recommendations leaves 17 million wheat acres that would need to be harvested.

Some farmers affected by the change will likely shift acreage to other crops or other varieties, such as hard-white winter wheat, a less common wheat. Manufacturers are increasingly using this variety to make whole-wheat products that have some of the desirable properties of refined-wheat products. Producers might plant more acreage to hard-white wheat if the demand increases for foods made with this variety and if the price premiums (currently 1 to 3 percent) are sufficiently high to induce producers to make the switch. (A drawback is that hard-white wheat varieties are more susceptible to preharvest rainfall damage than hard-red wheat varieties.) In 2003, plantings of hard-white wheat accounted for 2.3 percent of all wheat grown in major hard-white wheat-growing States—Washington, Kansas, and Colorado. A shift to whole grains could also affect the demand for certain kinds of grains—and the demand for acreage suitable for growing those varieties. Whole-grain products with the potential to increase in demand in such a scenario include those made with rye, oats, and barley, and minor grain products, such as kasha and quinoa. Switching grain production to other crops or varieties might have little effect on net crop acreage.

The net effect on grain producers of a shift to whole-grain products will depend on myriad factors, including the type of grain demanded by food processors and the location of the producer. Grain farmers in the Midwestern, South Central, and Eastern United States, with longer growing seasons and more abundant rainfall than elsewhere, might find it easier to switch to other crops.

The eventual impact of consumption changes on grain producers will also depend on the interaction of market forces in other U.S. commodity markets. These interactions could lessen changes in the grain market due to a shift to whole-grain products. For example, farmers may use a larger share of corn and sorghum instead of wheat byproducts in livestock rations. Additionally, if Americans were to reduce total meat consumption to meet the *Guidelines'* recommendations for meat, the demand for feed grain for U.S. livestock could decline, potentially reducing grain acreage even further. However, an increase in dairy herd size to meet the dietary recommendations for increased milk and milk product consumption would moderate such effects.

Interactions with international markets are also important in understanding the eventual impact of consumption changes on grain producers. For example, in international markets, if the domestic demand for wheat drops, U.S. supplies available for export to such countries as Egypt, Japan, and Mexico, three of the largest markets for U.S. wheat, could increase.

Discussion

This straightforward extrapolation demonstrates that if Americans were to alter their food consumption to meet select recommendations in the *Dietary Guidelines*, the impact on food demand and production in the United States could be substantial. Of course, it is unrealistic to assume a full adoption of the dietary recommendations. The previous *Dietary Guidelines,* released in June 2000, had several themes similar to those in the 2005 release (e.g., Americans need to eat more fruits and vegetables). However, according to ERS Food Guide Pyramid Servings data, estimated consumption changed little after the release of the 2000 version. For example, a comparison of average daily per capita servings adjusted for spoilage and other waste by commodity group between 1997-99 and 2001-03 shows vegetable and dairy consumption each rose by 0.2 percent, fruit consumption fell by 3.6 percent, and total flour and cereal products consumption fell by 2.3 percent.[18] These small changes suggest that consumers' adoption of the recommendations will likely continue to be slow and incomplete.

Even though Americans may never fully adopt the recommendations in the *Guidelines*, consumers are constantly making dietary changes and may well make at least some dietary improvements, particularly as information in the new *Dietary Guidelines* and MyPyramid Food Guidance System are more widely disseminated and as our aging population becomes more aware of the benefits of nutritious diets in maintaining good health. Compliance with the 2005 recommendations may be more successful than with previous versions because of the accessibility and user-friendly features of MyPyramid on the Internet and because new supporting educational materials continue to be developed and distributed. Dietary trends change slowly over time in response to new dietary or medical information, popularity of some diets, changing tastes and preferences, and availability of new food products. For example, it is conceivable that, in the long term, as companies develop and produce new nonfat and low-fat milk and milk products and whole-grain products that appeal to consumers, domestic demand for these products will increase.[19]

Nevertheless, our estimate of full adoption provides an indication of the potential long-term impact on U.S. agriculture. Small estimated changes in consumption also suggest that U.S. agriculture would have adequate time to adjust production and the food industry would have time to develop and market new packaged fresh-food options and new processed foods. As evidenced by the plethora of new low-fat and low-carb products introduced in recent years, U.S. agriculture is flexible, constantly changing in response to changes in demand, new production and processing technologies, and supply shocks (Buzby et al., 2005). The production, trade, and acreage adjustments resulting from consumption changes would not be immediate and may never reach the scale estimated here. Additionally, the speed and extent of any adjustments may be constrained by U.S. farm policy and U.S. commitments with trading partners (e.g., dairy commitments with international trading partners are components of bilateral trade agreements).

The food industry is closely watching to see if, when, and how consumers will react to the new dietary recommendations. Consumers' reactions will

[18] Meanwhile, consumption of added sugars fell by 3 percent and consumption of the meat, eggs, and nut group rose by 3.4 percent. Estimated changes in added fats and oils over this time frame are not reliable due to changes in data reporting.

[19] See Buzby et al. (2005) for more discussion on the potential role of and impact on the different grain sectors.

help determine the quantity and mix of commodities grown by farmers and the quantity and mix of fresh and processed food products supplied by manufacturers. The dairy industry is waiting and watching to see if consumers boost intake of milk products, particularly low-fat and fat-free milk and milk-equivalent products. Consumers' reactions to the recommendations will also help determine what items appear on the menus at restaurants and other food outlets. Nutrition policy analysts hope to see a closing of the gap between actual intake and the *Guidelines*' recommendations. Farm policy analysts are also closely observing how the food consumption story unfolds, as only then will they be able to start measuring the *Guidelines'* true impacts on agriculture.

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