# Alternative Crop Exports and Fertilizer Restrictions in 1980: Effects on Farm Prices, Food Costs, and Farm Income

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Miscellaneous Report

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# I. INTRODUCTION

## American Agriculture: An Overview

American agriculture provides a large and diversified supply of food for domestic consumers and foreign demand. Until recent years, farm commodities were produced at low costs as farmers improved technology and used more productive inputs. However, higher input prices have increased farm production costs and food prices during the 1970s. Even so, U.S. agriculture is efficient and productive. Table 1 indicates that both labor and land productivity have increased relative to the number of consumers supplied with food. In 1930 the average farm worker produced food for 8.8 people at home and one abroad. In 1972 one worker produced food for 42.0 at home and 10.4 abroad. Total land used to produce food for domestic and export markets declined from 369 million acres in 1930 to 293 million in 1972. Acres needed to produce food for one U.S. consumer declined from 2.68 in 1930 to 0.97 in 1972.

As Table 2 suggests, capital items such as machinery, fertilizer, and lime have substituted for labor and land in this process. Compared to 1950, labor usage declined 55 percent to 1973 while mechanical power and machinery increased 30 percent, and fertilization and liming increased 288 percent. Primary nutrients in fertilizers actually increased 419 percent from 1950 to 1973.

Table 3 helps explain changes in the pattern of input usage. The prices of labor and real estate have increased relative to machinery and

Table 1. Persons supplied farm products by one farm worker and acreage required for specific purposes [a]

| Year | Persons supplied per farmworker[2] Total | At home (number) | Abroad | Acres used for producing- Export products (million acres) | Domestic use Total | Per capita (acres) |
|---|---|---|---|---|---|---|
| 1930 | 9.8 | 8.8 | 1.0 | 39 | 330 | 2.68 |
| 1940 | 10.7 | 10.3 | .4 | 8 | 333 | 2.52 |
| 1950 | 15.5 | 13.8 | 1.7 | 50 | 295 | 1.94 |
| 1960 | 25.8 | 22.3 | 3.5 | 64 | 260 | 1.44 |
| 1961 | 27.6 | 23.6 | 4.0 | 67 | 235 | 1.28 |
| 1962 | 28.6 | 24.7 | 3.9 | 66 | 228 | 1.22 |
| 1963 | 30.7 | 25.8 | 4.9 | 77 | 221 | 1.17 |
| 1964 | 33.2 | 27.9 | 5.3 | 74 | 224 | 1.17 |
| 1965 | 37.0 | 30.8 | 6.2 | 76 | 223 | 1.15 |
| 1966 | 39.6 | 33.6 | 6.0 | 69 | 225 | 1.15 |
| 1967 | 42.1 | 36.0 | 6.1 | 69 | 237 | 1.19 |
| 1968 | 43.4 | 37.9 | 5.5 | 54 | 246 | 1.22 |
| 1969 | 45.1 | 39.0 | 6.1 | 61 | 229 | 1.13 |
| 1970 | 47.1 | 39.9 | 7.2 | 72 | 221 | 1.08 |
| 1971 | 49.2 | 41.7 | 7.5 | 62 | 243 | 1.17 |
| 1972[b] | 52.4 | 42.0 | 10.4 | 91 | 202 | .97 |
| 1973[c] | ---- | ---- | ---- | 96 | 226 | 1.08 |

[a]Sources: [2, 3].

[b]Preliminary.

[c]Not available. 1973 entries are preliminary.

fertilizer inputs. American farmers have changed the input mix in response to the relative changes in input prices. Farm output has continued to increase with these changes in inputs. Even with poor weather conditions in 1974, crop production was 49 percent greater than in 1950 (Table 4). Livestock production increased 48 percent from 1950 to 1974.

Table 2. Indices of farm input usage, 1955-73

| Year | Labor | Farm real estate | Mechanical power and machinery | Fertilizer and liming materials | All other inputs |
|---|---|---|---|---|---|
| | | | (1950 = 100) | | |
| 1955 | 85 | 100 | 115 | 140 | 110 |
| 1956 | 80 | 97 | 116 | 138 | 113 |
| 1957 | 75 | 97 | 115 | 144 | 111 |
| 1958 | 72 | 95 | 115 | 148 | 117 |
| 1959 | 70 | 95 | 116 | 168 | 123 |
| 1960 | 67 | 94 | 114 | 169 | 123 |
| 1961 | 65 | 94 | 112 | 180 | 128 |
| 1962 | 62 | 94 | 114 | 194 | 131 |
| 1963 | 60 | 94 | 114 | 218 | 134 |
| 1964 | 58 | 95 | 115 | 237 | 137 |
| 1965 | 55 | 94 | 118 | 249 | 139 |
| 1966 | 51 | 93 | 123 | 281 | 143 |
| 1967 | 50 | 94 | 124 | 312 | 147 |
| 1968 | 48 | 93 | 127 | 335 | 151 |
| 1969 | 47 | 92 | 127 | 344 | 155 |
| 1970 | 45 | 92 | 125 | 354 | 158 |
| 1971 | 44 | 91 | 128 | 377 | 157 |
| 1972 | 42 | 94 | 127 | 376 | 162 |
| 1973[a] | 45 | 91 | 130 | 388 | 161 |

Source: [4].

[a]Preliminary.

Exports have played an important role in utilization of the supply capacity of American agriculture. Exports under public assistance (e.g. P.L. 480) were important in the 1960s. During the 1970s expanded commercial exports have absorbed increased U.S. farm output. Exports in the 1974 fiscal year totaled 21.3 billion dollars, an increase of 65.3 percent over 1973 and 371.8 percent over 1960. Also, as shown in Table 5, commercial exports have represented a larger share of exports as those exports under government programs remained relatively constant during the 1970s.

Table 3. Indices of the prices of selected farm inputs, 1955-74

| Year | Farm wage rates | Farm machinery | Fertilizer | Farm real estate |
|---|---|---|---|---|
| | | (1950 = 100) | | |
| 1955 | 121 | 113 | 108 | 132 |
| 1956 | 126 | 118 | 106 | 138 |
| 1957 | 131 | 123 | 106 | 145 |
| 1958 | 135 | 129 | 106 | 152 |
| 1959 | 144 | 134 | 106 | 165 |
| 1960 | 148 | 138 | 106 | 170 |
| 1961 | 151 | 141 | 107 | 172 |
| 1962 | 155 | 144 | 106 | 182 |
| 1963 | 159 | 146 | 106 | 192 |
| 1964 | 163 | 149 | 105 | 205 |
| 1965 | 171 | 154 | 106 | 215 |
| 1966 | 185 | 160 | 106 | 232 |
| 1967 | 199 | 167 | 106 | 250 |
| 1968 | 216 | 175 | 103 | 268 |
| 1969 | 238 | 184 | 99 | 282 |
| 1970 | 255 | 194 | 103 | 292 |
| 1971 | 268 | 207 | 108 | 305 |
| 1972 | 283 | 222 | 110 | 330 |
| 1973 | 309 | 240 | 122 | 375 |
| 1974[a] | 328 | 257 | 124 | 468 |

Source: [4].

[a]Preliminary.

Farmers are not the sole beneficiaries of larger food exports. During the 1970s, farm commodity exports have been important in improving the nation's balance of payments. Also, increased income from higher exports leads to larger expenditures on agricultural inputs and consumers' goods. The secondary income and employment generations derived from higher exports benefit many Americans, especially rural communities. Unfortunately, higher exports lead to higher food costs which dampen increased real incomes of consumers.

Table 4. Indices of farm output, 1955-74

| Year | Farm output | Livestock production | Crop production |
|---|---|---|---|
| | | (1950 = 100) | |
| 1955 | 112 | 112 | 108 |
| 1956 | 112 | 112 | 108 |
| 1957 | 110 | 111 | 105 |
| 1958 | 118 | 113 | 117 |
| 1959 | 121 | 117 | 117 |
| 1960 | 123 | 116 | 121 |
| 1961 | 123 | 121 | 120 |
| 1962 | 125 | 123 | 121 |
| 1963 | 130 | 127 | 125 |
| 1964 | 129 | 129 | 122 |
| 1965 | 133 | 127 | 130 |
| 1966 | 132 | 129 | 125 |
| 1967 | 137 | 133 | 132 |
| 1968 | 140 | 133 | 136 |
| 1969 | 141 | 135 | 138 |
| 1970 | 140 | 140 | 133 |
| 1971 | 151 | 143 | 147 |
| 1972 | 153 | 144 | 149 |
| 1973 | 159 | 143 | 158 |
| 1974[a] | 155 | 148 | 149 |

Source: [4].

[a]Preliminary.

As a result of high productivity, farm prices were depressed two decades until the export market improved and unfavorable weather decreased U.S. yields. Low crop prices resulted in federal programs which idled land, stored excess production and through government action increased demand for food in the United States and abroad. Income per farm increased because of these programs and from a decrease in farm numbers.

Table 5. Value of U.S. agricultural exports, 1960-74

| Year ending June 30 | Commercial exports | Exported through government programs | Total exports |
|---|---|---|---|
| | (million dollars) | | |
| 1960 | 3,236 | 1,283 | 4,519 |
| 1961 | 3,443 | 1,503 | 4,946 |
| 1962 | 3,572 | 1,570 | 5,142 |
| 1963 | 3,612 | 1,466 | 5,078 |
| 1964 | 4,627 | 1,441 | 6,068 |
| 1965 | 4,499 | 1,598 | 6,097 |
| 1966 | 5,288 | 1,388 | 6,676 |
| 1967 | 5,463 | 1,308 | 6,711 |
| 1968 | 5,013 | 1,298 | 6,311 |
| 1969 | 4,697 | 1,044 | 5,741 |
| 1970 | 5,685 | 1,036 | 6,721 |
| 1971 | 6,678 | 1,080 | 7,758 |
| 1972 | 6,923 | 1,124 | 8,047 |
| 1973 | 11,872 | 1,030 | 12,902 |
| 1974 | 20,380 | 942 | 21,322 |

Source: [4].

Table 6 indicates changes in farm numbers and incomes for selected years between 1935 and 1974. Farm numbers were nearly halved in this period. Gross and net farm income increased gradually as farm numbers declined and supply control programs were initiated and maintained. Then, gross and net farm income leaped abruptly as exports increased in 1973.

## Fertilizer Usage in the United States

Accounting for a large part of the increased crop production, U.S. fertilizer use increased from 24.9 million tons in 1960 to an estimated 47.0 million tons in 1974 (Table 7). Primary nutrient use in 1974

Table 6. Farm numbers, realized gross income per farm, total net income per farm, and farm income as a percentage of nonfarm income

| Year | Number of farms (000) | Realized gross income per farm (dollars) | Operators' total net income per farm (dollars) | Per capita disposable income from all sources, farm as a percentage of nonfarm (percent) |
|---|---|---|---|---|
| 1935 | 6,814 | 1,423 | 775 | 44.3 |
| 1940 | 6,350 | 1,742 | 706 | 36.5 |
| 1945 | 5,967 | 4,326 | 2,063 | 56.4 |
| 1950 | 5,648 | 5,718 | 2,417 | 57.6 |
| 1955 | 4,654 | 7,147 | 2,429 | 47.8 |
| 1960 | 3,963 | 9,715 | 2,907 | 53.1 |
| 1965 | 3,356 | 13,559 | 3,830 | 67.4 |
| 1966 | 3,257 | 15,521 | 4,266 | 70.7 |
| 1967 | 3,162 | 15,771 | 3,867 | 67.8 |
| 1968 | 3,071 | 16,843 | 3,949 | 69.1 |
| 1969 | 2,999 | 18,775 | 4,672 | 72.2 |
| 1970 | 2,954 | 19,825 | 4,667 | 71.9 |
| 1971 | 2,909 | 20,833 | 4,879 | 72.4 |
| 1972 | 2,870 | 24,434 | 6,332 | 80.8 |
| 1973 | 2,844 | 33,514 | 11,639 | 106.8 |
| 1974 | 2,830 | 35,722 | 9,211 | 91.8 |

Source: [6].

was 2.58 times 1960 use. Total primary nutrient usage between these years has continued to increase until 19.3 million tons were used in the 1974 fiscal year.

Based on crop grower surveys, Table 8 shows estimates of fertilizer use for selected years, 1964 through 1974. Although not all states are included in these surveys, major states growing a specific crop are considered. Nitrogen application for corn grain was nearly twice as high in 1972 as in 1964. Small declines then took place with higher fertilizer prices. Nitrogen use for wheat also increased quite rapidly after 1964.

Table 7. All fertilizer: Total use and primary nutrient use, United States, 1960-74 [a]

| Fiscal year | Total use | Primary nutrient use: N | Available $P_2O_5$ | $K_2O$ | Total | Index |
|---|---|---|---|---|---|---|
| | (000 tons) | | | | | (1967=100) |
| 1960 | 24,887 | 2,738.0 | 2,572.4 | 2,153.3 | 7,463.7 | 53.4 |
| 1961 | 25,567 | 3,030.8 | 2,645.1 | 2,168.5 | 7,844.4 | 56.1 |
| 1962 | 26,615 | 3,370.0 | 2,807.0 | 2,270.5 | 8,447.5 | 60.5 |
| 1963 | 28,844 | 3,929.1 | 3,072.9 | 2,503.4 | 9,505.4 | 68.0 |
| 1964 | 30,681 | 4,352.8 | 3,377.8 | 2,729.7 | 10,460.3 | 74.9 |
| 1965 | 31,336 | 4,638.5 | 3,512.2 | 2,834.5 | 10,985.3 | 78.6 |
| 1966 | 34,532 | 5,326.3 | 3,897.1 | 3,221.2 | 12,444.7 | 89.1 |
| 1967 | 37,082 | 6,027.1 | 4,304.1 | 3,641.8 | 13,973.6 | 100.0 |
| 1968 | 38,743 | 6,787.6 | 4,453.3 | 3,792.6 | 15,033.5 | 107.6 |
| 1969 | 38,949 | 6,957.6 | 4,665.6 | 3,891.6 | 15,514.8 | 111.0 |
| 1970 | 39,591 | 7,459.2 | 4,573.9 | 4,035.7 | 16,068.8 | 115.0 |
| 1971 | 41,118 | 8,133.6 | 4,803.4 | 4,231.4 | 17,168.4 | 122.9 |
| 1972 | 41,206 | 8,016.0 | 4,863.7 | 4,326.8 | 17,212.8 | 123.2 |
| 1973 | 43,288 | 8,295.2 | 5,085.2 | 4,648.7 | 18,029.1 | 129.1 |
| 1974[b] | 46,997 | 9,123.8 | 5,070.6 | 5,085.7 | 19,280.1 | 138.0 |

Source: [9].

[a]Includes Puerto Rico.

[b]Preliminary.

Nitrogen application on soybeans remained in the 10 to 15 pound range from 1964 through 1974. Cotton nitrogen rates increased to 91 pounds in 1969 and then declined slightly. Total fertilizer use is affected not only by per acre application rates but also by the percentage of acres fertilizer. As Table 8 indicates, corn dominates in the percentage of acres fertilized.

Table 8. Estimated fertilizer use on major crops and percent of harvested acres receiving any fertilizer in the United States [a]

| Year | Ave. rate per acre receiving N | $P_2O_5$ | $K_2O$ | Pct. harvested acres receiving N | $P_2O_5$ | $K_2O$ |
|---|---|---|---|---|---|---|
| | (pounds) | | | (percent) | | |
| | | | Corn for grain | | | |
| 1964 | 58 | 41 | 35 | 85 | 78 | 72 |
| 1970 | 112 | 71 | 72 | 94 | 90 | 85 |
| 1971 | 107 | 62 | 64 | 94 | 88 | 82 |
| 1972 | 115 | 66 | 69 | 96 | 90 | 86 |
| 1973 | 114 | 64 | 71 | 93 | 86 | 80 |
| 1974 | 103 | 62 | 73 | 94 | 87 | 83 |
| | | | Wheat | | | |
| 1964 | 27 | 27 | 19 | 47 | 36 | 16 |
| 1970 | 39 | 30 | 36 | 61 | 44 | 20 |
| 1971 | 40 | 34 | 36 | 57 | 41 | 14 |
| 1972 | 46 | 37 | 38 | 62 | 44 | 15 |
| 1973 | 48 | 38 | 36 | 63 | 45 | 17 |
| 1974 | 46 | 38 | 37 | 66 | 46 | 20 |
| | | | Soybeans | | | |
| 1964 | 14 | 30 | 37 | 7 | 12 | 12 |
| 1970 | 14 | 37 | 51 | 21 | 27 | 28 |
| 1971 | 15 | 39 | 48 | 19 | 27 | 27 |
| 1972 | 14 | 42 | 51 | 22 | 29 | 31 |
| 1973 | 14 | 42 | 55 | 24 | 32 | 32 |
| 1974 | 15 | 41 | 55 | 22 | 28 | 28 |
| | | | Cotton | | | |
| 1964 | 69 | 50 | 37 | 77 | 58 | 43 |
| 1970 | 75 | 55 | 57 | 72 | 48 | 36 |
| 1971 | 75 | 53 | 58 | 74 | 50 | 39 |
| 1972 | 75 | 55 | 61 | 77 | 55 | 41 |
| 1973 | 73 | 53 | 62 | 74 | 55 | 39 |
| 1974 | 78 | 53 | 55 | 79 | 58 | 46 |

[a]Sources: [8, 9].

Data on previous pages indicated changes in farm structure and income that have occurred over the last two decades. During much of this period, U.S. agriculture was in a surplus producing position. During the 1960s and early 1970s, around 55 million acres were idled as a supply control measure. Government assistance in exports was an important element of the total demand picture. Then, in 1973 the Russian crop shortfall and large export demands caused a rapid jump in farm prices and income. During this period energy and fertilizer supplies tightened and their prices increased. Also, the general public became concerned with environmental problems relating to soil, nitrogen, and pesticide losses from agriculture and posed legislation to limit them. Hence, we now analyze the interaction of export and fertilization levels for U.S. agriculture in 1980.

# II. DIMENSIONS OF THE STUDY

## Objectives

The major objective of this study is to examine the possible effects of fertilizer rates and alternative export levels on production and prices of U.S. agriculture in 1980.

Two fertilization levels are used. One level is the trend on the amount of acreage fertilized and the fertilizer application rates on these acres. Under trend fertilization solutions, usage increases until 1980. The second fertilization level limits nitrogen application to 50 pounds per acre in 1980. Restricting nitrogen on some nonlegume crops also lowers the amounts of phosphorus and potassium used. Solutions using this nitrogen level are called limited fertilization solutions. This level is used not only to account for environmental concerns over water pollution but also to examine outcomes should energy, as well as a possible fertilizer shortage, bring it about.

Another objective of this study is to examine the effects of fertilization and export levels on the livestock industry and consumer food costs. Higher grain prices must result in higher livestock prices if profits of livestock producers are to be maintained. Higher livestock prices result in higher retail food costs and an expected change in consumer buying habits. Livestock prices are directly related to the prices of corn and soybeans for the model solutions.

Alternative fertilization and export levels also effect the gross and net farm income in different regions. Through the linear programming model used, increased demands result in higher supply prices for crops. Supply prices are used as crop prices in this study. Higher supply (crop) prices result in both higher gross and net farm incomes.

Two auxiliary objectives also are included. One is to determine crop production capacity of the United States possible under the two fertilization levels that will not seriously depress the livestock economy. The other is to estimate fertilizer demand for different crops when their production is optimally allocated among producing areas.

## Conditions of the Study

Estimates of the production potentials assume that land once retired under federal farm programs is available for production.

The total land base used for the study consists of the land growing feed grains, wheat, soybeans, and cotton in 1969 (the crops endogenous to the study) plus land retired under supply control programs in that year. The study analyzes production possibilities in 1980 if land was allocated in the best manner among crops and regions. It is not a prediction of what farmers will do in 1980.

Normal weather is assumed for crop yields. Regional acreages are not restrained at historic levels. Normal carryover stocks are used. Hence, grain production in 1980 meets demand without addition or subtraction for stock changes. Livestock are exogenous to the model. However, grain consumed by livestock serves as part of the demand to be met in the model.

## Models Used

The study is made by means of a national linear programming model. Land in each of 150 individual producing areas serve as production restraints (Figure 1). Land not in these 150 producing areas is called White Area. White Area production is small compared to that of the 150 producing areas, but it is treated exogenously.

Thirty-one consuming regions used (Figure 2) have different grain demands for each region in each solution. Transportation activities allow a system of interregional comparative advantage and regional interdependence to be expressed. A national domestic demand is specified for cotton lint. Export demands for the grains are determined by the ports through which grains are exported. Details of the basic programming model are outlined in the Appendix.

The objective function for the basic programming model requires that all factor costs be covered and that (a) the costs of producing each crop within each producing area and (b) the costs of transporting crops from producing areas to market regions and ports be minimized. Hence, the model assumes competitive equilibrium conditions.

Crop demands are totals of domestic and export demands. Domestic demands for grains include livestock feed requirements. Horses and mules, as well as pets and zoo animals, are included in determining total feed and oilmeal demands. Activities in the model replace feed grains by wheat in livestock feeding if this action is profitable. Imports and

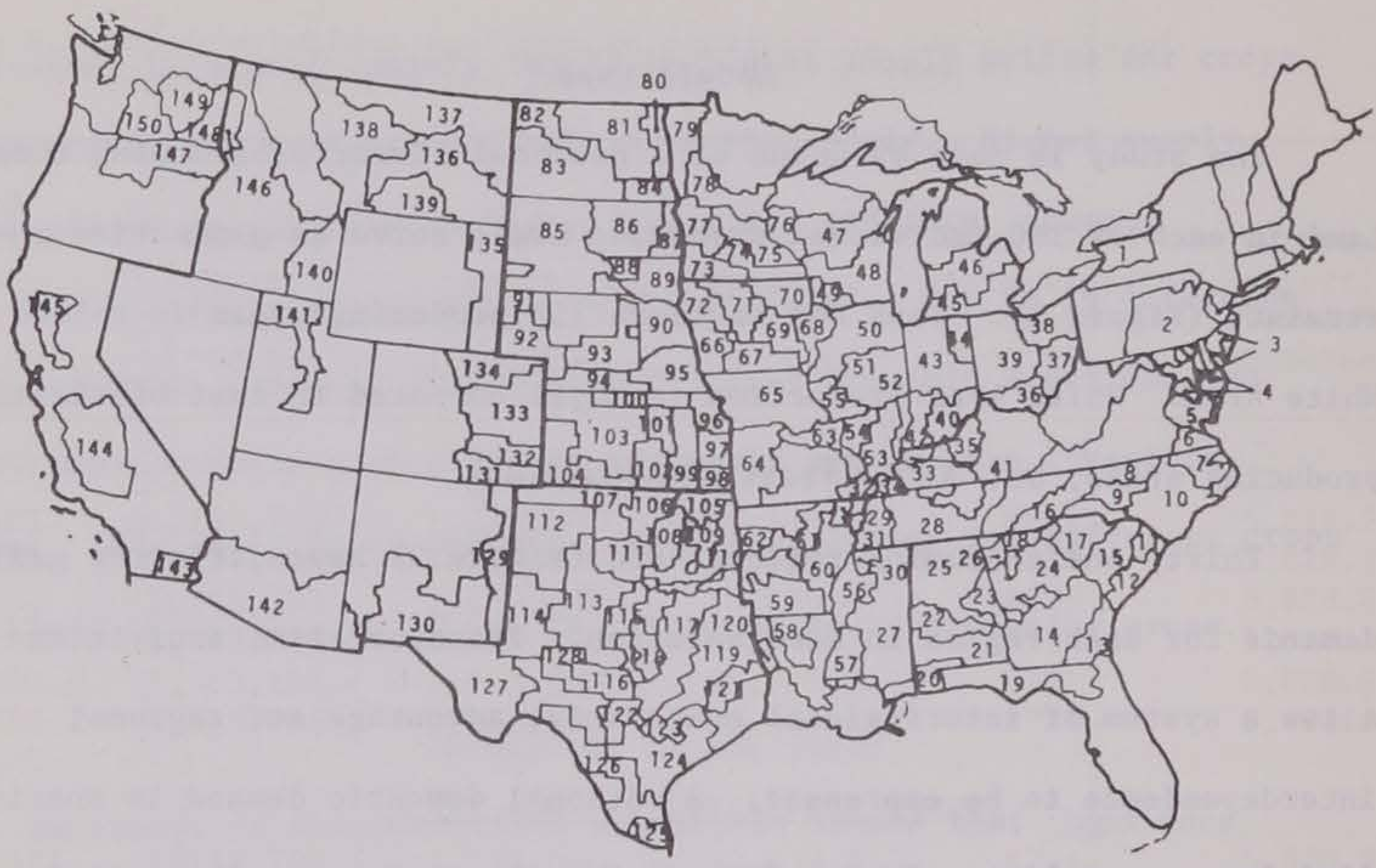

Figure 1. The 150 producing areas used in this study

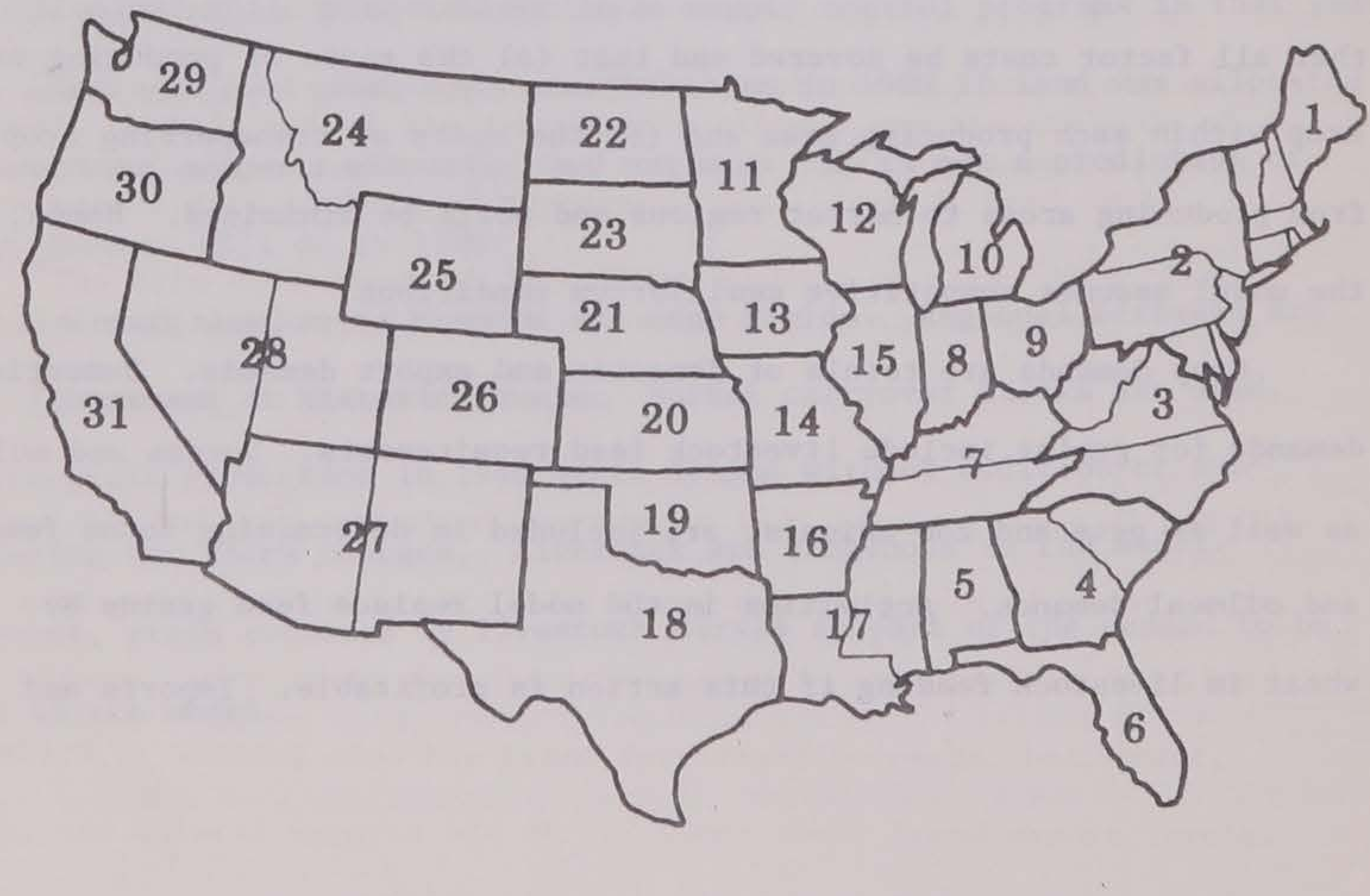


Figure 2. The 31 consuming regions used in this study

exports of livestock products are set at 1971-73 levels. Imports of grains are set at zero levels and cotton exports are the 1973 net exports.

Some model solutions are summarized by the 10 farm production regions shown in Figure 3. Many coefficients and parameters are needed for the programming model used in this study. A brief discussion of the procedures and assumptions is contained in this publication. More detailed information is presented in [1].

## Alternatives Analyzed

In the analysis of the impact of expanded agricultural exports and fertilizer use, 11 specific solutions or future alternatives are presented. Various levels of exports for wheat, corn, and soybeans are examined in these specific solutions. Other feed grain and cotton exports are held at constant levels throughout the analysis.

Table 9 summarizes the 11 specific alternative futures or model solutions and indicates their export levels. Each model solution is given a name or identification which describes its specific conditions. Thus, W stands for wheat, C for corn, and S for oilmeals. Digits following these letters are the levels relative to their 1973 exports. TREND stands for trend exports. The number following TREND is the level of trend exports of wheat, corn, and oilmeals in 1980. Solution names beginning with an L indicate a fertilizer limitation.

Solution W1C1S1 has all exports at 1973 levels and trend fertilizer usage. Trend fertilization, oilmeal exports at twice the 1973 level

Table 9. Model solutions analyzed in determining the effects of expanded exports and fertilizer use in 1980

| Model solution and name | Wheat export levels[a] (000 Bu) | Corn export levels (000 Bu) | Oilmeal export levels[b] (000 Tfu) | Other feed grain export levels (000 Tfu) | Cotton export levels[d] (000 Bales) |
|---|---|---|---|---|---|
| | | | For trend fertilizer usage | | |
| W1C1S1 | 1,148,703 | 1,225,000 | 30,639.6 | 8721 | 5,828.2 |
| W2C1S1 | 2,297,406 | 1,225,000 | 30,639.6 | 8721 | 5,828.2 |
| W1C2S1 | 1,148,703 | 2,450,000 | 30,639.6 | 8721 | 5,828.2 |
| W1C1S2 | 1,148,703 | 1,225,000 | 61,279.2 | 8721 | 5,828.2 |
| TREND1.0 | 1,553,105 | 1,963,000 | 46,706.3 | 8721 | 5,828.2 |
| TREND1.2 | 1,863,726 | 2,355,600 | 56,047.6 | 8721 | 5,828.2 |
| | | | For limited fertilizer usage | | |
| LW1C1S1 | 1,148,703 | 1,225,000 | 30,639.6 | 8721 | 5,828.2 |
| LW1.5C1S1 | 1,723,055 | 1,225,000 | 30,639.6 | 8721 | 5,828.2 |
| LW1C2S1 | 1,148,703 | 2,450,000 | 30,639.6 | 8721 | 5,828.2 |
| LW1C1S1.5 | 1,148,703 | 1,225,000 | 45,959.4 | 8721 | 5,828.2 |
| LTREND0.9 | 1,397,795 | 1,766,700 | 42,035.7 | 8721 | 5,828.2 |

[a]Including flour equivalent in bushels.

[b]Includes soybeans, soybean oilmeal, cottonseed, and cottonseed oilmeal. Nearly all of the increase in oilmeal exports are made of soybeans and soybean oilmeal. One ton of oilmeal expressed in feed units equals 25.7 bushels of soybeans. Tfu: tons of feed units.

[c]The corn equivalent of 58 million bushels of oats, 88 million bushels of barley, and 225 million bushels of grain sorghum.

[d]Expressed in 500-pound bales.

(hence S2) and corn and wheat exports at 1973 levels (hence W1 and C1) are expressed in Solution W1C1S2. Trend export levels of wheat, corn, and oilmeals with trend fertilization usage is expressed in Solution TREND1.0. TREND1.2 also has trend fertilization usage, but wheat, corn, and oilmeal exports are at 1.2 times their trend export levels.

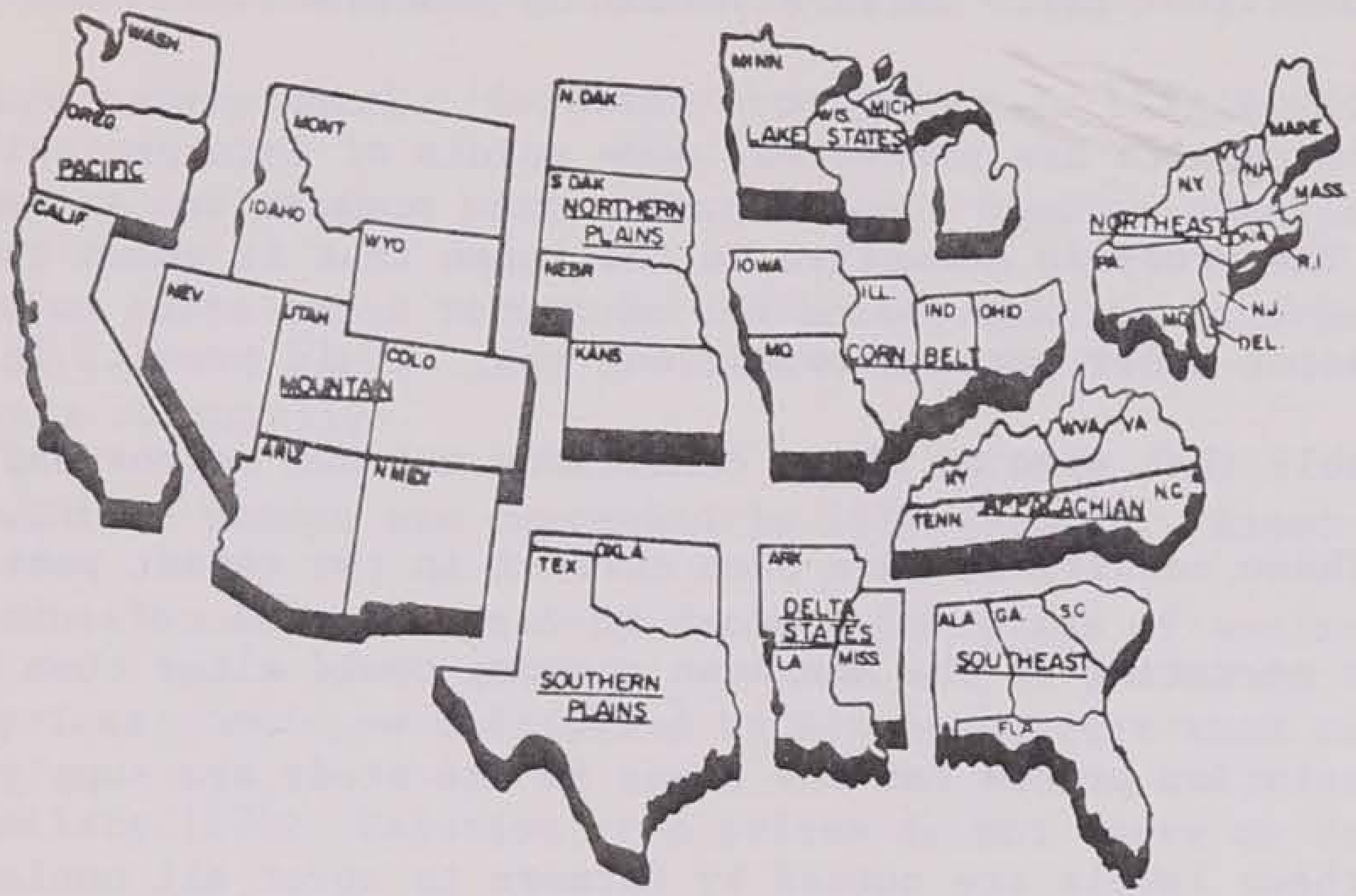


Figure 3. The 10 farm production regions used for summary

LW1C1S1 designates exports of wheat, corn, and oilmeals at 1973 levels, but nitrogen use is limited to 50 pounds per acre (hence the L). It has the same export levels as W1C1S1, but the fertilizer application rates are different. Total production also is different because less livestock is produced to meet domestic demands as will be shown later. LTREND0.9 has exports of wheat, corn, and oilmeals at 0.9 times their trend export levels and fertilizer usage at limited rates.

## III. INTERPRETATION OF RESULTS

Before results are presented, some points of interpretation are reviewed. The study is normative in the sense that it shows the agricultural sector under certain conditions that could prevail in 1980. It is possible that some of these conditions may not correspond to those in 1980. These conditions have been correct in the recent past, but the many forces operating in the American economy could alter them by 1980.

The solution prices for the crops in the study are supply prices. Prices at these levels are needed by farmers to cover all nonland production costs in meeting specified demands. As less productive land is brought into production, the value of better land increases. (Land costs are not part of production costs, but land is assigned values by the computer model.) When demands are increased, higher land values coupled with increased production costs per unit of yield on poorer quality land cause supply prices to increase. Subtracting the production costs from the supply prices gives the return above nonland costs. This return can be viewed as the return to land and management and is used in this study to portray changes in net farm income.

A market price is the result of supply and demand. The crop-year prices for 1973 represent the actual prices received by farmers. Large export demands from poor harvests in certain countries pushed against the available supply and resulted in high crop prices and farm profits. A large supply increase in anticipation of larger exports would have depressed these prices. Therefore, prices resulting from actual market equilibrium conditions and supply prices such as those programmed in this model are rarely equal. Solution crop prices in this study should be considered as the minimum prices that farmers need to cover all non-land production costs and a return on the better quality land to provide certain levels of supplies.

All solution prices are expressed in 1973 dollars. Based on the index of production expenses paid by farmers for items of nonfarm origin, these prices should be multiplied by 1.4 to convert them to January-June 1975 dollars [10]. Solution crop prices do not serve to reflect absolute market prices, but suggest relative price levels for each solution. By comparing the solution supply prices, the effects of various fertilizer use and export levels on relative supply prices can be viewed. Thus, this study does not project crop prices or livestock prices to 1980 in the sense of absolute levels of expected market prices.

Livestock activities are handled exogenously in the computer model. Changes in livestock and livestock produce prices are due to supply price changes of corn and soybeans. A 6 percent profit on total investment is assured for all livestock production.

Only major commodities of this study are included in the consumer food costs. Therefore, the percent of disposable income used for farm-food purchases is a little lower than the figure based on all food purchases. Another reason for the smaller figure is the use of 1973 farm-to-retail price spreads while the disposable income is increased in 1980. In addition, no attempt is made to estimate food expenditure away from home. During 1973, 3.4 percent of disposable income was used for food expenditures away from home as 15.9 percent of disposable income was spent on food. If allowances were made for food expenditures away from home, food costs in this study could increase 2 to 4 percent.

Certain per capita demands for livestock are based on the prices of different meats. Assuming 1973 farm-to-retail price spreads, an increase in livestock prices must also increase retail prices for livestock products. At higher retail prices, consumers will change their buying habits. Different classes of livestock have varying periods of adjustment to changes in consumer demands. An attempt is made to adjust crop export levels so that domestic livestock consumption does not vary drastically among solutions.

Because the computer model minimizes the production costs and transportation costs in meeting specified crop demands, the production locations are not necessarily those that farmers will individually determine in 1980. The absence of federal farm programs and no attempts to restrain acreages to historic patterns lead to a free market with only agronomic restraints on production. Thus, in terms of the independent actions of farmers supply prices might be adjusted upward.

# IV. SOLUTIONS WITH TREND FERTILIZATION

This section examines the production of feed grains, wheat, soybeans, and cotton when farmers continue to apply fertilizer following the trend from 1964 through 1973. Fertilizer usage has fallen markedly from the 1974 fiscal year in response to higher fertilizer prices. These solutions are not a prediction that farmers will follow trend fertilization in 1980. Instead, the solutions are presented to estimate the effects of using high application rates of fertilizer under alternative crop export levels.

Six different export levels are presented. Solution W1C1S1 has wheat, corn, and oilmeal exports at 1973 levels. This model solution is compared with other solutions throughout the study as the "benchmark situation". For this reason, Solution W1C1S1 is called the base solution. Wheat exports at twice the 1973 level and other crop exports at their 1973 levels are assumed for Solution W2C1S1. Corn exports at double the 1973 level and other crop exports at 1973 levels are specified for Solution W1C2S1. Oilmeal exports at twice the 1973 level and other crop exports at 1973 levels are assumed for Solution W1C1S2. Trend exports in 1980 of corn, wheat, and oilmeals are specified for Solution TREND1.0. This model holds exports of cotton and other feed grains at 1973 levels as do all the solutions in this study. (Other feed grains is a combination of barley, oats, and grain sorghum.) To estimate one production potential of the United States, Solution TREND1.2 is presented. It has exports of wheat, corn, and oilmeals at 1.2 times the trend export levels. Actual quantities of exports are given in Table 9.

Exports at 1973 Levels (W1C1S1)

A total of 179.2 million acres is planted to feed grains, wheat, soybeans, and cotton. Land not used for crop production totals 59.6 million acres. Acreages and production for this solution are shown in Table 10. White Area production is included in all farm production regions.

The Northern Plains region accounts for 33.5 percent of the 1.8 billion bushels of wheat produced. Productions exceeding 210 million bushels are found in the Corn Belt, Lake, Northern Plains, Mountain, and Pacific regions. The national wheat yield is 38.2 bushels per acre. Only 42.0 million bushels of wheat are fed to livestock. Wheat feeding is low because of the high fertilization rates on feed grains and the favorable prices of feed grains.

Corn Belt corn production is 48.2 percent of national production and averages a yield of 104.4 bushels per acre. The second largest production, 985.2 million bushels, is in the Northern Plains. A large amount of irrigated production in Kansas results in a yield of 128.3 bushels per acre for the Northern Plains. The national corn yield is 102.9 bushels per acre.

Other feed grain production of 1.6 billion corn-equivalent bushels is harvested from 26.2 million acres. The Northern Plains region produces 52.0 percent of the national production. Rotational weights with a large amount of grain sorghum production cause the Northern Plains and Southern Plains to account for 70.9 percent of the national production,

Table 10. Distribution of acreage and production for Solution W1C1S1 among the 10 farm production regions

| Farm production region | Wheat Acres (000) | Wheat Production (000 Bu) | Corn Acres (000) | Corn Production (000 Bu) | Other feed grains[a] Acres (000) | Other feed grains[a] Production (000 Bu) | Soybeans Acres (000) | Soybeans Production (000 Bu) | Cotton Acres (000) | Land unused[b] Acres (000) |
|---|---|---|---|---|---|---|---|---|---|---|
| Northeast | 2,075 | 87,277 | 794 | 65,749 | 1,484 | 55,317 | 10 | 207 | 0 | 680 |
| Appalachian | 1,235 | 55,075 | 4,101 | 391,401 | 1,565 | 62,126 | 2,472 | 69,234 | 247 | 697 |
| Southeast | 6 | 192 | 3,654 | 276,278 | 219 | 7,201 | 1,433 | 42,019 | 436 | 3,530 |
| Delta | 1,654 | 61,669 | 1,355 | 93,998 | 40 | 1,320 | 2,132 | 53,718 | 4,333 | 3,221 |
| Corn Belt | 6,027 | 246,759 | 24,376 | 2,545,784 | 821 | 27,038 | 31,525 | 996,743 | 1 | 6,433 |
| Lake | 6,133 | 230,534 | 4,721 | 449,275 | 3,884 | 120,338 | 1,077 | 29,545 | 0 | 7,215 |
| Northern Plains | 16,615 | 605,736 | 7,680 | 985,194 | 11,059 | 817,151 | 682 | 18,943 | 0 | 20,944 |
| Southern Plains | 1,713 | 63,882 | 2,455 | 265,038 | 3,821 | 297,395 | 1,830 | 54,009 | 7,846 | 10,744 |
| Mountain | 6,985 | 244,464 | 1,013 | 87,767 | 1,694 | 105,805 | -[c] | 3 | 294 | 5,931 |
| Pacific | 4,889 | 213,643 | 1,153 | 120,891 | 1,624 | 78,722 | 0 | 0 | 17 | 203 |
| United States | 47,332 | 1,809,231 | 51,302 | 5,281,375 | 26,211 | 1,572,413 | 41,161 | 1,264,421 | 13,174 | 59,598 |

[a]Includes barley, oats, and grain sorghum. Production is expressed in bushels of corn equivalent.

[b]Not needed in crops to meet specified domestic and export demands.

[c]White Area acreage of 189 acres.

but only 56.8 percent of the national acreage. Other feed grains yield 60.0 corn-equivalent bushels per acre for the nation.

Soybean production, 1.3 billion bushels nationally, is concentrated in the Corn Belt with 78.8 percent of the national total. The national yield of soybeans is 30.7 bushels per acre.

Land available for production, but not needed to meet domestic and export demands, ranges from 0.2 million acres in the Pacific region to 20.9 million acres in the Northern Plains. Over five million acres of unused land exist in the Corn Belt, Lake, Northern Plains, Southern Plains, and Mountain regions. The high fertilizer usage replaces land normally needed to meet total demands.

Crop prices for the 1973 crop year and this solution are given in Table 11. All solution prices for 1980 are below the 1973 prices. Both wheat and corn prices are less than half the 1973 price. Soybeans are only 28.0 percent of the 1973 price. Other feed grain prices are not fully comparable because they represent different combinations of barley, oats, and grain sorghum. The supply cotton lint price, 31.6 cents per pound, is 70.9 percent of the price received in the 1973 crop year. Livestock and livestock product prices for 1980 reflect the low prices of corn and soybeans.

The low crop prices result from the high fertilization application rates and the large amount of land not used for crop production. Crop prices are supply prices that cover all nonland production costs expressed in 1973 dollars, and a return on land which depends on the amount

Table 11. Farm supply prices under Solution W1C1S1 (with crop exports at 1973 levels and trend fertilization) and actual 1973 prices

| Commodity | Unit | 1973 Actual Price[a] | 1980 Supply Price[b] |
|---|---|---|---|
| Crops | | | |
| Wheat | $/bushel | 3.96 | 1.56 |
| Corn | $/bushel | 2.55 | 1.00 |
| Other feed grains | $/bushel[c] | 1.90 | 1.06 |
| Soybeans | $/bushel | 7.69 | 2.15 |
| Cotton | ¢/pound | 44.6 | 31.6 |
| Livestock & livestock products | | | |
| Beef | $/cwt. | 42.80 | 36.75 |
| Pork | $/cwt. | 39.40 | 25.50 |
| Broilers | ¢/pound | 24.0 | 14.9 |
| Lamb | $/cwt. | 35.10 | 28.46 |
| Turkey | ¢/pound | 34.8 | 23.5 |
| Eggs | ¢/dozen | 54.1 | 37.4 |
| Milk | $/cwt. | 7.14 | 5.57 |

[a] Sources: [5, 7].

[b] Prices are expressed in 1973 dollars using the production expenses paid by farmers index.

[c] Prices are expressed in dollars per bushel of corn equivalent.

of land used for production. High fertilization rates using 1973 fertilizer prices lead to low production costs as well as less land being used for crops to meet the specified export level.

Table 12 gives the primary nutrient usage for the crops grown in the 150 producing areas. Total fertilizer use in the 150 producing areas is 6.6 million tons of elemental nitrogen, 1.3 million tons of elemental phosphorus, and 2.0 million tons of elemental potassium. Corn production accounts for 61.4 percent of the nitrogen used, 45.6 percent of the phosphorus

Table 12. Fertilizer use by crop and average application rates in the 150 producing areas for Solution W1C1S1 and comparisons for 1973

| | Nitrogen | | | Phosphorus | | | Potassium | | |
|---|---|---|---|---|---|---|---|---|---|
| Crop | Tons used (000) | Lbs./acre 1973[a] | Lbs./acre 1980 | Tons used (000) | Lbs./acre 1973[a] | Lbs./acre 1980 | Tons used (000) | Lbs./acre 1973[a] | Lbs./acre 1980 |
| Wheat | 1032.6 | 30.2 | 45.2 | 334.8 | 7.5 | 14.7 | 377.3 | 5.1 | 16.5 |
| Corn | 4057.0 | 106.0 | 164.5 | 611.3 | 24.0 | 24.8 | 1055.2 | 47.1 | 42.8 |
| Other feed grains[b] | 1044.0 | NA[c] | 92.1 | 180.1 | NA[c] | 15.9 | 132.9 | NA[c] | 11.7 |
| Soybeans | 83.6 | 3.4 | 4.1 | 166.4 | 5.9 | 8.2 | 325.0 | 14.6 | 16.1 |
| Cotton | 395.0 | 54.0 | 60.5 | 47.1 | 12.7 | 7.2 | 89.0 | 20.1 | 13.6 |
| All crops | 6612.2 | | | 1339.7 | | | 1979.4 | | |

[a] Computed from estimates in Table 10 of source [9].

[b] Includes barley, oats, and grain sorghum.

[c] Not available.

used, and 53.3 percent of the potassium used for the crops in the model. Nitrogen application rates following trend fertilization for corn and wheat are much higher than the estimated rates for 1973. Application rates of phosphorus on wheat are nearly double 1973 estimates. Compared to 1973, phosphorus rates on soybeans are 39.0 percent higher and 43.3 percent lower on cotton acres. The phosphorus rates on corn acres average nearly the same as the 1973 estimated rates.

Consumer food costs for Solution W1C1S1 are presented in Table 13, with the qualification of nonexogenous products indicated previously. Expenditures for livestock and livestock products are 42.2 percent of

Table 13. Retail prices, per capita consumptions, and per capita expenditures for specified farm-food products in 1980 under Solution W1C1S1

| Commodity | Unit | Per capita consumption | Retail price per unit[a] | Expenditure |
|---|---|---|---|---|
| Livestock & livestock products | | | | |
| Beef | (lbs. retail wt.) | 89.9 | 1.19 | 106.98 |
| Pork | (lbs. retail wt.) | 71.7 | .81 | 58.08 |
| Chicken | (lbs. r.t.c. wt.) | 56.6 | .45 | 25.47 |
| Lamb | (lbs. retail wt.) | 2.9 | 1.24 | 3.60 |
| Turkey | (lbs. wt.) | 10.0 | .60 | 6.00 |
| Eggs | (number, incl. products) | 285.0 | .05 | 14.25 |
| Dairy | (lbs., whole milk equiv.) | 545.0 | .13 | 70.85 |
| Total | | | | 285.23 |
| Fruits and vegetables | | | | 152.75 |
| Bakery products | | | | 76.13 |
| Grain mill products | | | | 27.80 |
| Miscellaneous | | | | 134.15 |
| Average total consumer expenditure | | | | 676.06[b] |

[a]In 1973 dollars.

[b]Represents 13.6 percent of disposable income. The national expenditure totals 152.6 billion dollars.

the total per capita food expenditure. Red meats and poultry meats are 59.1 percent and 11.0 percent of the livestock and livestock products expenditure, respectively. Low crop prices and corresponding low livestock prices cause the per capita expenditure for food to equal 13.6 percent of U.S. consumer's disposable income.

Net incomes by crop and farm production region are shown in Table 14. Nationally, corn accounts for 30.5 percent, wheat for 23.0 percent, and soybeans for 22.5 percent of the total net farm income from endogenous crops grown in the 150 producing areas. The Corn Belt has 35.3 percent of the

Table 14. Net farm income by endogenous crop and farm production region for the 150 producing areas in Solution W1C1S1

| Farm production region | Wheat | Corn | Other feed grains | Soybeans | Cotton | Total |
|---|---|---|---|---|---|---|
| | | | (000 dollars)[a] | | | |
| Northeast | 15,979 | 8,550 | 5,421 | 0 | 0 | 29,950 |
| Appalachian | 10,287 | 72,522 | 10,012 | 32,400 | 6,267 | 131,488 |
| Southeast | 0 | 30,432 | 614 | 12,631 | 9,833 | 53,510 |
| Delta | 11,061 | 7,517 | 0 | 7,440 | 120,016 | 146,034 |
| Corn Belt | 29,536 | 347,989 | 4,985 | 416,467 | 0 | 798,977 |
| Lake | 50,436 | 48,708 | 15,780 | 13,826 | 0 | 128,750 |
| Northern Plains | 230,271 | 133,418 | 161,750 | 2,463 | 0 | 527,902 |
| Southern Plains | 14,602 | 10,427 | 23,392 | 23,853 | 144,831 | 217,105 |
| Mountain | 46,672 | 3,845 | 18,475 | 0 | 5,855 | 74,847 |
| Pacific | 112,357 | 28,178 | 15,092 | 0 | 0 | 155,627 |
| United States | 521,201 | 691,586 | 255,521 | 509,080 | 286,802 | 2,264,190 |

[a]Expressed in 1973 dollars.

national net farm income, followed by the Northern Plains with 23.3 percent. Different crops account for the major source of net income in different farm production regions. Total net farm income from the endogenous crops grown in the 150 producing areas is 2.3 billion dollars.

### Wheat Exports Doubled (W2C1S1)

This solution has wheat exports at twice the 1973 level, and exports of corn, other feed grains, oilmeals, and cotton at their 1973 levels. Table 15 gives the production and acreages for the 150 producing areas and the White Area. A total of 218.0 million acres is used to produce the endogenous crops in this study.

Table 15. Distribution of acreage and production for Solution W2C1S1 among the ten farm production regions

| Farm production region | Wheat | | Corn | | Other feed grains[a] | | Soybeans | | Cotton | Land unused for crops[b] |
|---|---|---|---|---|---|---|---|---|---|---|
| | Acres (000) | Production (000 Bu) | Acres (000) | Production (000 Bu) | Acres (000) | Production (000 Bu) | Acres (000) | Production (000 Bu) | Acres (000) | Acres (000) |
| Northeast | 2,075 | 87,277 | 1,474 | 118,741 | 1,329 | 48,721 | 164 | 4,752 | 0 | 0 |
| Appalachian | 2,387 | 106,134 | 4,101 | 391,401 | 1,284 | 51,511 | 1,932 | 52,624 | 247 | 365 |
| Southeast | 265 | 8,053 | 3,655 | 276,129 | 292 | 9,947 | 1,850 | 53,135 | 436 | 2,780 |
| Delta | 3,323 | 110,923 | 1,355 | 93,998 | 40 | 1,320 | 2,992 | 74,092 | 4,333 | 692 |
| Corn Belt | 11,467 | 467,790 | 24,108 | 2,512,998 | 1,160 | 42,654 | 30,762 | 975,541 | 1 | 1,684 |
| Lake | 9,136 | 333,570 | 4,712 | 448,469 | 4,649 | 141,656 | 2,107 | 48,711 | 0 | 2,426 |
| Northern Plains | 33,516 | 1,116,041 | 8,013 | 998,842 | 10,701 | 790,021 | 9 | 171 | 0 | 4,741 |
| Southern Plains | 8,994 | 223,431 | 2,448 | 264,238 | 3,704 | 291,668 | 1,830 | 54,009 | 7,885 | 3,550 |
| Mountain | 8,298 | 296,341 | 1,308 | 114,629 | 1,659 | 105,775 | -[c] | 3 | 294 | 4,358 |
| Pacific | 4,990 | 219,066 | 911 | 95,373 | 1,766 | 87,342 | 0 | 0 | 17 | 203 |
| United States | 84,451 | 2,968,626 | 52,085 | 5,314,818 | 26,584 | 1,570,615 | 41,646 | 1,263,038 | 13,213 | 20,799 |

[a]Includes barley, oats, and grain sorghum. Production is expressed in bushels of corn equivalent.

[b]Not needed in crops to meet specified domestic and export demands.

[c]White Area acreage of 189 acres.

National wheat production, 3.0 billion bushels, is 64.1 percent larger than in the base solution. Wheat acreage increases 78.4 percent over the base solution. A national yield of 35.2 bushels per acre is 3.0 bushels per acre lower than Solution W1C1S1. The Northern Plains leads production with 37.6 percent of the total and accounts for 44.0 percent of the total increase in production over the base solution. Production increases of over 100 million bushels from the base solution are found in the Corn Belt, Lake, Northern Plains, and Southern Plains. Compared to the base solution, the Northeast has production constant while all other regions increase production. Total wheat fed to livestock is only 3.8 million bushels which reflects the higher price of wheat compared to feed grains.

Although national corn production is 33.4 million bushels more than in the base solution, production is less in the Southeast, Corn Belt, Lake, Southern Plains, and Pacific regions. Corn production is concentrated in the Corn Belt with 47.3 percent and Northern Plains with 18.8 percent of national production, respectively. The national corn yield is 102.0 bushels per acre, 0.9 bushels lower than in the base solution. Domestic corn demand is higher because less wheat is fed to livestock than in Solution W1C1S1.

Other feed grain production is 1.8 million corn-equivalent bushels lower than the base solution. The Northern Plains accounts for more than half of the total production. The Southern Plains and Lake regions have 18.6 percent and 9.0 percent of the national production, respectively. Yields reflect the rotational weight of grain sorghum. The national yield is 59.1 corn-equivalent bushels per acre, versus 60.0 bushels in the base solution, but yields range from 30.5 bushels in the Lake region to 78.7 bushels in the Southern Plains region.

The decrease in livestock feed demands also affects soybean production. Soybean production falls 1.4 million bushels from the base solution. Although the Corn Belt decreases production by 21.2 million bushels from the base solution, it still accounts for 77.2 percent of the total production. Other large production decreases are found in the Appalachian and Northern Plains regions. Soybean production increases in the Northeast, Southeast, Delta, and Lake regions. The national yield, 30.3 bushels per acre, is only 0.4 bushels lower than in the base solution.

Land available for crop production, but not unused for crops, totals 20.8 million acres. Doubling wheat exports, while holding other crops exports constant, forces 38.8 million more acres into production. Except for the Pacific region, all regions have more acres in production than in the base solution.

Farm prices for this solution, with comparisons for 1973 and Solution W1C1S1, are presented in Table 16. All supply prices for Solution W2C1S1 are below 1973 actual prices (see earlier discussion), but are higher than base solution prices. Compared to the base solution, the wheat price increases by 11.5 percent, corn price by 5.0 percent, other feed grain price by 10.4 percent, soybean price by 7.0 percent, and cotton price by 1.0 percent. Livestock prices increase with corn and soybean prices, but the percentage increases are small.

Fertilizer usage and application rates are given in Table 17. Compared to the base solution, nitrogen usage increases by 11.2 percent, phosphorus

Table 16. Farm supply prices under Solution W2C1S1 (with wheat exports at twice the 1973 level and trend fertilization) and comparisons for 1973 and the base solution W1C1S1

| Commodity | Unit | 1973 Actual Price[a] | 1980 Supply Prices[b] Base solution | W2C1S1 |
|---|---|---|---|---|
| Crops | | | | |
| Wheat | $/bushel | 3.96 | 1.56 | 1.74 |
| Corn | $/bushel | 2.55 | 1.00 | 1.05 |
| Other feed grains | $/bushel[c] | 1.90 | 1.06 | 1.17 |
| Soybeans | $/bushel | 7.69 | 2.15 | 2.30 |
| Cotton | ¢/pound | 44.6 | 31.6 | 31.9 |
| Livestock & livestock products | | | | |
| Cattle | $/cwt. | 42.80 | 36.75 | 37.20 |
| Hogs | $/cwt. | 39.40 | 25.50 | 36.04 |
| Broilers | ¢/pound | 24.0 | 14.9 | 15.3 |
| Lamb | $/cwt. | 35.10 | 28.46 | 28.74 |
| Turkeys | ¢/pound | 34.8 | 23.5 | 24.0 |
| Eggs | ¢/dozen | 54.1 | 37.4 | 38.0 |
| Milk | $/cwt. | 7.14 | 5.57 | 5.65 |

[a] Sources: [5, 7].

[b] Prices are expressed in 1973 dollars using the production expenses paid by farmers index.

[c] Prices are expressed in dollars per bushel of corn equivalent.

usage is up by 21.0 percent, and potassium usage increases 12.8 percent. Application rates of the primary nutrients for Solution W2C1S1 differ markedly from 1973 estimated rates.

Consumer buying habits do not change very much from the base solution (compare Tables 13 and 18). Compared to the base solution, beef consumption decreases 0.5 pounds retail weight and pork consumption decreases by 0.2

Table 17. Fertilizer use by crop and average application rates in the 150 producing areas for Solution W2C1S1 and comparisons for 1973

| | Nitrogen | | | Phosphorus | | | Potassium | | |
|---|---|---|---|---|---|---|---|---|---|
| | Tons used | Lbs./acre | | Tons used | Lbs./acre | | Tons used | Lbs./acre | |
| Crop | (000) | 1973[a] | 1980 | (000) | 1973[a] | 1980 | (000) | 1973[a] | 1980 |
| Wheat | 1712.8 | 30.2 | 41.4 | 586.6 | 7.5 | 14.2 | 564.1 | 5.1 | 13.6 |
| Corn | 4117.4 | 106.0 | 164.4 | 626.1 | 24.0 | 25.0 | 1067.4 | 47.1 | 42.6 |
| Other feed grains[b] | 1041.1 | NA[c] | 90.3 | 179.0 | NA[c] | 15.5 | 134.7 | NA[c] | 11.7 |
| Soybeans | 87.0 | 3.4 | 4.3 | 181.8 | 5.9 | 8.9 | 374.8 | 14.6 | 18.4 |
| Cotton | 394.9 | 54.0 | 60.3 | 47.9 | 12.7 | 7.3 | 90.9 | 20.1 | 13.9 |
| All crops | 7353.2 | | | 1621.4 | | | 2231.9 | | |

[a]Computed from estimates in Table 10 of source [9].

[b]Includes barley, oats, and grain sorghum.

[c]Not available.

pounds retail weight. Chicken consumption increases by 0.1 pounds ready-to-cook weight. Lamb and other livestock consumptions are constant. The average per capita food expenditure for the exogenous commodities is only $1.49 higher than in the base solution.

As seen in Table 19, total net farm income from the endogenous crops in the 150 producing areas is $3.5 billion. This is an increase of $1.3 billion or 55.8 percent over the base solution. The Corn Belt leads in net farm income with 33.1 percent of the total while the Northern Plains region has 25.1 percent with wheat accounting for over half of its net farm income from endogenous crops.

## Corn Exports Doubled (W1C2S1)

A total of 193.1 million acres is used to meet domestic demands with corn exports at twice the 1973 level and exports of other crops at 1973

Table 18. Retail prices, per capita consumptions, and per capita expenditures for specified farm-food products in 1980 under Solution W2C1S1

| Commodity | Unit | Per capita consumption | Retail per unit[a] | Expenditure[a] |
|---|---|---|---|---|
| Livestock & livestock products | | | | |
| Beef | (lbs. retail wt.) | 89.4 | 1.20 | 107.28 |
| Pork | (lbs. retail wt.) | 71.5 | .82 | 58.63 |
| Chicken | (lbs. r.t.c. wt.) | 56.7 | .46 | 26.08 |
| Lamb | (lbs. retail wt.) | 2.9 | 1.25 | 3.63 |
| Turkey | (lbs. r.t.c. wt.) | 10.0 | .60 | 6.00 |
| Eggs | (number, incl. products) | 285.0 | .05 | 14.25 |
| Dairy | (lbs., whole milk equiv.) | 545.0 | .13 | 70.85 |
| Total | | | | 286.72 |
| Fruits and vegetables | | | | 152.75 |
| Bakery products | | | | 76.13 |
| Grain mill products | | | | 27.80 |
| Miscellaneous | | | | 134.15 |
| Average total consumer expenditure | | | | 677.55[b] |

[a] In 1973 dollars.

[b] Represents 13.7 percent of disposable income. The national expenditure totals 152.9 billion dollars.

levels. Table 20 shows acreages and production in the 150 producing areas and the White Area. Land used in crop production increases by 13.9 million acres over the base solution. (As before, comparisons are made with the base solution, W1C1S1.)

Although wheat production is only 4,000 bushels lower than the base solution, an additional 515,000 acres are used for the crop. Significant production increases occur in the Lake and Southern Plains regions while significant decreases occur in the Corn Belt and Northern Plains regions.

Table 19. Net farm income by endogenous crop and farm production region for the 150 production areas in Solution W2C1S1

| Farm production region | Wheat | Corn | Other feed grains | Soybeans | Cotton | Total |
|---|---|---|---|---|---|---|
| | | | (000 dollars)[a] | | | |
| Northeast | 30,736 | 11,055 | 6,903 | 2,530 | 0 | 51,234 |
| Appalachian | 42,777 | 91,259 | 13,055 | 30,441 | 6,784 | 184,316 |
| Southeast | 1,580 | 35,114 | 1,369 | 19,791 | 10,645 | 68,499 |
| Delta | 35,760 | 11,537 | 0 | 14,996 | 129,941 | 192,234 |
| Corn Belt | 153,662 | 451,968 | 5,514 | 554,458 | 0 | 1,166,602 |
| Lake | 103,728 | 67,194 | 29,554 | 18,273 | 0 | 318,749 |
| Northern Plains | 464,926 | 180,842 | 238,584 | 15 | 0 | 884,367 |
| Southern Plains | 75,609 | 25,799 | 41,454 | 31,667 | 156,805 | 331,334 |
| Mountain | 148,230 | 10,516 | 23,478 | 0 | 6,340 | 188,564 |
| Pacific | 191,730 | 25,512 | 23,412 | 0 | 0 | 240,656 |
| United States | 1,238,748 | 910,796 | 383,323 | 673,171 | 310,515 | 3,526,553 |

[a]Expressed in 1973 dollars.

Total corn production, 6.5 billion bushels, is 1.2 billion bushels over the base solution. An extra 12.5 million acres is used for corn production compared to the base solution. The Corn Belt accounts for 74.1 percent of the total increase in corn production.

Other feed grain production is down 3.7 million corn-equivalent bushels from the base solution. Only the Northern and Southern Plains have increased production. The Southeast, Delta, and Pacific regions have the same production levels as in the base solution. Accounting for the largest production decrease, the Corn Belt reduces production by 26.4 million corn-equivalent bushels. Production is concentrated in the Northern Plains and Southern Plains regions with 53.2 percent and 21.3 percent of the total production

Table 20. Distribution of acreage and production for Solution W1C2S1 among the 10 farm production regions

| Farm production region | Wheat | | Corn | | Other feed grains[a] | | Soybeans | | Cotton | Land unused for crops[b] |
|---|---|---|---|---|---|---|---|---|---|---|
| | Acres (000) | Production (000 Bu) | Acres (000) | Production (000 Bu) | Acres (000) | Production (000 Bu) | Acres (000) | Production (000 Bu) | Acres (000) | Acres (000) |
| Northeast | 2,075 | 87,277 | 1,474 | 118,741 | 1,329 | 48,721 | 164 | 4,752 | 0 | 0 |
| Appalachian | 1,235 | 55,075 | 4,385 | 418,075 | 1,081 | 41,596 | 2,675 | 75,043 | 247 | 693 |
| Southeast | 6 | 192 | 4,602 | 341,939 | 219 | 7,201 | 1,907 | 54,889 | 436 | 2,108 |
| Delta | 1,654 | 61,669 | 1,355 | 93,998 | 40 | 1,320 | 3,801 | 93,267 | 4,333 | 1,552 |
| Corn Belt | 5,630 | 229,746 | 33,342 | 3,446,806 | 13 | 647 | 27,628 | 869,698 | 1 | 2,568 |
| Lake | 6,539 | 247,546 | 5,621 | 537,708 | 3,781 | 115,217 | 2,819 | 63,323 | 0 | 4,271 |
| Northern Plains | 14,637 | 548,998 | 8,116 | 1,040,454 | 11,284 | 834,638 | 1,998 | 47,452 | 0 | 20,947 |
| Southern Plains | 4,195 | 120,557 | 2,709 | 291,473 | 4,410 | 334,918 | 1,830 | 54,009 | 7,846 | 7,419 |
| Mountain | 6,987 | 244,523 | 1,004 | 87,053 | 1,693 | 105,761 | –[c] | 3 | 294 | 5,940 |
| Pacific | 4,889 | 213,644 | 1,153 | 120,891 | 1,624 | 78,722 | 0 | 0 | 17 | 203 |
| United States | 47,847 | 1,809,227 | 63,761 | 6,497,138 | 25,474 | 1,568,741 | 42,822 | 1,262,436 | 13,174 | 45,701 |

[a]Includes barley, oats, and grain sorghum. Production is expressed in bushels of corn equivalent.

[b]Not needed in crops to meet specified domestic and export demands.

[c]White Area acreage of 189 acres.

respectively. The national yield is 61.6 corn-equivalent bushels per acre, 1.6 bushels higher than the base solution yield.

As with other feed grains, soybean production decreases as less feed is needed to produce livestock. The only production decrease is found in the Corn Belt where production falls by 127.0 million bushels from the base solution. Production is concentrated in the Corn Belt with 68.9 percent of the total. Increases in production of 39.5 million, 33.8 million, and 28.5 million bushels are found in the Delta, Lake, and Northern Plains regions respectively. The national yield is 29.5 bushels per acre, 1.2 bushels per acre less than the base solution.

Land not used for crops is 45.7 million acres, 13.9 million acres less than in the base solution. The Northern Plains and Mountain regions have slight increases in this land category. The Northern Plains region accounts for 45.8 percent of the total cropland base not used for crops.

Farm supply prices (Table 21) are higher than in the base solution, except for cotton. All supply prices for Solution W1C2S1 are lower than actual prices in 1973. Compared to the base solution, the wheat price is 2.6 percent higher, the corn price is 8.0 percent higher, and the soybean price is 7.9 percent higher. Small increases in the prices of corn and soybeans are reflected in the livestock prices which are based on them. The small increases in crop prices are the result of high fertilization rates which decrease the demand for land in meeting larger crop demands. In addition, the share of corn production used for exports is much less than the export shares of wheat or soybean production.

Table 21. Farm supply prices under Solution W1C2S1 (with corn exports at twice the 1973 level and trend fertilization) and comparisons for 1973 and the base solution W1C1S1

| Commodity | Unit | 1973 Actual Price[a] | 1980 Supply Prices[b] Base Solution | W1C2S1 |
|---|---|---|---|---|
| Crops | | | | |
| Wheat | $/bushel | 3.96 | 1.56 | 1.60 |
| Corn | $/bushel | 2.55 | 1.00 | 1.08 |
| Other feed grains | $/bushel[c] | 1.90 | 1.06 | 1.08 |
| Soybeans | $/bushel | 7.69 | 2.15 | 2.32 |
| Cotton | ¢/pound | 44.6 | 31.6 | 31.3 |
| Livestock & livestock products | | | | |
| Cattle | $/cwt. | 42.80 | 36.75 | 37.41 |
| Hogs | $/cwt. | 39.40 | 25.50 | 26.27 |
| Broilers | ¢/pound | 24.0 | 14.9 | 15.4 |
| Lamb | $/cwt. | 35.10 | 28.46 | 28.86 |
| Turkeys | ¢/pound | 34.8 | 23.5 | 24.2 |
| Eggs | ¢/dozen | 54.1 | 37.4 | 38.2 |
| Milk | $/cwt. | 7.14 | 5.57 | 5.68 |

[a] Sources: [5, 7].

[b] Prices are expressed in 1973 dollars using the production expenses paid by farmers index.

[c] Prices are expressed in dollars per bushel of corn equivalent.

Fertilizer use in the 150 producing areas is 7.6 million tons of elemental nitrogen, 1.5 million tons of elemental phosphorus, and 2.3 million tons of elemental potassium. Table 22 also shows corn production accounting for 65.8 percent of the nitrogen usage, 51.4 percent of the phosphorus usage, and 59.6 percent of the potassium usage. Compared to the base solution, nitrogen use is 15.1 percent higher, phosphorus use is 15.4 percent higher, and potassium use is 17.7 percent higher.

Table 22. Fertilizer use by crop and average application rates in the 150 producing areas for Solution W1C2S1 and comparisons for 1973

| | Nitrogen | | | Phosphorus | | | Potassium | | |
|---|---|---|---|---|---|---|---|---|---|
| | Tons used | Lbs./acre | | Tons used | Lbs./acre | | Tons used | Lbs./acre | |
| Crop | (000) | 1973[a] | 1980 | (000) | 1973[a] | 1980 | (000) | 1973[a] | 1980 |
| Wheat | 1038.3 | 30.2 | 45.0 | 342.9 | 7.5 | 14.8 | 384.8 | 5.1 | 16.7 |
| Corn | 5010.5 | 106.0 | 162.3 | 795.6 | 24.0 | 25.8 | 1388.7 | 47.1 | 45.0 |
| Other feed grains[b] | 1079.2 | NA[c] | 98.4 | 176.9 | NA[c] | 16.1 | 126.0 | NA[c] | 11.5 |
| Soybeans | 89.2 | 3.4 | 4.2 | 184.0 | 5.9 | 8.8 | 341.9 | 14.6 | 16.3 |
| Cotton | 395.0 | 54.0 | 60.5 | 47.1 | 12.7 | 7.2 | 89.0 | 20.1 | 13.6 |
| All crops | 7612.2 | | | 1546.5 | | | 2330.4 | | |

[a]Computed from estimates in Table 10 of source [9].

[b]Includes barley, oats, and grain sorghum.

[c]Not available.

Application rates differ little from the base solution, but other feed grains have an average of 6.3 pounds of nitrogen per acre above the base solution. Average nitrogen application rates are much higher on acres of wheat and corn than the 1973 rates.

Table 23 shows the consumer food costs for this solution. Beef consumption declines by only 0.8 pounds retail weight and pork consumption declines by 0.3 pounds retail weight from the base solution. Chicken consumption increases by 0.1 pounds ready-to-cook weight, and lamb consumption remains constant relative to the base solution. Expenditures for livestock products account for 42.9 percent of the total food expenditure. The average total expenditure ($684.16) is $8.10 higher than the base solution.

Table 23. Retail prices, per capita consumptions, and per capita expenditures for specified farm-food products in 1980 under Solution W1C2S1

| Commodity | Unit | Per capita consumption | Retail price per unit [a] | Expenditure [a] |
|---|---|---|---|---|
| Livestock & livestock products | | | | |
| Beef | (lbs. retail wt.) | 89.1 | 1.21 | 107.81 |
| Pork | (lbs. retail wt.) | 71.4 | .83 | 59.26 |
| Chicken | (lbs. r.t.c. wt.) | 56.7 | .46 | 26.08 |
| Lamb | (lbs. retail wt.) | 2.9 | 1.25 | 3.63 |
| Turkey | (lbs. r.t.c. wt.) | 10.0 | .60 | 6.00 |
| Eggs | (number, incl. products) | 285.0 | .05 | 14.25 |
| Dairy | (lbs., whole milk equiv.) | 545.0 | .14 | 76.30 |
| Total | | | | 293.33 |
| Fruits and vegetables | | | | 152.75 |
| Bakery products | | | | 76.13 |
| Grain mill products | | | | 27.80 |
| Miscellaneous | | | | 134.15 |
| Average total consumer expenditure | | | | 684.16 [b] |

[a] In 1973 dollars.

[b] Represents 13.8 percent of disposable income. The national expenditure totals 154.4 billion dollars.

As presented in Table 24, net farm income from crops in the 150 producing areas is 3.0 billion dollars. This is $773 million higher than in the base solution.

### Oilmeal Exports Doubled (W1C1S2)

Holding exports of wheat, corn, other feed grains, and cotton at 1973 levels, oilmeal exports at twice the 1973 level requires a total of 211.8 million acres in production (Table 24). This is 32.6 million

Table 24. Net farm income by endogenous crop and farm production region for the 150 producing areas in Solution W1C2S1

| Farm production region | Wheat | Corn | Other feed grains | Soybeans | Cotton | Total |
|---|---|---|---|---|---|---|
| | | | (000 dollars)[a] | | | |
| Northeast | 15,979 | 14,609 | 5,382 | 2,596 | 0 | 38,566 |
| Appalachian | 12,827 | 109,475 | 6,567 | 45,641 | 5,988 | 180,498 |
| Southeast | 0 | 46,405 | 966 | 19,410 | 9,395 | 76,176 |
| Delta | 14,879 | 16,596 | 0 | 15,049 | 114,672 | 161,196 |
| Corn Belt | 33,849 | 731,729 | 0 | 494,774 | 0 | 1,260,352 |
| Lake | 50,442 | 70,152 | 17,578 | 17,144 | 0 | 155,316 |
| Northern Plains | 250,618 | 217,035 | 205,250 | 16,165 | 0 | 689,068 |
| Southern Plains | 21,977 | 11,720 | 23,684 | 31,211 | 138,364 | 226,956 |
| Mountain | 46,852 | 5,241 | 21,612 | 0 | 5,595 | 79,300 |
| Pacific | 113,408 | 39,276 | 17,073 | 0 | 0 | 169,757 |
| United States | 560,831 | 1,262,238 | 298,112 | 641,990 | 274,014 | 3,037,185 |

[a]Expressed in 1973 dollars.

acres more than in the base solution, Solution W1C1S1. Land not used for crops is 27.0 million acres, 45.3 percent of the amount in the base solution.

Wheat production declines 37.6 million bushels from the base solution. The largest decrease, 109.4 million bushels, is in the Corn Belt. The Southern Plains increases production by 91.5 million bushels. Except for the Pacific, all regions have changed production levels from the base solution. Despite a 2.7 percent decrease in production, the Northern Plains accounts for 33.3 percent of the total wheat production. The national yield, 36.9 bushels per acre, is 1.3 bushels lower than the base solution yield.

Table 25. Distribution of acreage and production for Solution W1C1S2 among the 10 farm production regions

| Farm production region | Wheat Acres (000) | Wheat Production (000 Bu) | Corn Acres (000) | Corn Production (000 Bu) | Other feed grains[a] Acres (000) | Other feed grains[a] Production (000 Bu) | Soybeans Acres (000) | Soybeans Production (000 Bu) | Cotton Acres (000) | Land unused for crops[b] Acres (000) |
|---|---|---|---|---|---|---|---|---|---|---|
| Northeast | 1,818 | 77,027 | 1,474 | 118,741 | 1,087 | 38,392 | 664 | 17,747 | 0 | 0 |
| Appalachian | 1,521 | 67,214 | 4,689 | 441,897 | 403 | 15,427 | 3,181 | 86,898 | 247 | 276 |
| Southeast | 149 | 4,562 | 4,577 | 340,538 | 219 | 7,201 | 3,969 | 102,614 | 3 | 361 |
| Delta | 1,312 | 44,570 | 606 | 40,436 | 40 | 1,320 | 5,807 | 139,023 | 4,333 | 637 |
| Corn Belt | 3,337 | 137,360 | 22,467 | 2,317,068 | 610 | 25,082 | 42,767 | 1,311,926 | 1 | 0 |
| Lake | 6,902 | 262,280 | 4,862 | 445,628 | 2,182 | 66,581 | 7,266 | 174,138 | 0 | 1,819 |
| Northern Plains | 15,399 | 589,418 | 8,600 | 1,073,210 | 10,829 | 802,887 | 7,238 | 180,306 | 0 | 14,915 |
| Southern Plains | 6,276 | 155,405 | 2,421 | 261,600 | 5,520 | 402,101 | 2,387 | 67,635 | 8,527 | 3,278 |
| Mountain | 6,385 | 220,131 | 1,308 | 114,709 | 2,294 | 123,663 | -[c] | 3 | 294 | 5,636 |
| Pacific | 4,889 | 213,643 | 1,244 | 129,797 | 1,624 | 78,722 | 0 | 0 | 44 | 85 |
| United States | 47,988 | 1,771,610 | 52,248 | 5,283,624 | 24,808 | 1,561,376 | 73,279 | 2,080,290 | 13,449 | 27,007 |

[a]Includes barley, oats, and grain sorghum. Production is expressed in bushels of corn equivalent.

[b]Not needed in crops to meet specified domestic and export demands.

[c]White Area acreage of 189 acres.

Decreased wheat feeding results in 2.2 million more bushels of corn being produced. The Corn Belt reduces production by 228.7 million bushels from the base solution but still accounts for 43.9 percent of national production. Production increases of more than 50 million bushels are found in the Northeast, Appalachian, Southeast, and Northern Plains regions. A production increase of 88.0 million bushels in the Northern Plains makes this region have 20.3 percent of the national production. The national corn yield, 101.1 bushels per acre, is 1.8 bushels lower than in the base solution. Other feed grain production is 11.0 million corn-equivalent bushels lower than in the base solution.

Soybean production, 2.1 billion bushels, is 815.9 million bushels larger than in the base solution. All regions allowed to grow soybeans increase production. Compared to the base solution, the Corn Belt, Northern Plains, and Lake regions increase production by 315.2 million, 161.4 million, and 144.6 million bushels respectively. The Corn Belt has 63.1 percent of the national production. National yield declines 2.3 bushels from the base solution to a level of 28.4 bushels per acre.

Cropland not used for crops totals 27.0 million acres. This is 32.6 million acres less than in the base solution. Although all regions have less idle land than in the base solution, the Northern Plains and Mountain regions show the smallest percentage decreases.

Farm supply prices (see earlier discussion) for this solution are presented in Table 26. Compared to the base solution, the wheat price increases by 9.0 percent, the corn price by 18.0 percent, other feed grain

Table 26. Farm supply prices under Solution W1C1S2 (with oilmeal exports at twice the 1973 level and trend fertilization) and comparisons for 1973 and the base solution W1C1S1

| Commodity | Unit | 1973 Actual Price[a] | 1980 Supply Prices[b] Base solution | W1C1S2 |
|---|---|---|---|---|
| Crops | | | | |
| Wheat | $/bushel | 3.96 | 1.56 | 1.70 |
| Corn | $/bushel | 2.55 | 1.00 | 1.18 |
| Other feed grains | $/bushel[c] | 1.90 | 1.06 | 1.15 |
| Soybeans | $/bushel | 7.69 | 2.15 | 3.07 |
| Cotton | ¢/pound | 44.6 | 31.6 | 31.7 |
| Livestock & livestock products | | | | |
| Cattle | $/cwt. | 42.80 | 36.75 | 38.70 |
| Hogs | $/cwt. | 39.40 | 25.50 | 27.98 |
| Broilers | ¢/pound | 24.0 | 14.9 | 16.6 |
| Lamb | $/cwt. | 35.10 | 28.46 | 29.76 |
| Turkeys | ¢/pound | 34.8 | 23.5 | 26.0 |
| Eggs | ¢/dozen | 54.1 | 37.4 | 40.3 |
| Milk | $/cwt. | 7.14 | 5.57 | 5.94 |

[a] Sources: [5, 7].

[b] Prices are expressed in 1973 dollars using the production expenses paid by farmers index.

[c] Prices are expressed in dollars per bushel of corn equivalent.

price 8.5 percent, the soybean price by 42.8 percent, while the cotton price is almost the same. All programmed crop and livestock prices are below 1973 prices. Farm prices seem low compared to the present situation. However, we must remember that they are expressed in 1973 dollars, and reflect 1973 costs and do not include actual land prices.

As evident in Table 27, 6.9 million tons of elemental nitrogen, 1.5 million tons of elemental phosphorus, and 2.3 million tons of elemental

Table 27. Fertilizer use by crop and average application rates in the 150 producing areas for Solution W1C1S2 and comparisons for 1973

| Crop | Nitrogen | | | Phosphorus | | | Potassium | | |
|---|---|---|---|---|---|---|---|---|---|
| | Tons used (000) | Lbs./acre | | Tons used (000) | Lbs./acre | | Tons used (000) | Lbs./acre | |
| | | 1973[a] | 1980 | | 1973[a] | 1980 | | 1973[a] | 1980 |
| Wheat | 997.1 | 30.2 | 43.0 | 330.8 | 7.5 | 14.3 | 337.8 | 5.1 | 14.6 |
| Corn | 4157.6 | 106.0 | 165.4 | 638.4 | 24.0 | 25.4 | 1098.3 | 47.1 | 43.7 |
| Other feed grains[b] | 1151.5 | NA[c] | 108.3 | 183.1 | NA[c] | 17.2 | 134.8 | NA[c] | 12.7 |
| Soybeans | 158.0 | 3.4 | 4.4 | 310.7 | 5.9 | 8.6 | 650.9 | 14.6 | 18.0 |
| Cotton | 387.2 | 54.0 | 58.0 | 43.9 | 12.7 | 6.6 | 82.1 | 20.1 | 12.3 |
| All crops | 6851.4 | | | 1506.9 | | | 2303.9 | | |

[a]Computed from estimates in Table 10 of source [9].

[b]Includes barley, oats, and grain sorghum.

[c]Not available.

potassium are used in the 150 producing areas. These usages represent increases of 3.6 percent, 12.5 percent, and 16.4 percent for nitrogen, phosphorus, and potassium, respectively. Average application rates are nearly equal for this solution and the base solution except for other feed grains. The nitrogen rate on other feed grains has increased from 92.1 pounds per acre to 108.3 pounds per acre.

The average consumer expenditure for farm foods (Table 28) is \$688.26. This is \$12.20 higher than in the base solution. Although beef consumption is 2.1 pounds retail weight lower than in the base solution, it accounts for 36.6 percent of the expenditure on the specified livestock products. Pork consumption is down 1.1 pounds retail

Table 28. Retail prices, per capita consumptions, and per capita expenditures for specified farm-food products in 1980 under Solution W1C1S2

| Commodity | Unit | Per capita consumption | Retail price per unit[a] | Expenditure[a] |
|---|---|---|---|---|
| Livestock & livestock products | | | | |
| Beef | (lbs. retail wt.) | 87.8 | 1.24 | 108.87 |
| Pork | (lbs. retail wt.) | 70.6 | .86 | 60.72 |
| Chicken | (lbs. r.t.c. wt.) | 56.9 | .48 | 27.31 |
| Lamb | (lbs. retail wt.) | 2.9 | 1.27 | 3.68 |
| Turkey | (lbs. r.t.c. wt.) | 10.0 | .63 | 6.30 |
| Eggs | (number, incl. products) | 285.0 | .05 | 14.25 |
| Dairy | (lbs., whole milk equiv.) | 545.0 | .14 | 76.30 |
| Total | | | | 297.43 |
| Fruits and vegetables | | | | 152.75 |
| Bakery products | | | | 76.13 |
| Grain mill products | | | | 27.80 |
| Miscellaneous | | | | 134.15 |
| Average total consumer expenditure | | | | 688.26[b] |

[a] In 1973 dollars.

[b] Represents 13.9 percent of disposable income. The national expenditure totals 155.3 billion dollars.

weight from the base solution, but chicken consumption increases 0.3 pounds ready-to-cook weight. The specified food expenditures account for only 13.9 percent of disposable income.

Total net farm income from crops (Table 29) in the 150 producing areas is 5.3 billion dollars. This is $3.0 billion or 134.2 percent higher than in the base solution. The Corn Belt and Northern Plains regions have increased net incomes by 214.1 percent and 95.1 percent respectively. Soybeans are the major sources of the net farm income

Table 29. Net farm income by endogenous crop and farm production region for the 150 producing areas in Solution W1C1S2

| Farm production region | Wheat | Corn | Other feed grains | Soybeans | Cotton | Total |
|---|---|---|---|---|---|---|
| | | | (000 dollars)[a] | | | |
| Northeast | 27,553 | 26,194 | 5,152 | 14,565 | 0 | 73,464 |
| Appalachian | 29,837 | 165,114 | 3,018 | 101,430 | 6,592 | 305,991 |
| Southeast | 1,083 | 92,626 | 1,570 | 80,299 | 0 | 175,578 |
| Delta | 15,428 | 9,307 | 0 | 128,359 | 126,271 | 279,365 |
| Corn Belt | 54,498 | 737,422 | 1,419 | 1,716,186 | 0 | 2,509,525 |
| Lake | 74,835 | 89,341 | 19,314 | 96,290 | 0 | 279,780 |
| Northern Plains | 310,986 | 283,159 | 271,525 | 164,075 | 0 | 1,029,745 |
| Southern Plains | 45,741 | 26,020 | 56,071 | 83,393 | 161,039 | 372,264 |
| Mountain | 49,472 | 6,910 | 30,789 | 0 | 6,160 | 93,331 |
| Pacific | 120,630 | 41,403 | 20,213 | 0 | 1,670 | 183,916 |
| United States | 730,063 | 1,477,496 | 409,071 | 2,384,597 | 301,732 | 5,302,959 |

[a]Expressed in 1973 dollars.

from endogenous crops for the Delta, Corn Belt, and Lake regions. Soybeans also account for 45.0 percent of the total net farm income from crops in the model that are produced in the 150 producing areas.

### Trend Exports of Wheat, Corn, and Oilmeals (Trend1.0)

This solution is based on exports of wheat, corn, and oilmeals at levels equal to twice their 1973 exports minus their 1966 export levels. Exports of other feed grains and cotton are the same for all solutions by holding them at their 1973 levels. Comparisons are made with the base solution, Solution W1C1S1.

Acreages and production for the 150 producing areas and the White Area are shown in Table 30. A total of 217.2 million acres is used in

Table 30. Distribution of acreage and production for Solution TREND1.0 among the 10 farm production regions

| Farm production region | Wheat | | Corn | | Other feed grains[a] | | Soybeans | | Cotton | Land unused for crops[b] |
|---|---|---|---|---|---|---|---|---|---|---|
| | Acres (000) | Production (000 Bu) | Acres (000) | Production (000 Bu) | Acres (000) | Production (000 Bu) | Acres (000) | Production (000 Bu) | Acres (000) | Acres (000) |
| Northeast | 2,075 | 87,277 | 1,474 | 118,741 | 1,329 | 48,721 | 164 | 4,752 | 0 | 0 |
| Appalachian | 1,521 | 67,214 | 4,688 | 441,897 | 492 | 19,298 | 3,091 | 85,012 | 247 | 276 |
| Southeast | 149 | 4,562 | 4,592 | 341,427 | 292 | 9,947 | 3,624 | 94,194 | 120 | 500 |
| Delta | 2,113 | 69,779 | 1,391 | 96,044 | 40 | 1,320 | 4,204 | 105,041 | 4,333 | 655 |
| Corn Belt | 5,621 | 235,362 | 28,510 | 2,979,217 | 610 | 25,082 | 34,439 | 1,055,829 | 1 | 0 |
| Lake | 8,181 | 304,619 | 5,294 | 500,322 | 2,736 | 82,008 | 5,516 | 132,394 | 0 | 1,304 |
| Northern Plains | 19,792 | 726,150 | 8,172 | 1,018,119 | 11,273 | 834,329 | 5,964 | 150,691 | 0 | 11,781 |
| Southern Plains | 7,790 | 190,640 | 2,588 | 278,860 | 4,788 | 360,790 | 2,204 | 62,658 | 8,444 | 2,596 |
| Mountain | 8,205 | 291,861 | 1,420 | 125,672 | 1,656 | 105,691 | –[c] | 3 | 294 | 4,343 |
| Pacific | 4,925 | 215,552 | 1,264 | 131,703 | 1,588 | 76,578 | 0 | 0 | 17 | 92 |
| United States | 60,372 | 2,193,016 | 59,393 | 6,032,002 | 24,804 | 1,563,764 | 59,206 | 1,690,574 | 13,456 | 21,547 |

[a]Includes barley, oats, and grain sorghum. Production is expressed in bushels of corn equivalent.

[b]Not needed in crops to meet specified domestic and export demands.

[c]White Area acreage of 189 acres.

producing crops, an increase of 38.1 million acres over the base solution. Even with high export levels, 21.5 million acres of cropland are not needed to produce the endogenous crops in this study.

Wheat production, 2.2 billion bushels, is harvested from 60.4 million acres. The national yield 36.3 bushels per acre, is 1.9 bushels lower than in the base solution. Increases in production over the base solution of 126.8 million, 120.4 million, and 74.1 million bushels occur in the Southern Plains, Northern Plains, and Lake regions respectively. The Northern Plains leads in production with 33.1 percent of the total.

All farm production regions have higher corn production than in the base solution. While accounting for 49.4 percent of the national total, the Corn Belt, has the largest production increase at 433.4 million bushels. Per acre yields of 124.6 bushels, 107.8 bushels, 104.5 bushels, and 104.2 bushels occur in the Northern Plains, Southern Plains, Corn Belt, and Pacific regions respectively. The national yield, 101.6 bushels per acre, is 1.3 bushels lower than in the base solution.

All regions with soybean activities have increased production over the base solution. Production increases of more than 50 million bushels occur in the Southeast, Delta, Corn Belt, Lake, and Northern Plains regions. Production is still concentrated in the Corn Belt with 62.5 percent of the total.

Although cotton lint demand is the same, a 282,000 acre increase over the base solution exists. Only two regions change cotton acreage from the base solution. The Southeast region decreases acreage by 316,000 acres as the Southern Plains increases acreage by 598,000 acres. The national yield, 521.8 pounds of cotton lint per acre, is 11.2 pounds lower than the base solution yield.

All farm supply prices are higher (Table 31) than in the base solution. However, they are lower than in 1973. Price increases over the base solution are 14.7 percent for wheat, 17.0 percent for corn, 8.5 percent for other feed grains, and 26.5 percent for soybeans. Using trend fertilization levels, crop prices do not increase much when export levels increase. Livestock and livestock product prices reflect the small crop price increases.

Fertilizer data for the 150 producing areas are shown in Table 32. Nitrogen usage, 7.5 million tons, is 13.8 percent higher than in the base solution and elemental phosphorus usage, 1.6 million tons, is 20.1 percent higher. Elemental potassium usage, 2.4 million tons, is 21.2 percent higher than the base solution. Corn uses 61.3 percent of the nitrogen, 44.6 percent of the phosphorus, and 52.7 percent of the potassium. Application rates of the primary nutrients are close to the base solution rates, but the nitrogen rate on other feed grains increases from 92.1 pounds to 106.6 pounds per acre.

Consumer farm-food expenditures, presented in Table 33, increase by $10.61 over the base solution. The farm-food expenditure is 13.9 percent of disposable income. Trend fertilization not only keeps crop prices fairly stable but also keeps livestock production levels from changing greatly when exports are increased.

Table 31. Farm supply prices under Solution TREND1.0 (with trend fertilization and trend exports of wheat, corn, and oilmeals) and comparisons for 1973 and the base solution

| Commodity | Unit | 1973 Actual Price[a] | 1980 Supply Prices[b] Base solution | TREND1.0 |
|---|---|---|---|---|
| Crops | | | | |
| Wheat | $/bushel | 3.96 | 1.56 | 1.79 |
| Corn | $/bushel | 2.55 | 1.00 | 1.17 |
| Other feed grains | $/bushel[c] | 1.90 | 1.06 | 1.15 |
| Soybeans | $/bushel | 7.69 | 2.15 | 2.72 |
| Cotton | ¢/pound | 44.6 | 31.6 | 31.6 |
| Livestock & livestock products | | | | |
| Cattle | $/cwt. | 42.80 | 36.75 | 38.34 |
| Hogs | $/cwt. | 39.40 | 25.50 | 27.42 |
| Broilers | ¢/pound | 24.0 | 14.9 | 16.1 |
| Lamb | $/cwt. | 35.10 | 28.46 | 29,47 |
| Turkeys | ¢/pound | 34.8 | 23.5 | 25.3 |
| Eggs | ¢/dozen | 54.1 | 37.4 | 39.5 |
| Milk | $/cwt. | 7.14 | 5.57 | 5.85 |

[a] Sources: [5, 7].

[b] Prices are expressed in 1973 dollars using the index of production expenses paid by farmers.

[c] Prices are expressed in dollars per bushel of corn equivalent.

Table 34 shows net income from the endogenous crops produced in the 150 producing areas. The total, $4.8 billion, represents an increase of 113.2 percent over the base solution. As in all previous solutions, the Corn Belt and Northern Plains are the two leading farm production regions. Wheat, corn, and soybeans account for 21.8 percent, 34.6 percent, and 29.3 percent of the total net farm income from crops.

Table 32. Fertilizer use by crop and average application rates in the 150 producing areas for Solution TREND1.0 and comparisons for 1973

| Crop | Nitrogen | | | Phosphorus | | | Potassium | | |
|---|---|---|---|---|---|---|---|---|---|
| | Tons used (000) | Lbs./acre 1973[a] | Lbs./acre 1980 | Tons used (000) | Lbs./acre 1973[a] | Lbs./acre 1980 | Tons used (000) | Lbs./acre 1973[a] | Lbs./acre 1980 |
| Wheat | 1270.2 | 30.2 | 43.3 | 419.0 | 7.5 | 14.3 | 423.2 | 5.1 | 14.4 |
| Corn | 4610.0 | 106.0 | 160.6 | 718.1 | 24.0 | 25.0 | 1263.1 | 47.1 | 44.0 |
| Other feed grains[b] | 1133.7 | NA[c] | 106.6 | 181.1 | NA[c] | 17.0 | 134.8 | NA[c] | 12.7 |
| Soybeans | 125.0 | 3.4 | 4.3 | 245.7 | 5.9 | 8.4 | 493.2 | 14.6 | 16.9 |
| Cotton | 386.5 | 54.0 | 57.9 | 44.8 | 12.7 | 6.7 | 84.4 | 20.1 | 12.6 |
| All crops | 7525.4 | | | 1608.7 | | | 2398.7 | | |

[a]Computed from estimates in Table 10 of source [9].

[b]Includes barley, oats, and grain sorghum.

[c]Not available.

## Agriculture in "Tight" Production Capacity (TREND1.2)

Trend fertilization kept crop prices in the previous five solutions from extreme variations. These crop prices are the supply prices needed to cover nonland production costs in meeting specified demands. As more land is used in production, supply prices increase as less productive land is cultivated and the imputed value of higher quality land is increased. Trend fertilization has kept the nonland production costs at low levels using 1973 prices and has reduced the amount of land that would have been needed under lower fertilization levels.

This solution is used to show American agriculture at nearly full crop production capacity. Exports of wheat, corn, and oilmeals are at

Table 33. Retail prices, per capita consumptions, and per capita expenditures for specified farm-food products in 1980 under Solution TREND1.0

| Commodity | Unit | Per capita consumption | Retail price per unit | Expenditure[a] |
|---|---|---|---|---|
| Livestock & livestock products | | | | |
| Beef | (lbs. retail wt.) | 88.1 | 1.23 | 108.36 |
| Pork | (lbs. retail wt.) | 70.8 | .85 | 60.18 |
| Chicken | (lbs. r.t.c. wt.) | 56.9 | .47 | 26.74 |
| Lamb | (lbs. retail wt.) | 3.0 | 1.27 | 3.81 |
| Turkey | (lbs. r.t.c. wt.) | 10.0 | .62 | 6.20 |
| Eggs | (number, incl. products) | 285.0 | .05 | 14.25 |
| Dairy | (lbs., whole milk equiv.) | 545.0 | .14 | 76.30 |
| Total | | | | 295.84 |
| Fruits and vegetables | | | | 152.75 |
| Bakery products | | | | 76.13 |
| Grain mill products | | | | 27.80 |
| Miscellaneous | | | | 134.15 |
| Average total consumer expenditure | | | | 686.67[b] |

[a] In 1973 dollars.

[b] Represents 13.9 percent of disposable income. The national expenditure totals 155.0 billion dollars.

a level of 1.2 times twice the 1973 levels minus their 1966 levels. Other feed grain and cotton exports are held at 1973 levels throughout the study. As will be seen later, the increase in crop prices has a depressing effect on the livestock economy because of less livestock products being demanded.

The acreages and production in the 150 producing areas and the White Area are presented in Table 35. Except for the Delta and Corn Belt regions, all regions increase wheat production over the base solution. The national

Table 34. Net farm income by endogenous crop and farm production region for the 150 producing areas in Solution TREND1.0

| Farm production region | Wheat | Corn | Other feed grains | Soybeans | Cotton | Total |
|---|---|---|---|---|---|---|
| | | | (000 dollars)[a] | | | |
| Northeast | 34,355 | 22,166 | 8,215 | 4,043 | 0 | 68,779 |
| Appalachian | 29,535 | 146,301 | 3,505 | 77,174 | 6,254 | 262,769 |
| Southeast | 1,029 | 77,671 | 1,627 | 45,788 | 2,661 | 128,776 |
| Delta | 25,912 | 25,026 | 0 | 65,553 | 119,783 | 236,274 |
| Corn Belt | 107,060 | 944,137 | 1,111 | 1,025,670 | 0 | 2,077,978 |
| Lake | 101,891 | 87,543 | 20,715 | 51,043 | 0 | 261,192 |
| Northern Plains | 398,334 | 286,604 | 275,948 | 87,543 | 0 | 1,048,429 |
| Southern Plains | 68,298 | 27,973 | 49,198 | 59,308 | 151,690 | 356,467 |
| Mountain | 115,937 | 9,815 | 25,119 | 0 | 5,844 | 156,715 |
| Pacific | 169,363 | 41,401 | 18,837 | 0 | 0 | 229,601 |
| United States | 1,051,714 | 1,668,637 | 404,275 | 1,416,122 | 286,232 | 4,826,980 |

[a]Expressed in 1973 dollars.

yield, 34.5 bushels per acre, is 3.7 bushels less than in the base solution. No wheat is fed to livestock when based on the singular prices of grains.

Corn production, 6.3 billion bushels, is 1.0 billion bushels above the base solution. All regions but the Pacific and Delta have increased corn production over the base solution. The national yield, 100.6 bushels per acre, is 2.3 bushels lower than in the base solution. Other feed grain production is 46.7 million corn-equivalent bushels less than in the base solution because less feed is needed for the reduced livestock production. Soybean production, 1.9 billion bushels, is 658.1 million bushels higher than in the base solution. Production is concentrated in the Corn

Table 35. Distribution of acreage and production for Solution TREND1.2 among the 10 farm production regions

| Farm production region | Wheat | | Corn | | Other feed grains[a] | | Soybeans | | Cotton | Land unused for crops[b] |
|---|---|---|---|---|---|---|---|---|---|---|
| | Acres (000) | Production (000 Bu) | Acres (000) | Production (000 Bu) | Acres (000) | Production (000 Bu) | Acres (000) | Production (000 Bu) | Acres (000) | Acres (000) |
| Northeast | 2,318 | 96,925 | 1,474 | 118,741 | 829 | 27,418 | 422 | 11,446 | 0 | 0 |
| Appalachian | 1,593 | 69,753 | 4,567 | 433,728 | 330 | 12,164 | 3,578 | 96,844 | 247 | 0 |
| Southeast | 270 | 8,058 | 4,196 | 315,255 | 29 | 742 | 4,487 | 115,267 | 60 | 236 |
| Delta | 1,842 | 58,688 | 1,355 | 93,998 | 40 | 1,320 | 5,058 | 123,237 | 4,440 | 0 |
| Corn Belt | 3,512 | 140,833 | 28,046 | 2,884,622 | 13 | 647 | 37,611 | 1,166,313 | 1 | 0 |
| Lake | 9,120 | 338,056 | 5,874 | 528,238 | 1,290 | 37,939 | 6,747 | 166,685 | 0 | 0 |
| Northern Plains | 29,890 | 983,193 | 11,121 | 1,329,594 | 10,003 | 775,002 | 5,966 | 150,735 | 0 | 0 |
| Southern Plains | 8,073 | 227,497 | 3,216 | 330,274 | 7,663 | 475,064 | 3,503 | 91,948 | 5,954 | 0 |
| Mountain | 11,317 | 372,672 | 1,569 | 139,341 | 2,606 | 145,784 | -[c] | 3 | 294 | 132 |
| Pacific | 4,952 | 217,018 | 1,065 | 111,643 | 1,151 | 49,671 | 0 | 0 | 718 | 0 |
| Unites States | 72,887 | 2,512,693 | 62,483 | 6,285,434 | 23,954 | 1,525,751 | 67,372 | 1,922,478 | 11,714 | 368 |

[a]Includes barley, oats and grain sorghum. Production is expressed in bushels of corn equivalent.

[b]Not needed in crops to meet specified domestic and export demands.

[c]White Area acreage of 189 acres.

Belt with 60.7 percent of the national production. Soybean yields average 28.5 bushels per acre for this solution, compared to 30.7 bushels per acre for base solution W1C1S1.

Land used for cotton production declines 1.5 million acres from the base solution. Decreases from the base solution occur in both the Southeast and Southern Plains regions. Increased acreage occurs in the Delta and Pacific regions. Higher yields in the Pacific region and the national yield of 600.4 pounds of cotton lint per acre account for less land being used. Only 368,000 acres of available cropland is not used for crops.

Crop supply prices for this solution (Table 36) approach 1973 actual prices. Compared to 1973 prices, the wheat price is 14.4 percent lower, the corn price is 23.5 percent lower, the soybean price is 26.7 percent lower, and the cotton price is 9.9 percent lower. All crop supply prices for this solution are considerably higher than base solution prices. Compared to the base solution, the wheat price is 117.3 percent higher, the corn price is 95.0 percent higher and the soybean price is 162.3 percent higher.

Livestock and livestock supply prices also approach the 1973 feeding-year prices. The cattle supply price is nearly $3.00 per hundredweight higher than the 1973 actual price. Other prices, except milk, are slightly lower than 1973 prices.

Fertilizer usage and application rates for the 150 producing areas are shown in Table 37. All primary element usages increase over the base solution.

Table 36. Farm supply prices under Solution TREND1.2 (with trend fertilization and exports of wheat, corn, and oilmeals at 1.2 times their trend levels) and comparisons for 1973 and the base solution W1C1S1

| Commodity | Unit | 1973 Actual Price[a] | 1980 Supply Prices[b] Base solution | TREND1.2 |
|---|---|---|---|---|
| Crops | | | | |
| Wheat | $/bushel | 3.96 | 1.56 | 3.39 |
| Corn | $/bushel | 2.55 | 1.00 | 1.95 |
| Other feed grains | $/bushel[c] | 1.90 | 1.06 | 2.14 |
| Soybeans | $/bushel | 7.69 | 2.15 | 5.64 |
| Cotton | ¢/pound | 44.6 | 31.6 | 40.2 |
| Livestock & livestock products | | | | |
| Cattle | $/cwt. | 42.80 | 36.75 | 45.72 |
| Hogs | $/cwt. | 39.40 | 25.50 | 36.38 |
| Broilers | ¢/pound | 24.0 | 14.9 | 21.8 |
| Lamb | $/cwt. | 35.10 | 28.46 | 34.19 |
| Turkeys | ¢/pound | 34.8 | 23.5 | 34.0 |
| Eggs | ¢/dozen | 54.1 | 37.4 | 49.4 |
| Milk | $/cwt. | 7.14 | 5.57 | 7.15 |

[a] Sources: [5, 7].

[b] Prices are expressed in 1973 dollars using the production expenses paid by farmers index.

[c] Prices are expressed in dollars per bushel of corn equivalent.

Per capita expenditures for specified farm-food products is $724.12, an increase of $48.06 over the base solution. (See Table 38.) Compared to the base solution, beef and pork consumptions drop by 10.5 percent and 6.8 percent, respectively. Broiler consumption increases by 3.0 percent and lamb consumption increases by 3.4 percent over the base solution. The average consumer expenditure for the specified items is 14.6 percent of disposable income.

Table 37. Fertilizer use by crop and average application rates in the 150 producing areas for Solution TREND1.2 and comparisons for 1973

| | Nitrogen | | | Phosphorus | | | Potassium | | |
|---|---|---|---|---|---|---|---|---|---|
| | Tons used | Lbs./acre | | Tons used | Lbs./acre | | Tons used | Lbs./acre | |
| Crop | (000) | 1973[a] | 1980 | (000) | 1973[a] | 1980 | (000) | 1973[a] | 1980 |
| Wheat | 1393.0 | 30.2 | 39.1 | 502.5 | 7.5 | 14.1 | 412.7 | 5.1 | 11.6 |
| Corn | 4996.9 | 106.0 | 165.2 | 776.2 | 24.0 | 25.7 | 1362.6 | 47.1 | 45.0 |
| Other feed grains[b] | 1124.5 | NA[c] | 110.1 | 173.6 | NA[c] | 17.0 | 107.2 | NA[c] | 10.5 |
| Soybeans | 153.3 | 3.4 | 4.6 | 294.5 | 5.9 | 8.9 | 619.2 | 14.6 | 18.6 |
| Cotton | 433.2 | 54.0 | 74.6 | 50.0 | 12.7 | 8.6 | 129.4 | 20.1 | 22.3 |
| All crops | 8100.9 | | | 1796.8 | | | 2631.1 | | |

[a]Computed from estimates in Table 10 of source [9].

[b]Includes barley, oats, and grain sorghum.

[c]Not available.

Net income from crops produced in the 150 producing areas, shown in Table 39, is $21.4 billion. This is an increase of $19.2 billion over the base solution. Net income from crop production is the return to land and management which equals gross income minus nonland production costs.

Table 38. Retail prices, per capita consumptions, and per capita expenditures for specified farm-food products in 1980 under Solution TREND1.2

| Commodity | Unit | Per capita consumption | Retail price per unit[a] | Expenditure[a] |
|---|---|---|---|---|
| Livestock & livestock products | | | | |
| Beef | (lbs. retail wt.) | 80.5 | 1.39 | 111.89 |
| Pork | (lbs. retail wt.) | 66.8 | 1.02 | 68.14 |
| Chicken | (lbs. r.t.c. wt.) | 58.3 | .55 | 32.07 |
| Lamb | (lbs. retail wt.) | 3.0 | 1.38 | 4.14 |
| Turkey | (lbs. r.t.c. wt.) | 10.0 | .73 | 7.30 |
| Eggs | (number, incl. products) | 285.0 | .06 | 17.10 |
| Dairy | (lbs., whole milk equiv.) | 545.0 | .17 | 92.65 |
| Total | | | | 333.29 |
| Fruits and vegetables | | | | 152.75 |
| Bakery products | | | | 76.13 |
| Grain mill products | | | | 27.80 |
| Miscellaneous | | | | 134.15 |
| Average total consumer expenditure | | | | 724.12[b] |

[a] In 1973 dollars.

[b] Represents 14.6 percent of disposable income. The national expenditure totals 163.4 billion dollars.

Table 39. Net farm income by endogenous crop and farm production region for the 150 producing areas in Solution TREND1.2

| Farm production region | Wheat | Corn | Other feed grains | Soybeans | Cotton | Total |
|---|---|---|---|---|---|---|
| | | | (000 dollars)[a] | | | |
| Northeast | 207,526 | 94,098 | 10,821 | 38,459 | 0 | 350,904 |
| Appalachian | 141,360 | 472,059 | 5,612 | 335,081 | 17,480 | 971,592 |
| Southeast | 15,139 | 339,995 | 200 | 379,806 | 3,591 | 738,731 |
| Delta | 116,640 | 104,516 | 0 | 418,528 | 345,347 | 980,031 |
| Corn Belt | 298,537 | 3,344,173 | 0 | 4,616,662 | 0 | 8,259,372 |
| Lake | 686,625 | 416,120 | 42,714 | 534,172 | 0 | 1,679,631 |
| Northern Plains | 1,963,303 | 1,427,545 | 1,102,561 | 536,124 | 0 | 5,029,533 |
| Southern Plains | 478,841 | 258,702 | 485,151 | 316,441 | 329,169 | 1,868,304 |
| Mountain | 626,844 | 69,774 | 118,647 | 0 | 16,335 | 831,600 |
| Pacific | 496,679 | 111,065 | 12,446 | 0 | 93,093 | 713,283 |
| United States | 5,031,494 | 6,638,047 | 1,778,152 | 7,175,273 | 800,015 | 21,422,981 |

[a]Expressed in 1973 dollars.

## V. SOLUTIONS WITH LIMITED FERTILIZATION

The next five solutions limit nitrogen fertilization to 50 pounds per acre. Crop activities using no more than 50 pounds per acre under trend fertilization are not changed in the linear programming model. Thus, soybean activities are the same for both trend fertilization and limited fertilization. Decreasing the amount of nitrogen used in a crop activity usually results in a decrease in the amounts of phosphorus and potassium used.

The first solution presented, LW1C1S1, has exports of wheat, corn, and oilmeals at 1973 levels. Solution LW1.5C1S1 has wheat exports at 1.5 times the 1973 level and exports of corn and oilmeals at their 1973 levels. In Solution W1C2S1, corn exports are at twice the 1973 level and exports of wheat and oilmeals are at 1973 levels. The fourth solution, LW1C1S1.5, has exports of oilmeals at 1.5 times the 1973 level and exports of wheat and corn at 1973 levels. Finally, Solution LTREND0.9 has exports of wheat, corn, and oilmeals at 0.9 times their trend levels. Trend levels are the 1973 exports minus 1966 exports plus the 1973 exports. As before, exports of other feed grains and cotton are held at 1973 levels for all of the solutions.

Exports of wheat and oilmeals are held at 1.5 times their 1973 levels because the programming model can not meet the total demands at double exports and/or the resulting livestock prices cut livestock product consumption to very low levels. The same reasoning applies to the trend solution set at 0.9 times the trend exports of wheat, corn, and oilmeals. As will be seen later, the production flexibility and rather stable crop prices of the solutions based on trend fertilization are not present in the limited fertilization solutions. Comparisons are made with the base solution, W1C1S1, which uses the trend fertilization assumption.

### Exports of Wheat, Corn, and Oilmeals at 1973 Levels (LW1C1S1)

Although the export levels of all crops in this solution are the same as in the base solution, production of some crops shown in Table 40 are not as high as in the base solution. Reduced livestock demand, as the result of higher livestock prices, is one reason for reduced feed grain and soybean demands. A total of 212.8 million acres is used in crop production, 33.7 million more acres than in the base solution.

Wheat production, 1.8 billion bushels, requires 50.8 million acres. This results in a national yield of 36.3 bushels per acre, 1.9 bushels lower than in the base solution. A total of 80.4 million bushels of wheat is fed to livestock. Wheat feeding reduces the total demand for feed grains. Corn production is down 33.2 million bushels from the base solution, although acreage increases by 18.8 million acres.

Restricting fertilizer application rates on corn acres has greatly increased the amount of land needed for corn production. The national yield, 74.9 bushels per acre, is 28.0 bushels less than in the base solution. Production increases over the base solution occur in the Northeast, Corn Belt, Lake, and Mountain regions. However, the Corn Belt increases production by 577.5 million bushels over the base solution.

Table 40. Distribution of acreage and production for Solution LW1C1S1 among the 10 farm production regions

| Farm production region | Wheat | | Corn | | Other feed grains[a] | | Soybeans | | Cotton | Land unused for crops[b] |
|---|---|---|---|---|---|---|---|---|---|---|
| | Acres (000) | Production (000 Bu) | Acres (000) | Production (000 Bu) | Acres (000) | Production (000 Bu) | Acres (000) | Production (000 Bu) | Acres (000) | Acres (000) |
| Northeast | 1,435 | 58,928 | 2,115 | 158,977 | 1,480 | 53,265 | 14 | 329 | 0 | 0 |
| Appalachian | 996 | 38,631 | 5,052 | 324,262 | 1,276 | 45,654 | 2,651 | 72,944 | 247 | 94 |
| Southeast | 509 | 15,418 | 4,104 | 191,271 | 972 | 31,438 | 2,033 | 58,048 | 464 | 1,196 |
| Delta | 2,024 | 61,580 | 1,355 | 66,203 | 40 | 1,188 | 4,144 | 103,286 | 4,333 | 840 |
| Corn Belt | 5,863 | 233,005 | 37,359 | 3,123,319 | 1,401 | 41,956 | 24,556 | 769,539 | 1 | 0 |
| Lake | 6,635 | 249,739 | 5,597 | 464,752 | 4,441 | 132,591 | 2,835 | 63,076 | 0 | 3,522 |
| Northern Plains | 16,877 | 617,553 | 7,227 | 443,060 | 14,050 | 742,943 | 5,126 | 132,830 | 0 | 13,702 |
| Southern Plains | 4,153 | 102,841 | 4,478 | 255,237 | 6,415 | 291,911 | 2,022 | 58,464 | 8,947 | 2,394 |
| Mountain | 6,973 | 237,881 | 1,567 | 121,875 | 2,893 | 117,696 | –[c] | 3 | 294 | 4,190 |
| Pacific | 5,373 | 231,986 | 1,222 | 99,181 | 1,274 | 51,168 | 0 | 0 | 17 | 0 |
| United States | 50,838 | 1,847,562 | 70,076 | 5,248,137 | 34,242 | 1,509,810 | 43,381 | 1,258,519 | 14,303 | 25,938 |

[a]Includes barley, oats, and grain sorghum. Production is expressed in bushels of corn equivalent.

[b]Not needed in crops to meet specified domestic and export demands.

[c]White Area acreage of 189 acres.

Other feed grain production, 1.5 billion corn-equivalent bushels, is reduced by 62.6 million corn-equivalent bushels from the base solution. Although production is down only 4.0 percent from the base solution, acreage increases by 30.6 percent. The national yield is 44.1 corn-equivalent bushels per acre, 15.9 corn-equivalent bushels lower than in the base solution. As with corn production, restricting fertilizer causes much more land to come into production and a large drop in national yield.

Soybean production is down 0.5 percent from the base solution, but acres in soybeans increase by 5.4 percent. Both soybean and wheat production are less affected by the fertilizer limitation than are feed grains and cotton. Cotton acreage increases by 1.1 million acres or 8.6 percent over the base solution.

Farm prices for this solution are found in Table 41. Although crop supply prices are below 1973 crop-year levels, they are higher than the base solution supply prices. Compared to the base solution, wheat price increases by 7.1 percent, corn price by 29.0 percent, other feed grain price by 32.1 percent, soybean price by 13.5 percent, and cotton price by 8.2 percent. Livestock and livestock product prices for this solution are also between the base solution prices and 1973 prices. Increases in the prices of corn and soybeans over the base solution prices are reflected in livestock prices.

Fertilizer usage, shown in Table 42, changes considerably from the base solution with trend fertilization. Elemental nitrogen usage is

Table 41. Farm supply prices under Solution LW1C1S1 (with crop exports at 1973 levels and nitrogen application limited to 50 pounds per acre) and comparisons for 1973 and the base solution W1C1S1

| Commodity | Unit | 1973 Actual Price[a] | 1980 Supply Prices[b] Base solution | LW1C1S1 |
|---|---|---|---|---|
| Crops | | | | |
| Wheat | $/bushel | 3.96 | 1.56 | 1.67 |
| Corn | $/bushel | 2.55 | 1.00 | 1.29 |
| Other feed grains | $/bushel[c] | 1.90 | 1.06 | 1.40 |
| Soybeans | $/bushel | 7.69 | 2.15 | 2.44 |
| Cotton | ¢/pound | 44.6 | 31.6 | 34.2 |
| Livestock & livestock products | | | | |
| Cattle | $/cwt. | 42.80 | 36.75 | 38.89 |
| Hogs | $/cwt. | 39.40 | 25.50 | 27.82 |
| Broilers | ¢/pound | 24.0 | 14.9 | 16.0 |
| Lamb | $/cwt. | 35.10 | 28.46 | 29.67 |
| Turkeys | ¢/pound | 34.8 | 23.5 | 25.4 |
| Eggs | ¢/dozen | 54.1 | 37.4 | 39.6 |
| Milk | $/cwt. | 7.14 | 5.57 | 5.88 |

[a] Sources: [5, 7].

[b] Prices are expressed in 1973 dollars using the production expenses paid by farmers index.

[c] Prices are expressed in dollars per bushel of corn equivalent.

reduced by 48.8 percent, elemental phosphorus by 17.1 percent, and potassium by 13.6 percent. Compared to the base solution, nitrogen rates on wheat, corn, other feed grains, and cotton are down by 17.7 percent, 70.4 percent, 66.9 percent, and 43.1 percent, respectively. Application rates of nitrogen on soybeans has increased from 4.1 pounds per acre to 4.6 pounds per acre, a 12.2 percent increase over the base solution.

Table 42. Fertilizer use by crop and average application rates in the 150 producing areas for Solution LW1C1S1 and comparisons for 1973

| Crop | Nitrogen | | | Phosphorus | | | Potassium | | |
|---|---|---|---|---|---|---|---|---|---|
| | Tons used (000) | Lbs./acre | | Tons used (000) | Lbs./acre | | Tons used (000) | Lbs./acre | |
| | | 1973[a] | 1980 | | 1973[a] | 1980 | | 1973[a] | 1980 |
| Wheat | 915.6 | 30.2 | 37.2 | 323.0 | 7.5 | 13.1 | 354.1 | 5.1 | 14.4 |
| Corn | 1657.1 | 106.0 | 48.7 | 436.9 | 24.0 | 12.8 | 779.2 | 47.1 | 22.9 |
| Other feed grains[b] | 468.0 | NA[c] | 30.5 | 117.8 | NA[c] | 7.7 | 121.7 | NA[c] | 7.9 |
| Soybeans | 98.2 | 3.4 | 4.6 | 191.7 | 5.9 | 9.0 | 377.6 | 14.6 | 17.7 |
| Cotton | 244.0 | 54.0 | 34.4 | 41.7 | 12.7 | 5.9 | 77.3 | 20.1 | 10.9 |
| All crops | 3382.9 | | | 1111.1 | | | 1709.9 | | |

[a] Computed from estimates in Table 10 source [9].

[b] Includes barley, oats, and grain sorghum.

[c] Not available.

Consumer food costs for this solution are presented in Table 43. Beef and pork consumptions decline by 2.4 pounds and 1.1 pounds retail weight from the base solution respectively. Chicken and lamb consumptions rise slightly.

Net farm income from endogenous crops produced in the 150 producing areas is shown in Table 44. The total, $4.2 billion, is 85.4 percent higher than in the base solution. This increase in net farm income is the result of inelastic commodity demands and higher supply prices as more land of lower quality is used. All crops and farm production regions have higher net farm incomes than in the base solution.

Table 43. Retail prices, per capita consumptions, and per capita expenditures for specified farm-food products in 1980 under Solution LW1C1S1

| Commodity | Unit | Per capita consumption | Retail price per unit[a] | Expenditure[a] |
|---|---|---|---|---|
| Livestock & livestock products | | | | |
| Beef | (lbs. retail wt.) | 87.5 | 1.24 | 108.50 |
| Pork | (lbs. retail wt.) | 70.6 | .86 | 60.70 |
| Chicken | (lbs. r.t.c. wt.) | 57.3 | .47 | 26.93 |
| Lamb | (lbs. retail wt.) | 3.0 | 1.27 | 3.81 |
| Turkey | (lbs. r.t.c. wt.) | 10.0 | .62 | 6.20 |
| Eggs | (number, incl. products) | 285.0 | .05 | 14.25 |
| Dairy | (lbs., whole milk equiv.) | 545.0 | .14 | 76.30 |
| Total | | | | 296.69 |
| Fruits and vegetables | | | | 152.75 |
| Bakery products | | | | 76.13 |
| Grain mill products | | | | 27.80 |
| Miscellaneous | | | | 134.15 |
| Per capita expenditure | | | | 687.52[b] |

[a] In 1973 dollars.

[b] Represents 13.9 percent of disposable income. The national expenditure totals 155.2 billion dollars.

## Exports of Wheat at 1.5 Times the 1973 Level (LW1.5C1S1)

An attempt to run a solution with wheat exports at twice the 1973 level resulted in an infeasible solution unless domestic livestock demands were pushed to extremely low levels. Thus, this solution is used with wheat exports at 1.5 times the 1973 level and exports of other crops at 1973 levels.

As shown in Table 45, 230.7 million acres are used to produce crops in the 150 producing areas and the White Area. Compared to the base

Table 44. Net farm income by endogenous crop and farm production region for the 150 producing areas in Solution LW1C1S1

| Farm production region | Wheat | Corn | Other feed grains | Soybeans | Cotton | Total |
|---|---|---|---|---|---|---|
| | | | (000 dollars)[a] | | | |
| Northeast | 21,426 | 47,213 | 15,754 | 94 | 0 | 84,487 |
| Appalachian | 13,393 | 97,217 | 14,189 | 54,309 | 8,502 | 187,610 |
| Southeast | 2,382 | 39,918 | 4,566 | 30,252 | 12,354 | 89,472 |
| Delta | 13,723 | 13,260 | 0 | 33,324 | 149,004 | 209,311 |
| Corn Belt | 69,145 | 1,315,479 | 3,991 | 564,993 | 0 | 1,953,608 |
| Lake | 87,527 | 98,233 | 42,199 | 17,142 | 0 | 245,101 |
| Northern Plains | 258,783 | 97,478 | 273,057 | 43,326 | 0 | 672,644 |
| Southern Plains | 18,146 | 49,746 | 98,981 | 41,545 | 211,275 | 419,693 |
| Mountain | 55,911 | 15,370 | 50,000 | 0 | 7,956 | 129,237 |
| Pacific | 149,461 | 49,138 | 8,135 | 0 | 0 | 206,734 |
| United States | 689,897 | 1,823,052 | 510,872 | 784,985 | 389,091 | 4,197,897 |

[a]Expressed in 1973 dollars.

solution, wheat production is up 33.3 percent while acreage increases by 46.0 percent. Although corn production is reduced only 0.8 percent from the base solution, acreage increases by 35.4 percent. Corn productions decrease in the Appalachian, Southeast, Delta, Northern Plains, Southern Plains, and Pacific regions. Production increases 569.0 million bushels in the Corn Belt. Nationally, corn yields 75.4 bushels per acre, 27.5 bushels less than in the base solution. Compared to the base solution, other feed grain production decreases 3.8 percent while acreage increases 30.6 percent.

Reduced livestock production decreases total demands for feed grains and soybeans from the base solution. Increased wheat feeding also decreases feed grain demand.

Table 45. Distribution of acreage and production for Solution LW1.5C1S1 among the 10 farm production regions

| Farm production region | Wheat | | Corn | | Other feed grains[a] | | Soybeans | | Cotton | Land unused for crops[b] |
|---|---|---|---|---|---|---|---|---|---|---|
| | Acres (000) | Production (000 Bu) | Acres (000) | Production (000 Bu) | Acres (000) | Production (000 Bu) | Acres (000) | Production (000 Bu) | Acres (000) | Acres (000) |
| Northeast | 1,694 | 70,105 | 1,855 | 138,776 | 1,329 | 46,845 | 164 | 4,752 | 0 | 0 |
| Appalachian | 1,058 | 41,112 | 4,687 | 304,039 | 1,276 | 45,654 | 2,954 | 80,954 | 247 | 94 |
| Southeast | 628 | 18,014 | 3,374 | 160,159 | 961 | 31,411 | 2,839 | 77,627 | 771 | 704 |
| Delta | 2,751 | 80,690 | 1,373 | 66,920 | 40 | 1,188 | 4,131 | 102,918 | 4,333 | 107 |
| Corn Belt | 6,912 | 279,432 | 37,229 | 3,114,736 | 610 | 20,437 | 24,431 | 761,066 | 1 | 0 |
| Lake | 9,205 | 335,541 | 6,784 | 549,521 | 3,645 | 108,198 | 3,397 | 78,551 | 0 | 0 |
| Northern Plains | 27,727 | 931,360 | 6,917 | 421,006 | 15,292 | 777,806 | 3,639 | 85,954 | 0 | 3,406 |
| Southern Plains | 5,647 | 141,057 | 4,161 | 239,016 | 6,403 | 290,991 | 2,136 | 61,160 | 8,528 | 1,536 |
| Mountain | 8,468 | 298,715 | 1,873 | 145,726 | 3,048 | 119,221 | _[c] | 3 | 294 | 2,234 |
| Pacific | 5,017 | 215,643 | 1,222 | 99,181 | 1,629 | 70,288 | 0 | 0 | 17 | 0 |
| United States | 69,107 | 2,411,669 | 69,475 | 5,239,080 | 34,233 | 1,512,039 | 43,691 | 1,252,985 | 14,191 | 8,081 |

[a]Includes barley, oats, and grain sorghum. Production is expressed in bushels of corn equivalent.

[b]Not needed in crops to meet specified domestic and export demands.

[c]White Area acreage of 189 acres.

Cotton acreage, 14.2 million acres, is 1.0 million acres more than in the base solution. The Southeast and Southern Plains increase acreage as all other regions maintain the same acreages found in the base solution, Solution W1C1S1. National cotton lint yield is 494.2 pounds per acre, 38.8 pounds less than in the base solution.

Crop supply prices (Table 46) are considerably higher than in the base solution, but are below the 1973 crop-year prices. Compared to the base solution, the wheat price is 32.7 percent higher, the corn price is 50.0 percent higher, other feed grain price is 60.4 percent higher, the soybean price is 39.5 percent higher, and cotton price is 12.3 percent higher. Livestock and livestock product supply prices also are in the range between base solution supply prices and 1973 feeding-year prices. Although livestock prices are based on the prices of corn and soybeans, the percentage changes in livestock prices are markedly lower than the percentage changes in these grain prices. Compared to the base solution, the cattle price is 10.8 percent higher, the hog price is 17.6 percent higher, and the broiler price increases 16.1 percent higher.

As given in Table 47, fertilizer application rates in the 150 producing areas are much different than the 1973 estimated rates. Nitrogen usage, 3.7 million tons, is 44.6 percent less than the amount used in the base solution. Phosphorus and potassium usage is reduced 7.3 percent and 9.0 percent from the base solution respectively. Compared to the base solution, nitrogen rates on wheat, corn, and cotton are reduced by 21.5 percent, 70.5 percent, and 42.0 percent, respectively. Corn production

Table 46. Farm supply prices under Solution LW1.5C1S1 (with wheat exports at 1.5 times the 1973 level and nitrogen application limited to 50 pounds per acre) and comparisons for 1973 and the base solution W1C1S1

| Commodity | Unit | 1973 Actual Price[a] | 1980 Supply Prices[b] Base solution | LW1.5C1S1 |
|---|---|---|---|---|
| Crops | | | | |
| Wheat | $/bushel | 3.96 | 1.56 | 2.07 |
| Corn | $/bushel | 2.55 | 1.00 | 1.50 |
| Other feed grains | $/bushel[c] | 1.90 | 1.06 | 1.70 |
| Soybeans | $/bushel | 7.69 | 2.15 | 3.00 |
| Cotton | ¢/pound | 44.6 | 31.6 | 35.5 |
| Livestock & livestock products | | | | |
| Cattle | $/cwt. | 42.80 | 36.75 | 40.73 |
| Hogs | $/cwt. | 39.40 | 25.50 | 29.99 |
| Broilers | ¢/pound | 24.0 | 14.9 | 17.3 |
| Lamb | $/cwt. | 35.10 | 28.46 | 30.81 |
| Turkeys | ¢/pound | 34.8 | 23.5 | 27.4 |
| Eggs | ¢/dozen | 54.1 | 37.4 | 41.9 |
| Milk | $/cwt. | 7.14 | 5.57 | 6.18 |

[a] Sources: [5, 7].

[b] Prices are expressed in 1973 dollars using the production expenses paid by farmers index.

[c] Prices are expressed in dollars per bushel of corn equivalent.

accounts for 44.7 percent of the nitrogen used, 34.6 percent of the phosphorus used, and 42.8 percent of the potassium used.

Consumer food costs for this solution are presented in Table 48. Total per capita food expenditure is $697.58, $21.52 higher than in the base solution.

Net income from endogenous crops grown in the 150 producing areas, shown in Table 49, is 7.4 billion. This is an increase of 5.1 billion,

Table 47. Fertilizer use by crop and average application rates in the 150 producing areas for Solution LW1.5C1S1 and comparisons for 1973

| | Nitrogen | | | Phosphorus | | | Potassium | | |
|---|---|---|---|---|---|---|---|---|---|
| Crop | Tons used (000) | Lbs./acre 1973[a] | Lbs./acre 1980 | Tons used (000) | Lbs./acre 1973[a] | Lbs./acre 1980 | Tons used (000) | Lbs./acre 1973[a] | Lbs./acre 1980 |
| Wheat | 1198.0 | 30.2 | 35.5 | 452.9 | 7.5 | 13.4 | 432.6 | 5.1 | 12.8 |
| Corn | 1638.3 | 106.0 | 48.6 | 430.0 | 24.0 | 12.7 | 770.6 | 47.1 | 22.8 |
| Other feed grains[b] | 478.3 | NA[c] | 31.2 | 119.2 | NA[c] | 7.8 | 121.0 | NA[c] | 7.9 |
| Soybeans | 100.5 | 3.4 | 4.7 | 197.6 | 5.9 | 9.2 | 397.8 | 14.6 | 18.6 |
| Cotton | 247.2 | 54.0 | 35.1 | 42.4 | 12.7 | 6.0 | 79.3 | 20.1 | 11.3 |
| All crops | 3662.3 | | | 1242.1 | | | 1801.3 | | |

[a] Computed from estimates in Table 10 of source [9].

[b] Includes barley, oats, and grain sorghum.

[c] Not available.

226.9 percent over the base solution and occurs mainly because of inelastic price demands for the farm commodities involved. Although nonland production costs in a production activity are reduced with less fertilizer usage, more land of a lower quality is forced into production. The increase in net income and higher supply prices reflect the additional land use. All farm production regions at least double net farm incomes from the base solution.

### Exports of Corn at Twice the 1973 Levels (LW1C2S1)

Doubling corn exports does not lead to the problems encountered with doubled wheat or oilmeal exports. This is true since corn exports are a

Table 48. Retail prices, per capita consumptions, and per capita expenditures for specified farm-food products in 1980 under Solution LW1.5C1S1

| Commodity | Unit | Per capita consumption | Retail price per unit[a] | Expenditure[a] |
|---|---|---|---|---|
| Livestock & livestock products | | | | |
| Beef | (lbs. retail wt.) | 85.5 | 1.28 | 109.44 |
| Pork | (lbs. retail wt.) | 69.6 | .90 | 62.64 |
| Chicken | (lbs. r.t.c. wt.) | 57.7 | .49 | 28.27 |
| Lamb | (lbs. retail wt.) | 3.0 | 1.30 | 3.90 |
| Turkey | (lbs. r.t.c. wt.) | 10.0 | .65 | 6.50 |
| Eggs | (number, incl. products) | 285.0 | .05 | 14.25 |
| Dairy | (lbs., whole milk equiv.) | 545.0 | .15 | 81.75 |
| Total | | | | 306.75 |
| Fruits and vegetables | | | | 152.75 |
| Bakery products | | | | 76.13 |
| Grain mill products | | | | 27.80 |
| Miscellaneous | | | | 134.15 |
| Per capita expenditure | | | | 697.58[b] |

[a] In 1973 dollars.

[b] Represents 14.1 percent of disposable income. The national expenditure totals 157.4 billion dollars.

smaller share of domestic use than holds true for wheat and soybeans. This solution has the same crop exports as Solution W1C2S1, but domestic demands change as less feed is needed for livestock. As before, comparisons are made with the base solution (Solution W1C1S1). Acreages and production for the 150 producing areas and the White Area are shown in Table 50.

A total of 6.4 billion bushels of corn is needed to meet export and domestic demands. Production is concentrated in the Corn Belt, Lake and Northern Plains regions with 54.0 percent, 14.2 percent, and 9.9 percent of the national production, respectively. The national yield, 72.6 bushels per acre, is down 30.3 bushels from the base solution. The

Table 49. Net farm income by endogenous crop and farm production region for the 150 producing areas in Solution LW1.5C1S1

| Farm production region | Wheat | Corn | Other feed grains | Soybeans | Cotton | Total |
|---|---|---|---|---|---|---|
| | | | (000 dollars)[a] | | | |
| Northeast | 57,264 | 58,914 | 21,825 | 5,959 | 0 | 143,962 |
| Appalachian | 25,069 | 138,638 | 26,375 | 94,001 | 10,339 | 294,422 |
| Southeast | 6,610 | 61,940 | 12,362 | 69,264 | 25,029 | 175,205 |
| Delta | 46,356 | 27,323 | 0 | 86,725 | 181,206 | 341,610 |
| Corn Belt | 211,151 | 1,954,801 | 7,215 | 964,008 | 0 | 3,137,175 |
| Lake | 218,901 | 177,963 | 62,776 | 57,093 | 0 | 516,733 |
| Northern Plains | 705,875 | 198,905 | 529,656 | 76,326 | 0 | 1,510,762 |
| Southern Plains | 95,163 | 93,429 | 186,664 | 74,106 | 246,880 | 696,242 |
| Mountain | 183,518 | 33,236 | 40,804 | 0 | 9,675 | 267,233 |
| Pacific | 225,565 | 62,388 | 30,872 | 0 | 0 | 318,825 |
| United States | 1,775,472 | 2,807,537 | 918,549 | 1,427,482 | 473,129 | 7,402,169 |

[a]Expressed in 1973 dollars.

restriction on nitrogen application rates severely depresses yields. Compared to the base solution, production decreases occur in the Appalachian, Southeast, Northern Plains, and Pacific regions. Other feed grain production is 75.9 million corn-equivalent bushels lower than in the base solution. Since less feed is needed for livestock production, decreases 16.9 million bushels from the base solution. Land used in cotton production is 1.1 million acres more than in the base solution.

Farm prices for this solution are found in Table 51. Although some livestock supply prices are near 1973 actual prices, crop prices are far below 1973 crop-year prices. However, compared to the base solution, these prices are higher. Wheat price is 32.1 percent higher, corn price is 80.0 percent higher, other feed grain price is 71.7 percent higher, soybean price is 53.0 percent higher, and the cotton price is 15.8 percent higher. Livestock prices also are higher, reflecting price increases for corn and soybeans.

Table 50. Distribtuion of acreage and production for Solution LW1C2S1 among the 10 farm production regions

| Farm production region | Wheat | | Corn | | Other feed grains[a] | | Soybeans | | Cotton | Land unused for crops[b] |
|---|---|---|---|---|---|---|---|---|---|---|
| | Acres (000) | Production (000 Bu) | Acres (000) | Production (000 Bu) | Acres (000) | Production (000 Bu) | Acres (000) | Production (000 Bu) | Acres (000) | Acres (000) |
| Northeast | 1,084 | 44,301 | 2,466 | 182,394 | 1,329 | 46,845 | 164 | 4,752 | 0 | 0 |
| Appalachian | 889 | 34,320 | 5,269 | 337,310 | 1,167 | 41,547 | 2,651 | 72,944 | 247 | 94 |
| Southeast | 545 | 15,418 | 5,127 | 232,954 | 961 | 31,409 | 2,067 | 56,273 | 338 | 239 |
| Delta | 899 | 24,880 | 2,440 | 111,200 | 40 | 1,188 | 5,023 | 122,400 | 4,333 | 1 |
| Corn Belt | 3,731 | 151,076 | 42,595 | 3,470,908 | 13 | 583 | 22,841 | 714,618 | 1 | 0 |
| Lake | 5,427 | 201,865 | 12,050 | 915,163 | 2,756 | 82,145 | 2,797 | 67,472 | 0 | 0 |
| Northern Plains | 21,856 | 757,886 | 10,269 | 637,153 | 15,489 | 753,498 | 5,960 | 150,607 | 0 | 3,407 |
| Southern Plains | 5,034 | 123,442 | 4,840 | 276,150 | 6,970 | 289,934 | 2,022 | 58,464 | 9,065 | 478 |
| Mountain | 6,782 | 256,673 | 2,272 | 164,549 | 5,036 | 168,845 | –[c] | 3 | 294 | 1,534 |
| Pacific | 4,827 | 206,889 | 1,222 | 99,181 | 1,820 | 80,529 | 0 | 0 | 17 | 0 |
| United States | 51,074 | 1,816,750 | 88,550 | 6,426,962 | 35,581 | 1,496,523 | 43,525 | 1,247,533 | 14,295 | 5,753 |

[a]Includes barley, oats, and grain sorghum. Production is expressed in bushels of corn equivalent.

[b]Not needed in crops to meet specified domestic and export demands.

[c]White Area acreage of 189 acres.

Table 51. Farm supply prices under Solution LW1C2S1 (with corn exports at twice the 1973 level and nitrogen application limited to 50 pounds per acre) and comparisons for 1973 and the base solution W1C1S1

| Commodity | Unit | 1973 Actual Price[a] | 1980 Supply Prices[b] Base solution | LW1C2S1 |
|---|---|---|---|---|
| Crops | | | | |
| Wheat | $/bushel | 3.96 | 1.56 | 2.06 |
| Corn | $/bushel | 2.55 | 1.00 | 1.80 |
| Other feed grains | $/bushel[c] | 1.90 | 1.06 | 1.82 |
| Soybeans | $/bushel | 7.69 | 2.15 | 3.29 |
| Cotton | ¢/pound | 44.6 | 31.6 | 36.6 |
| Livestock & livestock products | | | | |
| Cattle | $/cwt. | 42.80 | 36.75 | 42.93 |
| Hogs | $/cwt. | 39.40 | 25.50 | 32.37 |
| Broilers | ¢/pound | 24.0 | 14.9 | 18.5 |
| Lamb | $/cwt. | 35.10 | 28.46 | 32.07 |
| Turkeys | ¢/pound | 34.8 | 23.5 | 29.4 |
| Eggs | ¢/dozen | 54.1 | 37.4 | 44.1 |
| Milk | $/cwt. | 7.14 | 5.57 | 6.50 |

[a] Sources: [5, 7].

[b] Prices are expressed in 1973 dollars using the production expenses paid by farmers index.

[c] Prices are expressed in dollars per bushel of corn equivalent.

As shown in Table 52, a total of 3.8 million tons of elemental nitrogen is used in the 150 producing areas. This represents a decrease of 50.3 percent from Solution W1C2S1 which has the same export levels. Decreases for phosphorus and potassium are 19.9 percent and 21.2 percent respectively. Compared to 1973 estimated rates, nitrogen application rates for wheat and soybean production are fairly close. The corn nitrogen limitation cuts average nitrogen rate to less than one-half of the estimated 1973 level.

The average consumer expenditure for specified farm-food products, found in Table 53, is $705.39. This is an increase of 4.3 percent from

Table 52. Fertilizer use by crop and average application rates in the 150 producing areas for Solution LW1C2S1 and comparisons for 1973

| | Nitrogen | | | Phosphorus | | | Potassium | | |
|---|---|---|---|---|---|---|---|---|---|
| Crop | Tons used (000) | Lbs./acre 1973[a] | Lbs./acre 1980 | Tons used (000) | Lbs./acre 1973[a] | Lbs./acre 1980 | Tons used (000) | Lbs./acre 1973[a] | Lbs./acre 1980 |
| Wheat | 881.4 | 30.2 | 35.7 | 333.8 | 7.5 | 13.5 | 310.5 | 5.1 | 12.6 |
| Corn | 2104.8 | 106.0 | 48.6 | 557.8 | 24.0 | 12.9 | 966.1 | 47.1 | 22.3 |
| Other feed grains[b] | 456.0 | NA[c] | 28.5 | 116.5 | NA[c] | 7.3 | 110.7 | NA[c] | 6.9 |
| Soybeans | 100.0 | 3.4 | 4.7 | 190.0 | 5.9 | 8.9 | 373.1 | 14.6 | 17.5 |
| Cotton | 244.4 | 54.0 | 34.4 | 41.3 | 12.7 | 5.8 | 76.1 | 20.1 | 10.7 |
| All crops | 3786.6 | | | 1239.4 | | | 1836.5 | | |

[a]Computed from estimates in Table 10 of source [9].

[b]Includes barley, oats, and grain sorghum.

[c]Not available.

the base solution. Total per capita expenditure represents 14.2 percent of disposable income.

Crops in the 150 producing areas provide a net farm income of $10.0 billion (See Table 54.) In the base solution, the comparable figure is $2.3 billion. The Corn Belt has 46.3 percent of the net farm income from the crops in the model but all regions greatly increased their net farm incomes from the base solution.

## Exports of Oilmeals at 1.5 Times the 1973 Levels (LW1C1S1.5)

The effects of increased oilmeal exports under limited fertilization are analyzed in this solution. Oilmeal exports are not doubled as in Solution W1C1S2, but are increased to 1.5 times the 1973 level. This action was taken in anticipation that limited fertilization could not produce the crops and/or the resulting supply prices of crops would reduce livestock product consumption to extremely low levels. After running the wheat export levels

Table 53. Retail prices, per capita consumptions, and per capita expenditures for specified farm-food products in 1980 under Solution LW1C2S1

| Commodity | Unit | Per capita consumption | Retail price per unit[a] | Expenditure[a] |
|---|---|---|---|---|
| Livestock & livestock products | | | | |
| Beef | (lbs. retail wt.) | 83.2 | 1.33 | 110.66 |
| Pork | (lbs. retail wt.) | 68.5 | .95 | 65.08 |
| Chicken | (lbs. r.t.c. wt.) | 58.3 | .50 | 29.15 |
| Lamb | (lbs. retail wt.) | 3.1 | 1.33 | 4.12 |
| Turkey | (lbs. r.t.c. wt.) | 10.0 | .67 | 6.70 |
| Eggs | (number, incl. products) | 285.0 | .06 | 17.10 |
| Dairy | (lbs., whole milk equiv.) | 545.0 | .15 | 81.75 |
| Total | | | | 314.56 |
| Fruits and vegetables | | | | 152.75 |
| Bakery products | | | | 76.13 |
| Grain mill products | | | | 27.80 |
| Miscellaneous | | | | 134.15 |
| Per capita expenditure | | | | 705.39[b] |

[a] In 1973 dollars

[b] Represents 14.2 precent of disposable income. The national expenditure totals 159.2 billion dollars.

with nitrogen use limited to 50 pounds per acre, the export factor was reduced from 2.0 to 1.5 because of the previously mentioned reasons. Since exports are also a large part of soybean demand, the factor also was reduced from 2.0 to 1.5 times for this crop.

Compared to the base solution, increasing oilmeal exports to 1.5 times the 1973 level causes 50.1 million acres of land previously not cropped to come into production. This solution uses 229.3 million acres to produce the crops in the model (Table 55).

An increase of 5.0 million acres over the base solution is required to produce an additional 23.5 million bushels of wheat. Corn production, 5.2 billion bushels, requires 69.9 million acres. Although the production

Table 54. Net farm income by endogenous crop and farm production region for the 150 producing areas in Solution LW1C2S1

| Farm production region | Wheat | Corn | Other feed grains | Soybeans | Cotton | Total |
|---|---|---|---|---|---|---|
| | | | (000 dollars)[a] | | | |
| Northeast | 37,281 | 134,809 | 27,270 | 6,889 | 0 | 206,249 |
| Appalachian | 25,696 | 253,643 | 29,107 | 107,692 | 12,213 | 428,351 |
| Southeast | 8,693 | 169,841 | 18,458 | 65,384 | 12,897 | 275,273 |
| Delta | 13,728 | 65,780 | 0 | 134,360 | 214,060 | 427,928 |
| Corn Belt | 125,581 | 3,397,423 | 0 | 1,102,628 | 0 | 4,625,632 |
| Lake | 163,691 | 552,795 | 58,102 | 82,222 | 0 | 856,810 |
| Northern Plains | 581,900 | 396,052 | 607,756 | 171,691 | 0 | 1,757,399 |
| Southern Plains | 80,374 | 174,599 | 196,811 | 89,592 | 308,364 | 849,740 |
| Mountain | 127,747 | 34,379 | 79,992 | 0 | 11,429 | 253,547 |
| Pacific | 199,199 | 67,685 | 48,479 | 0 | 0 | 315,363 |
| United States | 1,363,890 | 5,247,006 | 1,065,975 | 1,760,458 | 558,963 | 9,996,292 |

[a]Expressed in 1973 dollars.

is 55.7 million bushels less than in the base solution, 18.6 million more acres are needed. The national yield is lowered from 102.9 bushels per acre in the base solution to 74.8 bushels per acre for this solution. National yield for other feed grains declines to 43.7 corn-equivalent bushels per acre, compared to 60.0 corn-equivalent bushels per acre in the base solution. Soybean production is concentrated in the Corn Belt with 1.0 billion of the national production of 1.7 billion bushels. The Corn Belt has the highest regional yield, 31.0 bushels per acre, compared to a national yield of 28.5 bushels per acre for this solution and a yield of 30.7 bushels in the base solution. All regions with soybean activities, except the Corn Belt, increase production over the base solution.

Table 55. Distribution of acreage and production for Solution LW1C1S1.5 among the 10 farm production regions

| Farm production region | Wheat Acres (000) | Wheat Production (000 Bu) | Corn Acres (000) | Corn Production (000 Bu) | Other feed grains[a] Acres (000) | Other feed grains[a] Production (000 Bu) | Soybeans Acres (000) | Soybeans Production (000 Bu) | Cotton Acres (000) | Land unused for crops[b] Acres (000) |
|---|---|---|---|---|---|---|---|---|---|---|
| Northeast | 1,411 | 57,969 | 2,115 | 158,977 | 1,329 | 46,845 | 189 | 5,391 | 0 | 0 |
| Appalachian | 1,008 | 38,631 | 4,511 | 293,351 | 1,276 | 45,654 | 3,180 | 87,329 | 247 | 94 |
| Southeast | 545 | 15,418 | 3,051 | 146,800 | 612 | 19,416 | 3,931 | 103,347 | 436 | 702 |
| Delta | 1,329 | 41,386 | 1,028 | 49,988 | 40 | 1,188 | 5,368 | 129,774 | 4,333 | 637 |
| Corn Belt | 2,248 | 85,354 | 34,650 | 2,884,635 | 610 | 20,437 | 31,593 | 979,544 | 82 | 0 |
| Lake | 6,457 | 238,548 | 9,049 | 705,394 | 1,979 | 56,536 | 5,545 | 133,346 | 0 | 0 |
| Northern Plains | 21,964 | 759,013 | 8,020 | 491,923 | 16,971 | 822,051 | 6,449 | 162,359 | 0 | 3,578 |
| Southern Plains | 5,055 | 123,371 | 4,400 | 251,047 | 6,383 | 290,842 | 2,204 | 62,658 | 8,831 | 1,536 |
| Mountain | 6,925 | 241,042 | 1,855 | 144,395 | 3,862 | 146,498 | -[c] | 3 | 294 | 2,981 |
| Pacific | 5,373 | 231,986 | 1,222 | 99,181 | 1,274 | 51,168 | 0 | 0 | 17 | 0 |
| United States | 52,315 | 1,832,718 | 69,901 | 5,225,691 | 34,336 | 1,500,635 | 58,459 | 1,663,751 | 14,240 | 9,528 |

[a]Includes barley, oats, and grain sorghum. Production is expressed in bushels of corn equivalent.

[b]Not needed in crops to meet specified domestic and export demands.

[c]White Area acreage of 189 acres.

Practically, farmable land is fully used with only 9.5 million acres of the cropland base not in harvested crops (a usual quantity). This is a decrease of 84.0 percent from the 59.6 million acres of cropland base not cropped in the base solution.

Farm prices for Solution LW1C1S1.5 are given in Table 56. Supply prices of corn, other feed grains, and soybeans increase about 50 percent over the base solution supply prices. Wheat and cotton prices also increase, but no crop price is close to its 1973 crop-year price. All livestock supply prices increase over the base solution as a reflection of higher prices for corn and soybeans.

Fertilizer usage in the 150 producing areas is shown in Table 57. Nitrogen application rates on wheat and soybeans are higher than 1973 estimated rates. Cotton and corn have lower nitrogen application rates than 1973 estimates. Nitrogen used on all crops in the model is only 51.2 percent of the amount used in the base solution. Phosphorus and potassium usages are down 11.5 percent and 8.4 percent from the base solution respectively. The largest nitrogen decrease is for corn production. Solution LW1C1S1.5 uses only 40.6 percent as much as does the base solution. Soybean production has a 62.3 percent increase in nitrogen usage over the base solution.

Per capita expenditure for specified farm-food products (Table 58) is $700.99, a 3.7 percent increase over the base solution.

Net farm income from endogenous crops produced in the 150 producing areas is $7.2 billion (Table 59), 318.7 percent of the base solution

Table 56. Farm supply prices under Solution LW1C1S1.5 (with oilmeal exports at 1.5 times the 1973 level and nitrogen application limited to 50 pounds per acre) and comparisons for 1973 and the base solution W1C1S1

| Commodity | Unit | 1973 Actual Price[a] | 1980 Supply Prices[b] Base solution | W1C1S1.5 |
|---|---|---|---|---|
| Crops | | | | |
| Wheat | $/bushel | 3.96 | 1.56 | 1.85 |
| Corn | $/bushel | 2.55 | 1.00 | 1.50 |
| Other feed grains | $/bushel[c] | 1.90 | 1.06 | 1.58 |
| Soybeans | $/bushel | 7.69 | 2.15 | 3.27 |
| Cotton | ¢/pound | 44.6 | 31.6 | 35.5 |
| Livestock & livestock products | | | | |
| Cattle | $/cwt. | 42.80 | 36.75 | 40.95 |
| Hogs | $/cwt. | 39.40 | 25.50 | 30.05 |
| Broilers | ¢/pound | 24.0 | 14.9 | 17.7 |
| Lamb | $/cwt. | 35.10 | 28.46 | 31.01 |
| Turkeys | ¢/pound | 34.8 | 23.5 | 27.9 |
| Eggs | ¢/dozen | 54.1 | 37.4 | 42.4 |
| Milk | $/cwt. | 7.14 | 5.57 | 6.25 |

[a] Sources: [5, 7].

[b] Prices are epxressed in 1973 dollars using the production expenses paid by farmers index.

[c] Prices are expressed in dollars per bushel of corn equivalent.

figure. Income from soybean production increases nearly 342 percent above the base solution.

## Exports of Wheat, Corn, and Oilmeals at 0.9 Times the Trend (LTREND0.9)

Except for the first solution, previous solutions with limited fertilization have increased the exports of one crop while holding others at 1973 level. The last solution combines limited fertilization and

Table 57. Fertilizer use by crop and average application rates in the 150 producing areas for Solution LW1C1S1.5 and comparisons for 1973

| | Nitrogen | | | Phosphorus | | | Potassium | | |
|---|---|---|---|---|---|---|---|---|---|
| Crop | Tons used (000) | Lbs./acre 1973[a] | Lbs./acre 1980 | Tons used (000) | Lbs./acre 1973[a] | Lbs./acre 1980 | Tons used (000) | Lbs./acre 1973[a] | Lbs./acre 1980 |
| Wheat | 889.1 | 30.2 | 35.1 | 325.8 | 7.5 | 12.9 | 305.3 | 5.1 | 12.1 |
| Corn | 1647.7 | 106.0 | 48.5 | 430.4 | 24.0 | 12.7 | 759.3 | 47.1 | 22.4 |
| Other feed grains[b] | 467.0 | NA[c] | 30.3 | 119.6 | NA[c] | 7.8 | 112.4 | NA[c] | 7.3 |
| Soybeans | 135.7 | 3.4 | 4.7 | 268.2 | 5.9 | 9.3 | 557.3 | 14.6 | 19.3 |
| Cotton | 244.6 | 54.0 | 34.6 | 42.1 | 12.7 | 6.0 | 78.5 | 20.1 | 11.1 |
| All crops | 3384.1 | | | 1186.1 | | | 1812.8 | | |

[a]Computed from estimates in Table 10 of source [9].

[b]Includes barley, oats, and grain sorghum

[c]Not available.

trend exports of wheat, corn, and oilmeals. In anticipation that resources could not meet total demands and/or the livestock prices would cause consumptions to be unrealistically low, the exports of wheat, corn, and oilmeals are set at 0.9 times their trend levels. Comparisons are made with the base solution, Solution W1C1S1.

This solution, LTREND0.9, also becomes the maximum production solution under limited fertilization. It uses 238.4 million acres for endogenous crop production--a condition of full production from the standpoint of land use (Table 60).

Wheat production, 2.1 billion bushels, is 13.5 percent larger than in the base solution. The amount of land needed for corn production

Table 58. Retail prices, per capita consumptions, and per capita expenditures for specified farm-food products in 1980 under Solution LW1C1S1.5

| Commodity | Unit | Per capita consumption | Retail price per unit[a] | Expenditure[a] |
|---|---|---|---|---|
| Livestock & livestock products | | | | |
| Beef | (lbs. retail wt.) | 85.2 | 1.29 | 109.91 |
| Pork | (lbs. retail wt.) | 69.8 | .90 | 62.82 |
| Chicken | (lbs. r.t.c. wt.) | 57.5 | .49 | 28.18 |
| Lamb | (lbs. retail wt.) | 3.0 | 1.30 | 3.90 |
| Turkey | (lbs. r.t.c. wt.) | 10.0 | .65 | 6.50 |
| Eggs | (number, incl. products) | 285.0 | .06 | 17.10 |
| Dairy | (lbs., whole milk equiv.) | 545.0 | .15 | 81.75 |
| Total | | | | 310.16 |
| Fruits and vegetables | | | | 152.75 |
| Bakery products | | | | 76.13 |
| Grain mill products | | | | 27.80 |
| Miscellaneous | | | | 134.15 |
| Average total consumer expenditure | | | | 700.99[b] |

[a] In 1973 dollars.

[b] Represents 14.2 percent of disposable income. The national expenditure totals 158.2 billion dollars.

increases 25.2 million acres over the base solution to a total acreage of 76.5 million acres. Other feed grain production utilizes 34.4 million acres to produce 1.5 billion corn-equivalent bushels. Soybean production is 1.5 billion bushels, compared to 1.3 billion bushels in the base solution. Nearly 54 million acres are used for soybean production with a national yield of 28.5 bushels per acre. Cotton lint production uses 13.7 million acres.

Table 61 gives supply prices for crops and livestock and allows comparisons with 1973 actual prices and the base solution supply prices.

Table 59. Net farm income by endogenous crop and farm production region for the 150 producing areas in Solution LW1C1S1.5

| Farm production region | Wheat | Corn | Other feed grains | Soybeans | Cotton | Total |
|---|---|---|---|---|---|---|
| | | | (000 dollars)[a] | | | |
| Northeast | 35,607 | 70,695 | 19,662 | 6,424 | 0 | 132,388 |
| Appalachian | 22,119 | 135,377 | 24,764 | 115,226 | 10,545 | 308,031 |
| Southeast | 5,109 | 59,984 | 8,774 | 104,211 | 14,392 | 192,470 |
| Delta | 19,625 | 20,832 | 0 | 141,945 | 184,815 | 367,217 |
| Corn Belt | 49,766 | 1,837,120 | 5,461 | 1,503,424 | 3,197 | 3,398,968 |
| Lake | 126,648 | 214,716 | 21,053 | 103,416 | 0 | 465,833 |
| Northern Plains | 418,158 | 180,216 | 448,709 | 180,264 | 0 | 1,227,347 |
| Southern Plains | 52,182 | 94,298 | 174,983 | 93,633 | 259,784 | 674,880 |
| Mountain | 87,337 | 26,405 | 61,951 | 0 | 9,867 | 185,560 |
| Pacific | 188,322 | 62,794 | 11,464 | 0 | 0 | 262,580 |
| United States | 1,004,873 | 2,702,437 | 776,821 | 2,248,543 | 482,600 | 7,215,274 |

[a]Expressed in 1973 dollars.

All crop supply prices, except cotton and wheat, are at least double the base solution supply prices. Proportionately, other feed grains increase the most in supply price. Soybeans is second in proportional price rises, going from \$2.15 per bushel in the base solution to \$4.77 per bushel for this solution. The supply price of other feed grains exceeds the actual 1973 price, but all other crops have supply prices below 1973 actual prices. Livestock supply prices are above the base solution prices and near the 1973 actual prices.

Fertilizer use (Table 62), is decreased from the base solution, and nitrogen rates are lower for all crops except soybeans. Compared to the base solution, nitrogen application rates on wheat, corn, other feed

Table 60. Distribution of acreage and production for Solution LTREND0.9 among the 10 farm production regions

| Farm production region | Wheat Acres (000) | Wheat Production (000 Bu) | Corn Acres (000) | Corn Production (000 Bu) | Other feed grains[a] Acres (000) | Other feed grains[a] Production (000 Bu) | Soybeans Acres (000) | Soybeans Production (000 Bu) | Cotton Acres (000) | Land unused for crops[b] Acres (000) |
|---|---|---|---|---|---|---|---|---|---|---|
| Northeast | 1,435 | 58,928 | 2,115 | 158,977 | 1,329 | 46,845 | 164 | 4,752 | 0 | 0 |
| Appalachian | 1,059 | 39,707 | 4,651 | 301,935 | 1,202 | 42,846 | 3,157 | 86,763 | 247 | 0 |
| Southeast | 581 | 16,544 | 3,599 | 164,577 | 654 | 21,130 | 3,787 | 100,197 | 418 | 238 |
| Delta | 1,859 | 54,490 | 1,219 | 59,450 | 41 | 1,211 | 5,177 | 125,722 | 4,439 | 0 |
| Corn Belt | 3,134 | 121,281 | 37,768 | 3,142,387 | 49 | 1,755 | 28,166 | 870,238 | 66 | 0 |
| Lake | 5,297 | 198,183 | 11,331 | 867,435 | 1,588 | 46,024 | 4,814 | 119,425 | 0 | 0 |
| Northern Plains | 27,199 | 904,867 | 7,724 | 483,245 | 16,096 | 803,298 | 5,963 | 150,664 | 0 | 0 |
| Southern Plains | 5,391 | 142,112 | 4,264 | 243,766 | 7,931 | 307,689 | 2,898 | 85,928 | 7,926 | 0 |
| Mountain | 8,846 | 310,149 | 3,268 | 215,788 | 3,378 | 132,575 | –[c] | 3 | 294 | 132 |
| Pacific | 4,827 | 206,889 | 610 | 50,134 | 2,148 | 98,118 | 0 | 0 | 300 | 0 |
| United States | 59,628 | 2,053,150 | 76,549 | 5,687,694 | 34,416 | 1,501,491 | 54,126 | 1,543,692 | 13,690 | 370 |

[a]Includes barley, oats, and grain sorghum. Production is expressed in bushels of corn equivalent.

[b]Not needed in crops to meet specified domestic and export demands.

[c]White Area acreage of 189 acres.

Table 61. Farm supply prices under Solution LTREND0.9 (with exports of wheat, corn, and oilmeals at 0.9 times their trend levels and nitrogen application limited to 50 pounds per acre) and comparisons for 1973 and the base solution W1C1S1

| Commodity | Unit | 1973 Actual Price[a] | 1980 Supply Prices[b] | |
|---|---|---|---|---|
| | | | Base solution | LTREND0.9 |
| Crops | | | | |
| Wheat | $/bushel | 3.96 | 1.56 | 3.04 |
| Corn | $/bushel | 2.55 | 1.00 | 2.15 |
| Other feed grains | $/bushel[c] | 1.90 | 1.06 | 2.58 |
| Soybeans | $/bushel | 7.69 | 2.15 | 4.77 |
| Cotton | ¢/pound | 44.6 | 31.6 | 40.0 |
| Livestock & livestock products | | | | |
| Cattle | $/cwt. | 42.80 | 36.75 | 45.98 |
| Hogs | $/cwt. | 39.40 | 25.50 | 36.18 |
| Broilers | ¢/pound | 24.0 | 14.9 | 21.0 |
| Lamb | $/cwt. | 35.10 | 28.46 | 34.07 |
| Turkeys | ¢/pound | 34.8 | 23.5 | 33.1 |
| Eggs | ¢/dozen | 54.1 | 37.4 | 48.4 |
| Milk | $/cwt. | 7.14 | 5.57 | 7.06 |

[a] Sources: [5, 7]

[b] Prices are expressed in 1973 dollars using the production expenses paid by farmers index.

[c] Prices are expressed in dollars per bushel of corn equivalent.

grains, and cotton decrease by 24.6 percent, 70.4 percent, 66.2 percent, and 40.8 percent, respectively. Total fertilizer use in the 150 producing areas is 3.7 million tons of nitrogen, 1.3 million tons of phosphorus, and 1.9 million tons of potassium.

Per capita expenditure for specified farm-foods increases from $676.06 in the base solution to $724.75, an increase of 7.2 percent (Table 63). This expenditure represents 14.6 percent of disposable income. The comparable figure for the base solution is 13.6 percent.

Table 62. Fertilizer use by crop and average application rates in the 150 producing areas for Solution LTRENDO.9 and comparisons for 1973

| Crop | Nitrogen Tons used (000) | Nitrogen Lbs./acre 1973[a] | Nitrogen Lbs./acre 1980 | Phosphorus Tons used (000) | Phosphorus Lbs./acre 1973[a] | Phosphorus Lbs./acre 1980 | Potassium Tons used (000) | Potassium Lbs./acre 1973[a] | Potassium Lbs./acre 1980 |
|---|---|---|---|---|---|---|---|---|---|
| Wheat | 988.1 | 30.2 | 34.1 | 387.6 | 7.5 | 13.4 | 331.7 | 5.1 | 11.4 |
| Corn | 1816.2 | 106.0 | 48.7 | 476.2 | 24.0 | 12.8 | 835.4 | 47.1 | 22.4 |
| Other feed grains[b] | 480.6 | NA[c] | 31.1 | 118.0 | NA[c] | 7.6 | 114.2 | NA[c] | 7.4 |
| Soybeans | 135.5 | 3.4 | 5.1 | 251.4 | 5.9 | 9.4 | 511.6 | 14.6 | 19.2 |
| Cotton | 243.4 | 54.0 | 35.8 | 42.1 | 12.7 | 6.2 | 86.9 | 20.1 | 12.8 |
| All crops | 3663.8 | | | 1275.3 | | | 1879.8 | | |

[a]Computed from estimates in Table 10 of source [9].

[b]Includes barley, oats, and grain sorghum.

[c]Not available.

Table 64 shows the net farm income from the endogenous crops produced in the 150 producing areas. Net farm income from crops increase $15.1 billion from the base solution level of $2.3 billion. Corn production accounts for 38.3 percent of the net farm income. Soybean and wheat production follow with 25.2 percent and 19.9 percent, respectively.

Table 63. Retail prices, per capita consumptions, and per capita expenditures for specified farm-food products in 1980 under Solution LTREND0.9

| Commodity | Unit | Per capita consumption | Retail price per unit[a] | Expenditure[a] |
|---|---|---|---|---|
| Livestock & livestock products | | | | |
| Beef | (lbs. retail wt.) | 80.1 | 1.40 | 112.14 |
| Pork | (lbs. retail wt.) | 66.8 | 1.03 | 68.80 |
| Chicken | (lbs. r.t.c. wt.) | 58.8 | .54 | 31.75 |
| Lamb | (lbs. retail wt.) | 3.1 | 1.38 | 4.28 |
| Turkey | (lbs. r.t.c. wt.) | 10.0 | .72 | 7.20 |
| Eggs | (number, incl. products) | 285.0 | .06 | 17.10 |
| Dairy | (lbs., whole milk equiv.) | 545.0 | .17 | 92.65 |
| Total | | | | 333.92 |
| Fruits and vegetables | | | | 152.75 |
| Bakery products | | | | 76.13 |
| Grain mill products | | | | 27.80 |
| Miscellaneous | | | | 134.15 |
| Average total consumer expenditure | | | | 724.75[b] |

[a] In 1973 dollars.

[b] Represents 14.6 percent of disposable income. The national expenditure totals 163.6 billion dollars.

Table 64. Net farm income by endogenous crop and farm production region for the 150 producing areas in Solution LTREND0.9

| Farm production region | Wheat | Corn | Other feed grains | Soybeans | Cotton | Total |
|---|---|---|---|---|---|---|
| | | | (000 dollars)[a] | | | |
| Northeast | 101,605 | 161,540 | 50,305 | 13,343 | 0 | 326,793 |
| Appalachian | 55,693 | 319,212 | 58,203 | 237,853 | 17,021 | 687,982 |
| Southeast | 24,205 | 173,681 | 30,777 | 254,175 | 22,266 | 505,104 |
| Delta | 86,325 | 61,937 | 17 | 313,635 | 303,481 | 765,395 |
| Corn Belt | 214,328 | 4,234,610 | 1,521 | 2,626,758 | 4,141 | 7,081,358 |
| Lake | 342,098 | 819,128 | 63,194 | 310,922 | 0 | 1,535,342 |
| Northern Plains | 1,526,595 | 500,453 | 1,276,492 | 395,930 | 0 | 3,699,470 |
| Southern Plains | 241,642 | 201,381 | 391,396 | 235,674 | 385,335 | 1,455,428 |
| Mountain | 460,716 | 140,568 | 120,315 | 0 | 15,928 | 737,527 |
| Pacific | 409,904 | 52,291 | 111,819 | 0 | 30,476 | 604,490 |
| United States | 3,463,111 | 6,664,801 | 2,104,039 | 4,388,290 | 778,648 | 17,398,889 |

[a]Expressed in 1973 dollars.

# VI. SUMMARY

This study analyzes the interactions of fertilizer usage and exports in relation to U.S. farm production, prices, and income. It is concerned with a particular set of major crops: wheat, corn, soybeans, cotton, and other feed grains. (Other feed grains is a combination of barley, oats, and grain sorghum.) In addition, resulting food costs and commodity supply prices are estimated. Two levels of fertilization are incorporated into a linear programming model that meets crop demands, minimizes production and transportation costs, and returns nonland resources their market rates.

One fertilization level is based on trends in the use of this resource. Linear regressions are used to estimate both the percentage of acres receiving any fertilizer and the application rates on these acres in 1980. Model solutions based on these conditions are called trend fertilization solutions. The other fertilization level, nitrogen application rates limited to 50 pounds per acre, is used to show the effects of restricting fertilizer application rates as a result of limited fertilizer supplies or environmental concerns over water pollution. Model solutions based on this assumption are called limited fertilization solutions.

Eleven solutions are presented. Six solutions use the trend fertilization conditions as exports of wheat, corn, and soybeans are varied. The five limited fertilization solutions also have varying export levels of wheat, corn, and soybeans. Exports of cotton lint and other feed grains are held constant at 1973 levels for all solutions.

Supply prices are generated from the linear programming model and are expressed in 1973 dollars. These supply prices are the prices needed by farmers to cover all nonland production costs in meeting the specified demand levels. Land costs are not included in production costs, but the model imputes land values which are reflected in the supply prices. Larger crop demands increase supply prices as less productive land is brought under cultivation and the imputed land values increase on the better quality land. Crop prices used in this study must be inflated to account for the increases in production costs since 1973. Based on the index of production expenses paid by farmers in the first half of 1975, these crop prices should be multiplied by 1.4 to reflect prices based in current dollars. No attempts have been made to restrain acreages to historical patterns.

Supply prices in this study need not equal the actual market prices in 1980 as expressed in 1973 dollars. They are supply prices as mentioned above and are not equilibrium prices. The relative prices from the different solutions can, however, give an indication of the price changes needed by farmers in order to meet alternative crop demands and fertilization levels. This study is not an attempt to predict absolute prices in 1980. Instead, it analyzes the effects of fertilizer usage and export levels on various farm variables.

A free market economy is used since no government programs for feed grains, wheat, and cotton are specified in the model. The land available for production of the endogenous crops in the model consists of harvested acres of these crops in 1969 plus all the land retired in the federal farm programs for wheat, feed grains, and cotton in 1969. Acres available for production of feed grains, wheat, and cotton total 230.1 million acres in the 150 producing areas. Acreage devoted to crop production outside of the 150 producing areas is 8.1 million acres.

Table 65 shows national statistics for solutions using trend fertilization. All crops have their lowest prices for Solution W1C1S1 and their highest prices for Solution TREND1.2. Solution W1C1S1 has all crop exports at 1973 levels. Solution Trend1.2 has exports of wheat, corn, and oilmeals at 1.2 times the trend and exports of other feed grains and cotton at 1973 levels. A crop's price increases as the result of an increase in its exports or greater exports of another crop. The crop prices appear low compared to recent years, but remember they are expressed in 1973 dollars, reflect the prices resulting from minimizing production and transportation costs in the continental United States, and are supply prices in the absence of land costs. For this reason, their main function is comparative among the different solutions.

The livestock sector relates livestock prices to prices of corn and soybeans and is sensitive to crop exports. As exports increase, higher crop prices result in higher livestock prices. Using 1973 farm-to-retail price spreads, higher livestock prices also lead to higher retail prices for livestock products.

Harvested acres and crop yields also are shown in Table 65. Trend fertilization rates result in rather stable yields when more acreage is brought under cultivation as crop demands increase. Wheat yields

Table 65. National farm prices, productions, acreages, and yields of crops produced with trend fertilization in 1980

| Model solution | Commodity | Unit | Supply Price per unit[a] | Disposition uses Domestic | Export | Total | Harvested acres (000) | Yield per acre (Units) |
|---|---|---|---|---|---|---|---|---|
| | | | | (-- 1,000,000 Units --) | | | | |
| W1C1S1 | Wheat | Bushel | 1.56 | 660 | 1,149 | 1,809 | 47,332 | 38.2 |
| | Corn | Bushel | 1.00 | 4,056 | 1,225 | 5,281 | 51,302 | 102.9 |
| | Other feed grains | C.e.b.[c] | 1.06 | 1,261 | 311 | 1,572 | 26,211 | 60.0 |
| | Soybeans | Bushel | 2.15 | 476 | 788 | 1,264 | 41,161 | 30.7 |
| | Cotton lint | Bale,lb.[d] | 31.6 | 8 | 6 | 14 | 13,174 | 533.0 |
| W2C1S1 | Wheat | Bushel | 1.74 | 671 | 2,298 | 2,969 | 84,451 | 35.2 |
| | Corn | Bushel | 1.05 | 4,090 | 1,225 | 5,315 | 52,085 | 102.0 |
| | Other feed grains | C.e.b. | 1.17 | 1,260 | 311 | 1,571 | 26,584 | 59.1 |
| | Soybeans | Bushel | 2.30 | 475 | 788 | 1,263 | 41,646 | 30.3 |
| | Cotton lint | Bale,lb. | 31.9 | 8 | 6 | 14 | 13,213 | 531.4 |
| W1C2S1 | Wheat | Bushel | 1.60 | 660 | 1,149 | 1,809 | 47,847 | 37.8 |
| | Corn | Bushel | 1.08 | 4,047 | 2,450 | 6,497 | 63,761 | 101.9 |
| | Other feed grains | C.e.b. | 1.08 | 1,258 | 311 | 1,569 | 25,474 | 61.6 |
| | Soybeans | Bushel | 2.32 | 474 | 788 | 1,262 | 42,822 | 29.5 |
| | Cotton lint | Bale,lb. | 31.3 | 8 | 6 | 14 | 13,174 | 533.0 |
| W1C1S2 | Wheat | Bushel | 1.70 | 623 | 1,149 | 1,772 | 47,988 | 36.9 |
| | Corn | Bushel | 1.18 | 4,059 | 1,225 | 5,284 | 52,248 | 101.1 |
| | Other feed grains | C.e.b. | 1.15 | 1,250 | 311 | 1,561 | 24,808 | 62.9 |
| | Soybeans | Bushel | 3.07 | 504 | 1,576 | 2,080 | 73,279 | 28.4 |
| | Cotton lint | Bale,lb. | 31.7 | 8 | 6 | 14 | 13,449 | 522.1 |
| TREND1.0 | Wheat | Bushel | 1.79 | 640 | 1,553 | 2,193 | 60,372 | 36.3 |
| | Corn | Bushel | 1.17 | 4,069 | 1,963 | 6,032 | 59,393 | 101.6 |
| | Other feed grains | C.e.b. | 1.15 | 1,253 | 311 | 1,564 | 24,804 | 63.0 |
| | Soybeans | Bushel | 2.72 | 490 | 1,201 | 1,691 | 59,206 | 28.6 |
| | Cotton lint | Bale,lb. | 31.6 | 8 | 6 | 14 | 13,456 | 521.8 |
| TREND1.2 | Wheat | Bushel | 3.39 | 649 | 1,864 | 2,513 | 72,887 | 34.5 |
| | Corn | Bushel | 1.95 | 3,929 | 2,356 | 6,285 | 62,483 | 100.6 |
| | Other feed grains | C.e.b. | 2.14 | 1,215 | 311 | 1,526 | 23,954 | 63.7 |
| | Soybeans | Bushel | 5.64 | 551 | 1,441 | 1,992 | 67,372 | 28.5 |
| | Cotton lint | Bale,lb. | 40.2 | 8 | 6 | 14 | 11,714 | 599.5 |

[a]All prices are expressed in 1973 dollars.

[b]Soybean exports include a very small amount of cottonseed and cottonseed oilmeal.

[c]Other feed grains is a combination of oats, barley, and grain sorghum. Quantities are measured in corn-equivalent bushels (c.e.b.).

[d]Cotton lint prices and yields are expressed by pounds. Production uses are measured in bales of 500 pounds of lint.

range from 38.2 bushels per acre to 34.5 bushels per acre. Corn yields stay above 100 bushels per acre, and soybean yields range from 30.7 to 28.4 bushels per acre. Cotton yields stay in the 520-535 pound range except for Solution TREND1.2. In this solution, production has shifted to the West where higher yields are found.

National statistics for solutions using limited fertilization are given in Table 66. These solutions have nitrogen application rates of 50 pounds or less on those acres receiving any nitrogen. Lower nitrogen application rates usually have lower phosphorus and potassium application rates when compared to trend fertilization crop activities. Limited fertilization increases crop prices substantially over the same export levels produced with trend fertilization. Comparing Solutions W1C1S1 and LW1C1S1, the latter wheat price is 7.1 percent higher, corn price is 29.0 percent higher, and soybean price is 13.5 percent higher than in the former. Domestic crop demands are nearly the same for both solutions. Solutions W1C2S1 and LW1C2S1 have the same export levels, but the price of wheat increases 28.8 percent, the price of corn increases 66.7 percent, and the price of soybeans increases 41.8 percent when all crops are produced with limited fertilization. Domestic crop demands for these solutions also are fairly close.

When trying to achieve a solution with exports of wheat or oilmeal at twice the 1973 level and other crop exports at the 1973 level, the linear programming model could not meet the crop demands unless livestock consumption was cut drastically. Hence, the limited fertilization

Table 66. National farm prices, productions, acreages, and yields of crops produced with nitrogen application rates limited to 50 pounds per acre in 1980

| Model solution | Commodity | Unit | Supply price per unit[a] | Disposition uses: Domestic | Export[b] | Total | Harvested acres (000) | Yield per acre (Units) |
|---|---|---|---|---|---|---|---|---|
| | | | | (-- 1,000,000 Units --) | | | | |
| LW1C1S1 | Wheat | Bushel | 1.67 | 699 | 1,149 | 1,848 | 50,838 | 36.3 |
| | Corn | Bushel | 1.29 | 4,023 | 1,225 | 5,248 | 70,076 | 74.9 |
| | Other feed grains | C.e.b.[c] | 1.40 | 1,199 | 311 | 1,510 | 34,242 | 44.1 |
| | Soybeans | Bushel | 2.44 | 471 | 788 | 1,259 | 43,381 | 29.0 |
| | Cotton lint | Bale,lb.[d] | 34.2 | 8 | 6 | 14 | 14,303 | 490.3 |
| LW1.5C1S1 | Wheat | Bushel | 2.07 | 689 | 1,723 | 2,412 | 69,107 | 34.9 |
| | Corn | Bushel | 1.50 | 4,014 | 1,225 | 5,239 | 69,475 | 75.4 |
| | Other feed grains | C.e.b. | 1.70 | 1,201 | 311 | 1,512 | 34,233 | 44.2 |
| | Soybeans | Bushel | 3.00 | 465 | 788 | 1,253 | 43,691 | 28.7 |
| | Cotton lint | Bale,lb. | 35.5 | 8 | 6 | 14 | 14,191 | 494.2 |
| LW1C2S1 | Wheat | Bushel | 2.06 | 668 | 1,149 | 1,817 | 51,074 | 35.6 |
| | Corn | Bushel | 1.80 | 3,977 | 2,450 | 6,427 | 88,550 | 72.6 |
| | Other feed grains | C.e.b. | 1.82 | 1,186 | 311 | 1,497 | 35,581 | 42.1 |
| | Soybeans | Bushel | 3.29 | 460 | 788 | 1,248 | 43,525 | 28.7 |
| | Cotton lint | Bale,lb. | 36.6 | 8 | 6 | 14 | 14,295 | 490.6 |
| LW1C1S1.5 | Wheat | Bushel | 1.85 | 684 | 1,149 | 1,833 | 52,315 | 35.0 |
| | Corn | Bushel | 1.50 | 4,001 | 1,225 | 5,226 | 69,901 | 74.8 |
| | Other feed grains | C.e.b | 1.58 | 1,190 | 311 | 1,501 | 34,336 | 43.7 |
| | Soybeans | Bushel | 3.27 | 482 | 1,182 | 1,664 | 58,459 | 28.5 |
| | Cotton lint | Bale,lb. | 35.5 | 8 | 6 | 14 | 14,240 | 492.5 |
| LTREND0.9 | Wheat | Bushel | 3.04 | 655 | 1,398 | 2,053 | 59,628 | 34.4 |
| | Corn | Bushel | 2.15 | 3,921 | 1,767 | 5,688 | 76,549 | 74.3 |
| | Other feed grains | C.e.b. | 2.58 | 1,190 | 311 | 1,501 | 34,416 | 43.6 |
| | Soybeans | Bushel | 4.77 | 463 | 1,081 | 1,544 | 54,126 | 28.5 |
| | Cotton lint | Bale,lb. | 40.0 | 8 | 6 | 14 | 13,690 | 512.3 |

[a]All prices are expressed in 1973 dollars.

[b]Soybean exports include a very small amount of cottonseed and cottonseed oilmeal.

[c]Other feed grains is a combination of oats, barley, and grain sorghum. Quantities are measured in corn-equivalent bushels (c.e.b.).

[d]Cotton lint prices and yields are expressed by pounds. Production uses are measured in bales of 500 pounds of lint.

solutions for wheat and soybeans at increased levels use exports at only 1.5 times 1973 export levels (instead of twice these levels as in other solutions).

Even though the export levels were modified downward, substantial crop price increases occur when fertilizer usage is limited. Comparing Solutions W2C1S1 and LW1.5C1S1, the latter solution has a wheat price 19.0 percent higher, a corn price 42.9 percent higher, and a soybean price 30.4 percent higher than the W2C1S1 solution. Domestic as well as the export demands are different for these solutions. Solutions W1C1S2 and LW1C1S1.5 have the same exports for all crops except soybeans. Even with a smaller export of soybeans, Solutions LW1C1S1.5, with limited fertilization, has an 8.8 percent higher wheat price, a 27.1 percent higher corn price, and a 6.5 percent higher soybean price.

Solution LTREND0.9 with limited fertilizer has productions of all the crops at lower levels than Solution TREND1.0 where fertilizer is not limiting. Crop prices are much higher for the solution with limited fertilization . Compared to Solution TREND1.0, supply prices are 69.8 percent higher for wheat, 83.8 percent higher for corn and 75.4 percent higher for soybeans.

Decreasing the amount of fertilizer used in crop production results in higher crop supply prices. Part of the increase is due to higher costs per unit of yield. In addition, the assigned values of land from the computer model increase as more land is brought into production to meet specified crop demands. The yields in the final column of Table 66 reflect the decreased fertilizer usage. Corn yields stabilize around 75 bushels per acre under the limited fertilizer solutions as compared to around 100 bushels for the trend solutions without limited fertilizer.

Livestock prices and consumer food costs also differ among solutions. National farm supply prices and per capita food costs for the eleven solutions are shown in Table 67. All prices and costs are expressed in 1973 dollars.

Table 67. National livestock supply prices and per capita food costs under alternative export levels and fertilizer usage in 1980 [a]

| Model solution | Supply prices of Beef | Pork ($/Cwt.) | Lamb | Broiler | Turkey (¢/Lb.) | Eggs (¢/Doz.) | Milk ($/Cwt.) | Food costs per capita ($) |
|---|---|---|---|---|---|---|---|---|
| Trend fertilization solutions | | | | | | | | |
| W1C1S1 | 36.75 | 25.50 | 28.46 | 14.9 | 23.5 | 37.4 | 5.57 | 676.06 |
| W2C1S1 | 37.20 | 26.04 | 28.74 | 15.3 | 24.0 | 38.0 | 5.65 | 677.55 |
| W1C2S1 | 37.41 | 26.27 | 28.86 | 15.4 | 24.2 | 38.2 | 5.68 | 684.16 |
| W1C1S2 | 38.70 | 27.98 | 29.76 | 16.6 | 26.0 | 40.3 | 5.94 | 688.26 |
| TREND1.0 | 38.34 | 27.42 | 29.47 | 16.1 | 25.3 | 39.5 | 5.85 | 686.67 |
| TREND1.2 | 45.72 | 36.38 | 34.19 | 21.8 | 34.0 | 49.4 | 7.15 | 724.12 |
| Limited fertilization solutions | | | | | | | | |
| LW1C1S1 | 38.89 | 27.82 | 29.67 | 16.0 | 25.4 | 39.6 | 5.88 | 687.52 |
| LW1.5C1S1 | 40.73 | 29.99 | 30.81 | 17.3 | 27.4 | 41.9 | 6.18 | 697.58 |
| LW1C2S1 | 42.93 | 32.37 | 32.07 | 18.5 | 29.4 | 44.1 | 6.50 | 705.39 |
| LW1C1S1.5 | 40.95 | 30.05 | 31.01 | 17.7 | 27.9 | 42.4 | 6.25 | 700.99 |
| LTREND0.9 | 45.98 | 36.18 | 34.07 | 21.0 | 33.1 | 48.4 | 7.06 | 724.75 |

[a]All prices and costs are expressed in 1973 dollars.

Each solution has the fertilizer usage by crop. In the trend fertilization solutions, national nitrogen application rates are between 39.1 and 45.2 pounds per acre for all acres of wheat, and between 160.6 and 165.4 pounds of nitrogen per acre of corn. Other feed grain acres receive between 90.3 and 110.1 pounds of nitrogen per acre. Average nitrogen usage on soybeans is between 4.1 and 4.6 pounds per acre. Acres in cotton receive between 57.9 and 74.6 pounds of nitrogen per acre.

With nitrogen rates held to 50 pounds per acre, corn, other feed grains, and cotton are affected the most. In limited fertilization solutions, average nitrogen application rates on corn range between 48.5 and 48.7 pounds. Comparable figures for other feed grains are 28.5 and 31.2 pounds per acre. Cotton acres receive between 34.4 and 35.8 pounds of nitrogen per acre, soybeans between 4.6 and 5.1 pounds per acre, and wheat between 34.1 and 37.2 pounds.

In two sets of export levels, crop demands can be met when fertilizer usage is restricted. Solutions W1C1S1 and LW1C1S1 have the same export levels and nearly equal domestic demands. In Solution LW1C1S1, nitrogen usage is 48.8 percent lower, phosphorus usage is 17.1 percent lower, and potassium usage is 13.6 percent lower than for the trend fertilization solution. Solutions W1C2S1 and LW1C2S1 have nearly the same crop production. Compared to the trend fertilization solution, Solution LW1C2S1 uses 50.3 percent less nitrogen, 19.9 percent less phosphorus and 21.2 percent less potassium. The limited fertilization solutions use more land in order to meet the crop demands.

Net farm incomes for each solution are given by crop and farm production region. The net farm incomes are returns to both land and management. In the trend fertilization solutions, net farm incomes for endogenous crops produced in the 150 producing areas range from $2.3 billion for Solution W1C1S1 with low exports to $21.4 billion for Solution TREND1.2 with high exports. All net farm incomes are expressed in 1973 dollars. Net farm incomes for the limited fertilization solutions range from $4.2 billion to $17.4 billion. Caution should be taken when comparing the net farm incomes under different export levels and fertilizer use. Both net farm incomes and crop supply prices include the imputed values of land used in production. Hence, both income and supply prices increase as less productive land is brought into production.

As crop export levels change, production locations also change. A comparison of the production locations are included for each solution. Solution W1C1S1 is compared with all solutions. It serves as the base solution for this purpose. Indications of the changes in production locations are shown in Tables 68 and 69. In these tables the names of the 10 farm production regions are abbreviated. Table 68 lists the production changes for the trend fertilization solutions. With all other crop exports held at 1973 levels, doubling wheat exports leads to a 64 percent increase in national wheat production as shown for Solution W2C1S1. All farm production regions have at least the same production found in Solution W1C1S1. The Southeast has the largest relative increase. National corn production increases one percent, but large percentage

Table 68. Production location changes based on Solution W1C1S1 for the trend fertilization solutions (Solution W1C1S1 = 100) [a]

| Model solution name | Crop | Production level by farm producing region | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | NE | AP | SE | DL | CB | LK | NP | SP | MT | PC | US |
| W1C1S1 (base solution) | Wheat | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| | Corn | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| | Other feed grains | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| | Soybeans | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | - | 100 |
| | Cotton | -[b] | 100 | 100 | 100 | 100 | - | - | 100 | 100 | 100 | 100 |
| W2C1S1 | Wheat | 100 | 193 | 4194 | 180 | 190 | 145 | 184 | 350 | 121 | 103 | 164 |
| | Corn | 181 | 100 | 100 | 100 | 99 | 100 | 101 | 100 | 131 | 79 | 101 |
| | Other feed grains | 88 | 83 | 138 | 100 | 158 | 118 | 97 | 98 | 100 | 111 | 100 |
| | Soybeans | 2296 | 76 | 126 | 138 | 98 | 165 | 1 | 100 | 100 | - | 100 |
| | Cotton | - | 100 | 100 | 100 | 100 | - | - | 100 | 100 | 100 | 100 |
| W1C2S1 | Wheat | 100 | 100 | 100 | 100 | 93 | 107 | 91 | 189 | 100 | 100 | 100 |
| | Corn | 181 | 107 | 124 | 100 | 135 | 120 | 106 | 110 | 99 | 100 | 123 |
| | Other feed grains | 88 | 67 | 100 | 100 | 2 | 96 | 102 | 113 | 100 | 100 | 100 |
| | Soybeans | 2296 | 108 | 131 | 174 | 87 | 214 | 250 | 100 | 100 | - | 100 |
| | Cotton | - | 100 | 100 | 100 | 100 | - | - | 100 | 100 | 100 | 100 |
| W1C1S2 | Wheat | 88 | 122 | 2376 | 72 | 56 | 114 | 97 | 243 | 90 | 100 | 98 |
| | Corn | 181 | 113 | 123 | 43 | 91 | 99 | 109 | 99 | 131 | 107 | 100 |
| | Other feed grains | 69 | 25 | 100 | 100 | 93 | 55 | 98 | 135 | 117 | 100 | 99 |
| | Soybeans | 8573 | 126 | 244 | 259 | 132 | 589 | 952 | 125 | 100 | - | 165 |
| | Cotton | - | 100 | 1 | 100 | 100 | - | - | 109 | 100 | 259 | 102 |
| TREND1.0 | Wheat | 100 | 122 | 2376 | 113 | 95 | 132 | 120 | 298 | 119 | 101 | 121 |
| | Corn | 181 | 113 | 124 | 102 | 117 | 111 | 103 | 105 | 143 | 109 | 114 |
| | Other feed grains | 88 | 31 | 138 | 100 | 93 | 68 | 102 | 121 | 100 | 97 | 99 |
| | Soybeans | 2296 | 123 | 224 | 196 | 106 | 448 | 795 | 116 | 100 | - | 134 |
| | Cotton | - | 100 | 28 | 100 | 100 | - | - | 108 | 100 | 100 | 102 |
| TREND1.2 | Wheat | 111 | 127 | 4197 | 95 | 57 | 147 | 162 | 356 | 152 | 102 | 139 |
| | Corn | 181 | 111 | 114 | 100 | 113 | 118 | 135 | 125 | 159 | 92 | 119 |
| | Other feed grains | 49 | 20 | 10 | 100 | 2 | 32 | 95 | 160 | 138 | 63 | 97 |
| | Soybeans | 5529 | 140 | 274 | 229 | 117 | 564 | 796 | 170 | 100 | - | 152 |
| | Cotton | - | 100 | 14 | 102 | 100 | - | - | 76 | 100 | 4224 | 89 |

[a]Found by dividing productions by productions in by the corresponding crop and region for Solution W1C1S1. Cotton numbers are based on acres. Only changes of 0.5 percent or more are reflected in the numbers.

[b]Bars indicate no production.

Table 69. Production location changes based on Solution W1C1S1 for the limited fertilization solutions (Solution W1C1S1 = 100) [a]

| Model solution name | Crop | NE | AP | SE | DL | CB | LK | NP | SP | MT | PC | US |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Production level by farm production region | | | | | | | | | | |
| W1C1S1 (base solution) | Wheat | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| | Corn | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| | Other feed grains | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| | Soybeans | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | - | 100 |
| | Cotton | -[b] | 100 | 100 | 100 | 100 | - | - | 100 | 100 | 100 | 100 |
| LW1C1S1 | Wheat | 68 | 70 | 8030 | 100 | 94 | 108 | 102 | 161 | 97 | 109 | 102 |
| | Corn | 242 | 83 | 69 | 70 | 123 | 103 | 45 | 96 | 139 | 82 | 99 |
| | Other feed grains | 96 | 73 | 437 | 90 | 155 | 110 | 91 | 98 | 111 | 65 | 96 |
| | Soybeans | 159 | 105 | 138 | 192 | 77 | 213 | 701 | 108 | 100 | - | 100 |
| | Cotton | - | 100 | 106 | 100 | 100 | - | - | 114 | 100 | 100 | 109 |
| LW1.5C1S1 | Wheat | 80 | 75 | 9382 | 131 | 113 | 146 | 154 | 221 | 122 | 101 | 133 |
| | Corn | 211 | 78 | 58 | 71 | 122 | 122 | 43 | 90 | 166 | 82 | 99 |
| | Other feed grains | 85 | 73 | 436 | 90 | 76 | 90 | 95 | 98 | 113 | 89 | 96 |
| | Soybeans | 2296 | 117 | 185 | 192 | 76 | 266 | 454 | 113 | 100 | - | 99 |
| | Cotton | - | 100 | 177 | 100 | 100 | - | - | 109 | 100 | 100 | 108 |
| LW1C2S1 | Wheat | 51 | 62 | 8030 | 40 | 61 | 88 | 125 | 193 | 105 | 97 | 100 |
| | Corn | 277 | 86 | 84 | 118 | 136 | 204 | 65 | 104 | 187 | 82 | 122 |
| | Other feed grains | 85 | 67 | 436 | 90 | 2 | 68 | 92 | 97 | 160 | 102 | 95 |
| | Soybeans | 2296 | 105 | 134 | 228 | 72 | 228 | 795 | 108 | 100 | - | 99 |
| | Cotton | - | 100 | 78 | 100 | 100 | - | - | 116 | 100 | 100 | 109 |
| LW1C1S1.5 | Wheat | 66 | 70 | 8030 | 67 | 35 | 103 | 125 | 193 | 99 | 109 | 101 |
| | Corn | 242 | 75 | 53 | 53 | 113 | 157 | 50 | 95 | 165 | 82 | 99 |
| | Other feed grains | 85 | 73 | 270 | 90 | 76 | 47 | 101 | 98 | 138 | 65 | 95 |
| | Soybeans | 2604 | 126 | 246 | 242 | 98 | 451 | 857 | 116 | 100 | - | 132 |
| | Cotton | - | 100 | 100 | 100 | 8200 | - | - | 113 | 100 | 100 | 108 |
| LTREND0.9 | Wheat | 68 | 72 | 8617 | 88 | 49 | 86 | 149 | 222 | 127 | 97 | 113 |
| | Corn | 242 | 77 | 60 | 63 | 123 | 193 | 49 | 92 | 246 | 41 | 108 |
| | Other feed grains | 85 | 69 | 293 | 92 | 6 | 38 | 98 | 103 | 125 | 125 | 95 |
| | Soybeans | 2296 | 125 | 238 | 234 | 87 | 404 | 795 | 159 | 100 | - | 122 |
| | Cotton | - | 100 | 96 | 102 | 6600 | - | - | 101 | 100 | 1765 | 104 |

[a]Found by dividing productions of each crop for each region by the corresponding crop and region for Solution W1C1S1. Cotton numbers are based on acres. Only changes of 0.5 percent or more are reflected in the numbers.

[b]Bars indicate no production.

changes in production occur in the Northeast, Mountain, and Pacific regions. Total soybean production does not vary significantly from the base solution, but large percentage changes are found in all regions except the Corn Belt, Southern Plains, Mountain, and Pacific regions.

Corn exports at twice the 1973 level and other crop exports at their 1973 levels are assumed for Solution W1C2S1. Except for the Delta and Pacific regions, all regions change corn production significantly from the base solution. Large changes in the location of wheat production occur in the Corn Belt, Lake, Northern Plains, and Southern Plains regions.

Solution W1C1S2 has oilmeal exports at twice the 1973 level and all other crop exports at 1973 levels. A decrease in the amount of feed needed for livestock leads to lower national productions of wheat and other feed grains. With cotton demand constant for all trend fertilization solutions, increased oilmeal exports is made up of soybeans and soybean oilmeal. All regions with soybean growing activities increased soybean production over the base solution. Although national productions of wheat, corn, and other feed grains do not differ greatly from the base solution, large shifts occur among regions when compared to the base solution. Cotton acreage changes in the Southeast, Southern Plains, and Pacific regions lead to an overall increase in acres devoted to cotton production.

Under Solution TREND1.0, the Southeast increases production of all grains while decreasing cotton acreage by 72 percent when compared to the base solution, Solution W1C1S1. The Corn Belt increases corn and soybean production, and decreases wheat and other feed grain production. Compared to the base solution, over twice as much soybeans are produced in the Northeast, Southeast, Lake, and Northern Plains regions.

Under Solution TREND1.2 with exports of wheat, corn, oilmeals at 1.2 times the trend and exports of other feed grains and cotton at 1973 levels, the Northeast, Appalachian, Southeast, Lake, and Northern Plains increase productions of all grains except other feed grains. Wheat production decreases in the Delta as soybean production increases. Compared to the base solution, the Corn Belt increases corn and soybean production while decreasing wheat and other feed grain production. All grain crop productions increase in the Southern Plains as cotton acreage declines 24 percent.

The production changes for the limited fertilization solutions are given in Table 69. Solution W1C1S1 with trend fertilization still serves as the base solution for comparisons. Feed grain production decreases for Solution LW1C1S1 as domestic grain demand declines. More wheat is produced in the Southeast, Lake, Northern Plains, Southern Plains, and Pacific regions than in the base solution. All other regions, except the Delta, decrease wheat production. Although national corn production is lower than in base solution, the Northeast, Corn Belt, Lake, and Mountain regions increase production. Soybean production declines by 2.3 percent in the Corn Belt.

In Solution LW1.5C1S1, wheat exports are at 1.5 times the 1973 level. National wheat production is 33 percent higher than in the base solution. Only the Northeast and Appalachian regions do not increase wheat production. Compared to the base solution, corn production increases in the Northeast, Corn Belt, Lake, and Mountain regions. Several regions increase soybean production but the Corn Belt reduces production by 24 percent. Cotton acreage in the Southeast is 77 percent higher than in the base solution.

Doubling corn exports while holding other crop exports constant LW1C2S1, reduces demands for other feed grains and soybeans. The Corn Belt reduces wheat, other feed grain, and soybean production as it increases corn production by 36 percent. Production of wheat, corn, and soybeans are increased from the base solution for the Southern Plains. Cotton acreage falls by 22 percent in the Southeast and increases by 16 percent in the Southern Plains. Other comparisons are obvious in the data for Solution LW1C2S1.

Solution LW1C1S1.5, exports of oilmeals at 1.5 times the 1973 level, increases national production of wheat and soybeans while feed grain production is lower. Only the Corn Belt reduces soybean production from the base solution. Compared to the base solution, both the Appalachian and Delta regions increase soybean production and decrease other grain productions. While increasing corn production by 13 percent, the Corn Belt reduces all other grain production. In the Lake region, other feed grain production declines 53 percent as corn, wheat, and soybean production increases. Cotton acreage increases, particularly in Missouri.

With nitrogen limited and exports of wheat, corn, and oilmeals at 0.9 times the trend, LTREND0.9, all national productions of grains are larger than in the base solution except for other feed grains. Compared to the base solution, wheat production increases in the Southeast, Northern Plains, Southern Plains, and Mountain regions. Corn production increases in the Northeast, Corn Belt, Lake, and Mountain regions. Soybean production is larger than in the base solution for all regions except the Corn Belt, Mountain, and Pacific regions.

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# APPENDIX

## The Basic Model

This study is based on a linear programming model of U.S. agriculture. The objective function simulates market equilibrium (with constant stocks) and minimizes national production and transport costs subject to the requirement that all factor costs be covered. The continental United States is divided into 150 spatially delineated agricultural production regions (Figure 1) of reasonably homogenous production possibilities. Crop production is specified exogenously for areas not included otherwise. Demand of the agricultural commodities is allocated exogenously to the 31 consuming regions shown in Figure 2. Demands for wheat, corn, other feed grains, and oilmeals are allocated regionally, while a national equation is used for cotton.

Production activities are defined for each production area where such production activities are feasible. The following production activities satisfy demand in a consuming region: (a) wheat production (132 activities) credited against wheat demand; (b) corn production (141 activities) credited against corn demand; (c) other feed grain production (148 activities which are a weighted average of grain sorghum, oats, and barley) credited against other feed grain demand; (d) soybean production (114 activities) credited against oilmeal demand; and (e) cotton lint production (60 activities) credited against national cotton lint demand, and cottonmeal which is credited against oilmeal demand. Transfer activities are defined for each consuming region so that wheat can be used to satisfy corn and/or other feed grain demands. These activities allow wheat to be substituted for feed grains in livestock rations. Transportation activities are defined between pairs of consuming regions for the four commodities--wheat, corn, other feed grains, and oilmeals. No government program restraints are included in the model solutions. Therefore, the land base is composed of the 1969 harvested acres of the major crops listed above and land formerly retired under the 1969 wheat and feed grain programs.

The variables of the model are divided into activities, costs of activities, and demand and land restraints. Activities are: $X_{ij}$ = crop production activity level; $P_{ij}$ = yield per unit of crop production; $T_{kmn}$ = transportation activity level for the nth commodity from the mth to the kth consuming region; and $WF_k$ = wheat-feed grain transfer activity level. Activity costs are: $c_{ij}$ = crop production activity cost; $d_{kmn}$ = transportation activity cost; and $v_k$ = cost per unit of wheat-feed grain transfer activity. Activity restraints are: $L_i$ = land restraint for land using activities in each area; and $D_{mn}$ = demands for commodities in each region. The subscripts are as follows: i = index of crop production regions, i = 1, 2, ..., 150; j = index of crop production activities, (j = 1 for wheat, j = 2 for corn, j = 3 for other feed grains, j = 4 for soybeans, j = 5 cotton); k, m = indices of consuming or demand regions; (k, m = 1, 2, ..., 31); k, m = 32 is the national cotton region; n = index of agricultural commodities, (n = 1 for wheat, n = 2 for corn, n = 3 for other feed grains, n = 4 for oilmeals).

The <u>objective function</u> is:

$$\text{MIN} \sum_{i=1}^{150} \sum_{j=1}^{5} c_{ij}X_{ij} + \sum_{k=1}^{31} \sum_{m=1}^{31} \sum_{n=1}^{4} T_{kmn}d_{kmn} + \sum_{k=1}^{31} WF_k v_k .$$

<u>Land restraints</u> are:

$$\sum_{j=1}^{5} X_{ij} \leq L_i \qquad i = 1, 2, \ldots, 150.$$

<u>Demand restraints</u> are:

(a) Wheat

$$\sum_{i\varepsilon k} X_{i1}P_{i1} + \sum_{m=1}^{31} (T_{km1} - T_{mk1}) - WF_k \geq D_{k1}^{1} \quad k = 1, 2, \ldots, 31;$$

(b) Corn

$$\sum_{i\varepsilon k} X_{i2}P_{i2} + \sum_{m=1}^{31} (T_{km2} - T_{mk2}) + WF_k \geq D_{k2} \quad k = 1, 2, \ldots, 31;$$

(c) Other feed grains

$$\sum_{i\varepsilon k} X_{i3}P_{i3} + \sum_{m=1}^{31} (T_{km3} - T_{mk3}) - WF_k \geq D_{k3} \quad k = 1, 2, \ldots, 31;$$

(d) Oilmeals

$$\sum_{i\varepsilon k} \sum_{j=4}^{5} X_{ij}P_{ij} + \sum_{m=1}^{31} (T_{km4} - T_{mk4}) \geq D_{k4} \quad k = 1, 2, \ldots, 31;$$

(e) Cotton lint

$$\sum_{i=1}^{150} X_{i5}P_{i5} \geq D_{32,5} .$$

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[1] $\sum_{i\varepsilon k}$ indicates that the summation is over all producing regions (i) within the kth consuming region.

Activity bounds

Corn, soybean, other feed grain, and cotton activities are controlled by upper bounds set at 66 percent of the land in a production area. Wheat activities in the eastern half of the United States are also bounded at this level while no bounds are specified for most of the western half of the United States. Wheat-feed grain activities were assigned upper bounds at 50 percent of the feed units fed in a consuming region.

Nonnegativity

Activity levels of the variables are restricted to values greater than or equal to zero.

The above summarizes the basic model which is used for all solutions of the study. Different model solutions are made by changing elements in the right-hand sides of the crop demands and in the wheat feeding bounds. The crop yields and costs are different for the solutions with nitrogen use limited to 50 pounds per acre and the solutions based on trend fertilization.

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