Linkages between Greater Fruit and Vegetable Consumption and Agriculture

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Introduction

This study estimates the economic impact on fruit and vegetable industries in the U.S. from an increase in consumption to levels recommended in the Dietary Guidelines for Americans 2005 (UDHH & USDA). Previous evaluations of the societal benefits of eating more fruits and vegetables have focused on the reductions in the incidence of chronic diseases associated with poor diets, including but not limited to some cancers, diabetes, and heart disease (Hung et al., Kant, WHO). We take it as given that healthier diets are desirable, and identify the extent to which agricultural producers benefit from such an outcome. This study represents the first attempt to quantify the effect on growers who could expect to gain from such as increase. The benefits to producers might justify additional public sector investment in promoting healthier diets. Much like the situation with generic advertising of specific commodities, when individual producers and even entire industries have limited incentives to invest in promotion healthier diets; there is an underinvestment in promoting such messages by industry, since the producers capture only a portion of the benefits to society.

Increased consumption of fruits and vegetables has been linked to a decrease in dietary related chronic diseases such as obesity, heart disease, diabetes, and some types of cancer. Greater consumption of fruits and vegetables has been shown to regulate blood sugar (Coyne et al.) and lower blood pressure (Steffen et al.). In a review of 196 epidemiology studies, scientists determined that preventable cancers could be reduced by about one third if people ate 7 to 9 servings of fruit and vegetables a day (World Cancer Research Fund, 1997). In addition, convincing evidence exists linking the consumption of specific fruit and vegetable groups to reductions in certain types of cancers. For example, eating dark green vegetables has been associated with a lower incidence of lung and stomach cancers (World Cancer Research Fund, 1997). Therefore, the USDA dietary recommendations diet provides recommendations for the *composition* of fruit and vegetable consumption, as well as the total level.

Recommended and current consumption of fruit and vegetables.

Current dietary guidelines recommend consuming at least 3 to 4 fruit servings and 4 to 5 vegetable servings a day (Table 1) (USDHH & USDA). The subgroup recommendations are at least 0.5 servings of deep yellow vegetables, 0.85 servings of dark green leafy vegetables, 0.85 servings of starchy vegetables under the 7 a day scenario, and 1.5 servings of starchy vegetables under the 9 a day scenario.

Table 1 about here

Despite the known health benefits, many people do not eat the amounts recommended in the dietary guidelines. People in households that earn less than $25,000 a year average even fewer servings per day than do people in higher income households. Based on author analysis of the National Health and Examination Survey (NHANES) data average consumption for low-income consumers is 1.6 servings a day for fruit and 2.9 a day for vegetables (Table 1) (USDHH 2003). Higher income consumers eat slightly more fruits and vegetables. Average consumption by high-income consumers is 1.8 servings of fruit a day and 3.1 servings of vegetables (Table 1). The servings are net of potato consumption in the form of French fries and potato chips, average consumption of which is about 0.7 servings a day for both low and high income households.

Fruit consumption would need to increase by 83 percent for low-income consumers and by 66 percent for high-income consumers to achieve the 3-a-day recommendation. Vegetable consumption would need to increase by 39 percent for low-income consumers, but only30 percent for high-income consumers, for these groups to reach the recommended 4-a-day target.

Even though overall consumption of fruits and vegetables is higher for people with a higher income, people with lower incomes eat more of certain types of fruits and vegetables. Average consumption of apples, bananas, cabbage, celery, cucumbers, pears, tangerines, watermelon, and all juices but grapefruit juice is greater by people with a household income of less than $25,000 a year. In general, these items have lower retail prices than the other fruits and vegetables. Consumption of high-priced items tends to be lower for the low-income group. For instance, consumption of items such as artichokes and raspberries was zero among the low-income households surveyed.

Implications for U.S. fruit and vegetable industries

A shift in demand toward more fruits and vegetables would be met through increased production from within the U.S., and a reduction in exports to or increased imports from other regions. Agricultural industries stand to benefit significantly, should consumers achieve the recommended levels of fruit and vegetable consumption. The annual farmgate value of U.S. production of fruit and vegetables is $21 billion (USDA 2003). The volume of fruits and vegetables imported into the U.S. is another $10 billion; because it is a wholesale value, that figure is not directly comparable to the farmgate value of U.S. production above, but it does serve to put the relative importance of U.S. production sources in meeting overall U.S. consumption into further perspective.

The states with the greatest amount of fruit and vegetable production, in order by acreage, are California, Florida, Washington, Texas and Georgia (USDA 2003). These states have about 70 percent of the total acreage planted in fruits and vegetables with Californian's share equal to 45 percent. California also tends to specialize in production for the fresh market and is the largest producer of fresh oranges, spinach, carrots, green beans, etc., even though it is not the largest overall producer of these commodities.

The ability of growers to increase production of fruits and vegetables depends on the resources, such as land, water, labor, and other purchased inputs, at their disposal. However, there is not an unlimited supply of land, agricultural labor or water in dryer states. Drawing additional resources into the production of fruit and vegetables will raise the prices of those resources, to the extent that their supply is limited.

Estimating the benefits to fruit and vegetable industries

To measure how increases in demand for fruit and vegetables impacts final consumption, trade, production and the demand for agricultural inputs an equilibrium displacement model of individual fruit and vegetable industries is developed. This model is used to simulate the price and quantity effects of six scenarios describing new levels of fruit and vegetable consumption. The first two are a general 10 percent increase and a general 25 percent increase. The next two are an increase to the 7-a-day and to the 9-a-day daily servings. The final two scenarios are for the specific food subgroups within the 7-a-day and 9-a-day recommendations. Because people with lower incomes eat fewer fruits and vegetables than do people with higher incomes, the change in eating habits for individuals with lower incomes who move to a diet with more fruits and vegetables may be greater. Consequently, this study distinguishes between people living in lower income households (less than $25,000 a year) and people living in higher income households (more than $25,000 a year). That level of income is about equal to 130 percent of the poverty level for a family of four. Due to California's large share of domestic production and its specialization in fresh produce, separate equations are included for production from California and for production from the Rest of the United States.

A Market Model of U.S Fruit and Vegetable Industries

A multistage equilibrium displacement model is developed to calculate the changes in prices, market supply, trade and production for the six scenarios being simulated. The model uses the dual approach developed by Wohlgenant to characterize the demand and supply relations. The model contains a final retail market, a marketing sector, where non-farm inputs are used to bring the farm commodity to market, and an agricultural sector where production takes place. Finally, the model incorporates the agricultural input markets for land, labor, and all other inputs.

Final market demand equations

The quantity demanded, Y, for fruit or vegetable commodity j by income group k, depends upon its own-price P_j, the price of other commodities, P_{-j}, and an exogenous demand shifter ϕ that represents preferences for fruits and vegetables (eq. (1))

(1) $$Y_{jk} = d_{jk}\left(P_1, \ldots, P_J; \phi_{jk}\right).$$

Total demand for commodity j is the sum of demand for each income group k (eq. (2))

(2) $$Y_j = \sum_k Y_{jk} \ .$$

Final Market Supply Equations

The U.S. market supply, Y, of commodity j comes from production, Q, by the marketing sector in region i, where i is California or the rest of the U.S., and from net trade, T, with other countries (eq. (3)). Net trade is equal to total imports less total exports. If T is positive, the U.S. imported more than it exported. If T is negative, the U.S. exported more than it imported. Trade in commodity j depends on its U.S. market price (eq. (4)). As U.S. prices increase, the amount of commodity j that goes to the U.S. market also increases.

(3) $$Y_j = \sum_i Q_{ji} + T_j$$

(4) $$T_j = t_j\left(P_j\right)$$

Marketing Sector

The marketing sector takes the farm product and either packs it fresh for delivery to markets, or processes it to sell as juiced, canned, frozen or dried products. Non-farm inputs such as labor, transportation, packing materials, machinery in processing plants, etc., are used to bring fresh and processed fruits and vegetables to market. The total cost of the non-farm inputs is w_m. The price received by growers of fruits and vegetables, w_g, will change as the quantity demanded for fruits and vegetables changes. The cost to produce commodity j depends on the price of the farm and non-far inputs, and the level of production Q. Firms in the marketing sector produce where marginal revenue (P_j) is equal to marginal cost ($\partial C_{ji}(\cdot)/\partial Q_{ji}$) in each region i (eq. (5)).

(5) $$P_j = \partial C_{ji}\left(w_{jgi}, w_{jmi}; Q_{ji}\right) / \partial Q_{ji}$$

The marketing sector receives the farm commodity from growers and the non-farm inputs from other suppliers. As demand for the final output changes, demand for the farm commodity and non-farm inputs changes. Using Shepard's Lemma, the derived demand for the farm commodity, x_{jgi}, (eq. (6)) by the marketing sector is

(6) $$x_{jgi} = \partial C_{ji}\left(w_{jgi}, w_{jmi}; Q_{ji}\right) / \partial w_{jgi}.$$

Again using Shepard's Lemma, the derived demand for the farm commodity, x_{jmi}, is

(7) $x_{jmi} = \partial C_{ji}\left(w_{jgi}, w_{jmi}; Q_{ji}\right) / \partial w_{jmi}$

Agricultural Sector

The farm commodity, x_{jgi}, is grown using land, labor, and other purchased inputs. The grower produces farm commodity j where marginal revenue, w_{jgi}, is equal to marginal cost $\partial C_{jgi}(\cdot)/\partial x_{jgi}$ (eq.(8)). The cost to produce farm commodity j depends on the price of agricultural inputs, and the level of production, x_{jgi}. Since this model uses the cost function, instead of the production function to specify the equilibrium production relation, the production of all other fruit and vegetable crops, x_{-jgi}, grown in region i, is included in the cost function to incorporate all grower planting options in the model.

(8) $w_{jgi} = \partial C_{jgi}\left(v_{1i},...v_{Ri}; x_{jgi}, x_{-jgi}\right)/\partial x_{jgi}$

As production of farm commodity j changes, the demand for agricultural inputs also changes. Using Shepard's Lemma, the quantity demanded, z_{jri}, for agricultural input r by farm product j, is the derivative of the grower's cost function, $C_{jgi}\left(v_{1i},...v_{Ri}; x_{jgi}\right)$, with respect to the price, v_{ri}, of input r (eq. (9)). The change in agricultural input use in each region for a change in the consumption of fruits and vegetables is calculated for land, and labor, and a general all other inputs category.

(9) $z_{jri} = \partial C_{jgi}\left(v_{1i},...v_{Ri}; x_{jgi}, x_{-jgi}\right)/\partial v_{ri}$

The total quantity demanded, Z, for input r in region j is the sum of the quantity demanded for the production of each farm product (eq. (10)).

(10) $Z_{ri} = \sum_{j} z_{jri}$

The quantity supplied, Z, of input r is a function of its price, v_r (eq. A.14).

(11) $Z_{ri} = f_{ri}(v_{ri})$

Model in Log-linear Specification

The log-differential is taken of the system of equations specified above, and parameters converted into elasticities, and demand, supply and cost shares. The final simulation model is:

(12) $d\ln Y_{jk} = \eta_{jjk} d\ln P_j + \sum_{-j} \eta_{j-jk} d\ln P_{-j} + d\ln \phi_{jk}$

(13) $d\ln Y_j = \sum_k \gamma_k d\ln Y_{jk}$

(14) $d\ln Y_j = \sum_i \lambda_{ji} d\ln Q_{ji} + \lambda_{jT} d\ln T_j$

(15) $d\ln T_j = \varepsilon_{jT} d\ln P_j$

(16) $d\ln P_j = \alpha_{jgi} d\ln w_{jgi} + \alpha_{jmi} d\ln w_{jmi} + \frac{1}{\varepsilon_{Q_{ji}}} d\ln Q_{ji}$.

(17) $d\ln x_{jgi} = -\alpha_{jmi}\sigma_{jgmi} d\ln w_{jgi} + \alpha_{jmi}\sigma_{jgmi} d\ln w_{jmi} + d\ln Q_{ji}$

(18) $d\ln z_{jri} = -\sum_{-r} \pi_{j-ri}\sigma_{j-rr} d\ln v_{ri} + \sum_{-r} \pi_{j-ri}\sigma_{j-rr} d\ln v_{-ri} + d\ln x_{jgi}$

(19) $d\ln x_{jmi} = \alpha_{jgi}\sigma_{jgmi} d\ln w_{jgi} - \alpha_{jgi}\sigma_{jgmi} d\ln w_{jmi} + d\ln Q_{ji}$

(20) $d\ln w_{jgi} = \pi_{jai} d\ln v_{ai} + \pi_{jli} d\ln v_{li} + \pi_{joi} d\ln v_{oi} + \frac{1}{\varepsilon_{x_{jgi}}} d\ln \partial x_{jgi} + \sum_{-j} \frac{\varepsilon_{x_{-jgi}}}{\varepsilon_{x_{jgi}}} d\ln w_{-jgi}$

(21) $d\ln w_{jmi} = \frac{1}{\varepsilon_{x_{jmi}}} d\ln \partial x_{jmi}$

(22) $d\ln Z_{ri} = \sum_j \beta_{jri} d\ln z_{jri}$

(23) $d\ln Z_{ri} = \varepsilon_{ri} d\ln v_{ri}$

where η_{jj} is the own price elasticity of demand, η_{j-j} is the cross price elasticity of demand, ε_{Tj} is the elasticity of quantity traded, $\varepsilon_{Q_{ji}}$ is the elasticity of supply from the marketing to the retail sector, $\varepsilon_{x_{jgi}}$ is the elasticity of supply from the farm sector, $\varepsilon_{x_{jmi}}$ is the elasticity of supply for the marketing input, ε_{rcal} is the elasticity of supply for the agricultural inputs, σ_{jgmi} is the elasticity of substitution between the farm and marketing input, σ_{j-rr} is the elasticity of substitution between agricultural inputs, , γ_{jk} is the share of retail market supply consumed by income group k, λ_{ji} is the share of total market supply for commodity j supplied by region i and through trade, α_{jg} and α_{jm} are cost shares for the marketing sector, π_{jr-ri} are cost shares for the agricultural inputs, and β_{jri} are the input shares for each commodity.

The solutions to the model above can be used to estimate the changes in producer surplus to growers in the U.S. and to producers of the marketing input.

The change in producer surplus (ΔPS) for growers in both California and the rest of the U.S. is

(24) $$\Delta PS_{gji} = \left(d\ln P_{gji} - d\ln C_{gji}\right) * OP_{gji} * OQ_{ji} * (1 + 0.5 * d\ln Q_{ji})$$

where $d\ln P_{gji}$ is the percentage change in the grower price per ton received for commodity j, $d\ln C_{gji}$ is the percentage change in the grower cost per ton to produce commodity j, OP_{gji} is the original price of commodity j paid to growers, OQ_{ji} is the original level of production of commodity j in region i, and $d\ln Q_{ji}$ is the percentage change in production of commodity j in region i. The total change in producer surplus for fruit and vegetable growers is

(25) $$\Delta PS_{gj} = \sum_i \Delta PS_{gji}$$

Marketing inputs are used to move production from growers to the final market and imports to retail outlets. Because producer surplus in the retail market is equal to the sum of producer surplus for the suppliers of farm inputs and marketing inputs (Alston, Norton and Pardey 1995), producer surplus for the marketing input is calculated as

(26) $$\Delta PS_{mj} = \Delta PS_{rj} - \sum_i \Delta PS_{gji}$$

Thirty-seven commodities are included in this analysis. The final fruits and vegetables selected were those for which a complete data set was available. Data are needed on the consumption of different food items by income, current level of retail prices, U.S. and California crop production and value, imports, exports, demand and supply elasticities (used to measure the responsiveness of growers and consumers to price changes), and agricultural inputs. The commodities included and the USDA sub-groups to which they belong are shown below:

Fruit:	Apple, apricots, avocados, bananas, cantaloupe, cherries, grapes, grapefruit, honeydew melon, oranges, peaches and nectarines, pears, pineapples, plums and prunes, strawberries, tangerines and other citrus, watermelon.
Dark green:	Spinach, broccoli.
Deep yellow:	Carrots, sweet potatoes
Starchy Vegetables:	Corn (fresh market sweet), peas.
Other vegetables:	Lettuces (green leaf, head, romaine, endive, etc.), artichokes, asparagus, beans (snap), celery, cucumbers, eggplant, onions, bell

peppers, fresh market tomatoes, processing market tomatoes, cabbage, cauliflower.

Potatoes: All varieties

Potatoes are a starchy vegetable, but are listed separately because the percentage shift in demand for potatoes will include a decrease in demand to account for the elimination of French fries and potato chips from consumer diets, before the total shift in starchy vegetables is calculated. Increased consumption of fruits and vegetables need not come at the expense of any particular substitute good; however, it seems unlikely that an increased awareness of the role of diet in disease prevention large enough to cause shifts in fruit and vegetable consumption of the magnitudes in the six scenarios would not also be accompanied by reductions in the number of servings of less healthy foods. Most such reductions would have small effects on the fruit and vegetable markets of interest in this study. An exception occurs with potatoes. Since a significant number of potatoes are consumed in the form of chips or French fries, we would probably end up with misleading results for potato producers if we modeled the effects of increased fruit and vegetable consumption without accounting for the decrease in the demand for potatoes eaten as French fries or chips.

Data

<u>Consumption</u>

The consumption data for fruits and vegetables was obtained from the surveys. These are 24-hour recall surveys and administered during person-to-person interviews. The data were downloaded from the NHANES website (http://www.cdc.gov/nchs/about/major/nhanes/nhanes01-02.htm).

To estimate the percentage increase in demand *(dln*ϕ_{kj}*)* for individual commodities, the fruits and vegetables were separated into their appropriate categories (Table 2). The categories may be the general fruit and vegetables categories, or the more specific USDA subgroups. Using the NHANES data, the average daily servings of all fruits or vegetables belonging to the same category, by commodity and income, were summed to calculate the total average servings consumed per day per category. The consumption data include information on the average daily consumption of many types of fruits and vegetables that were omitted from the economic analysis due to a lack of sufficient market data. For example, the consumption of blueberries, blackberries, Crenshaw melons, and unspecified fruit is included along with the oranges, bananas, and apples, etc., in the total servings of fruit consumed each day, even though they are not included in the economic analysis. Based on current serving numbers, the percentage increase needed to attain the recommended level of consumption for the category is calculated, and consumption of each commodity is increased by that percentage.

Table 2 here

For potatoes, as already noted, we decided to simulate a decrease in the consumption of French fries and potato chips, while increasing the consumption of potatoes prepared in other ways. To calculate the change in the demand for potatoes, first the required total percentage increase in consumption of starchy vegetables was calculated. Consumption of potatoes not in the form of French fries or potato chips is included in the starchy vegetable category. This percentage increase is used to calculate the new level of "healthy" potato consumption. The percentage change in demand for potatoes was then calculated using the original consumption of potatoes, including

French fries and potato chips, and the new level, which excludes French fries and potato chips, but includes the “healthy” form of potatoes.

Production and Trade

U.S. and California production and farm value data are available from the USDA’s Fruit and Nut Yearbook and Outlook reports, the Vegetable and Melon Yearbook and Outlook reports, and Agricultural Statistics. The USDA data has California statistics for most, but not all crops. Additional data for California are available from the California Agricultural Statistics Service (1998-2002). The crop figures for grapes exclude production that is used in wine production.

Data on agricultural inputs used in the production of individual commodities are available from crop budgets that were downloaded from the Internet. Crop budgets for the fruits and vegetables included in the analysis were obtained from 26 states. Important parameters needed for this study are the elasticities of demand and supply. The only available data on elasticities of demand were taken from Huang, and Huang and Lin. Huang estimated the own price, cross price and income elasticities of demand for a variety of foods including beef, chicken, apples, oranges, lettuce, fresh and processed tomatoes, etc. Huang and Bin estimated own price, cross price and income elasticities of demand for low, medium and high-income households, but used a general fruit and general vegetable category. The elasticities of demand by household income type in Huang and Lin were used to weight the elasticities for individual commodities in Huang. For items included in this study that were not included in the Huang study such as eggplant, peaches, etc., average elasticity values for the own price and income elasticity were used. Cross prices elasticities were calculated using the homogeneity conditions for demand functions.

There is no study that has estimated supply elasticities in a system that includes individual crops, though the fruit and vegetable sectors are included in studies that have estimated input and output elasticities of supply for U.S. agriculture (Chavas and Cox 1995; Shumway and Lim 1993; and Shumway and Alexander 1988).   The supply elasticities for individual fruits and vegetables are extrapolated from this literature. The supply elasticities are determined for two different production groups. The first group includes all annual fruit and vegetables and the second perennial fruit crops (Table 3). The cross price elasticities of supply are calculated using the homogeneity conditions for supply functions.

Table 3 here

When the U.S. is a net importer of commodity, the elasticity of supply for trade is positive, and when the U.S. is a net exporter it is negative. The elasticity of supply from the marketing sector to the final sector is the same as the own-price elasticity of supply by the grower to the marketing sector (Table 3). Because other crops are not explicitly included in this analysis the elasticity of supply for agricultural land is relatively elastic. The elasticities of supply for land and labor are also elastic, but not perfectly elastic. Therefore, an increase in the demand for land or labor will cause their price to go up.

The elasticity of substitution between the farm and non-farm input in the marketing sector depends upon the share of the commodity that is marketed as a fresh commodity. For commodities with a high share of production entering the fresh market, such as artichokes and asparagus, few non-farm inputs can be substituted for the farm product, and the elasticity of substitution is low (Table 3). For commodities with a low share of production entering the fresh market (such as grapes/raisins, potatoes, and processed tomatoes), a high share is processed, and more non-farm inputs can be substituted for the farm product in production, and the elasticity of substitution is higher. Only one value is used for the elasticity of substitution. A sensitivity analysis was completed for other reasonable values and found to have no effect on the final results.

Results

Even though California was included as a separate region in the analysis, the total changes in producer surplus are reported here. As would be expected, as the percentage increase in demand increases, the benefits to agricultural industries increases (Table 4). When demand increases by 10 percent, the increase in producer surplus for growers is \$0.71 billion. This represents just over three percent of the \$21 billion in farm receipts. The producer surplus for the marketing sector increases by \$4.91 billion, for a total increase of \$5.61 billion for the fruit and vegetable industries analyzed in this study. This result shows that for even relatively small changes in demand, the total benefits to the agricultural sector can be substantial.

Table 4 here

When demand for fruits and vegetables increases by 25 percent, total benefits to growers increase to \$2.12 billion. Under the 7 a day scenario grower benefits are \$4.66 billion and \$9.81 billion under the 9 a day scenario (Table 4). Even though the demand for fruit in the 9-a-day scenario is increasing from 122 percent for low-income households to 144 percent for high-income households and the demand for vegetables from 66 percent to 73 percent, the increase in producer surplus for growers is only 47 percent of farm receipts. The low percentage is due to trade and an increase in the costs of agricultural inputs. Production can be redirected from export markets to domestic markets, and foreign producers can increase their exports to the U.S. In the latter case, foreign producers are capturing a portion of the benefits from increased U.S. consumption in fruit and vegetables. An increase in the costs of production will also lower the benefits from increases in demand.

Total producer surplus increases from $37.84 billion a year in the 7-a-day scenario to $39.50 billion in the 7-a-day USDA scenario, but *decreases* from $84.63 billion a year the 9-a-day scenario to $80.32 billion the 9-a-day USDA scenario. In the 9-a-day scenario there is an increase in the recommendations for starchy vegetables to 1.5 servings a day from 0.85 servings a day in the 7-a-day USDA scenario; however the daily recommendations for dark green and deep yellow vegetables do not change. Consequently, "other" vegetables have a smaller share of the increase in consumption in the 9-a-day USDA scenario. For the sub-group recommendations, even though the increase in producer surplus is greater under the USDA scenarios for the dark green and deep yellow vegetables, the benefits from growers of "other" vegetables declines from $22.44 billion under the 9-a-day scenario to only $4.57 billion in the 9-a-day USDA scenario. This smaller benefit more than offsets the gains to growers of the vegetables emphasized in the USDA sub-groups, and benefits are lower in the 9-a-day USDA scenario. For the 7-a-day USDA scenario, even though the benefits to "other" vegetable industries are also smaller, they do not offset the gains to producers of dark green and deep yellow vegetables.

The increase in the demand for fruit and vegetables will cause the demand for agricultural inputs to increase as well (Table 5). The demand for land increases from two percent in the 10 percent scenario to 36 percent in the 9 a day USDA scenario. This represents an additional 146 thousand to 2.6 million acres in fruit and vegetable production. In this analysis the changes in production of non-fruit and vegetable crops are not explicitly modeled. Using the assumption that the acreage for increased fruit and vegetable production will come mainly from field crops such as alfalfa, rice, wheat, field corn, and cotton, the combined acreage for these crops is 218 million acres. About one percent of total acreage in select field crops would need to be converted to fruit and vegetable production in order to meet the increase in demand for fruit and vegetables.

Table 5 about here

The demand for labor will also increase. Under the 10 percent scenario the demand for labor increases by four percent and under the 9-a-day scenario the increase is 43 percent. Fruit and vegetable cultivation, especially for the fresh market, requires more labor than for the cultivation of field crops as many crops require hand thinning and harvesting. Therefore the increase in the demand for labor is likely to not be significantly offset by decreases in the demand for labor used in the cultivation of field crops.

Conclusion

Consuming more fruit and vegetables would have a positive impact on the incidence of chronic diseases such as diabetes, heart disease, and dietary related cancers. The results of this study show that fruit and vegetable industries would also substantially benefit should people eat more fruit and vegetables. Even small changes of, say, 10 percent, result in large changes in producer surplus. The benefits to the different industries from public policies to encourage healthier vary according to which scenario is considered. Producers of dark green and deep yellow are better off with messages that emphasize consumption of the USDA scenarios. Producers of other vegetables are better off under general recommendations to eat more fruit and vegetables.

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Table 1. Recommended and current consumption levels by household median income.

	7 a day	7 a day sub-group	9 a day	9-a-day subgroup	Low-Income*	High-Income*
Total Fruit	3	3	4	4	1.6	1.8
Total Vegetables	4		5		2.9	3.1
Deep Yellow		0.5		0.5	0.2	0.2
Dark green		0.85		0.85	0.2	0.3
Starchy		0.85		1.5	0.8	0.6
Other vegetables		1.8		2.15	1.7	1.98
Total	7	7	9	9	4.5	4.9

*Low income is less than $25,000 a year, high income is equal to or greater than $25,000 a year

Table 2. The Percentage Shift in Demand Needed to Attain the Recommended Levels of Fruit or Vegetable Consumption for Each Scenario.[a]

	Scenarios					
Fruit and Vegetable Subgroups	10 percent	25 percent	7 a day	9 a day	7 a day USDA	9 a day USDA
			Low Income Households[b]			
Fruit	10	25	83	144	83	144
Dark Green Vegetables	10	25	39	73	176	176
Deep Yellow Vegetables	10	25	39	73	293	293
Other vegetable	10	25	39	73	4	25
Starchy – no potatoes	10	25	39	73	11	96
Potato	-52	-46	-40	-25	-52	-15
			Higher Income Households[b]			
Fruit	10	25	66	122	66	122
Dark Green Vegetables	10	25	30	62	151	151
Deep Yellow Vegetables	10	25	30	62	189	189
Other vegetable	10	25	30	62	-9	9
Starchy – no potatoes	10	25	30	62	38	143
Potato	10	25	66	122	66	122

[s]NHANES V

[b]low income in $25,000 annual household income or less, higher income is over $25,000

Table 3. Miscellaneous Elasticity Values.

	Low	High
Trade	2	5
Elasticity of supply		
Row vegetable	1	1.2
Row fruit	1	1.2
Perennial fruit	.85	1
Agricultural inputs		
Land	2	5
Labor	5	10
Elasticity of substitution		
Farm and Non-farm	LSF* = .1	HSF* = .05
Land and labor	.05	.1
Land and other inputs	.05	.1
Labor and other inputs	.05	.1

HSF =a high share of total production is marketed fresh, LSF =a low share of total production is marketed fresh

Table 4. The total change in annual producer surplus for U.S. growers and the marketing sector under each scenario by agricultural industry.

Fruit and vegetable subgroups	10 percent	25 percent	7 a day	9 a day	7 a day USDA	9 a day USDA
			($billions)			
			Grower Surplus			
Fruit	0.37	0.98	2.98	6.00	3.00	5.99
Dark Green	0.04	0.10	0.13	0.29	0.88	0.92
Deep Yellow	0.05	0.12	0.17	0.38	0.83	0.89
Other vegetable	0.32	0.87	1.22	2.64	0.40	1.15
Starchy - no potato	0.05	0.13	0.18	0.39	0.16	0.67
Potato	-0.13	-0.07	-0.03	0.10	-0.01	0.16
Total	0.71	2.12	4.66	9.81	5.26	9.78
			Marketing Surplus			
Fruit	2.5	6.72	23	50.37	23.01	50.38
Dark Green	0.17	0.47	0.62	1.46	5.89	6.11
Deep Yellow	0.21	0.57	0.77	1.78	4.58	4.79
Other vegetable	2.32	6.38	8.48	19.79	0.55	5.55
Starchy - no potato	0.22	0.60	0.81	1.88	0.76	3.90

Potato	-0.51	-0.50	-0.50	-0.45	-0.53	-0.19
Total	4.91	14.25	33.18	74.83	34.25	70.54
			Total Surplus			
Fruit	2.88	7.7	25.99	56.37	26.01	56.36
Dark Green	0.21	0.56	0.76	1.75	6.77	7.04
Deep Yellow	0.25	0.70	0.94	2.16	5.41	5.68
Other vegetable	2.65	7.25	9.70	22.44	0.94	6.70
Starchy - no potato	0.26	0.72	0.99	2.27	0.92	4.57
Potato	-0.64	-0.57	-0.53	-0.35	-0.54	-0.03
Total	5.61	16.36	37.84	84.63	39.50	80.32

Table 5. The Percentage Increase in Quantity Demanded of Land and Labor by Fruit and Vegetable Industry.

	10 percent	25 percent	7 a day	9 a day	7 a day USDA	9 a day USDA
Land	2	8	17	34	17	36
Labor	4	10	23	43	23	42