# Assumptions in the 1985 RCA: A Review

by

CARD Series Paper 83-7

Burton C. English

The purpose of this paper is to elaborate on the basic assumptions that have been made or need to be made before the solutions for the 1985 RCA.

At the last Project Advisory Committee (PAC) meeting a paper put together by USDA's Basic Assumption Work Group (BAWG) was presented (Appendix A). This paper, written by BAWG, examines population levels, gross national product, disposable personal income, institutional and technical change, energy cost, and capital availability. A second paper handed out at the last meeting outlined some of the programming models' assumptions. Many of the points listed in this outline will be examined more completely in this working paper.

This paper will state the regions to be used in the programming model, the assumptions used in the creation of the crop sector, the land base, and input costs. It will examine technology and demands.

## Regions

There are numerous sets of regions used in the programming models built for the 1985 RCA. These include data collection regions, crop producing regions, marketing and livestock producing regions, and range producing regions.

### Data collection regions

There are numerous data collection regions used in the CARD/RCA programming models. The smallest collection regions used in this effort are counties. However, very little information is available at this and terracing. It is assumed that strip cropping can not occur unless at least 25 percent of a rotation is in hay. In addition, it is assumed that terraces are built on the contour.

4. Tillage practices incorporate fall plow, spring plow, reduced tillage, and no-till. Reduced tillage is defined as a tillage practice leaving some residue on the ground year around.
5. The eight land groups are defined as aggregations of the Land Capability Class/Subclass system. The aggregations are shown in Table 1.
6. Cropping practice is defined as a single combination of rotation, conservation practice, and tillage practice on a given land group. Thus, an example of cropping practice would be 50 percent corn, 50 percent soybeans using conventional reduced tillage conservation/tillage practice in Land Group I.

Table 1. The definition of conservation practices by land group used for the 1985 RCA

| Land group | Land capability class/subclass | Straight row | Contour | Strip cropping | Terracing |
|---|---|---|---|---|---|
| I | I, $II_{wa}$, $III_{wa}$[a] | X[b] | | | |
| II | $II_e$ | X | X | X | X |
| III | $III_e$ | X | X | X | X |
| IV | $IV_e$ | X | | X | X |
| V | $II_c$, $III_c$, $IV_c$ | X | | X | |
| VI | $II_s$, $III_s$, $IV_s$ | X | X[c] | X | |
| VII | $II_w$, $III_w$, $IV_w$ | X | | | |
| VIII | V, VI, VII, VIII | X | X | X | X |

[a]wa indicates land classified as having a wetness problem but that problem is adequately treated.

[b]Each X incorporates fall plow, spring plow, reduced tillage, and no tillage practices in combination with the conservation practice.

[c]Not on sand.

Table 3. Rotation selection rules

1. Continuous rotations for HLH and NLH shall be included in all PA's.

2. If over 20% of the acreage in a given PA is in a single crop, then a continuous crop rotation for that crop is to be included in the PA.

3. At this point keep all double cropping rotations.

4. Eliminate all rotations with winter cover. If winter cover is desired, it will be treated as a different conservation practice.

5. If more than one percent of the acreage within a given PA is planted in a given crop, then that crop must appear in 3 or more rotations.

6. All sunflower rotations are to be kept.

7. All minor crops (minor to a PA is defined as less than 1 %) shall be represented in at least one rotation. However, if it is less than .05% then it is assumed not to exist.

8. If a rotation is greater than 6 years then it is not included.

9. If a rotation is greater than 5 years and has 4 years of contiguous crop then it is not included. Example Corn,corn,hay,hay,hay,hay.

10. Keep the number of rotations below 20 rotations in a given PA. Do not count double crop or sunflower rotations at this point.

Three steps will be used to determine the yields used as input into the CARD/RCA model from the EPIC output. First, for each crop in each rotation[1] a yield trend equation must be estimated. This equation is:

$$EY_{kmpt} = Z_{kmnp} + b_{kmnp} t$$

where:

$EY_{kmnpt}$ is the EPIC yield in year t for crop k in sequance position n in the crop sequence m under the tillage and conservation practice p;

t is the year where t = 0, 1, 2, 3 ... with 1980 = 0;

$Z_{kmnp}$ is the intercept term and will represent $EY_{kmnp}$ in 1980; and

$b_{kmnp}$ is the slope coefficient representing the change in $EY_{kmnp}$ over time due to changes in the soil profile.

Assuming 60,000 EPIC runs[2] and an average rotation of three years, 180,000 regressions will be necessary. The significance of b will be checked and if it is insignificant it will be set to zero. It is expected that b will only be significant for the land capability subclass e soils.

The second step in the transformation process is to normalize the intercept coefficients to actual 1980 yields. The normalization will be achieved by the following methodology:

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[1]A rotation is defined as a sequence of crops planted using a given tillage and conservation practice on a given land group.

[2]The 60,000 EPIC runs are derived from the estimated size of the 1985 CARD/RCA model times 180 MLRAs/105 PAs.

1. Determine an average MLRA yield ($\overline{YC}_k$) for each crop using 1978, 1979, and 1980 county yields and acreages.
2. Determine simulated 1980 production by land group by multiplying the estimated Z coefficient for each crop for the continuous grown rotation under straight row conventional tillage system by the 1982 NRI acres for the land group in the MLRA. Then sum these products across land groups and divide by the total acres in the MLRA to determine an average simulated MLRA yield ($\overline{YE}_k$).
3. Determine $YADJ_k = \overline{YC}_k / \overline{YE}_k$ for each crop.
4. Determine a new Z coefficient (ZN) for each equation by multiplying by the appropriate $YADJ_k$.

$$ZN_{kmnp} = Z_{kmnp} * YADJ_k$$

The third step is to adjust yields to the desired technology level as follows.

$$Y_{kmnpt} = ZN_{kmnp} (1 + D_{kt}) + b_{kmnp} t$$

where:

$D_{kt}$ is the national growth rate in yields between year 0 (1980) and year t for crop k;

$Y_{kmnpt}$ is the yield to be used in CARD/RCA for year t for crop k in sequence position n in the crop sequence m under the tillage and conservation practice p.

The $D_{kt}$ is to be provided by USDA from either their official estimates or the RCA symposium held in December 1982.

A yield check program will be developed to test if the crop yields fell within some given range.

For nitrogen and phosphorus (EPIC has no information on potassium), the data will be transformed using the following steps:

1. Determine the average nitrogen (phosphorus) application rate and the average yield from EPIC for each crop in a given rotation run.
2. Derive a fertilizer to yield ratio for nitrogen ($\overline{FN}$) and phosphorus ($\overline{FP}$).
3. Determine $N_{kmnpt} = \overline{FN}_{kmnp} Y_{kmnpt} (1-NE_{kt})$ and $P_{kmnpt} = \overline{FP}_{kmnp} Y_{kmnpt} (1-PE_{kt})$

where:

$N_{kmnpt}(P_{kmnpt})$ is the amount of nitrogen (phosphorus) required to produce $Y_{kmnp}$ in year t and

$NE_{kt}(PE_{kt})$ is the increased efficiency use of nitrogen (phosphorus) in year t for crop k.

The $NE_{kt}$ and $PE_{kt}$ are again to be provided by USDA.

Potassium (K) will be derived from the FEDs budget generator using the pounds of K per unit of yield times $Y_{kmnpt}$.

There are three methods of using the EPIC output information on applied irrigation water. One of the three or a combination of them shall be chosen.

1. Assume irrigation machinery technology will offset the increase requirement for water resulting from the yield increase due to yield technology and use the average water application from EPIC.

2. Compute a water per unit of yield similar to that used in deriving $N_{kmnpt}$ and $P_{kmnpt}$ above.
3. Use information from the RCA symposium to blend methods one and two.

USLE, wind erosion, and the water soil erosion driver (if other than USLE) need to be linked. The link will be achieved by regressing each erosion variable on time for each EPIC rotation run. Using the regression equations, the value of each erosion variable can be computed for the year of interest.

Livestock production

Grain-fed and roughage-fed beef, pork, and milk can either be endogenous or exogenous. Turkeys, eggs, lamb and mutton, and poultry will always be exogenous.

For the exogenous livestock commodities, location, nitrogen production, and water and feed requirements will be estimated and placed into the model (see the working paper on the exogenous livestock sector for further information).

The endogenous livestock sector requires several different types of coefficients.[1] Feed coefficients, costs of production, nitrogen production, and water requirements are required.

The costs of production are for the most part determined from existing FEDs' budgets. Roughage fed budgets are developed, however,

[1]A working paper on the endogenous livestock production sector was presented at an earlier PAC meeting.

From the PA rotation file, a RCA MLRA's rotation file was constructed by requiring each MLRA portion of a PA to have the rotation within that PA. This increased the rotation file from 2,100 records to approximately 7,500 records. Presently, checks are being run to make sure these rotations are agronomically correct.

Machinery complement and other input file:

Crop and tillage practice machinery complements and input requirements were obtained from the SCS state offices. These complements were placed on a state based computerized data set. Once coded, these budgets were assigned to the RCA MLRA's and sent back to the states for review.

Data requirements for yield sector:

One of the most important data sets in the Center for Agricultural and Rural Development, Soil and Water Resources Conservation Act's family of models (CARD/RCA) is the crop sector. The crop sector requires information on yields, nitrogen,* phosphorus,* potassium,* and energy use (electricity, diesel, natural gas, and LPG); irrigation water requirements;* soil erosion* (water and wind); and costs of production.[1] Information for the items with an * can be derived from EPIC. This paper addresses the transformations required to use EPIC output information as input information in the CARD/RCA crop sector models.

EPIC can be defined as a sophisticated production function that incorporates numerous algebraic submodels which interact to simulate

[1]In this paper, costs of production are defined as costs other than the costs accounted for by the endogenous variables.

the values of many input and output variables of the plant growth process (Table 4). By matching these variables to those needed by the CARD/RCA models, an information flow between EPIC and CARD/RCA can be established. A proposed linkage of data items is presented in Table 5.

However, before the transformation methodology can be used, the following actions must take place:

1. The EPIC model must be validated;
2. The EPIC model will be run on all RCA MLRAs (The RCA-PAC has recommeded to run on each MLRA and to aggregate to the 105 PAs; and
3. The version of the EPIC model used in the 1985 RCA will be documented and not changed once information is derived from it.

The EPIC will be run using the following assumptions:

1. An automatic fertilizer test will conducted at the beginning of each crop year. The soil test will indicate the quantities of N and P that EPIC will apply to meet the crop's nutrient demands given the condition of the soil.
2. Technology will be held constant in the EPIC runs. It is, therefore, assumed that a change in technology will not significantly affect the residue left on the ground.
3. A weather seed will be selected, such that no bias in yields (resulting from weather) exist over time. To find this seed, a linear regression will be performed with rainfall as the dependent variable.

$$R = a + bt$$

Three steps will be used to determine the yields used as input into the CARD/RCA model from the EPIC output. First, for each crop in each rotation[1] a yield trend equation must be estimated. This equation is:

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from other sources of information. The costs, as in the rest of the model, are in 1980 dollars.

Livestock feed requirements are derived from the National Research Councils' recommendations. Energy, protein, calcium, and phosphorous requirements are determined for each livestock activity. Two problems exist with using the NRC data:

1. These data do not include waste; and
2. These data, based on early 1970's technology, do not have any efficiency assumptions.

Test runs have indicated that this sector is approximately 7 percent more efficient than what is actually occurring. The assumed feed efficiency for various years are presented in Table 6.

Water and nitrogen production are the other coefficients required by the endogenous livestock sector. The water coefficient is based on information provided to CARD during 1974-1975 with the coefficients published in CARD Report 107T, pages 97-99. The procedure used in determining the nitrogen coefficient takes into account the amount of nitrogen excreted, the losses associated with handling and storage, and the losses associated with field application. These coefficients are presented in CARD Report 107T, page 101.

## Major Assumption in the Development of the Land Base

Many of the assumptions in developing the land base are presented in a working paper that was presented before PAC. There are several different types of land that must be determined 1) The land RHS, potential land conversion, the range/forest RHS, and dry to irrigated land conversion.

Table 6. Feed efficiency for the livestock sector

| Livestock type | 2000 feed efficiency |
|---|---|
| | (percent) |
| Beef | 15.5 |
| Pork | 15.5 |
| Dairy | 10.3 |
| Sheep | 15.5 |
| Broilers | 15.5 |
| Turkey | 15.5 |
| Eggs | 21.0 |

Land RHS

The basic data source for the development of the land RHS will be the 1982 NRI. The land capability classes/subclass system will be aggregated into eight land groups as previously stated in Table 1.

These data represent the land base in 1982. Thus, for solving the programming models for the years 1990, 2000, and 2030, estimates of agricultural to nonagricultural land conversion must be made. Nonagricultural use is classified into five categories:

a) urban expansion,

b) roads and airports,

c) mining,

d) vacation/second homes, and

e) recreation and wildlife.

The assumptions used in estimating agriculture to nonagriculture conversion in each of these categories are explained in the Land Use working paper. The state projections are illustrated in Table 7. These losses are distributed to cropland, pasture and range, forest land, and other uses (Table 8). Since information on the type of land taken from agricultural production is sparse, it is suggested that the land be distributed to land group based on the current distribution.[1]

In examining resource use, an important consideration is land availability. From the 1982 NRI, the quantities of potential land will be identified. They will be identified by land group and productivity and condition class. (Productivity and condition class, along

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[1] It has been suggested that this method is incorrect and that further research be conducted. Comparison of 1977 NRI points with those in the 1982 NRI may offer some insights.

Table 7. Projected land conversion among nonagricultural uses between 1981-2000.

(Acres)

| State | State | Urban loss (1) | Roads (2) | Airports (3) | Total mining loss (4) | Reclamation percentage (5) | Net loss in mining (6) | Second homes or vacation (7) | Recreation & wildlife (8) | Total* (9) |
|---|---|---|---|---|---|---|---|---|---|---|
| 01 | Alabama | 50,373.7 | 25,000.0 | 300.0 | 616,000.0 | 43.8 | 346,192.0 | 13,200.0 | 33,800.0 | 468,865.7 |
| 04 | Arizona | 157,804.4 | 56,600.0 | 1,136.3 | 207,660.0 | 6.7 | 193,147.0 | 13,700.0 | 7,100.0 | 430,087.7 |
| 05 | Arkansas | 30,481.8 | 09,000.0 | 0,070.8 | 139,900.0 | 30.6 | 97,091.0 | 11,700.0 | 51,500.0 | 199,843.6 |
| 06 | California | 423,173.7 | 60,091.0 | 1,143.2 | 173,400.0 | 19.3 | 139,934.0 | 227,900.0 | 262,800.0 | 1,115,041.9 |
| 08 | Colorado | 114,631.1 | 15,000.0 | 76.3 | 427,680.0 | 28.7 | 304,936.0 | 18,300.0 | 37,700.0 | 490,643.4 |
| 09 | Connecticut | 132,834.7 | 04,000.0 | 0.0 | 10,800.0 | 27.7 | 7,808.0 | 18,700.0 | 23,900.0 | 187,242.7 |
| 10 | Delaware | 4,406.4 | 04,500.0 | 0.0 | 4,000.0 | 27.8 | 2,888.0 | 3,500.0 | 5,600.0 | 20,894.4 |
| 12 | Florida | 362,235.9 | 19,000.0 | 278.9 | 238,000.0 | 19.3 | 192,066.0 | 44,500.0 | 220,300.0 | 838,380.8 |
| 13 | Georgia | 136,211.0 | 22,000.0 | 207.9 | 46,800.0 | 28.1 | 33,649.0 | 34,300.0 | 71,000.0 | 297,367.9 |
| 16 | Idaho | 19,887.4 | 30,085.0 | 0.0 | 28,600.0 | 21.1 | 22,594.0 | 3,800.0 | 9,100.0 | 85,466.4 |
| 17 | Illinois | 60,225.2 | 32,000.0 | 181.9 | 591,220.0 | 63.3 | 216,978.0 | 98,200.0 | 131,100.0 | 538,684.9 |
| 18 | Indiana | 53,694.6 | 16,000.0 | 100.0 | 695,480.0 | 64.6 | 246,200.0 | 48,200.0 | 76,000.0 | 440,194.6 |
| 19 | Iowa | 6,694.6 | 15,000.0 | 0.0 | 34,800.0 | 33.1 | 23,281.0 | 24,100.0 | 181,300.0 | 250,375.6 |
| 20 | Kansas | 29,759.1 | 18,000.0 | 183.1 | 122,660.0 | 48.9 | 62,679.0 | 21,500.0 | 36,900.0 | 169,021.2 |
| 21 | Kentucky | 42,078.0 | 11,000.0 | 166.0 | 1,263,580.0 | 64.1 | 453,625.0 | 10,900.0 | 17,800.0 | 535,569.0 |
| 22 | Louisiana | 69,081.5 | 28,000.0 | 139.0 | 24,800.0 | 28.6 | 17,707.0 | 20,300.0 | 99,700.0 | 234,927.0 |

Table 7. (cont.)

(Acres)

| State | State | Urban loss (1) | Roads (2) | Airports (3) | Total mining loss (4) | Reclamation percentage (5) | Net loss in mining (6) | Second homes or vacation (7) | Recreation & wildlife (8) | Total* (9) |
|---|---|---|---|---|---|---|---|---|---|---|
| 23 | Maine | 21,063.0 | 10,500.0 | 0.0 | 14,000.0 | 30.2 | 9,772.0 | 4,500.0 | 6,800.0 | 52,635.0 |
| 24 | Maryland | 72,814.9 | 10,200.0 | 0.0 | 66,660.0 | 35.8 | 42,796.0 | 25,400.0 | 39,100.0 | 190,310.9 |
| 25 | Massachusetts | 114,533.2 | 04,100.0 | 0.0 | 29,200.0 | 27.6 | 21,141.0 | 33,900.0 | 37,700.0 | 211,374.2 |
| 26 | Michigan | 120,859.4 | 32,000.0 | 158.1 | 98,000.0 | 24.2 | 74,284.0 | 30,700.0 | 100,200.0 | 358,201.5 |
| 27 | Minnesota | 67,184.9 | 28,200.0 | 0.0 | 150,800.0 | 9.6 | 136,323.0 | 14,000.0 | 61,200.0 | 306,907.0 |
| 28 | Mississippi | 31,607.4 | 16,000.0 | 222.7 | 14,000.0 | 30.9 | 9,674.0 | 14,900.0 | 60,400.0 | 132,804.1 |
| 29 | Missouri | 76,405.6 | 14,000.0 | 240.5 | 237,740.0 | 40.6 | 141,218.0 | 32,200.0 | 59,000.0 | 323,064.1 |
| 30 | Montana | 14,314.6 | 21,400.0 | 0.0 | 411,400.0 | 24.8 | 309,373.0 | 4,100.0 | 10,100.0 | 359,287.0 |
| 31 | Nebraska | 18,653.5 | 16,200.0 | 135.4 | 18,800.0 | 29.1 | 13,329.0 | 9,800.0 | 12,000.0 | 70,117.4 |
| 32 | Nevada | 39,702.9 | 21,200.0 | 1,419.5 | 62,800.0 | 9.1 | 57,085.0 | 5,000.0 | 6,100.0 | 130,507.4 |
| 33 | New Hampshire | 34,514.2 | 14,300.0 | 0.0 | 6,600.0 | 30.0 | 4,620.0 | 3,600.0 | 4,200.0 | 61,234.2 |
| 34 | New Jersey | 21,182.9 | 21,400.0 | 0.0 | 24,800.0 | 26.3 | 18,278.0 | 56,400.0 | 83,100.0 | 200,363.9 |
| 35 | New Mexico | 37,780.6 | 26,100.0 | 202.0 | 675,800.0 | 20.5 | 537,261.0 | 6,800.0 | 16,800.0 | 624,943.6 |
| 36 | New York | 45,886.3 | 28,900.0 | 113.1 | 54,200.0 | 25.5 | 40,379.0 | 121,500.0 | 162,800.0 | 399,578.4 |
| 37 | N. Carolina | 77,256.0 | 22,400.0 | 0.0 | 44,800.0 | 26.3 | 33,018.0 | 38,100.0 | 91,000.0 | 261,774.0 |
| 38 | N. Dakota | 4,097.0 | 03,200.0 | 0.0 | 429,880.0 | 68.1 | 137,132.0 | 3,700.0 | 245,600.0 | 393,729.0 |

Table 7. (cont.)

(Acres)

| State | State | Urban loss (1) | Roads (2) | Airports (3) | Total mining loss (4) | Reclamation percentage (5) | Net loss in mining (6) | Second homes or vacation (7) | Recreation & wildlife (8) | Total* (9) |
|---|---|---|---|---|---|---|---|---|---|---|
| 39 | Ohio | 56,099.2 | 11,200.0 | 247.4 | 674,240.0 | 62.0 | 256,211.0 | 69,600.0 | 86,100.0 | 479,457.6 |
| 40 | Oklahoma | 64,711.5 | 09,200.0 | 100.0 | 345,460.0 | 46.5 | 184,821.0 | 18,700.0 | 56,600.0 | 334,132.5 |
| 41 | Oregon | 69,241.4 | 40,230.0 | 113.7 | 32,800.0 | 26.3 | 24,174.0 | 15,200.0 | 16,100.0 | 165,059.1 |
| 42 | Pennsylvania | 36,983.8 | 13,200.0 | 0.0 | 1,034,660.0 | 48.8 | 529,746.0 | 42,900.0 | 131,600.0 | 754,428.8 |
| 44 | Rhode Island | 14,448.4 | 11,400.0 | 0.0 | 3,600.0 | 23.2 | 2,765.0 | 5,900.0 | 6,900.0 | 41,413.4 |
| 45 | S. Carolina | 46,680.6 | 14,400.0 | 0.0 | 16,000.0 | 28.3 | 11,472.0 | 18,700.0 | 29,900.0 | 121,152.6 |
| 46 | S. Dakota | 5,260.8 | 12,300.0 | 0.0 | 20,000.0 | 28.2 | 14,360.0 | 3,700.0 | 253,160.0 | 288,780.8 |
| 47 | Tennessee | 65,914.9 | 23,400.0 | 0.0 | 64,660.0 | 34.5 | 42,352.0 | 12,300.0 | 22,300.0 | 166,266.9 |
| 48 | Texas | 474,238.7 | 34,100.0 | 516.0 | 655,800.0 | 26.3 | 483,325.0 | 96,300.0 | 205,500.0 | 1,293,979.7 |
| 49 | Utah | 67,990.5 | 19,900.0 | 0.0 | 87,420.0 | 9.6 | 79,028.0 | 7,300.0 | 22,600.0 | 196,818.5 |
| 50 | Vermont | 11,773.9 | 04,200.0 | 0.0 | 5,000.0 | 16.3 | 4,185.0 | 1,800.0 | 9,000.0 | 30,958.9 |
| 51 | Virginia | 85,050.7 | 21,000.0 | 0.0 | 279,760.0 | 36.7 | 177,088.0 | 20,200.0 | 60,500.0 | 363,838.7 |
| 53 | Washington | 103,407.1 | 14,100.0 | 182.5 | 41,200.0 | 27.1 | 30,035.0 | 21,600.0 | 37,700.0 | 207,024.6 |
| 54 | W. Virginia | 3,829.6 | 13,100.0 | 0.0 | 477,820.0 | 50.0 | 238,910.0 | 5,500.0 | 15,000.0 | 276,339.6 |

Table 17. (cont.)

(Acres)

| State | State | Urban loss (1) | Roads (2) | Airports (3) | Total mining loss (4) | Reclamation percentage (5) | Net loss in mining (6) | Second homes or vacation (7) | Recreation & wildlife (8) | Total* (9) |
|---|---|---|---|---|---|---|---|---|---|---|
| 55 | Wisconsin | 39,121.3 | 28,200.0 | 120.0 | 42,600.0 | 26.4 | 31,354.0 | 18,400.0 | 76,300.0 | 193,495.3 |
| 56 | Wyoming | 12,618.7 | 21,200.0 | 0.0 | 1,230,840.0 | 31.4 | 844,356.0 | 1,600.0 | 7,000.0 | 886,774.7 |
| | TOTAL | 3,648,800.7 | 946,506.0 | 7,754.3 | 11,976,720.0 | | 6,901,240.0 | 1,377,100.0 | 3,297,960.0 | 16,179,361.0 |
| Average ** yearly loss | | 183,400.0 | 47,328.3 | 387.7 | 598,836.0 | | 345,062.0 | 68,885.0 | 164,898.0 | 808,968.1 |

Note:

* 9 = 1+2+3+6+7+8.

** Average land loss per year = Total land loss/20;

Table 8. Projected average yearly loss of agricultural land losses among land groups.

| State | Crop-land | Pasture & range | Forest | Others | Cropland | Pasture & range | Forest land | Others |
|---|---|---|---|---|---|---|---|---|
| | (in percent) | | | | (in acres) | | | |
| Alabama | 34.1 | 2.2 | 15.9 | 47.8 | 7,994.2 | 515.8 | 3,727.5 | 11,205.9 |
| Arizona | 70.1 | 7.2 | 3.5 | 19.2 | 15,074.6 | 1,548.3 | 752.7 | 4,128.8 |
| Arkansas | 9.7 | - | 66.1 | 24.2 | 969.2 | 0 | 6604.8 | 2,418.1 |
| California | 70.1 | 7.2 | 3.5 | 19.2 | 39,082.2 | 4,014.2 | 1,951.3 | 10,704.4 |
| Colorado | 55.8 | 3.6 | 0 | 40.6 | 13,688.9 | 883.2 | 0 | 9,960.1 |
| Connecticut | 25.5 | 1.0 | 49.8 | 23.7 | 2,387.3 | 93.6 | 4,662.3 | 2,218.8 |
| Delaware | 25.5 | 1.0 | 49.8 | 23.7 | 266.4 | 10.4 | 520.3 | 247.6 |
| Florida | 6.2 | 10.0 | 16.2 | 67.6 | 2,599.0 | 4,191.9 | 6,790.9 | 28,337.2 |
| Georgia | 19.2 | 0 | 57.2 | 23.6 | 2,854.7 | 0 | 8,504.7 | 3,508.9 |
| Idaho | 55.8 | 3.6 | 0 | 40.6 | 2,384.5 | 153.8 | 0 | 1,735.0 |
| Illinois | 49.2 | 0.6 | 12.4 | 37.8 | 13,251.6 | 161.6 | 3,339.8 | 10,181.1 |
| Indiana | 34.1 | 2.2 | 15.9 | 47.8 | 7,505.3 | 484.2 | 3,499.5 | 10,520.6 |
| Iowa | 49.2 | 0.6 | 12.4 | 37.8 | 6,159.3 | 75.1 | 1,552.3 | 4,732.1 |
| Kansas | 49.2 | 0.6 | 12.4 | 37.8 | 4,157.9 | 50.7 | 1,047.9 | 3,194.5 |
| Kentucky | 34.1 | 2.2 | 15.9 | 47.8 | 9,131.5 | 589.1 | 4,257.8 | 12,800.1 |
| Louisiana | 9.7 | 0 | 66.1 | 24.2 | 1,139.4 | 0 | 7,834.8 | 2,842.6 |

Table 8. (cont.)

| States | Crop-land | Pasture & range | Forest | Others | Cropland | Pasture & range | Forest land | Others |
|---|---|---|---|---|---|---|---|---|
| | (in percent) | | | | (in acres) | | | |
| Maine | 25.5 | 1.0 | 49.8 | 23.7 | 671.1 | 26.3 | 1,310.6 | 623.7 |
| Maryland | 39.3 | 0.5 | 26.6 | 33.6 | 3,739.6 | 47.6 | 2,531.1 | 3,197.2 |
| Massachusetts | 25.5 | 1.0 | 49.8 | 23.7 | 2,695.0 | 105.7 | 5,263.2 | 2,504.8 |
| Michigan | 62.0 | 2.7 | 20.2 | 15.1 | 11,104.3 | 483.6 | 3,617.8 | 2,704.4 |
| Minnesota | 62.0 | 2.7 | 20.2 | 15.1 | 9,514.0 | 415.3 | 3,099.7 | 2,317.1 |
| Mississippi | 9.7 | – | 66.1 | 24.2 | 644.1 | 0 | 4,389.0 | 1,606.9 |
| Missouri | 49.2 | 0.6 | 12.4 | 37.8 | 7,947.3 | 96.9 | 2,003.0 | 6,105.9 |
| Montana | 55.8 | 3.6 | 0 | 40.6 | 10,024.1 | 646.7 | 0 | 7,293.5 |
| Nebraska | 49.2 | 0.6 | 12.4 | 37.8 | 1,724.9 | 21.0 | 434.7 | 1,325.2 |
| Nevada | 55.8 | 3.6 | 0 | 40.6 | 3,641.0 | 234.9 | 0 | 2,649.2 |
| New Hampshire | 25.5 | 1.0 | 49.8 | 23.7 | 780.7 | 30.6 | 1,524.7 | 725.6 |
| New Jersey | 25.5 | 1.0 | 49.8 | 23.7 | 2,554.6 | 100.2 | 4,989.1 | 2,374.3 |
| New Mexico | 70.1 | 7.2 | 3.5 | 19.2 | 21,904.3 | 2,249.8 | 1,093.7 | 5,999.5 |
| New York | 25.5 | 1.0 | 49.8 | 23.7 | 5,094.6 | 199.8 | 9,949.5 | 4,734.9 |
| N. Carolina | 19.2 | 0 | 57.2 | 23.6 | 2,513.0 | 0 | 7,486.7 | 3,088.9 |
| N. Dakota | 49.2 | 0.6 | 12.4 | 37.8 | 9,685.8 | 118.1 | 2,441.1 | 7,441.5 |

Table 8. (cont.)

| State | Crop-land | Pasture & range | Forest | Others | Cropland | Pasture & range | Forest land | Others |
|---|---|---|---|---|---|---|---|---|
| | - - - - - - - (in percent) | - - - - - - | | | - - - - - - - - -(in acres)- - - - - - - - - | | | |
| Ohio | 34.1 | 2.2 | 15.9 | 47.8 | 8,174.8 | 527.4 | 3,811.7 | 11,459.0 |
| Oklahoma | 14.8 | 4.6 | 39.9 | 40.7 | 2,472.6 | 768.5 | 6,665.9 | 6,761.6 |
| Oregon | 70.1 | 7.2 | 3.5 | 19.2 | 5,785.3 | 594.2 | 288.9 | 1,584.6 |
| Pennsylvania | 25.5 | 1.0 | 49.8 | 23.7 | 9,618.9 | 377.2 | 18,785.3 | 8,940.0 |
| Rhode Island | 25.5 | 1.0 | 49.8 | 23.7 | 528.0 | 20.7 | 1,031.2 | 490.8 |
| S. Carolina | 19.2 | 0 | 57.2 | 23.6 | 1,163.1 | 0 | 3,464.9 | 1,429.6 |
| S. Dakota | 49.2 | 0.6 | 12.4 | 37.8 | 7,104.0 | 86.6 | 1,790.4 | 5,457.9 |
| Tennessee | 39.3 | 0.5 | 26.6 | 33.6 | 3,267.1 | 41.6 | 2,211.3 | 2,793.3 |
| Texas | 48.8 | 8.7 | 11.3 | 31.2 | 31,573.0 | 5,628.8 | 7,311.0 | 20,186.0 |
| Utah | 55.8 | 3.6 | 0 | 40.6 | 5,491.2 | 354.2 | 0 | 3,995.4 |
| Vermont | 25.5 | 1.0 | 49.8 | 23.7 | 394.7 | 15.5 | 770.9 | 366.9 |
| Virginia | 39.3 | 0.5 | 26.6 | 33.6 | 7,149.4 | 91.0 | 4,839.0 | 6,112.4 |
| Washington | 70.1 | 7.2 | 3.5 | 19.2 | 7,256.2 | 745.3 | 362.3 | 1,987.4 |
| West Virginia | 39.3 | 0.5 | 26.6 | 33.6 | 5,430.0 | 69.1 | 3,675.3 | 4,642.5 |
| Wisconsin | 62.0 | 2.7 | 14.8 | 20.5 | 5,997.9 | 261.2 | 1,431.8 | 1,983.2 |
| Wyoming | 55.8 | 3.6 | 0 | 40.6 | 24,741.0 | 1,596.2 | 0 | 18,001.5 |
| TOTAL | | | | | 349,031.8 | 28,658.0 | 161,658.8 | 269,619.5 |

with Küchler potential natural community identification is required when incorporated with the range sector.) An acre of range/forest land will be taken out of production and transferred to cropland. An acre of converted land will be defined as representing all land groups in the same proportion that they are classifed (aggregated from land capability class/subclass to land group).

Range/forest land RHS

For the range/forest land RHS's, quantity of land will be identified by ecosystem (aggregations of Küchler's PNC's), and productivity and condition class. These data are available in the 1982 NRI. Adjustment will be made to these data for nonagricultural land requirements as specified in Table 8.

Irrigated land conversion

Dry to irrigated land conversion will be included in the model. These activities will allow conversion by PA. Projected public irrigation development will be based on the Bureau of Reclamation estimates and shall include 85 percent of the full-service acreage in authorized and funded projects expected to be in place by 2000. It will be assumed that only replacement and maintenance funds will result after the year 2000. Thus, no additional land will be converted by the public for irrigated purposes. between 2000 and 2030. These acres will be subtracted from the dry land base and added to the irrigated land RHS.

Private irrigation development will not be included in the irrigated land base. An upper limit will be placed on the amount of land that can be converted. The method to be used in determining this upper limit has yet to be determined. The costs of this conversion will equal the depreciation and interest on well investments since investments in irrigation wells, structure, and major land preparation are sunken investments and do not enter into production and land use decisions simulated by the LP model.

## Assumptions in Developing Input Costs

Input costs will be expressed in 1980 dollars. It is assumed that the prices of agricultural inputs used in the production of endogenous commodities will reflect 1980 relative prices. (There may be certain instances where for an alternative, the relative price changes for one input.)

The interest rate changed for short-term inputs will equal the 1978-1981 PCA rates and for longer term inputs such as machinery and land, the rate will be 4.27 percent. The 4.27 percent is the rate assumed in the 1981 FEDs budgets.

Costs that need to be determined and the recommended sources are presented in Table 9.

## Assumptions in Incorporating Technology in the Programming Models

There has not been any decision made as to the levels of technology assumed. In the 1980 RCA, it was assumed that technology increased other than additional fertilizer requirements were input neutral. In other words, quantities of inputs other than N, P, and K did not increase as yields changed.

Table 9. Costs type required for operation of the programming models

| Cost type | Probable source |
|---|---|
| Crop | FEDs budget generator with developed machinery and input files |
| Livestock | 1980 FEDs Budgets |
| Terracing | ND[a] |
| Potential Land Conversion | Costs used in 1980 RCA adjusted to 1980 dollars by ________ index |
| Private irrigated land conversion | Depreciation and interest on well investments, using a 4.27% interest rate |
| Fertilizers | Agricultural Prices costs for N, P, K weighted by quantities of fertilizers used |
| Irrigation System | FEDs Budget generator (see water sector paper) |
| Surface Water | Bureau of Census's report on irrigation organizations |
| Range/Forest | Forest Service's NI MRIM model adjusted to 1980 dollars based on the prices paid by farmers index |
| Crop Transportation | Car wayload data, information on barges where applicable and mileage between MR, by rail and barge |
| Livestock Transportation | Based on secondary sources and mileage between MR, by truck |
| Conversion Cropland to Range | ND |
| Conversion Cropland to Forest | ND |

[a]ND not determined.

For crop production, the araas where technology estimates are required are identified under the crop sector assumptions. For additional information in this area, please refer to the letter sent to the PAC on technology (Appendix B).

## Demand For Exogenous and Endogenous Commodities

The demand for exogenous and endogenous commodities are the driving force in the CARD/RCA programming models. For exogenous commodities, the resources used must be subtracted from the resources available for agricultural production. While for the endogenous commodities, the model's solution determines the required resources.

### Exogenous commodities

The exogenous commodities can be grouped into four types--row, close grown, vineyards and orchards, and livestock. The commodities within each of these categories are shown in Table 10. Land and water requirements must be determined for the first three categories as well as location of production. Location of the exogenous livestock and their water and feed requirements are also needed.

For the exogenous crops, the location and land use will be determined by NIRAP at a state level and distributed to the PA. The quantity of land taken out of production will be disaggregated to land group and subtracted from land availability. This will be achieved by using the proportion of land in production on a given land group as identified by the NRI. It is assumed that the land cover/use numbers as reflected in Table 11 will be used to identify the proportions required.

Table 10. Land and water requirements

| Crop type | Exogenous commodity |
|---|---|
| Row | Sugarcane, sugar beets, tobacco, vegetables and melons, Irish potatoes, sweet potatoes, dry beans, flaxseed |
| Close grown | Rice, rye |
| Vineyard and orchards | Citrus fruits, noncitrus fruits, and nuts |
| Livestock | Lambs and mutton, chicken, turkeys, and eggs |

Table 11. Exogenous crops and their corresponding NRI codes

| Exogenous crop | NRI code | Crop type |
|---|---|---|
| Tobacco | 016 | Row |
| Sugar beets | 017 | Row |
| Potatoes | 018 | Row |
| Other vegetables | 019 | Row |
| All other row crops | 020 | Row |
| Flax | 115 | Row |
| Rice | 115 | Close grown |
| All other close grown | 116 | Close grown |
| Fruit | 001 | V and 0[a] |
| Nut | 002 | V and 0 |
| Vineyard | 003 | V and 0 |
| Bush fruit | 009 | V and 0 |
| Berries | 005 | V and 0 |
| Other horticulture | 006 | V and 0 |

[a]Vinyards and orchards.

Water requirements will be done in a similar manner to that in the 1980 RCA. The projected irrigated acres producing exogenous crops will be used in conjunction with consumptive water use coefficient developed by the Special Projects Division of SCS and summed to find a total exogenous crop water requirement.

For the exogenous livestock, location will be determined from NIRAP state production estimates and weighted to the Market Regions using one of two methods. If over time (1949-1978) the livestock within a state has no noticably shifted from one state portion of a market region to another, then the 1978 Census information will be used to create weights. If shifting has occurred, then a trend over time will be used. Once location is determined, feed and water requirements are found.

# APPENDIX A

DRAFT
(December 1982)

# WORKING PAPER ON BASIC ASSUMPTIONS FOR THE 1984 FOREST SERVICE ASSESSMENT SUPPLEMENT AND 1985 SOIL CONSERVATION SERVICE APPRAISAL

NOTE: This paper is a working draft of the chapter on Basic Assumptions that will be used in Forest Service Assessment and Soil Conservation Service Appraisals. It will be revised and updated as new data become available and to reflect changed expectations about the future.

# WORKING PAPER ON BASIC ASSUMPTIONS FOR THE 1984 FOREST SERVICE ASSESSMENT SUPPLEMENT AND 1985 SOIL CONSERVATION SERVICE APPRAISAL

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INTRODUCTION

This paper presents the general basic assumptions to be used in making analyses of demands upon and supplies from the Nation's soil, water, forest, and range land resources as required by the Soil and Water Resources Conservation Act and the Renewable Resources Planning Act. 1/ These assumptions will be used in the 1984 Forest Service Assessment Supplement and the 1985 Soil Conservation Service Appraisal.

In partial recognition of the uncertainty about future changes, three different assumptions (low, medium, and high) are presented for population, economic activity, and disposable personal income. Other futures which go beyond the range of these assumptions and which could significantly affect demands and/or supplies of soil, water, forest and range land resources are also described.

In making the general assumptions for the Assessment and Appraisal, it is recognized that completely accurate predictions about long-run population and economic growth, or any of the other determinants of demands and supplies are beyond attainment. The intent is to make assumptions, based on historical trends, current knowledge about developments which affect these trends, and present expectations about future changes which can be generally accepted as reasonable at this time.

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1/ 91 Stat. 1407; 16 USC, 2004: 88 Stat. 476; 16 USC, 1601.

Historical trends in the major determinants specified here result from massive social, political, technological, and institutional forces that are not easily or quickly changed. Barring major catastrophes, such as a world war or a depression, recent trends are likely to persist over a considerable time. Thus, basis assumptions, derived as described, should provide a realistic basis for preparing an assessment for the development and guidance of policies and programs in the 1980's. Near the end of the 1980's the basic assumptions will be reevaluated and new expectations will be incorporated in the Assessment and Appraisal which must be submitted to Congress at the end of that decade.

POPULATION

Changes in population have an important effect on the demands upon the Nation's soil, water, forest, and range land resources. They also influence the size of the labor force, a major determinant of the level of economic activity and related materials use.

In the last five decades, the population of the United states increased by about 110 million people (table 1). The most recent projections of the Bureau of the Census 2/ indicate that population is likely to continue to grow during

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2/ U.S. Department of Commerce, Bureau of the Census. Population estimates and projections. "Projections of the population of the United States: 1982 to 2050 (Advance Report)." Cur. Pop. Reps. Ser. P-25, No. 922, Gov. Print. Off., Washington, DC, 15 p. 1982.

Table 1--Population, gross national product, and disposable personal income in the United States, specified years 1920-81, with projections to 2030

| Year | Population | | Gross national product | | Per capita gross national product | | Disposable personal income | | Per capita disposabl personal income | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Millions | Annual rate of change | Billion 1972 dollars | Annual rate of change | 1972 dollars | Annual rate of change | Billion 1972 dollars | Annual rate of change | 1972 dollars | Annual rate of change |
| 1929 | 121.8 | --- | 315.7 | --- | 2,592 | --- | 229.5 | --- | 1,884 | --- |
| 1933 | 125.7 | 0.8 | 222.1 | -8.4 | 1,767 | -9.1 | 169.6 | -7.3 | 1,349 | -8.0 |
| 1940 | 132.6 | .8 | 344.1 | 6.5 | 2,595 | 5.6 | 244.0 | 5.3 | 1,840 | 4.5 |
| 1945 | 140.5 | 1.2 | 560.4 | 10.2 | 3,989 | 9.0 | 338.1 | 6.7 | 2,406 | 5.5 |
| 1950 | 152.3 | 1.6 | 534.8 | - .9 | 3,511 | -2.5 | 362.8 | 1.4 | 2,382 | - .2 |
| 1955 | 165.9 | 1.7 | 657.5 | 4.2 | 3,963 | 2.5 | 426.8 | 3.3 | 2,573 | 1.6 |
| 1960 | 180.7 | 1.7 | 737.2 | 2.3 | 4,080 | .6 | 489.7 | 2.8 | 2,710 | 1.0 |
| 1965 | 194.3 | 1.5 | 929.3 | 4.7 | 4,783 | 3.2 | 616.3 | 4.7 | 3,172 | 3.2 |
| 1970 | 205.1 | 1.1 | 1,085.6 | 3.2 | 5,293 | 2.0 | 751.6 | 4.0 | 3,665 | 2.9 |
| 1971 | 207.7 | 1.3 | 1,122.4 | 3.4 | 5,404 | 2.1 | 779.2 | 3.7 | 3,752 | 2.4 |
| 1972 | 209.9 | 1.1 | 1,185.9 | 5.7 | 5,650 | 4.6 | 810.3 | 4.0 | 3,860 | 2.9 |
| 1973 | 211.9 | 1.0 | 1,254.3 | 5.8 | 5,919 | 4.8 | 864.6 | 6.7 | 4,080 | 5.7 |
| 1974 | 213.9 | .9 | 1,246.3 | -.6 | 5,827 | -1.6 | 857.5 | -.8 | 4,009 | -1.7 |
| 1975 | 216.0 | 1.0 | 1,231.6 | -1.2 | 5,702 | -2.1 | 875.0 | 2.0 | 4,051 | 1.0 |
| 1976 | 218.0 | .9 | 1,298.2 | 5.4 | 5,955 | 4.4 | 906.4 | 3.6 | 4,158 | 2.6 |
| 1977 | 220.2 | 1.0 | 1,369.7 | 5.5 | 6,220 | 4.5 | 942.5 | 4.0 | 4,280 | 2.9 |
| 1978 | 222.6 | 1.1 | 1,438.6 | 5.0 | 6,463 | 3.9 | 988.6 | 4.9 | 4,441 | 3.8 |
| 1979 | 225.1 | 1.1 | 1,479.4 | 2.8 | 6,572 | 1.7 | 1,015.7 | 2.7 | 4,512 | 1.6 |
| 1980 | 227.7 | 1.2 | 1,474.0 | -.4 | 6,473 | -1.5 | 1,018.3 | .3 | 4,472 | -.9 |
| 1981 1/ | 229.8 | .9 | 1,502.6 | 1.9 | 6,539 | 1.0 | 1,042.8 | 2.4 | 4,538 | 1.5 |
| | | | | | Low projections | | | | | |
| 1990 | 245.5 | .7 | 1,890 | 2.9 | 7,700 | 2.2 | 1,320 | 2.9 | 5,380 | 2.2 |
| 2000 | 255.6 | .4 | 2,350 | 2.2 | 9,190 | 1.8 | 1,640 | 2.2 | 6,420 | 1.8 |
| 2010 | 260.7 | .2 | 2,860 | 2.0 | 10,970 | 1.8 | 2,000 | 2.0 | 7,670 | 1.8 |
| 2020 | 261.6 | (2/) | 3,350 | 1.6 | 12,810 | 1.6 | 2,340 | 1.6 | 8,940 | 1.6 |
| 2030 | 256.1 | -.2 | 3,970 | 1.7 | 15,500 | 1.9 | 2,770 | 1.7 | 10,820 | 1.9 |
| | | | | | Medium projections | | | | | |
| 1990 | 249.7 | .9 | 1,970 | 3.4 | 7,890 | 2.4 | 1,380 | 3.4 | 5,530 | 2.4 |
| 2000 | 268.0 | .7 | 2,580 | 2.7 | 9,630 | 2.0 | 1,800 | 2.7 | 6,720 | 2.0 |
| 2010 | 283.1 | .5 | 3,310 | 2.5 | 11,690 | 2.0 | 2,310 | 2.5 | 8,160 | 2.0 |
| 2020 | 296.3 | .5 | 4,070 | 2.1 | 13,740 | 1.6 | 2,840 | 2.1 | 9,580 | 1.6 |
| 2030 | 304.3 | .3 | 5,050 | 2.2 | 16,600 | 1.9 | 3,520 | 2.2 | 11,570 | 1.9 |
| | | | | | High projections | | | | | |
| 1990 | 254.7 | 1.1 | 2,060 | 3.9 | 8,090 | 2.7 | 1,440 | 3.9 | 5,650 | 2.7 |
| 2000 | 282.3 | 1.0 | 2,820 | 3.2 | 9,990 | 2.1 | 1,970 | 3.2 | 6,980 | 2.1 |
| 2010 | 311.1 | 1.0 | 3,790 | 3.0 | 12,180 | 2.0 | 2,650 | 3.0 | 8,520 | 2.0 |
| 2020 | 341.9 | .9 | 4,900 | 2.6 | 14,330 | 1.6 | 3,430 | 2.6 | 10,030 | 1.6 |
| 2030 | 370.8 | .8 | 6,400 | 2.7 | 17,260 | 1.9 | 4,480 | 2.7 | 12,080 | 1.9 |

1/ Preliminary.
2/ Less than 0.1 percent.
Note: Annual rates of increase were calculated for the various periods indicated, except for the 1990 gross national product and disposable personal income projections which were based on the 1981 trend level ($1,460 billion).

Sources: Population: U.S. Department of Commerce, Bureau of the Census. Population estimates and projections. Curr. Pop. Reps. Ser. P-25. 1929-69--"Estimates of the population of the United States and components of change: 1940 to 1978." No. 802, 1979. 1970-81--"Estimates of the population of the United States to June 1, 1982." No. 918, 1982. Projections--"Projections of the population of the United States: 1982 to 2050 (Advance report)." No. 922, 1982.
Gross national product: Council of Economic Advisers. 1929-70--Economic report of the President. January 1982. 1971-81--Economic indicators. September 1982. Projections, Medium rates--U.S. Department of Commerce, Bureau of Economic Analysis. 1980 OBERS BEA regional projections. Volume 1. methodology, concepts, and State data. July 1981. Projections, Low and High rates--U.S. Department of Agriculture, Forest Service and Soil Conservation Service.
Disposable personal income: Council of Economic Advisers. 1929-72--Economic report of the President. January 1982. 1973-81--Economic indicators. September 1982. Projections--U.S. Department of Agriculture, Forest Service and Soil Conservation Service.

the next five decades. The Census Middle Series projections--the projections used in the Assessment and Appraisal--show population rising by another 75 million by 2030. The annual rate of growth declines from about 1 percent in the 1970's to 0.3 percent in the decade 2020-2030.

The alternative projections (Lowest and Highest Series) prepared by the Bureau of Census also show substantial increases in population. However, under the low projections, nearly all of this occurs prior to 2010. Population growth under this assumption is very slow in the 2010-19 decade and begins to decline in the first half of the following decade.

The decline in the rate of population growth reflects Bureau of the Census assumptions about fertility rates. 3/ Fertility rates have fluctuated widely in recent decades, but since the late 1950's have fallen sharply. The medium projection is based on an assumed fertility rate of 1.9--a level close to current birth expectations of females of child bearing age. 4/ The current fertility rate is below this figure and approximates a level which would end population growth in the first part of the twenty-first century.

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3/ Fertility rates indicate the number of births per 1,000 women during their childbearing years. For a more detailed technical definition, see U.S. Department of Health, Education, and Welfare (now U.S. Department of Health and Human Services), Public Health Service. National Center for Health Statistics. Trends in fertility in the United States. Ser. 21, No. 28, Gov. Print. Off., Washingtion, DC, 41 p. 1977.

4/ U.S. Department of Commerce, Bureau of the Census. Population characteristics. "Fertility of American women: June 1980." Cur. Pop. Reps. Ser. P-20, No. 375, Gov. Print. Off., Washington, DC, 89 p. 1982.

Legal immigration accounts for a significant part of U.S. population growth, and the Census projections shown in table 1 include a net addition of 450,000 immigrants each year. No allowance was made for illegal immigration.

The geographic distribution of the population has a strong influence on State and regional demands for many products, particularly those that must be produced and consumed at the same place. State projections prepared by the Bureau of Economic Analysis 5/ are used as the basis for regional projections of demands upon soil, water, forest and range land resources. The Bureau projections show significant differences in population trends among the States and regions. In general, the most rapid growth is projected to be in the South and on the Pacific coast. Rapid growth is also projected in some areas in the Rocky Mountains. The major propulation concentrations, however, remain much as they are today in the North Central region and in the regions along the Atlantic and Pacific coasts.

The age distribution of the population is another significant factor in estimating demands for many products. the Bureau of the Census projection by age classes indicate a substantial increase, during most of the projection period, in the number and proportion of people in the middle-age classes, the classes that have the highest income levels and the largest demands for goods and services.

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5/ U.S. Department of Commerce, Bureau of Economic Analysis. Population, personal income, and earnings by State projections to 2020. 25 p. 1977.

Population is also important as a determinant of the labor force, which in turn is a major determinant of the gross national product. The labor force associated with the medium population projection is expected to grow somewhat more rapidly than total population during this early part of the projection period 6/. This mostly reflects increased female participation in the labor force--which is associated with the relatively low fertility rates underlying the medium projection. 7/ The age structure is also important; changes in the distribution by age classes are expected to be a major factor in the decline in labor force participation rates after 1990.

In addition to the size of the labor force, the average number of hours worked per year has a substantial impact on the gross national product and on demand for some products such as outdoor recreation. Historical trends in the hours worked per year show a slow decline that is projected to continue through 2030. Although the decline is slow, average hours worked per year in 2030 are projected to be some 292 below the 1977 average, the equivalent of over seven 40-hours weeks. 6/

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6/ U.S. Department of Commerce, Bureau of Economic Analysis. 1980 OBERS BEA Regional projections. Volume 1., methodology, concepts, and State data. 166 p. 1981.

7/ The alternative assumptions of fertility rates underlying the low and high population projections are likely to result in substantial differences in labor force participation rates. The highest rates would be associated with the low population projection because, with the associated lower fertility rates, more females would be free to join the labor force. It would also imply a more experienced labor force with somewhat higher productivity. Conversely, the lowest rates of labor force participation would be with the high population projection and the associated higher fertility rates.

## GROSS NATIONAL PRODUCT

In recent decades, changes in the consumption of many soil, water, forest, and range land products have been closely associated with changes in the Nation's gross national product.

Between 1929 and 1980, the gross national product, measured in constant 1972 dollars, increased more than four times--rising at an average annual rate of 3.1 percent (table 1). Annual changes have fluctuated widely, from as much as +16.4 percent to -14.7 percent. The highest sustained rate of growth in gross national product occurred in the 1960's, when it averaged 4.2 percent per year.

The wide fluctuations in annual rates of growth in the gross national product have reflected factors such as differences in the rates of change in the labor force, rates of unemployment, hours worked per year, and productivity. These factors will presumably continue to cause fluctuations in the years ahead. But for the Assessment and Appraisal analyses only trends in growth were needed, and the gross national product projections are based on the following assumed average annual rates of growth:

(Percent)

| Period | Low | Medium | High |
|---|---|---|---|
| 1981-89 | 2.9 | 3.4 | 3.9 |
| 1990-99 | 2.2 | 2.7 | 3.2 |
| 2000-09 | 2.0 | 2.5 | 3.0 |
| 2010-19 | 1.6 | 2.1 | 2.6 |
| 2020-29 | 1.7 | 2.2 | 2.7 |

The medium rates for the decades beyond the 1970's are derived from projections of the Bureau of Economic Analysis. 6/ These in turn are based in part upon the medium projections of population and the associated projections of labor force and projectivity. The low and high rates are Forest Service/Soil Conservation Service assumptions chosen to display a range over which the gross national product could vary and to test the sensitivity of product demand projections to different levels of economic activity. The range is consistant with the general historical range of fluctuation in annual growth rates.

The medium assumed rate of growth would result in a gross national product of $2,580 billion (1972 dollars) in 2000--some 1.8 times that of 1980 (table 1). By 2030, this projection would reach $5,050 billion--some 3.4 times that of 1980. The associated projection of per capita gross national product in 2030 rises to 16,600--some 2.6 times the 1980 average.

The detailed projections of gross national product by industry, prepared by the Bureau of Economic Analysis, 7/ indicate that the proportion of the gross national product originating in manufacturing and construction activity declines slowly over the projection period. Transportation, trade, and other services account for a slowly growing share of the total. These changes are consistent with long-established trends.

Even though there is some decline in their relative importance, the projected increases in manufacturing and construction are large. This means that the U.S. economy will continue to produce huge quantities of physical goods. In turn, large supplies of energy, minerals, and other raw materials will be needed to produce those goods.

The future adequacy of supplies of raw materials, and especially energy, is a matter of widespread concern. Concern is also evident about the ways the various programs designed to protect or improve the environment will affect the kinds of goods produced, productivity, and various other factors which determine the rate of growth in economic activity. Of course, no one knows how things will work out. Up to this time, there is no statistical basis for assuming that there has been a signicant change in the historical growth trends.

## DISPOSABLE PERSONAL INCOME

Disposable personal income, i.e., the income available for spending or saving by the nation's population, has been another important determinant of the demand upon soil, water, forest, and range land resources. Since 1929, disposable personal income has equaled about 70 percent of the gross national product. This historical and rather constant relationship was assumed to continue through the projection period (table 1). 8/

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8/ Disposable personal income, derived by the Forest Service and Soil Conservation Service from the gross national product data projected by the Bureau of Economic Analysis, is preferred to personal income as a determinant for projecting demands for most soil, water, forest, and range land products. The projections of personal income prepared by the Bureau of Economic Analysis (see footnote 5) were used for some products. Disposable personal income is personal income minus personal tax and nontax payments for government services. The relationship between total personal income and disposable personal income for the medium projection is shown below:

| Year | Total personal income | Disposable personal income |
|---|---|---|
| | (Billion 1972 dollars) | |
| 1990 | 1,675 | 1,380 |
| 2000 | 2,214 | 1,800 |
| 2010 | 2,870 | 2,310 |
| 2020 | 3,577 | 2,840 |
| 2030 | 4,467 | 3,520 |

The resulting estimates (medium level) show per capita disposable personal income rising to $11,570 by 2030 (1972 dollars), nearly three times the 1980 average. This growth means that the Nation is faced not only with the task of meeting the resource demands of an additional 75 million people, but also the demands of 304 million people with much greater purchasing power than today's population.

## INSTITUTIONAL AND TECHNOLOGICAL CHANGE

In the past, institutional and technological changes have substantially influenced demands upon soil, water, forest, and range land resources. For the Assessment and Appraisal, it has been assumed that a stream of institutional and technological changes will continue and will affect demands and uses of soil, water, and forest and range lands. It was also assumed that the effects of these changes are likely to be similar to those that have taken place in the past and that are accounted for in the historical data used in preparing the projections. Because of their importance, the assumptions on the technological changes affecting crop and product yields are specified in the appropriate places in the following material.

A recent development not adequately reflected in the historical data base is the growing constraints on the extractive, manufacturing, and energy industries to satisfy environmental and health objectives. This development is certain to bring about major changes over the projection period. Although it is too early to quantify the changes that will actually take place and their overall impacts with any certainty, such constraints have been considered in projecting economic activity and demands and supplies.

A related development, the reservation of forest and range lands for designated uses such as wilderness, parks, and wildlife refuges has been going on for a long time; this development is specifically taken into account in the projections of the forest and range land areas.

ENERGY COSTS

Changes in energy costs have substantial effects on demands upon soils, waters, and forest and range lands, and some impact on the level of economic activity. 9/

The unit cost of energy minerals, which today accounts for the bulk of United States energy production, decreased steadily from about 1870 to the late 1960's.10/ Since then, however, there have been very large increases in energy prices, with the average relative price of crude oil in the United States more than doubling, and the price of coal and natural gas also doubling. At the same time, dependence on relatively high-cost imported crude oil and petroleum products has grown rapidly.

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9/ Analysis of the U.S. Department of Energy (In Interrelationships of Energy and the Economy A Supplement to the National Energy Policy Plan Required by Title VII of the U.S. Department of Energy Organization Act, 67 p. 1981) indicate that even large increases in world oil prices will not reduce the rate of economic growth by much.

10/ Barnet, Harold and Chandler Mose (In Scarcity and Growth. The Johns Hopkins Press 1963. p. 164-201) show that the unit cost of energy minerals declined from 1870 to 1957. Data from other sources show a continuation of this downward trend in relative energy prices until 1969. See, for example, the New York Times National Economic Survey, January 8, 1978.

There are no quantitive estimates of the impacts of increases in energy prices on the use of renewable natural resources. However, it is evident that there will be a tendency to increase use of those renewable resources that require relatively little energy in use and processing at the expense of substitute resources that require relatively large amounts of energy, and vice versa. For example, lumber and plywood are likely to be substituted to some extent for steel and concrete, which have heavy energy requirements in processing. On the other hand, demand for those kinds of outdoor recreation that require long-distance travel may be dampened somewhat by higher travel costs that result from higher energy prices.

A long historical period has obviously ended. During that time, improvements in technology offset the increase in costs of energy produced from lower quality and/or less accessible resources. Many of the remaining petroleum reserves are concentrated in areas such as interior Alaska, the Arctic, and the Outer Continental Shelf where the physical environment is severe and where development, operating, and transportation costs are high. Production of oil from shale and tar sands, which may begin before the end of this century, will entail very high development costs. In recent years, programs to protect the environment have also added to energy exploration and development costs.

In summary, the use of increasingly high-cost energy reserves, the removal of remaining controls on natural gas, and added environmental protection costs are likely to push energy prices still higher relative to the general price level in the decades immediately ahead. For the purposes of this work, it has been assumed that the prices of the major energy materials will change as follows: 11/

| Year | Oil | Gas | Coal | Electricity |
|---|---|---|---|---|
| | | (1972 dollars per M/Btu) | | |
| 1977 | 2.96 | 0.94 | 0.99 | 7.46 |
| 1990 | 5.93 | 3.53 | 1.10 | 10.99 |
| 2000 | 7.94 | 4.88 | 1.14 | 9.96 |
| 2010 | 9.21 | 6.62 | 1.24 | 9.75 |
| 2020 | 10.68 | 9.78 | 1.39 | 9.22 |
| 2030 | 10.68 | 7.06 | 1.45 | 8.37 |

CAPITAL AVAILABILITY

Large amounts of capital will be required to make the necessary investments in management, physical facilities, and processing plants to accommodate increased demands for products of soils, waters, and forest and range lands. Far larger amounts of capital will be needed to make possible the levels of overall economic growth that are projected. It is reasonable to ask whether such vast amounts of capital will be available to develop new energy sources, meet environmental protection requirements, provide for general economic activity, and meet the requirements for forest and range land resources. However, when potential capital requirements are compared with past investment rates and with expected growth in gross national product, future requirements for capital do not appear particularly imposing. They seem likely to fall well within the range of experience in the United States

11/ Projections from a special analysis: FOSSIL 79, The Energy Transition Policy Model (1950-2030). School of Industrial Engineering, Purdue University. 1981. The medium gross national product projections shown in table 1 were used in the analysis.

and western European countries. 12/ It has, therefore, been assumed that capital availability will not significantly constrain long-term economic growth in general or intensified use of forest and range lands and the production of renewable resources products.

## OTHER FUTURES

To be prepared.

## OTHER ASSUMPTIONS

In addition to the general assumptions outlined above, the projections of demands and supplies for the products included in the Forest Service Assessment Supplement and Soil Conservation Service Appraisal rest on a variety of other specified and implied assumptions. The most important are described in the appropriate places in the material that follows. Such assumptions include those on specific technological changes such as crop and product yields; prices; changes in crop, pasture, timberland and rangeland areas; management intensities; the continuation of past relationships between variables; and the impacts on the outputs of forest and range lands associated with protection of the environment and multiple-use management.

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12/ Hagenstein, Perry R. Basic assumptions on energy supplies and costs, technological and institutional change and capital formation for the 1980 RPA Assessment. Unpublished report to the U.S. Forest. 21 p. 1978

# APPENDIX B

the center for agricultural and rural development
578 heady hall | iowa state university | ames, iowa 50011 | 515/294-1183

May 24, 1983

Burton English
Iowa State University
578 Heady Hall
Ames, IA 50011

Dear Burt:

The crop technology work group developed some interesting projections at the RCA symposium held last December (see Table 1). The most probable estimate for 2000 is based on technology already here but not widely adopted. These estimates are much higher than the ones used by NIRAP (1.1%) in the 1980 RCA and proposed for the 1985 RCA.

In addition, I have determined the improved efficiencies for livestock (Table 2).

You will note that the percentages are much higher than those assumed in NIRAP. If these are placed in NIRAP without rerunnning the export model, one would assume prices to fall, idle acres, and more production.

Best Regards,

Burton C. English
Staff Economist

Encl.

BCE:ph

Table 1. Annual growth rates for eleven major crops in the United States

| Confidence of Estimate Period | Crop | | | | | |
|---|---|---|---|---|---|---|
| | Feedgrains[a] | Alfalfa | Wheat | Cotton | Rice | Soybeans |
| Most Probable | | | | | | |
| 1982-2000 | 1.887 | 1.018 | 2.278 | 2.278 | 3.926 | 2.646 |
| 2001-2030 | 1.196 | 0.746 | 0.964 | 0.00 | 0.746 | 1.067 |
| 1982-2030 | 1.455 | 0.848 | 1.455 | 0.848 | 1.927 | 1.656 |
| High | | | | | | |
| 1982-2000 | 2.646 | 2.086 | 3.158 | 1.887 | 5.222 | 4.478 |
| 2001-2030 | 1.499 | 1.242 | 1.196 | 0.649 | 0.610 | 0.807 |
| 1982-2030 | 1.927 | 1.558 | 1.927 | 1.112 | 2.332 | 2.168 |
| Optimistic | | | | | | |
| 1982-2000 | 3.926 | 2.646 | 3.926 | 3.926 | 6.294 | 5.222 |
| 2001-2030 | 1.361 | 1.499 | 1.361 | 1.361 | 0.515 | 1.579 |
| 1982-2030 | 2.315 | 1.927 | 2.315 | 2.315 | 2.644 | 2.930 |
| Low | | | | | | |
| 1982-2000 | 1.018 | 0.531 | 1.247 | 1.018 | 2.278 | 1.468 |
| 2001-2030 | 0.746 | 0.427 | 0.610 | 0.000 | 0.964 | 0.695 |
| 1982-2030 | 0.848 | 0.466 | 0.848 | 0.391 | 1.455 | 0.984 |

[a]Feedgrains consist of barley, corn, corn silage, oats, sorghum and sorghum silage.

Table 2. Potential for increased efficiency in animal production, 2000 and 2030 (annual rate)

| Livestock Type | Units | 1982-2000 | 2001-2030 | 1982-2030 |
|---|---|---|---|---|
| | | percent improvement per year | | |
| Beef | Liveweight marketed per breeding female | 1.247 | 0.826 | 0.944 |
| Pork | Liveweight marketed per breeding female | 1.681 | 0.568 | 0.944 |
| Dairy | Milk marketed per breeding female | 1.468 | 0.798 | 1.007 |
| Sheep | Liveweight marketed per breeding female | 1.681 | 0.771 | 1.067 |
| Broilers | Liveweight marketed per breeding female | 1.468 | 0.126 | 0.602 |
| Turkeys | Liveweight marketed per breeding female | 1.887 | 0.0 | 0.675 |
| Laying Hens | Number of eggs | 1.018 | 0.126 | 0.447 |
| Fish (catfish) | Age to market weight of one pound | 2.278 | 0.964 | 1.396 |