# A Systems Approach to Projecting Per Capita Food Consumption*

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## Introduction

American agriculture has produced an abundant supply of food and fiber at low direct cost to consumers. But environmental concerns, energy shortages, health considerations and other constraints are causing concern as to whether sufficient food commodities can be produced to meet U.S. requirements and at the same time continue expanding exports. To provide public decisionmakers with information with respect to this and other major uncertainties about the future of the U.S. food and fiber system, the Economic Research Service is devoting renewed attention to its Economic Projections Program. Part of this attention is in developing the National-Interregional Agricultural Projections (NIRAP) System. This paper relates to those NIRAP components used to project domestic food use and more specifically per capita consumption of major food commodities.

Total U.S. requirements for food commodities are much higher today than in the 1960's due mainly to higher export markets. The index of the volume of agricultural exports almost doubled from 1960 to 1973 mostly from food and feed commodities [U.S. Department of Agriculture, 1974]. Domestic U.S. food requirements however, increased at only 1.9 percent a year. Most of this increase in food requirements has come from increased population, which increased at about 1.2 percent annually during the same period. [Council of Economic Advisers]. But the index of total per capita food consumption increased only 0.5 percent per year from 1960 to 1973. [U.S. Department of Agriculture 1968, p. 561]. Thus, there has been no sudden change in total per capita food consumption.

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While total U.S. per capita food consumption has not changed greatly, the consumption pattern has changed. In 1946, we were eating about 62 pounds of beef per capita (carcass weight), 10 pounds of veal, and 76 pounds of pork [U.S. Department of Agriculture 1968, plus supplements]. Our per capita poultry consumption was 14 pounds of chicken and 3 pounds of turkey in that year. By 1973, per capita consumption had increased to 110 pounds of beef, but veal dropped to only about 2 pounds. Pork consumption was down to 66 pounds per person. In contrast, per capita consumption of poultry had almost tripled to 41 pounds of chicken and 9 pounds of turkey. Egg per capita consumption declined from about 49 pounds in 1946 to 38 pounds in 1973, while milk declined from 786 pounds to 554 pounds during the same period.

For crops, wheat and wheat products consumption per person has decreased, but corn use is up. Citrus fruit consumption is increasing, but noncitrus is declining. With total per capita food consumption changing slowly but the composition changing rapidly, what are the long-run prospects for food consumption in the U.S.?

## The Projections System

Components of the NIRAP system determining domestic food consumption are illustrated in figure 1 and include (1) scenario development, (2) technological change simulator (3) world trade (4) general economy (5) constant price commodity demand (6) aggregate farm output and (7) commodity production and utilization. In this paper, I will concentrate on the constant price commodity demand model but will indicate major linkages of this to other NIRAP system components.

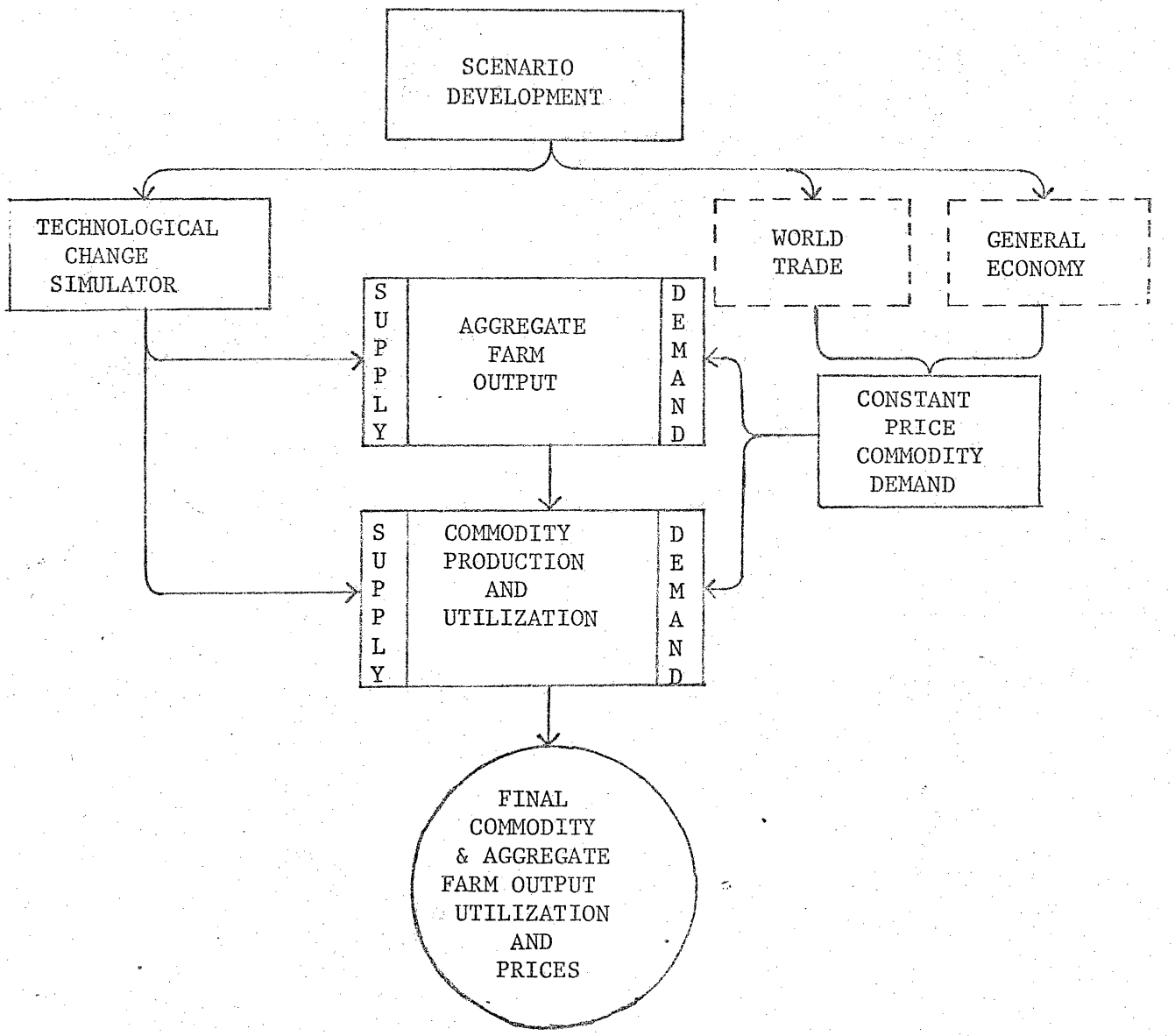


Figure 1.--NIRAP System Components Determing U.S. Domestic Food Consumption

Constant Price Commodity Demand Model

The constant price commodity demand component was designed based on conventional supply-utilization calculations with parameters estimated using ordinary least squares and historical data for the period 1953-73. The general form of the per capita consumption equation was:

1. $PCC_{it} = a + [b-[c(PCDI_t - PCDI_k)]\ PCDI_t$

where $PCC_{it}$ = the per capita consumption of the ith commodity (i = 1--23) in the t th year.

PCDI = per capita disposable income in 1958 dollars.

k = base year selected

t = projected year

a = intercept

b = regression coefficient

c = the estimated adjustment coefficient to constrain consumption at the upper or lower bound.

As real income increases, the proportion of income used for food decreases. Upper and lower bounds were placed on most commodities for the year 2025 using the subjective judgment of commodity analysts and consumption specialists. These bounds were placed at limits that could be reasonably expected to be attainable for each commodity. For example, the unconstrained estimating equation would place beef consumption above 200 pounds per person after the year 2000, given the assumption of the growth of real per capita disposable income of 3.2 percent annually. Since this is beyond the limits that could be expected, the limit was placed at 155 pounds, which is slightly lower than the production specialists feel is attainable, but higher than the consumption specialists thought was likely. Total food consumption for the ith commodity in year t is:

2. $TFC_{it} = (PCC_{it}) \quad (TP_t)$

where $TP_t$ = total projected population in the projected year.

Based on food use of livestock commodities, and feed-livestock conversion factors, feed grain requirements are estimated. Then export projections provided by the Foreign Demand and Competition Division and estimates of "other uses" of farm commodities complete the initial projections of commodity demands.

The initial per capita consumption projections are based on projected increases in per capita personal disposable income and estimated income elasticities of demand. Other determinants used in these initial commodity food use projections are demand shift variables such as population and do not account for own price and cross commodity price effects. Thus we refer to these initial commodity projections as constant price demand projections and they serve to shift the commodity and aggregate farm output demand functions in other components of the NIRAP system.

Aggregate Farm Output

A koyck-type geometrically distributed lag aggregate farm output two equation supply-demand model provides the overall constraints on projections of alternative futures generated in the NIRAP system. Based on short and long-run elasticities of supply and demand, a supply shifter generated by the technological change simulator and the demand shifter provided by the constant price commodity demand component, provides for the projection of aggretate farm output, prices paid and received by farmers, production costs, and gross and net farm income.

Commodity Production and Utilization

The fourth component was constraints from the aggregate farm output and prices received by farmers generated by the aggregate farm output component; the supply shifters generated by the technological change simulator; and the demand shifters provided by the constant price commodity demand model. This component projects equilibrium prices and quantities for 21 farm commodities. Prices of commodities not included in this model are projected using the index of prices received by farmers provided by the aggregate famr output model. Quantities of commodities not included in this component are projected at their constant prices quantities determined in the constant price commodity model and adjusted for consistency with the aggregate farm output component. Commodity price effects are derived using a Newton-Rapnson method for solving nonlinear equations to project equilibrium prices and quantities. Internally fixed own and cross-price elasticity matrices for U.S. supply, imports domestic food demand, domestic feed demand, domestic other use demand and exports make up the bulk of parameters used in this component.

## Results

To illustrate the effects of each NIRAP component, the following assumptions were used to project per capita consumption of selected commodities in 1985:

1. The annual growth rate in Gross National Product in 1958 dollars was assumed to be 3.98 percent from 1975 to 1985. With this GNP assumption, per capita disposable income in 1958 dollars increased at 3.2 percent annually from 1975 to 1985.

2. Total population for 1985 was projected at 234.1 million based on the Series II projections of total population, Bureau of the Census (U.S. Department of Commerce). This is a growth rate of 0.9 percent a year.
3. Public expenditures for research and extention in agriculture are assumed to increase 3 percent per year (1958 dollars) and this results in about a 1.0 percent per year increase in agriculture productivity.
4. "Baseline" export projections provided by the Foreign Deamand and Competition Division are used.

The resulting per capita consumption projections (table 1) indicate that generally the "price constrained" output is lower than the constant price component projections. Citrus fruit, noncitrus fruit, lamb and mutton, and Irish potatoes are exceptions. Price effects in the commodity price equilibrium model tend to lower per capita consumption. Overall constraints imposed by prices received by farmers and the supply quantity for aggregate farm output provided by the aggregate farm output model tends to further dampen the commodity projections.

Beef and veal per capita consumption appears too low, given the past trend. This may be due to the constraints on the income elasticity of demand imposed in the constant price component. Further research to test the model without constraints is planned. The constant price projections indicate beef and veal consumption will move upward, but not as rapidly as recent trends. With the price effects included, consumption tends to level out.

Table 1.--A Comparison of Projected Per Capita Consumption of Selected Commodities for 1985 at Different Points in the System

| Commodity | Average 1970-72 | Constant price: Commodity demand Component | Commodity price Equilibrium Component | Final Output Adjusted on the Aggregate farm output constraint |
|---|---|---|---|---|
| Beef & veal 1/ | 116.8 | 131.6 | 118.4 | 116.8 |
| Pork 1/ | 68.9 | 67.6 | 65.4 | 64.5 |
| Lamb & mutton 1/ | 3.2 | 2.3 | 3.0 | 3.0 |
| Chicken 2/ | 41.9 | 44.3 | 41.2 | 40.6 |
| Turkey 2/ | 8.6 | 10.2 | 8.9 | 8.7 |
| Eggs | 40.7 | 40.2 | 38.8 | 38.2 |
| Milk 3/ | 560.0 | 529.9 | 517.2 | 509.9 |
| Wheat 4/ | 151.3 | 146.6 | 145.5 | 143.5 |
| Rice 5/ | 12.0 | 12.7 | 10.4 | 10.3 |
| Soybeans 6/ | - | 0.1 | 0.1 | 0.1 |
| Corn 7/ | 61.8 | 65.6 | 65.6 | 64.7 |
| Oats | 7.0 | 7.1 | 7.1 | 7.0 |
| Barley | 1.9 | 1.9 | 1.9 | 1.9 |
| Rye | 1.4 | 1.3 | - | 1.2 |
| Peanuts 8/ | 8.0 | 9.8 | 8.1 | 8.0 |
| Sugar 9/ | 109.8 | 109.0 | - | 101.5 |
| Citrus fruit 10/ | 96.5 | 100.4 | 103.4 | 102.0 |
| Noncitrus fruit 10/ | 99.7 | 98.1 | 101.1 | 99.7 |
| Vegetables & melons 10/ | 236.5 | 238.3 | 231.1 | 227.9 |
| Irish potatoes 10/ | 119.1 | 122.4 | 124.1 | 122.4 |
| Sweet potatoes 10/ | 4.7 | 4.6 | - | 4.3 |
| Dry beans 11/ | 6.0 | 6.3 | - | 5.9 |
| Dry peas 11/ | 0.2 | 0.3 | - | 0.3 |

1/ Carcass weight. 2/ Ready-to-cook weight. 3/ Milk equivalent. 4/ Grain equivalent. 5/ Rough basis including shipments to territories. 6/ Nominal amount, no data are available to estimate this use. 7/ Grain only. 8/ Farmers' stock basis. 9/ Raw value. 10/ Fresh equivalent. 11/ Cleaned basis.

Total pounds of these farm commodities consumed per capita in 1970-72 was 1756. The adjusted total was 1682 pounds for 1985 or 74 pounds per person less than in 1970-72. Under the constant price assumptions, total pounds consumed totaled 1851 pounds, or only 5 pounds less than the 1970-72 average. In 1960, the total pounds consumed per person of these same commodities total 1753 pounds. Thus, total pounds consumed have not changed greatly, but the amount for individual commodities has changed. Beef and veal per capita consumption in 1960 was only 91 pounds, with beef at 85 and veal at 6. Milk, in contrast, was 653 pounds, compared with 560 pounds in 1970-72. The relative position between citrus and noncitrus fruit has also changed. Citrus per capita consumption increased from 86 pounds in 1960 to 97 average for 1970-72. Noncitrus per capita consumption decreased during the same period from 110 to 100 pounds.

## Other Uses for the NIRAP System

The commodity supply-demand components of the NIRAP system are also useful to answer "what if" questions. Alternative scenarios can be developed and the impacts on per capita consumption and total commodity market quantities measured of changing income, population, technology, tastes and preferences, and other supply or demand shifters at a relatively low operational cost.

## References

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*The results in this paper are a product of the coordinated ERS Economic Projections Program. As such, it is an integration and analysis of relevant data, and professional judgment contributed by many economists and support personnel in several program areas and divisions of ERS and sister agencies of the U.S. Department of Agriculture. Because so many persons supply materials for the Projections Program, it is not feasible to name all participants. Also, it is necessary to include some analysis and interpretations of these projections that should be attributed only to the compiler of this report. Agricultural projections presented herein are preliminary working materials and not official U.S. Department of Agricultural projections.