TR-129
1984

# Recursive Programming Model and Crop Production on the Texas High Plains

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# RECURSIVE PROGRAMMING MODEL FOR CROP PRODUCTION ON THE TEXAS HIGH PLAINS

Program and Model Documentation

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The study on which this report is based was funded by the Texas Water Resources Institute and Expanded Research Funds of the Texas Agricultural Experiment Station, Texas A&M University

Technical Report No. 129
Texas Water Resources Institute
Texas A&M University
February 1984

# ABSTRACT

A flexible, recursive programming model of crop production on the Texas High Plains was developed. Besides the linear programming (LP) optimization routine and recursive feedback section, the model also includes a matrix generator and report writer to make scenario definition and output analysis faster and easier.

The production activities for each run of the model, are defined for one acre of a specific crop or crop rotation, irrigated at particular times, using a chosen irrigation distribution system and tillage method, on a given land class. The irrigation level may be zero (i.e. dryland) and the land class can include terracing when appropriate. The objective function for the LP optimization routine is the maximization of net returns (gross returns minus all variable, or variable and fixed, costs) to land, water and management. For static runs, the maximization includes net returns over variable costs only; for temporal runs, over variable and fixed costs. LP constraints include land by soil class, irrigation water availability for each of 18 irrigation periods and a total annual water use constraint.

The model can be run as either a static single period optimization or as a recursive, temporal model. When operated in the recursive mode, the model will loop through up to 20 iterations, rebuilding the LP matrix for each iteration and writing a report for each period. The feedback section of the recursive model is used to update the groundwater situation after solution of each iteration. The amount of groundwater used is summed and that usage translated into the reduction in aquifer saturated thickness, increased pump lift and reduced well yield per period. The new groundwater situation plus any inputted changes in prices, technical efficiencies or crop yields form the data, from which the production activities and constraints for the next iteration are built. At the end of the prescribed number of iterations, a summary report covering the whole time horizon is written and the discounted present value of net returns is calculated at three prescribed discount rates.

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# GENERAL DESCRIPTION OF THE MODEL

Evaluation of new technology as it relates to crop production on the Texas High Plains requires large amounts of detailed data, as well as an analytical procedure or model. The variables in the recursive programming model developed for this study, the sources of their specification and how they interact are outlined.

## Recursive Model Structure

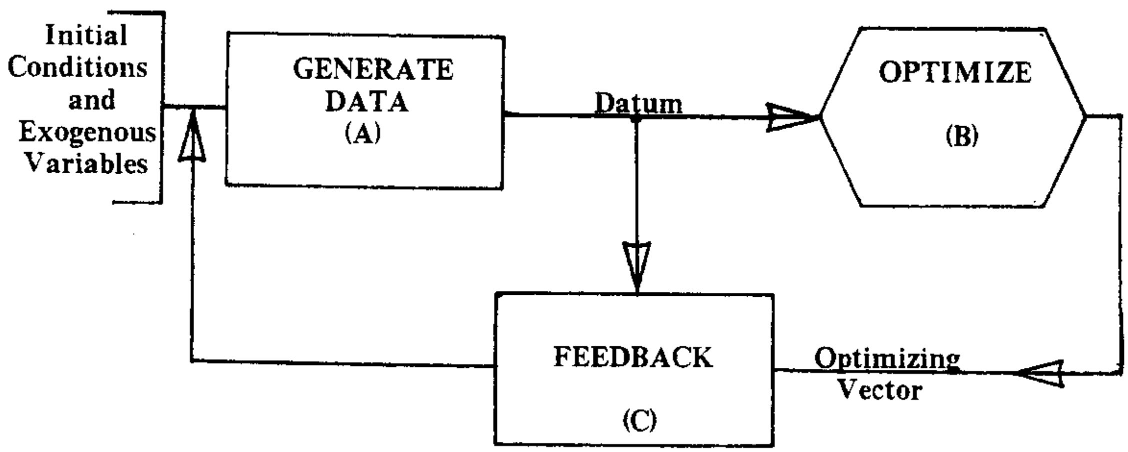
Basically, a recursive programming (RP) model is an extension and adaption of the static linear programming (LP) model to allow revision of parts of the LP model for period t+1, based upon the solution of period t, and conditions that prevail in period t+1. The revision may involve the objective function, the coefficient matrix, the level of constraints or any combination thereof.

A recursive programming model can be described schematically as a three component system (Figure 1).

> The *optimizing operator* (B) describes the dependence of certain decision or choice variables on objective constraint functions that in turn depend on various parameters or data. The *data operator* (A) defines how the data entering objective and constraint functions depend on the current state of the system as a whole. The *feedback operator* (C) specifies how the succeeding state of the system depends on the current optimal decision variables, the data and the current state. Given an initial state for the system the data for an optimization can be generated, the optimization problem formed and solved, and the next state of the system evolved through feedback. In this way, a sequence of optimizations is generated in which the parameters upon which any one optimization are based depend on past optimizations and parameters in the sequence. (Day 1976, p. 12).

The optimizing and data operators are specified to define a closed dynamic system. In principle, the data and feedback operators could be thought of as simulation and iteration loops, respectively. Because these operators may not choose globally optimal strategies with respect to the feedback operator, the system is characterized, by Day, as "suboptimization with feedback", or "suboptimal control". Detailed discussion of the theoretical foundations of recursive programming including a wide range of applications, can be found in Day (1963), and Day and Cigno.

The recursive programming model for this study was designed for flexibility, while keeping the input data required manageable, and maximizing the output of useful information. The model is divided into




Source: Day and Cigno, p. 10

Figure 1. Schematic of Information Flow in a Recursive Programming Model

three sections. Figure 2 details the model flow chart. The first section uses input data defining a specific scenario and internally stored data to create a set of alternatives for land improvement, irrigation application and land preparation, planting and pest control. These alternatives are combined to generate production activities and a constraint set for a linear programming (LP) optimization routine which makes up section two of the model. The third section interprets the LP solution and reports the results in a convenient format. A complete listing of the model Fortran routines is given in Section IV.

The internally stored data in section one is partitioned into blocks, each of which deal with a given aspect of resource management or crop production. The input that defines a particular model run indicates which parts of the internal data will be used, sets initial resource levels for groundwater and soils and gives the technology and price situation for the run. An example input data set is discussed in Section II and will be referred to, as necessary.

## Soil Classes

Since land is the basis of crop agriculture, soil units by texture, slope and yield potential for major crops and relative acreage are established first. Soil is divided into three texture classes by permeability and available water capacity. Permeability is the speed with which water enters the soil in inches per hour. The higher the permeability the less time rainfall or irrigation water stays on the soil surface, evaporating or forming runoff. Alternatively, a highly permeable soil may absorb water too fast for surface irrigation to spread properly, or lose excessive amounts of water and leach nutrients through depp percolation below the root zone.

Available water capacity is a measure of a soils ability to hold inches of plant available water per inch of soil. The higher the available water capacity the more water stored for periods of greater crop need or low precipitation. High available water soils can save more fallow season rain, go longer between irrigations, and better maintain production through drought periods. Their drawbacks include longer field drying times that can hamper field work or crop harvest, and cooler soil temperatures that may delay planting or interfere with plant germination.

Three texture classes are defined:

(1) Fine, with available water capacity greater than .17 inches per inch of soil and permeability less than .8 inches per hour. The fine or hardland soils are principally clay or clay loams, such as Pullman, Mansker or Ulysses clay loam. Hardland soils are restricted to furrow irrigation systems.

(2) Mixed, with available water capacity between .12 to .17 inches per inch of soil and permeability between .8 to 2.5 inches per hour. The mixed soils are made up of loams or loamy sands, such as Portales, Olton or Amarillo soils. Mixed soils can be either furrow or sprinkler irrigated.

(3) Sandy, with available water capacity less than .12 inches per inch of soil and permeability greater than 2.5 inches per hour. Sandy soils, such as Brownfield or Tivoli soils, are too porous for furrow irrigation techniques. If they are to be irrigated some type of sprinkler system

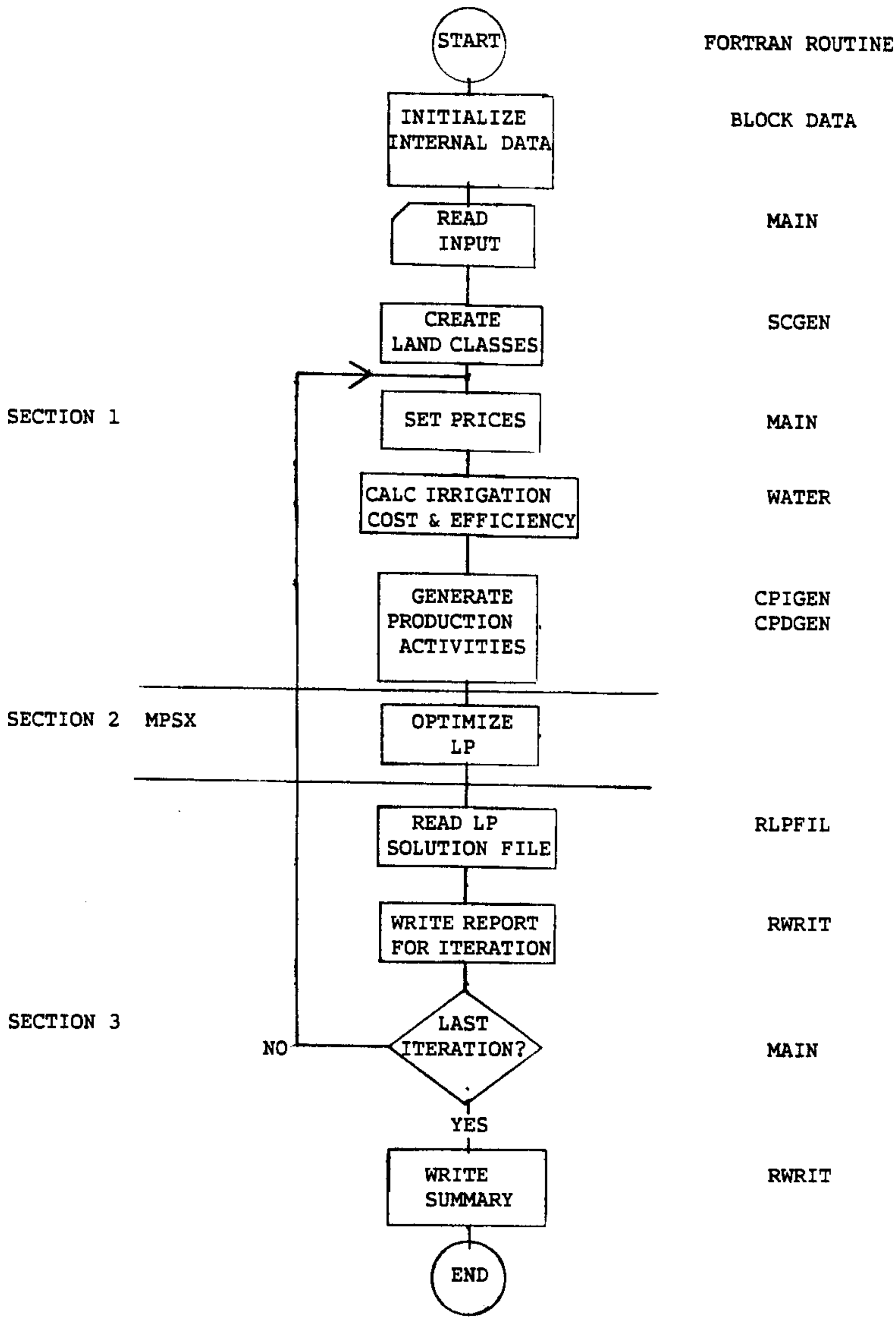



Figure 2. Recursive Programming Model Flow Chart

must be used.

The High Plains, in general, is relatively level to gently sloping, but there are areas ranging from undulating to steeply sloped. Because the slopes tend to have different production characteristics than similar level soils, the amount of slope is also a defining characteristic. Slopes often have thinner, less fertile topsoils that are more prone to erosion. They also tend to be dryer, since more rainfall is lost to runoff. Slope has been broken into 4 discrete categories: relatively level, with less than .5% slope, gently sloping with inclines between .5% to 1.5% and averaging 1%, moderately sloped with an average fall of 2% and ranging from 1.5% to 3%, and slopes greater than 3%. For the latter three classes the possibility exists to apply terracing techniques to reduce runoff and soil erosion, and to improve irrigation management.

## Land Improvement Techniques

From the many land modification techniques - ranging from simple contour furrows to elaborate systems of laser leveling - available to farmers in the High Plains, two have been chosen to represent the costs and benefits of topographic modification in the area. The two techniques, bench terraces and conservation bench terraces have wide applicability in the area and have been sufficiently researched (Jones 1979; Jones and Shipley; Young and Merrick) to demonstrate their efficiency at conserving water and soil, and to provide reliable data on construction and maintenance costs.

Bench terraces are constructed by cutting and filling to create a series of level benches with a raised lip or ridge to prevent runoff. The width of the bench decreases with the steepness of the slope, due to the depth of the cut and the amount of soil that must be moved as the slope increases. Thus, construction costs increase rapidly as slope increases, while the narrow benches are both harder to farm and likely to be less fertile if too much of the topsoil is removed from the cut.

Conservation bench terraces (CBT) were designed to overcome some of the difficulties encountered in conventional bench terraces, while retaining the soil and water preservation features. They are constructed by leveling only the bottom third of the terrace interval, allowing the upper two-thirds to act as a watershed. To assure retention of runoff, the terrace ridge is built higher than for conventional bench terraces, but construction costs are much lower and terrace intervals are wider for any particular slope.

Input requirements for each system, by slope class, which is stored as internal data, is shown in Table 1. Since terrace ridges and other areas are lost to cropping, terracing reduces the amount of cropland available per acre of farmland and the loss is both greater for bench terraces and as the slope increases.

Construction costs for each system were calculated using the average slope in each slope category and the cost estimates in Jones and Shipley (p. 178, Figure 2) updated to 1982 prices. Construction costs were then turned into an annualized fixed cost by calculating the equivalent infinite annuity at a 3% real rate of interest. Variable costs for repairs and maintenance were calculated using the data from Young and Merrick (p. 8, Table 4) and Jones and Shipley (p. 178, Table 1) updated

Table 1. Per Acre Input Requirements and Effects for Bench and Conservation Bench Terraces

| Item | .5 to 1.5 % Slope | | 1.5 to 3 % Slope | | Greater Than 3 % Slope | |
|---|---|---|---|---|---|---|
| | Bench | CBT | Bench | CBT | Bench | CBT |
| Land Required[a] | 1.02 | 1.01 | 1.03 | 1.02 | 1.05 | 1.03 |
| Annual Fixed Cost ($) | 5.10 | 1.74 | 7.80 | 2.88 | 8.94 | 3.84 |
| Repair and Maintenance ($) | 4.43 | 1.52 | 6.78 | 2.50 | 7.76 | 3.34 |
| Labor and Machinery Multiplier[b] | 1.05 | 1.03 | 1.07 | 1.05 | 1.10 | 1.07 |
| Dryland Yield Multiplier[c] | 1.10 | 1.05 | 1.15 | 1.09 | 1.20 | 1.12 |
| Irrigation Multiplier[d] | .95 | .97 | .92 | .96 | .90 | .93 |

[a] Acres of Farmland Needed per Acre of Cropland. Costs and multipliers are listed on a per cropland acre basis.

[b] Additional Labor and Machinery Relative to a Non-Terraced Acre of Cropland.

[c] Increase in Dryland Yield Relative to a Similar but Non-Terraced Crop Acre.

[d] Reduction in Irrigation Needed Relative to a Similar but Non-Terraced Irrigated Crop Acre.

Sources: Jones (1979); Jones and Shipley; Young and Merrick.

to 1982 prices using the cost of production index (U. S. Department of Agriculture). The construction of terraces changes the field geometry and increases the amount of labor and machinery time to carry out necessary field operations. Since the additional requirements vary over operations and crops, a simple multiplier is used to approximate the added costs involved. This multiplier, like the dryland yield change and the irrigation multiplier, is based on the findings of the previously cited references and on the judgement of local experts. The dryland yield multiplier gives the added dryland crop yield expected due to the extra water retained on the field by the terraces. For irrigated crops, the multiplier indicates the reduction in irrigation water that would have to be applied to obtain the planned yield, as on the same land class if left unterraced.

### Yield Potential

The last set of information necessary to differentiate each soil is the relative yield potential of the main crops (cotton, grain sorghum, wheat), compared to some norm for the region as a whole. The relative yield variable is used as a proxy for local microclimate variations and those aspects of soil not included in texture and slope. The norm chosen was the average dryland harvested yield in the region in the early 1970's, since most of the area soil surveys, from which this data was derived, were published around that time. The input data for each soil, in a particular model run, contain an expected yield from the appropriate soil survey for the 3 main crops. These yields are then compared to the norms (230 lb cotton, 15 cwt grain sorghum and 15 bu wheat), to establish soil quality yield multipliers, for each crop and soil. The grain sorghum multiplier is used for corn, soybeans and sunflowers, since these are also summer crops with approximately the same growing season.

The soil data are combined with the internally stored information on expected regional crop yields and terracing to generate land classes. A land class, of which up to 20 can be considered in a model run, consists of a particular soil combined with a terracing option. Thus, a soil with an original slope of 2% would give rise to three land classes: (1) the soil without terracing, (2) the soil with bench terracing, and (3) the soil with conservation bench terracing.

## Crop Yield and Irrigation Timing

The yield data for different intensities and timing of irrigation, developed by Hardin and Lacewell (1981), were used as the starting point for generating the irrigation requirements and expected yield for all the cropping activities. Their data were based on an extensive set of experiments conducted over the years at Texas A&M Research centers in Amarillo and Lubbock, and at the U. S. Department of Agriculture Southwestern Great Plains Research Center in Bushland, Texas. The Hardin and Lacewell data were supplemented by current research findings concerning new wheat varieties and short season grain sorghum, and expanded by adding soybeans and sunflowers to the crop choices.

Pre-plant irrigation for all the crops was assumed to apply six inches of crop usable water and post-plant irrigations, three inches. Different post-plant irrigation timings cause yields to vary, due to the amount of water stress the crop must surmount.

Irrigation application periods were defined by breaking the year into 18 uneven segments. The periods range in length from two months (Nov.-Dec., Jan.-Feb.), during times of the year when irrigation requirements are low, to ten day periods during the critical summer irrigation season (June, July, August). The watering periods were established to acknowledge the importance of timeliness of irrigation application, given the limited capacity of pumping and distribution systems, the cost of wells and pumping equipment, and limits on the rate of aquifer drawdown. However, plants can survive a certain amount of water stress with limited effect on growth and production. This allows alternative post-plant irrigation timings which, though yield is reduced by irrigating at other than the optimal period, increases irrigation flexibility and, thus, make better use of the complete set of farm inputs.

Cotton yields, irrigation levels and time periods when each post-plant irrigation is applied are given in Table 2. Cotton cultivation leads to the production of cotton seed as a joint product with the lint. As in Hardin and Lacewell (1981), cotton seed production was set at 1.67 lbs of seed per lb of lint.

Table 3 gives the data for corn. Both corn and soybeans are only grown with irrigation, as they are not drought tolerant and are incapable of consistently producing under dryland or limited irrigation.

Grain sorghum base yields and irrigation regimes are shown in Table 4. Short season grain sorghum which can be planted up to a month later, was added to increase the available choice set. Even though the short season varieties do not have as high yields as full season sorghum, they may be useful, since their critical irrigation periods are different and hence, more options for irrigation scheduling are obtained. Also, the short season varieties can be used after a late spring, or to take advantage of early summer precipitation. Irrigation timing and expected yield for the short season alternatives were adapted from Eck and Musick.

Sunflowers are a relatively new crop to the region, with the potential for increased production, due to drought tolerance and the ability to fit into the crop calendar, both as a dryland and irrigated crop. Sunflowers, for which base yields and irrigation timing are given in Table 5, have not been sufficiently researched to develop accurate data on yield response to irrigation timing. Nor has their use in the area been as a main crop, but rather, as either a catch crop or a supplemental crop, where flexibility in planting date may be the more important feature. Therefore, Paul Unger's Bushland research (1978a, 1980) was used to develop a range of planting dates and irrigation levels, ignoring at this point the possibilities of non-optimal irrigation timing for sunflowers.

Soybeans, like sunflowers, are a minor crop at the present time on the High Plains, but one that can be used as an irrigated crop filler if a cotton crop is lost early in the season. Soybeans do best under irrigation since, like corn, they are not drought tolerant. Soybean yields and irrigation timing are listed in Table 6.

Winter wheat is the other major crop grown on the Texas High Plains, having averaged more than 2.89 million planted acres a year over the last

Table 2. Timing of Irrigation and Related Yield for Cotton: Texas High Plains

| Irrigation Level | Time of Post-Plant Irrigation | | | Yield Per Acre |
|---|---|---|---|---|
| | $June_3$ [a] | $July_2$ | $Aug._1$ | |
| | | | | (lb) |
| Dryland: | | | | 230 |
| Pre-Plant Only: | | | | 420 |
| Pre-Plant + 1 Post-Plant: | | | X[b] | 517 |
| | | X | | 470 |
| | X | | | 450 |
| Pre-Plant + 2 Post-Plants: | | X | X | 590 |
| | X | | X | 588 |

[a] Subscript number refers to the 1st, 2nd, or 3rd water period in month.

[b] "X" indicates a post-plant irrigation during the specifed period.

Sources: Hardin and Lacewell (1981); Jones, et al.

Table 3. Timing of Irrigation and Related Yield for Corn: Texas High Plains

| Irrigation Level | Time of Post-Plant Irrigation | | | | | | Yield Per Acre |
|---|---|---|---|---|---|---|---|
| | $July_1$ [a] | $July_2$ | $July_3$ | $Aug._1$ | $Aug._3$ | $Sept._1$ | |
| | | | | | | | (bu) |
| Pre-Plant + 3 Post-Plants: | | X[b] | X | X | | | 116 |
| | | X | X | | X | | 107 |
| | X | | X | | X | | 102 |
| Pre-Plant + 4 Post-Plants: | | X | X | X | | X | 126 |
| | | X | X | X | X | | 122 |
| | X | X | X | X | | | 120 |
| Pre-Plant + 5 Post-Plants: | X | X | X | X | X | | 146 |
| | X | X | | X | X | X | 137 |
| | X | X | X | X | | X | 136 |
| Pre-Plant + 6 Post-Plants: | X | X | X | X | X | X | 148 |

[a] Subscript number refers to the 1st, 2nd, or 3rd water period in month.

[b] "X" indicates a post-plant irrigation during the specifed period.

Sources: Hardin and Lacewell (1981); Musick (1978); Musick and Dusek (1978); Shipley and Regier (1976); Undersander.

Table 4. Timing of Irrigation and Related Yield for Grain Sorghum: Texas High Plains

| Irrigation Level | Time of Post-Plant Irrigation | | | | | | | | Yield Per Acre |
|---|---|---|---|---|---|---|---|---|---|
| | $July_1$ [a] | $July_3$ | $Aug._1$ | $Aug._2$ | $Aug._3$ | $Sept._1$ | $Sept._2$ | Oct. | |
| | | | | | | | | | (cwt) |
| Dryland: | | | | | | | | | 15.00 |
| Pre-Plant + 1 Post-Plant: | | | | X[b] | | | | | 45.10 |
| Pre-Plant + 2 Post-Plants: | X | X | | X | | | | | 53.70 |
| | | X | | | X | | | | 51.90 |
| | X | | | X | | | | | 50.40 |
| | | | X | | | | X | | 47.18 SS[c] |
| | | | | | | X | X | | 45.39 SS |
| Pre-Plant + 3 Post-Plants: | | | X | | | X | X | | 63.84 |
| | X | | X | | X | | | | 63.00 |
| | | X | | X | X | | | | 60.50 |
| | | | | | X | X | X | | 59.42 SS |
| | | | X | | X | | X | | 59.33 SS |
| Pre-Plant + 4 Post-Plants: | X | X | | X | X | | | | 69.00 |
| | | | X | | X | X | | X | 63.33 SS |

[a] Subscript number refers to the 1st, 2nd, or 3rd water period in month.

[b] "X" indicates a post-plant irrigation during the specifed period.

[c] "SS" indicates a short season grain sorghum variety.

Sources: Hardin and Lacewell (1981); Shipley and Regier (1975); Musick and Dusek (1971); Eck and Musick.

Table 5. Planting Period; Timing of Irrigation and Related Yield for Sunflowers: Texas High Plains

| Irrigation Level | Planting Period[a] | Time of Post-Plant Irrigation | | | | | | | | Yield Per Acre |
|---|---|---|---|---|---|---|---|---|---|---|
| | | $June_2$[b] | $June_3$ | $July_1$ | $July_2$ | $July_3$ | $Aug._1$ | $Aug._2$ | $Aug._3$ | |
| | | | | | | | | | | (cwt) |
| Dryland: | | | | | | | | | | 8.04 |
| Pre-Plant + 1 Post-Plant: | APR | | | X[c] | | | | | | 15.48 |
| | MAY | | | | X | | | | | 15.48 |
| | JUN | | | | | X | | | | 15.48 |
| Pre-Plant + 2 Post-Plants: | APR | X | | | X | | | | | 17.97 |
| | MAY | | X | | | X | | | | 17.97 |
| | JUN | | | X | | | X | | | 17.97 |
| Pre-Plant + 3 Post-Plants: | APR | X | | X | | X | | | | 19.60 |
| | MAY | | X | | X | | X | | | 19.60 |
| | JUN | | | X | | X | | X | | 19.60 |
| Pre-Plant + 4 Post-Plants: | APR | X | | X | | X | X | | | 20.78 |
| | MAY | | X | | X | | X | X | | 20.78 |
| | JUN | | | X | | X | | X | X | 20.78 |

[a] Planting Period: APR = last of April, MAY = mid-May, JUN = first part of June.

[b] Subscript number refers to the 1st, 2nd, or 3rd water period in month.

[c] "X" indicates a post-plant irrigation during the specifed period.

Sources: Harman, Unger and Jones; Shipley and Regier (1976b); Unger (1978); Unger (1980); Unger, Jones and Allen.

Table 6. Timing of Irrigation and Related Yield for Soybeans: Texas High Plains

| Irrigation Level | Time of Post-Plant Irrigation | | | | | Yield Per Acre |
|---|---|---|---|---|---|---|
| | $June_2$ [a] | $July_1$ | $July_2$ | $Aug._1$ | $Aug._2$ | |
| | | | | | | (bu) |
| Pre-Plant + 2 Post-Plants: | | | X[b] | | X | 32.60 |
| | | | X | X | | 28.40 |
| Pre-Plant + 3 Post Plants: | | | X | X | X | 44.60 |
| | | X | | X | X | 39.70 |
| | X | | X | | X | 33.80 |
| Pre-Plant + 4 Post-Plants: | | X | X | X | X | 49.00 |

[a] Subscript number refers to the 1st, 2nd, or 3rd water period in month.

[b] "X" indicates a post-plant irrigation during the specifed period.

Sources: Dusek, Musick and Porter; Shipley and Regier (1968); Shipley and Regier (1970).

10 years (Texas Crop and Livestock Reporting Service, 1981c). It is also a crop that has shown considerable yield increase as new varieties, specifically bred for the local conditions, are introduced. Thus, the yields specified in Hardin and Lacewell (1981) have been increased for this study based upon the recently introduced TAM 105 wheat variety. Four year yield trial data (Musick, 1982) were adjusted for average conditions in the area with the help of local experts, to derive the base yields by irrigation level and timing that are shown in Table 7. Wheat, like cotton, produces a joint output, in this instance grazing for beef cattle. The new varieties are not as productive for grazing as the older varieties, especially at the most intense irrigation levels, thus, only two levels of grazing production were included; dryland wheat grazing at a base of $9 an acre, and irrigated wheat grazing at four times the dryland rate.

## Input Requirements

All crop production activities are based upon a one acre land unit. Inputs needed in land preparation, planting and crop protection are defined per acre regardless of crop yield, as their level of use is principally dependent on the amount of land covered. Input usage varies by crop, by crop intensity (i.e., whether the crop is grown with irrigation or as a dryland crop), and by tillage management.

Tables 8 and 9 give the level of each input for the different groupings. Labor and diesel were defined in physical units, since labor is sometimes in short supply in agriculture and a constraint on its availability might be of interest for some users of the model. Diesel has suffered supply short falls in the recent past and thus, the possibility of a diesel constraint was considered in the design of the model. The irrigation efficiency and dryland yield indices are used to approximate the effect of limited tillage systems on soil moisture levels. Limited tillage is used in this study as the name for a set of advanced management practices that include minimizing tillage operations, machinery that maintains residue on the surface and chemical weed control. Since limited tillage methods reduce runoff and evaporation losses, the dryland yield index indicates the percentage increase in yield, due to the additional precipitation available for crop growth. The irrigation efficiency index specifies the relative amount of irrigation water that must be applied to obtain the expected yield with minimum tillage, as compared to conventional tillage methods. The rationale behind the two indices is that while dryland yield is dependent on soil moisture levels and cannot be directly controlled, an irrigated crop yield is chosen by the farmer, who plans his irrigation schedule accordingly. Since limited tillage methods conserve moisture, the farmer need not apply as much irrigation water to obtain a specified yield.

The amount of other inputs (fertilizer, irrigation water and custom harvesting) required depend on expected yield. Fertilizer and harvesting equations for each crop are given in Table 10. Fertilizer application was set to maintain soil fertility levels for the majority of soils in the region for the production expected. Harvesting and hauling costs were based on local custom rates. Cotton harvest costs are set per lb of seed cotton, which contains all the material (lint, seed, leaves, burrs

Table 7. Timing of Irrigation and Related Yield for Wheat: Texas High Plains

| Irrigation Level | Time of Post-Plant Irrigation | | | | | Yield Per Acre |
|---|---|---|---|---|---|---|
| | Jan/Feb | March | April | $May_1$ [a] | $May_2$ | |
| | | | | | | (bu) |
| Dryland: | | | | | | 16.20 |
| Pre-Plant + 1 Post-Plant: | | | X[b] | | | 38.00 |
| | | | | X | | 31.20 |
| Pre-Plant + 2 Post-Plants: | | X | X | | | 56.80 |
| | | X | | X | | 56.10 |
| Pre-Plant + 3 Post-Plants: | | X | | X | X | 66.00 |
| | | | X | X | X | 62.70 |
| Pre-plant + 4 Post-Plants: | X | | X | X | X | 73.00 |
| | | X | X | X | X | 72.70 |

[a] Subscript number refers to the 1st, 2nd, or 3rd water period in month.

[b] "X" indicates a post-plant irrigation during the specifed period.

Sources: Hardin and Lacewell (1981); Harman; Musick (1982); Schneider, Musick and Dusek.

Table 8. Production Inputs per Acre with Conventional Tillage

| Item | Unit | Cotton | Corn | Sorghum | Sunflowers | Soybean | Wheat | Fallow[a] |
|---|---|---|---|---|---|---|---|---|
| Irrigated Cropland | | | | | | | | |
| Labor | Hours | 6.13 | 4.61 | 5.35 | 5.40 | 4.55 | 3.10 | |
| Seed | $ | 9.00 | 17.20 | 3.60 | 10.00 | 13.80 | 9.75 | |
| Biocides | $ | | 28.00 | 10.50 | 12.00 | 7.00 | 5.62 | |
| Diesel | Gal | 14.63 | 12.76 | 20.62 | 19.90 | 12.85 | 8.74 | |
| Machinery Variable | $ | 9.16 | 6.62 | 7.21 | 5.61 | 7.49 | 6.66 | |
| Fixed | $ | 37.21 | 36.31 | 23.42 | 22.66 | 21.91 | 26.53 | |
| Irrigation Efficiency | Index | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | |
| Dryland Cropland[b] | | | | | | | | |
| Labor | Hours | 5.28 | | 2.31 | 1.49 | | 2.18 | 1.84 |
| Seed | $ | 4.75 | | 1.80 | 6.00 | | 3.00 | |
| Biocide | $ | 6.00 | | | 8.00 | | | |
| Diesel | Gal | 14.15 | | 9.47 | 8.14 | | 8.19 | 5.10 |
| Machinery Variable | $ | 6.74 | | 4.10 | 2.21 | | 3.58 | 3.19 |
| Fixed | $ | 31.16 | | 17.37 | 16.20 | | 19.63 | 15.63 |
| Yield | Index | 1.00 | | 1.00 | 1.00 | | 1.00 | |

[a] Fallow is a practice used only with dryland production.

[b] Corn and soybeans are not raised dryland.

Sources: Extention Economists-Management; Hardin and Lacewell (1981); Petty et al.

Table 9. Production Inputs per Acre with Limited Tillage

| Item | Unit | Cotton | Corn | Sorghum | Sunflowers | Soybean | Wheat | Fallow[a] |
|---|---|---|---|---|---|---|---|---|
| Irrigated Cropland | | | | | | | | |
| Labor | Hours | 4.64 | 2.73 | 3.72 | 3.14 | 2.83 | 1.88 | |
| Seed | $ | 9.00 | 17.20 | 3.60 | 10.00 | 13.80 | 9.75 | |
| Biocides | $ | 6.00 | 42.00 | 17.00 | 20.00 | 12.00 | 17.00 | |
| Diesel | Gal | 10.70 | 9.65 | 14.22 | 14.11 | 8.86 | 6.03 | |
| Machinery Variable | $ | 7.07 | 4.57 | 4.97 | 3.87 | 5.24 | 4.59 | |
| Fixed | $ | 30.38 | 27.44 | 16.15 | 15.63 | 15.35 | 20.41 | |
| Irrigation Efficiency | Index | .97 | .97 | .89 | .91 | .98 | .92 | |
| Dryland Cropland[b] | | | | | | | | |
| Labor | Hours | 2.92 | | 1.39 | .86 | | 1.32 | 1.07 |
| Seed | $ | 6.75 | | 1.80 | 6.00 | | 3.00 | |
| Biocide | $ | 6.00 | | 6.00 | 15.00 | | 4.00 | 7.50 |
| Diesel | Gal | 8.53 | | 5.69 | 5.61 | | 5.65 | 2.34 |
| Machinery Variable | $ | 5.12 | | 2.41 | 1.28 | | 2.47 | 1.81 |
| Fixed | $ | 28.73 | | 13.36 | 11.17 | | 15.10 | 9.09 |
| Yield | Index | 1.04 | | 1.12 | 1.09 | | 1.08 | |

[a] Fallow is a practice used only with dryland production.

[b] Corn and soybeans are not raised dryland.

Sources: Extention Economists-Management; Hardin and Lacewell (1981); Petty et al.

Table 10. Yield Related Inputs: Fertilizer and Harvesting Equations

| Crop | Crop Unit | Yield Level | Nitrogen | Phosphorus | Harvesting, Hauling |
|---|---|---|---|---|---|
| | | | (lb) | (lb) | ($) |
| Cotton | lb | | .0533Y | .0533Y | 5.5[a] (.04Y) |
| Corn | bu | Y<100 | 1Y | .6Y | .60Y |
| | | Y>100 | 100 + .8(Y-100) | 60. | |
| Sorghum | cwt | Y<40 | 1.5Y | 1Y | .62Y |
| | | 40<Y<60 | 60 + 2(Y-40) | 40 | |
| | | Y>60 | 100 + 2(Y-60) | 40 + (Y-60) | |
| Sunflower | cwt | Y<15 | 1.5Y | .5Y | 12 + 2.10Y |
| | | Y>15 | 3.5Y | 1.16Y | |
| Soybeans | bu | | 20 | .5Y | 12.50 + .10Y |
| Wheat | bu | Y<20 | | | 12 + .12Y |
| | | Y<40 | 1.5Y | .5Y | |
| | | Y>20 | | | 14.40 + .24(Y-20) |
| | | Y>40 | 60 + 2(Y-40) | 20 + (Y-40) | |

[a] Cotton harvest, gin, bag and tie based on seed cotton at 5.5 lbs seed cotton per lb lint.

Sources: Extention Economists-Management; Hardin and Lacewell (1981); Unger (1980); Valentine et al.

and trash) brought to the gin, computed at 5.5 lbs seed cotton per lb lint. Sunflower harvesting has an added hauling cost included, due to the lack of processing plants in the region that can handle sunflower seeds (Wyatte Harman, Personal Communication). Wheat harvest base cost is calculated at $12 an acre plus 12 cents a bushel over 20 bushels, with hauling at 12 cents a bushel for all wheat harvested.

Water requirements for irrigation are derived, using the application timing information in Tables 2-7, assuming a basic usable plant water delivery rate of 6 inches per pre-plant and 3 inches per post-plant irrigation. These base requirements are translated to water applied by consideration of terracing and tillage effects on water use and the delivery efficiency of the irrigation distribution system. Given the required amount of water to be pumped, per acre-inch charges may then be calculated. These consist of fixed and variable pumping costs, plus distribution costs. The latter are shown in Table 11.

Fixed cost for the furrow distribution system include gated aluminum pipe, hydrants, end plug, main pipeline and gate valve. Improved furrow, in addition, includes a recirculation pit and associated plumbing. Sprinkler system costs are based upon a standard center pivot with mainline, pad for pivot, control and drives. The LEPA system includes the addition of pressure regulator, drop tubes and nozzles.

Table 11. Inputs Per Acre-Inch, for Alternate Irrigation Systems, at Specified Pressure and Delivery Efficiency

| Item | Unit | Furrow | | Sprinkler | |
|---|---|---|---|---|---|
| | | Standard | Improved | Standard | LEPA[a] |
| Annual Fixed Cost[b] | $ | 1.06 | 1.14 | 1.61 | 1.93 |
| Annual Variable Cost[b] | $ | .21 | .27 | .46 | .59 |
| Labor | Hr | .10 | .15 | .033 | .043 |
| Pumping Head | Psi | 5 | 5 | 45 | 6 |
| Delivery Efficiency | % | 69 | 80 | 80 | 92 |

[a] LEPA is a Low Energy Precision Irrigation System as described by Lyle.

[b] Fixed and Variable Cost specified are for the distribution system only. Well, pump and fuel costs are calculated separately.

Sources: Extention Economists-Management; Kletke, Harris and Mapp; Lyle and Bordovsky; Lyle, Fenster, Ferguson and Wendt; Wyatt.

Variable costs for irrigation consist of the maintenance and repair costs for the distribution system, fuel for pumping, and labor. Approximately 70% of the wells on the High Plains are fueled by natural gas ("Texas Irrigation Survey 1976, 1980", Texas Crop and Livestock Reporting Service, 1981c, pp.6-8). Further, more than 95% of the pumping energy (measured in BTU equivalent units) comes from natural gas (Texas Crop and Livestock Reporting Service, 1976). Thus, the fuel cost for pumping has been calculated using the formula for natural gas powered pumps from Kletke, Harris and Mapp,

(1) $$FUELC = (.0014539HEAD * PNGAS) / EFPUMP,$$

where FUELC is the cost to pump one acre-inch of water from the aquifer and distribute it on a field, HEAD is the total pumping lift in feet including the distribution system pressure, PNGAS is the present price of natural gas in dollars per mcf, and EFPUMP is the energy efficiency of the pump.

The price of natural gas and the pump efficiency are set at the start of each iteration of the model. The pumping head depends on the distribution system and the changes in pump lift, as the depth to the top of the aquifer increases with aquifer mining. Labor for irrigation is calculated as distribution labor (Table 11), plus 5% for pump and well maintenance.

Total fixed cost per acre-inch is derived as the sum of fixed cost for the well, the pumping unit and the distribution system. Well and pumping fixed cost equations were estimated from data for the region (Hardin and Lacewell 1981; Petty et al.). The equation for well fixed cost is

(2) $$WELLFX = 230.3 + 4.22(PLIFT + SAT),$$

where WELLFX is the annual fixed cost per irrigation well, PLIFT is the pump lift from the top of the aquifer to the land surface in feet, and SAT is the aquifer saturated thickness in feet. The fixed cost for the pumping unit is derived as

(3) $$PUMPFX = 429.5 + 4.5HEAD + 2.82GPM - .0051HEAD^2 - .002GPM^2 ,$$

where PUMPFX is the annual cost to own a pumping unit, HEAD is the required distribution system pressure (equal to "pumping head", Table 11 plus pump lift), and GPM is the expected pumping rate from the well in gallons per minute.

Well yield or pumping rate (GPM) is a function of the saturated thickness. The equations (Pearce) to describe this relationship are:

If (SAT is less than or equal to 155 ft) then,

(4) $$GPM = 2.264SAT + .007833SAT^2 - .0000282SAT^3 .$$

If (SAT is greater than 155 ft but less than 210 ft) then,

(5) $$GPM = 800(SAT/210)^2 .$$

If (SAT is greater than or equal to 210 ft) then,

(6) $$GPM = 800.$$

## Linear Programming Matrix Generation

The discussion above has emphasized a large number of different techniques for terracing, crop tillage, irrigation application and groundwater pumping and distribution. A major part of the first section of the computer program was built to assemble these techniques into alternate crop production activities. The assemblage takes place under the direction of the given scenario, as defined by the input data. Since the production activities are generated to form an input array for a linear programming optimization routine, they must contain an identifying name and the name and coefficient values for the objective function and appropriate constraint rows. Also, since the third component of the model is a report writer, additional information not needed as part of the LP is loaded into a separate, but coordinated direct access file.

To keep the linear programming matrix as simple as possible, all the economic information concerning each production activity is stored in a direct access file for later use, and only the net return is used in the LP as the objective function coefficient. Each LP column vector (production activity) is defined for one acre of a particular crop or crop rotation grown on a specified land class, using a unique combination of irrigation distribution system, tillage method, and irrigation level and timing regime.

To generate the production activities for each run of the model, a sequence of steps are required. First the input data are read. This contains all the necessary information to define a particular scenario.

After the input data have been read, land classes are generated and stored, as land classes do not change across iterations. Prices for each iteration are derived by updating (according to inputted data) the internally stored base prices. Internally stored prices for both inputs and commodities are given in Table 12. Prices for those inputs which are defined in physical units (natural gas, diesel, nitrogen, phosphorus and labor), were set at an average 1982 base price for the region, by using the area crop budgets (Extention Economists- Management) and local expertise (Wyatte Harman, personal communication). Commodity prices were calculated by taking 20 years of state seasonal average prices, stating them in 1982 dollars, by using the parity price index (U.S. Department of Agriculture) and then averaging. Also shown in Table 12 are the alternate prices used in some situations, to test the model's sensitivity to expected price. The alternate natural gas price is the estimated deregulated price (Turhollow, Short and Heady) expressed in 1982 Dollars. The alternate commodity prices are the lowest prices in the 20 year price series, when each year is expressed in 1982 dollars.

### LP Production Activities

The program next generates the production activities, by time period, by updating terracing and irrigation costs, and looping through all possible combinations, (as set by inputted control codes) of crop, crop specific irrigation regime, irrigation distribution system, tillage method, and land class.

To demonstrate how the production activities are generated in the

Table 12. Input and Commodity Prices: Texas High Plains

| Item | Unit | Expected[a] Price | Alternate[b] Price |
|---|---|---|---|
| Inputs | | ($) | ($) |
| Natural Gas | mcf | 3.85 | 8.86 |
| Diesel | gal | 1.16 | |
| Nitrogen | lb | .28 | |
| Phosphorus | lb | .30 | |
| Labor | hr | 5.00 | |
| Interest on Capital | percent | 10.00 | |
| Commodities | | | |
| Cotton | lb | .74 | .48 |
| Cotton Seed | ton | 151.53 | 104.56 |
| Corn | bu | 3.95 | 3.00 |
| Grain Sorghum | cwt | 5.95 | 4.52 |
| Sunflowers | cwt | 15.17 | 10.47 |
| Soybeans | bu | 8.08 | 5.58 |
| Wheat | bu | 4.71 | 3.25 |
| Wheat Grazing | | | |
| Dryland | ac | 9.00 | 6.84 |
| Irrigated | ac | 36.00 | 27.36 |

[a] Input Prices - 1982 average price in region, Commodity Prices - average price received 1962-1981 expressed in 1982 Dollars using the Parity Price Index.

[b] Natural Gas - expected deregulated price in 1982 Dollars, Commodities - lowest average annual price received 1962-1981 expressed in 1982 Dollars.

Sources: Extention Economists-Management; Hardin and Lacewell (1981); Texas Crop and Livestock Reporting Service (1962-1981); Turhollow, Short and Heady; U. S. Department of Agriculture.

model, the process is enumerated for a single activity.

1) The crop irrigation regime, irrigation distribution system, tillage method and land class is specified.
2) Check if activity is multi-crop or dryland. If so a modified procedure is followed. Differences will be discussed after activities for the single year irrigated crop are outlined.
3) Calculate yield and return. Yield is equal to the base yield (Tables 2-7) times the soil quality multiplier times the input yield change index. Return equals the yield times commodity price. If the crop is cotton or wheat the joint product yield and return are also calculated and added.
4) Calculate the irrigation water requirement. First, the amount of water that must be pumped for each of the eighteen water periods is figured, by taking the base requirement (Tables 2-7) times the land class, tillage system (Table 8 or 9) and irrigation distribution system delivery efficiency (Table 11) multipliers. After the individual period requirements are calculated, they are summed to derive an annual total use.
5) Calculate labor use. Labor hours, per acre of the specific production activity, are the sum of tillage plus irrigation labor multiplied by terracing and inputted labor efficiency change multipliers. Labor cost is then derived by multiplying by the wage rate.
6) Calculate machinery variable and fixed costs. Machinery costs include tillage (Tables 8 or 9), irrigation (Table 11) and terracing (Table 1) machinery multiplied by inputted machinery efficiency and price change.
7) Derive fuel use and cost. Diesel fuel use is calculated in gallons by taking the amount used for tillage and multiplying by terracing and inputted efficiency change multipliers. Total fuel cost is estimated by adding the fuel cost for irrigation to the gallons of diesel times its price plus 10% for oil and lubricants.
8) Calculate fertilizer usage and fertilizer and harvest costs. For the crop and expected yield under this production scheme, functions (Table 10) are applied with the calculated yield to derive a fertilizer use level. Fertilizer cost is then found by applying the fertilizer price. Harvest costs are similarly derived using the harvest cost function updated by present labor and machinery cost change indices.
10) Sum all variable costs; all fixed costs. All variable costs and all fixed costs as calculated above are summed into separate totals. An additional operating capital financing charge is added to the variable cost then the total is subtracted from gross returns to obtain expected return, over variable cost. Net return over variable and fixed costs is also calculated.
11) Test if net return is positive. If the activity does not generate positive net returns it is dropped from further consideration, since it is preferable to let the land lay idle than to crop it, using this production method.
12) Write activity identifier and the individual use levels and costs to a direct access file for use by the report writer (section three of the program).
13) Write to the linear programming input file. The activity

identifing code and coefficients for the objective function, land of the specified type, annual water requirement and those water periods which require irrigation, are written to the LP input file. Both returns over variable, and returns over variable and fixed cost, are written as separate objective function values. Depending on the purpose of the model run, either one or the other is actually used.

Besides the standard irrigated cropping activities, there is also the possibility of considering dryland crop production, mixed rotations (an irrigated crop followed by a dryland crop), the limited-irrigation-dryland system (LID) developed by Stewart, Dusek and Musick, and dryland rotations. For dryland crop activities, the irrigation requirements and costs are excluded, but the generation procedure is the same otherwise. For mixed and dryland rotations, the production activity is equivalent to the sum of two activities with a percentage change in the yield of the second, due to the beneficial effect of the sequence. It is an implied assumption of the model that the farmers use good management on all crops, rotating them over various fields and years for weed and insect control, field operation timeliness, and soil fertility maintenance. Thus, added yield from specific rotations is mainly attributed to additional soil moisture preservation. Mixed rotations show an increased yield for the subsequent dryland crop because the first crop is fully irrigated and when harvested leaves the soil with some residual moisture for the following crop. Dryland rotations get their added boost from the fallow period included in them.

The limited-irrigation-dryland system (LID) is a newly developed concept for managing irrigation tail water and runoff from rainfall. LID calls for the field to be divided into 3 segments, with the top half managed as fully irrigated, the next quarter as a "tail-water-runoff" section, utilizing irrigation runoff, and the last one-fourth as a "dryland" section. The "dryland" section is available to retain and utilize any rainfall and irrigation runoff that gets past the tail-water section (Stewart, Dusek and Musick). This field geometry uses irrigation water much more effectively than separate irrigated and dryland fields, but requires higher level management and more machinery field time due to the need to change planting and fertilization rates down the field. The LID plan was approximated in the model by creating production activities consisting of a fully irrigated crop plus the same crop dryland. Machinery and labor costs were increased 5% and the yield on the dryland portion was raised 55%, consistent with the limited research findings to date. Because of the newness of the concept and limited data on costs and returns only wheat and grain sorghum LID production activities were considered. The ability to remove the LID option for a specific run is also built into the model structure.

## LP Constraints

A LP model is a mathematical procedure that maximizes an objective function subject to a set of constraints. In the model developed for this study, net returns are maximized subject to various resource constraints. The first set of constraints is for land by soil type, as previously discussed. The amount of acreage available by soil type is read in as part of the input data and is used directly to form the righthand side values for each soil. These constraints remain constant over iterations for a particular model run.

The second set of constraints control the irrigation water available by irrigation period and in total. The amount of water that can be pumped in any one period depends on the average well capacity, the number of wells, the amount of time in the period and the percentage of down time required for pump repairs and maintenance. The equation to describe this relationship is

$$(7) \qquad WATPMP_i = .0528\ GPM(PDAY_i)\ P\%(WELL),$$

where $WATPMP_i$ is ac-in of water pumped in period i, .0528 converts GPM to ac-in-day, GPM (gallons of water pumped per minute per well), which is dependent on saturated thickness, has been discussed previously, $PDAY_i$ is the number of days in period i, P% is the percentage of time the pumps operate (1-downtime), and WELL is the number of wells available.

The number of days in each of the 18 pumping periods was set to conform to the critical irrigation periods for the crops in the region and is specified in the model structure. For a single static run or the first iteration of a temporal run the saturated thickness, on which the well yield depends, and the number of wells are part of the input data. The percentage of time the pumps operate is also input data and can be changed from iteration to iteration for temporal runs.

Since the recharge rate of the Ogalalla aquifer is nearly zero, pumping causes the water level in the aquifer to drop over time as the water is withdrawn. This drop manifests itself as a reduction in the saturated thickness and an increase in the average pump lift. For temporal runs, these changes and their effects must be incorporated. At the start of the first iteration, the beginning saturated thickness, pump lift, coefficient of storage, aquifer surface area and number of wells are read as input data (Section II). The amount of water that can be pumped each period ($WATPMP_i$) is then calculated and used for the water constraint for that period in the LP section of the model.

After the LP is solved for the optimal crop mix a simple summation procedure is used to calculate total water pumped. Dividing water pumped by the aquifer surface area times the coefficient of storage gives the amount of aquifer decline. Since the Ogalalla is an unconfined aquifer, the decline translates directly into increased pump lift and decreased saturated thickness for the next iteration. Thus, at the start of each iteration of a temporal run, the pump lift and saturated thickness are updated. In turn, the cost of pumping increases due to increased lift, and well yield and pumping capacity per irrigation period decreases due to reduced saturated thickness.

The final constraint available in the present model design is for total water use per year. It is used to limit the feet of annual aquifer decline for certain model runs and is read, in those situations, from the input data.

## The Report Writer

Once the production activities and constraints are generated for an iteration, the LP section of the model is solved. The solution, which contains the set of activities maximizing net revenue given the land and water constraints, is outputted to a file and the third section of the model is called to write a report. The purpose of the report writing section is: (1) return enough of the input data to identify the run and specify the price situation, (2) meld the LP output with the cost and returns data for the chosen production activities, (3) filter out extraneous information, and (4) report information in a standard, easy to read form. An example report is given in Section III. Four pages are printed for each iteration plus a six page summary if a multi-iteration temporal run is made.

Page one of the report includes the inputted title, the iteration number and years covered, as well as the current price and efficiency index values. The actual prices for the iteration (inputted index times the stored base price) are also listed for easy reference and error detection.

Page two details the groundwater and irrigation results for the iteration. This includes the starting and ending saturated thickness, pump lift and well yield, as well as, the total pumpage limit, if any, the actual amount pumped and the shadow price of the irrigation water if the limit is reached. The amount of irrigation water available, the actual usage, and shadow prices for each of the 18 irrigation periods is listed next. This makes it easier to identify the critical water periods and the marginal value of water during times of peak demand. Information on the costs associated with each irrigation distribution system and the acreage irrigated by each makes up the last table on page two.

Page three lists the costs and returns for each production activity on a per acre and total area planted basis. Use levels for the major inputs are given both to allow checking for plausibility and for comparison across crop, tillage method and soil types. After all production activities are listed, totals for the whole farm or region being modeled are reported.

Page four contains 4 tables. The first summarizes acreage, production and value of production for each of the six possible crops. The next lists the soils inputted, the acreage of each used for crop production and the shadow price on the last acre available if the soil is completely planted. The third table shows available cropland and its allocation between dryland, irrigated and fallow. The final table on page four again lists the production activities and shows the soil involved, whether terraces are employed, acreage planted, crops grown and their per acre yield.

When a multi-year temporal situation is modeled, the report writer prints a final summary. The summary is six pages in length. The first page lists the price, efficiency and yield indices from the input data. This allows a quick check on the iteration related input, both for error detection and as a reminder of trends designed into a particular run.

The second page delineates the change in the groundwater situation over the time horizon. The decline in aquifer saturated thickness and subsequent well yield capacity is shown by iteration, along with the increasing pump lift. Acre-feet of water pumped per period is also given, as well as, the limit on total pumpage, if any. For those iterations where the total pumpage constraint is binding, the shadow price on the marginal acre foot pumped is reported.

Pages three and four give the annual acreage, production, yield and value for each crop by irrigated (page 3) or dryland (page 4) for each iteration. This overview of the shifts in cropping pattern and intensity of production is helpful when analyzing the response to decreasing water supplies under different scenarios. The fifth page of the summary repeats the production costs and return totals for each iteration. This again, facilitates comparison across time; making it easier to spot trends in input uses and net returns.

The last page of the summary deals with cropland usage and discounted present value of net returns. Net returns over variable costs and over all costs, excluding land, water and management, are separately summed using a standard present value formula. The formula is

$$\text{PVALUE} = \Sigma_{t=1}^{T} \ \text{NR}_t/(1 + \text{DRATE})^t \qquad (8)$$

where PVALUE is the present value, $NR_t$ equals the net returns in year t, and DRATE is the discount rate. The present value is calculated at three different discount rates; a rate that is exogenously set as part of the input data, and rates that equal one-half and one and one-half the inputted rate. Discounted present value is particularly useful when comparing the effects of different technologies or resource constraints over time periods greater than a single year.

# II

# INPUT DATA FORMAT

## Sample Input Data File

```
Line

A   1000000001 HALE CO, AVE PRICE, GWL= 3FT, FIX 9/2/83

B   CROP123456DSYS69800000TILL12IRREG071014130609ITERATIONS08PVR% 4.0

C   139.      281.       .15       1284.      9.17      578.    0.

D   1980 1985 1.   1.   1.   1.   1.   1.   1.   1.   1.   1.
E   1980 1985  .55  .8  1.   1.   1.   1.   1.   1.   1.   1.

    1985 1990 1.   1.   1.   1.   1.   1.   1.   1.   1.   1.
    1985 1990  .55  .8  1.   1.   1.   1.   1.   1.   1.   1.

    1990 1995 1.   1.   1.   1.   1.   1.   1.   1.   1.   1.
    1990 1995  .55  .8  1.   1.   1.   1.   1.   1.   1.   1.

    1995 2000 1.   1.   1.   1.   1.   1.   1.   1.   1.   1.
    1995 2000  .55  .8  1.   1.   1.   1.   1.   1.   1.   1.

    2000 2005 1.   1.   1.   1.   1.   1.   1.   1.   1.   1.
    2000 2005  .55  .8  1.   1.   1.   1.   1.   1.   1.   1.

    2005 2010 1.   1.   1.   1.   1.   1.   1.   1.   1.   1.
    2005 2010  .55  .8  1.   1.   1.   1.   1.   1.   1.   1.

    2010 2015 1.   1.   1.   1.   1.   1.   1.   1.   1.   1.
    2010 2015  .55  .8  1.   1.   1.   1.   1.   1.   1.   1.

    2015 2020 1.   1.   1.   1.   1.   1.   1.   1.   1.   1.
    2015 2020  .55  .8  1.   1.   1.   1.   1.   1.   1.   1.

F   ESTOL01      30.     2.      .7       237.      15.    16.
    ESTOL13      30.     2.     1.5       216.      13.    14.
    LOFCL01      50.     1.      .3       237.      16.    15.7
    OLTNL01     160.     2.      .4       240.      16.    17.
    OLTNL13      80.     2.     1.5       230.      14.    15.
    PULCL01     650.     1.      .4       230.      15.    15.    1.
```

## Explanation of Input Data File

Line A (format 10I1,10A4) contains 10 control codes and a 40 character title. The control codes allow internal files to be printed for debugging or data checks, generated or solution files to be printed and certain options to be removed. If control code I is set to 1 then for I=:

1) Print input data, land class information
2) Hold saturated thickness, pumplift at initial values (for static, parametric analysis)
3) Print internal data matrices for checking
4) Print economic data for all production activities generated
5) Print LP solution output, corresponding file 1 records (file 1 contains economic data for each production activity)
6) Delete off-optimal irrigation timing regimes from run
7) Delete mixed and LID rotations from the run
8) Delete dryland rotations from the run
9) Delete terracing options from the run
10) Delete activities with revenue - total cost ≤ 0 (Use for long planning horizon runs)

Line B (format 4X,6I1,4X,4I2,4X,2I1,5X,6I2,10X,I2,4X,F5.2) contains control codes for specifying which crops, irrigation distribution systems, tillage methods, and irrigation regimes will be available for the run. For example ,a "0" in col 5 would drop all cotton production activities from consideration. Col 6 is for corn, 7 for sorghum, 8 for sunflowers, 9 for soybeans, and 10 for wheat. DSYS identifies the irrigation distribution system control. Col 15-16 sets the application efficiency for standard furrow irrigatin. It is entered as a percentage and if set to "00" will eliminate the system from consideration for the run. Col 17-18 sets the efficiency for Improved Furrow, 19-20 for standard sprinkler, and 21-22 for LEPA. Till identifies the tillage options; col 27 for conventional tillage, col 28 for limited tillage. If a "0" is placed in the appropriate col that tillage method is eliminated from the run. IRREG identifies the controls for the number of irrigation regime options for each crop. Tables 2-7 Section I list the available regimes for each crop. Each crop (same order as CROP) has 2 columns and by reducing the number therein the more intensve irrigation options can be dropped from the run. Reducing it to "01" would eliminate all but dryland crop production. ITERATIONS identify the columns for the number of iterations. Presently no more than 20 iterations may be run at one time. If more are necessary a subsequent run can be set to begin where the first ends. A "D" and "E" card must be entered for each iteration. PVR% identifies the middle present value discount rate for temporal runs. Values equal to one-half and one-and-one-half this value are internally generated and used to report present value of net returns.

The next line (C) (format 8F10.3) defines the groundwater situation, listing initial saturated thickness, pump lift, coefficient of storage, aquifer surface area, number of wells, annual groundwater withdrawal limit and dryland net returns. The annual groundwater withdrawal limit is calculated as the product of the assumed maximum allowable decline in the aquifer, the aquifer surface area, and the coefficient of storage. Thus the 578 acre-foot limit on total water use per year is the product ( 3 ft./year)*(1284 acres of aquifer)*(.15).

The next group of input data lines (D and E), (format I1,I4,1X,I4,13F5.2) define the number of years in each iteration and a relative change index for select input prices and efficiencies, and commodity prices and yields for that iteration. Price indices are specified for (by order in line D), Natural Gas, Diesel, Labor, Machinery, Chemicals, Interest rate on capital, Wheat, Cotton, Feedgrains, and Oilseed prices. Line E sets efficiency indices for: Pump energy use, Percent of time pumps operate, Labor, and Machinery, as well as yield change indices for Cotton, Corn, Grain Sorghum, Sunflowers, Soybeans, and Wheat. The change is relative to the prices, yields and efficiencies stored as part of the internal data.

The last set of information (F), (format 2A4,2X,7F10.2) identifies the soils to be considered (8 characters), and their associated acreage, texture (1 for Hardlands, 2 for Mixed, and 3 for Sandy), slope (entered as percent), and expected dryland cotton, wheat and sorghum yields. Expected yield is used as a proxy for relative soil quality and should be entered relative to regional averages internally stored, i.e. (Cotton 230 lb, Wheat 15 bu, and Sorghum 15 cwt). The last soils card must contain a "1." in columns 71-80 to indicate the end of the soils data.

The input data file should be created on a WYLBUR file and saved in CARD image. Since the input file is read by the Fortran, it must be in the correct format. If it is not, or the file is not in card image, the job will fail due to errors.

## Possible Applications

The input file shown on page 28 results in an 8 iteration run using average prices while accounting for aquifer decline over time. Numerous other possible options exist. For example, to evaluate the same water and soil scenario using the alternative commodity prices shown on page 22, one would alter the price indices in line type (D) as shown below.

```
D 1980 1985 1.   1.   1.   1.   1.   1.  .69  .65  .76  .69
```

The cotton and wheat indices apply uniquely to those crops, while the feedgrain index applies to corn, grain sorghum, and grazing activities. The oilseed price index applies to sunflowers, soybeans, and cotton seed. Line type D would be altered for each iteration for which an alternative set of prices was desired.

Another possible application is to hold the groundwater situation constant and parametrically change the price of an input or output. Suppose the natural gas prices are expected to change by 10% per period for the second and third periods. Line types A and D would be altered as shown below.

```
A  1100000001 HALE CO, NG PARA, GWL= 3FT, FIX 9/2/83


D  1980 1985 1.   1.   1.   1.   1.   1.   1.   1.   1.   1.

D  1985 1990 1.1  1.   1.   1.   1.   1.   1.   1.   1.   1.

D  1990 1995 1.2  1.   1.   1.   1.   1.   1.   1.   1.   1.
```

Note that option code 2 in line A is set to "1" to hold the groundwater level constant. The natural gas price index increases from 1 to 1.2 over the 3 iterations. Recall that use of the price, yield, and efficiency indices are all relative to the base values stored in main program. The natural gas base price of $3.86/mcf therefore increases to $4.25 and then to $4.63/mcf for the input alterations shown.

One additional point worth noting concerns the calculation as well as possible use of the dryland net returns figure mentioned as the last entry in line type C. If at any time the returns from a single iteration fall below this figure, the program will preclude generation of all irrigated activities in subsequent iterations. Elimination of those activities greatly reduces the size of the LP matrix as well as the cost of multi-iteration runs. To obtain the dryland net returns for a given groundwater, soil, and price situation, alter each of the irrigation regime codes in line type B to "01" as shown below.

```
B  CROP123456DSYS69800000TILL12IRREG010101010101ITERATIONS08PVR% 4.0
```

This should be done in a separate single iteration run, with the resulting dryland net return entered in line C of the multiple iteration run. Option code 10 in line A (dealing with the possible exclusion of activities with negative net returns) should be set in accordance with the assumed planning horizon when calculating the dryland net return. Use of the dryland net return option is obviously not critical, but can be a cost saving technique in many situations.

# III

# EXAMPLE OUTPUT

The amount of output generated by a model run is dependent on the CONTROL OPTIONS specified, the number of iterations, and the size of the LP problem generated each iteration. The example on the following pages includes most of the printing caused by the CONTROL OPTION codes, and an example of the report for one iteration and the summary. It does not include any of the MPSX generated output, nor the report segments written for the other iterations.

WHEN OPTION CODES 1 IS SET TO "1" THE INPUT DATA IS RETURNED AS PART OF THE OUTPUT FOR CHECKING.

OPTION CODES= 1010100001 TITLE= HALE CO, AVE PRICE, GWL= 3FT,FIX,11/2/83
CONTROL CODES CROPS 123456 DSYS 1234 TILL 12 IRREG 7101413 6 9 ITERATIONS 8 DISCOUNT RATE 4.00 %
INITIAL GROUNDWATER DATA

| SAT THK | PLIFT | COEF-STR | AQ-SURF | NO. WELLS | TWATER (ACFT) |
|---|---|---|---|---|---|
| 139.00 | 281.00 | 0.15 | 1284.0 | 9.2 | 578.0 |

PRICE AND YIELD INDEX CHANGES

| | PRICES | | | | | | | | | | EFFICIENCY & YIELD | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PERIOD | NGAS | DESL | LAB | MACH | CHEM | CAPL | WHET | COTN | FEED | OILS | P-EF | P-% | LAB | MACH | Y-CT | Y-CO | Y-GS | Y-SU | Y-SO | Y-WT |
| 1980-1985 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.55 | 0.80 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 1985-1990 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.55 | 0.80 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 1990-1995 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.55 | 0.80 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 1995-2000 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.55 | 0.80 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 2000-2005 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.55 | 0.80 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 2005-2010 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.55 | 0.80 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 2010-2015 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.55 | 0.80 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 2015-2020 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.55 | 0.80 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

SOIL DATA

| NAME | ACREAGE | TEXTURE | SLOPE | YLD-COT | WHT | SORG | E COD |
|---|---|---|---|---|---|---|---|
| ESTOL01 | 30.00 | 2.00 | 0.70 | 237.00 | 15.00 | 16.00 | 0.0 |
| ESTOL13 | 30.00 | 2.00 | 1.50 | 216.00 | 13.00 | 14.00 | 0.0 |
| LOFCL01 | 50.00 | 1.00 | 0.30 | 237.00 | 16.00 | 15.70 | 0.0 |
| OLTNL01 | 160.00 | 2.00 | 0.40 | 240.00 | 16.00 | 17.00 | 0.0 |
| OLTNL13 | 80.00 | 2.00 | 1.50 | 230.00 | 14.00 | 15.00 | 0.0 |
| PULCL01 | 650.00 | 1.00 | 0.40 | 230.00 | 15.00 | 15.00 | 1.00 |

THE INTERNAL DATA FOR TERRACES (SAME AS TABLE 1) IS REPORTED WHEN OPTION CODE 3 IS SET TO "1".

DATA SOAM(J,K,6) TERRACES

| | 0-1% | | | 1-3% | | | >3% | | |
|---|---|---|---|---|---|---|---|---|---|
| | NONE | BENCH | CBT | NONE | BENCH | CBT | NONE | BENCH | CBT |
| LAND USED | 1.00 | 1.02 | 1.01 | 1.00 | 1.03 | 1.02 | 1.00 | 1.05 | 1.03 |
| ANN FIX C | 0.0 | 5.10 | 1.74 | 0.0 | 7.80 | 2.88 | 0.0 | 8.94 | 3.84 |
| ANN VAR C | 0.0 | 4.43 | 1.52 | 0.0 | 6.78 | 2.50 | 0.0 | 7.76 | 3.34 |
| L&M MULT | 1.00 | 1.05 | 1.03 | 1.00 | 1.07 | 1.05 | 1.00 | 1.10 | 1.07 |
| YLD D MULT | 1.00 | 1.10 | 1.05 | 1.00 | 1.15 | 1.09 | 1.00 | 1.20 | 1.12 |
| IRRIG MULT | 1.00 | 0.95 | 0.97 | 1.00 | 0.92 | 0.96 | 1.00 | 0.90 | 0.93 |

THE INPUTTED SOIL DATA IS COMBINED WITH THE INTERNAL TERRACING INFORMATION TO GENERATE LAND CLASSES.
THE LAND CLASS DATA (INTERNAL MATRIX SCLA) IS THE BASIS FOR ALL CROP PRODUCTION ACTIVITIES GENERATED.
THE CODE (LAST COLUMN) IS USED TO IDENTIFY THE LAND CLASS IN EACH ACTIVITY.
IT IS THE LAST CHARACTER IN THE 8 CHARACTER NAME GENERATED FOR EACH ACTIVITY.

LAND CLASS INFORMATION (SCLA(L,13) )

| SOIL | TERRACE | TEXTURE | LD-USE | AFIX | AVAR | L&M MULT | YD MULT | I MULT | YLD-COT | WHT | GSORG | CODE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ESTOL01 | - | 2.00 | 1.00 | 0.05 | 0.05 | 1.000 | 1.000 | 1.000 | 1.030 | 1.000 | 1.067 | A |
| ESTOL01 | BNCH | 2.00 | 1.02 | 4.89 | 4.26 | 1.047 | 1.095 | 0.953 | 1.030 | 1.000 | 1.067 | B |
| ESTOL01 | CBT | 2.00 | 1.01 | 1.70 | 1.49 | 1.028 | 1.047 | 0.969 | 1.030 | 1.000 | 1.067 | C |
| ESTOL13 | - | 2.00 | 1.00 | 0.05 | 0.05 | 1.000 | 1.000 | 1.000 | 0.939 | 0.867 | 0.933 | D |
| ESTOL13 | BNCH | 2.00 | 1.03 | 7.46 | 6.49 | 1.066 | 1.142 | 0.924 | 0.939 | 0.867 | 0.933 | E |
| ESTOL13 | CBT | 2.00 | 1.02 | 2.79 | 2.42 | 1.047 | 1.085 | 0.962 | 0.939 | 0.867 | 0.933 | F |
| LOFCL01 | - | 1.00 | 1.00 | 0.0 | 0.0 | 1.000 | 1.000 | 1.000 | 1.030 | 1.067 | 1.047 | G |
| OLTNL01 | - | 2.00 | 1.00 | 0.0 | 0.0 | 1.000 | 1.000 | 1.000 | 1.043 | 1.067 | 1.133 | H |
| OLTNL13 | - | 2.00 | 1.00 | 0.05 | 0.05 | 1.000 | 1.000 | 1.000 | 1.000 | 0.933 | 1.000 | I |
| OLTNL13 | BNCH | 2.00 | 1.03 | 7.46 | 6.49 | 1.066 | 1.142 | 0.924 | 1.000 | 0.933 | 1.000 | J |
| OLTNL13 | CBT | 2.00 | 1.02 | 2.79 | 2.42 | 1.047 | 1.085 | 0.962 | 1.000 | 0.933 | 1.000 | K |
| PULCL01 | - | 1.00 | 1.00 | 0.0 | 0.0 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | L |

THE IRRIGATION DISTRIBUTION INTERNAL DATA (TABLE 11) IS STORED AS MATRIX DSYS AND IS REPORTED WHEN OPTION CODE 3 IS SET TO "1".

IRRIGATION DIST SYS DATA (DSYS)

| | FURROW | IMP FURROW | SPRINKLER | IMP SPRINKLER |
|---|---|---|---|---|
| ANN FIX C | 1.060 | 1.140 | 1.610 | 1.930 |
| ANN VAR C | 0.210 | 0.270 | 0.460 | 0.590 |
| ELEC USED | 32.100 | 32.100 | 43.500 | 34.600 |
| LABOR HRS | 0.100 | 0.150 | 0.033 | 0.043 |
| HEAD (FT) | 2.000 | 2.000 | 117.000 | 14.000 |
| DELIV EFF | 0.690 | 0.800 | 0.800 | 0.920 |

GROUNDWATER INFORMATION (INPUT LINE C) AND DISTRIBUTION SYSTEM DATA ARE COMBINED WITH VARIABLE AND FIXED COST EQUATIONS TO CALCULATE PUMPING AND DISTRIBUTION COSTS AND REQUIREMENTS BY SYSTEM (MATRIX WAT).

PUMPING & DIST SYSTEM INFO (WAT)

| | FURROW | IMP FURROW | SPRINKLER | IMP SPRINKLER |
|---|---|---|---|---|
| ANN FIX C | 3.531 | 3.611 | 4.172 | 4.416 |
| ANN VAR C | 3.945 | 4.011 | 5.391 | 4.485 |
| LABOR HRS | 0.105 | 0.157 | 0.035 | 0.045 |
| IRR EFFIC | 0.690 | 0.800 | 0.800 | 0.920 |
| NGAS $/ACIN | 2.880 | 2.880 | 4.051 | 3.002 |

WHEN OPTION CODE 3 IS SET TO "1" INTERNAL DATA CONCERNING IRRIGATION REGIMES FOR EACH CROP IS REPORTED (SAME AS TABLES 2-7).
THE CODE (LAST COLUMN) IDENTIFIES THE IRRIGATION REGIME IN EACH LP ACTIVITY.
THEY ARE THE 3RD AND 4TH CHARACTERS IN THE 8 CHARACTER ACTIVITY NAME.

IRRIGATION REGIME DATA FOR COTTON(J,20)

| YIELD | WJNFB | WMA | WAP | WMA1 | WMA2 | WJU1 | WJU2 | WJU3 | WJL1 | WJL2 | WJL3 | WAU1 | WAU2 | WAU3 | WSE1 | WSE2 | WOC | WNODC | CODE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 230.00 | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | DY |
| 420.00 | 0. | 6. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0A |
| 450.00 | 0. | 6. | 0. | 0. | 0. | 0. | 0. | 3. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 1A |
| 470.00 | 0. | 0. | 6. | 0. | 0. | 0. | 0. | 0. | 0. | 3. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 1B |
| 517.00 | 0. | 0. | 6. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 3. | 0. | 0. | 0. | 0. | 0. | 0. | 1C |
| 588.00 | 0. | 6. | 0. | 0. | 0. | 0. | 0. | 3. | 0. | 0. | 0. | 3. | 0. | 0. | 0. | 0. | 0. | 0. | 2A |
| 590.00 | 0. | 0. | 6. | 0. | 0. | 0. | 0. | 0. | 0. | 3. | 0. | 3. | 0. | 0. | 0. | 0. | 0. | 0. | 2B |

IRRIGATION REGIME DATA FOR CORN(J,20)

| YIELD | WJNFB | WMA | WAP | WMA1 | WMA2 | WJU1 | WJU2 | WJU3 | WJL1 | WJL2 | WJL3 | WAU1 | WAU2 | WAU3 | WSE1 | WSE2 | WOC | WNODC | CODE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 116.00 | 0. | 6. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 3. | 3. | 3. | 0. | 0. | 0. | 0. | 0. | 0. | 3A |
| 107.00 | 0. | 0. | 6. | 0. | 0. | 0. | 0. | 0. | 0. | 3. | 3. | 0. | 0. | 3. | 0. | 0. | 0. | 0. | 3B |
| 102.00 | 0. | 0. | 6. | 0. | 0. | 0. | 0. | 0. | 0. | 3. | 0. | 3. | 0. | 3. | 0. | 0. | 0. | 0. | 3C |
| 120.00 | 0. | 6. | 0. | 0. | 0. | 0. | 0. | 0. | 3. | 3. | 3. | 3. | 0. | 0. | 0. | 0. | 0. | 0. | 4A |
| 122.00 | 0. | 0. | 6. | 0. | 0. | 0. | 0. | 0. | 0. | 3. | 3. | 3. | 0. | 3. | 0. | 0. | 0. | 0. | 4B |
| 126.00 | 0. | 0. | 6. | 0. | 0. | 0. | 0. | 0. | 0. | 3. | 3. | 3. | 0. | 0. | 3. | 0. | 0. | 0. | 4C |
| 146.00 | 0. | 6. | 0. | 0. | 0. | 0. | 0. | 0. | 3. | 3. | 3. | 3. | 0. | 3. | 0. | 0. | 0. | 0. | 5A |
| 136.00 | 0. | 0. | 6. | 0. | 0. | 0. | 0. | 0. | 3. | 3. | 3. | 3. | 0. | 0. | 3. | 0. | 0. | 0. | 5B |
| 137.00 | 0. | 6. | 0. | 0. | 0. | 0. | 0. | 0. | 3. | 3. | 0. | 3. | 0. | 3. | 3. | 0. | 0. | 0. | 5C |
| 148.00 | 0. | 6. | 0. | 0. | 0. | 0. | 0. | 0. | 3. | 3. | 3. | 3. | 0. | 3. | 3. | 0. | 0. | 0. | 6A |

IRRIGATION REGIME DATA FOR SORGHUM(J,20) PAGE 4

| YIELD | WJNFB | WMA | WAP | WMA1 | WMA2 | WJU1 | WJU2 | WJU3 | WJL1 | WJL2 | WJL3 | WAU1 | WAU2 | WAU3 | WSE1 | WSE2 | WOC | WNODC | CODE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15.00 | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | DY |
| 45.10 | 0. | 0. | 0. | 6. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 3. | 0. | 0. | 0. | 0. | 0. | 1A |
| 50.40 | 0. | 0. | 6. | 0. | 0. | 0. | 0. | 0. | 3. | 0. | 0. | 0. | 3. | 0. | 0. | 0. | 0. | 0. | 2A |
| 53.70 | 0. | 0. | 6. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 3. | 0. | 3. | 0. | 0. | 0. | 0. | 0. | 2B |
| 51.90 | 0. | 0. | 0. | 6. | 0. | 0. | 0. | 0. | 0. | 0. | 3. | 0. | 0. | 3. | 0. | 0. | 0. | 0. | 2C |
| 45.39 | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 4. | 0. | 0. | 0. | 0. | 0. | 0. | 3. | 3. | 0. | 0. | 2D |
| 47.18 | 0. | 0. | 0. | 0. | 0. | 0. | 4. | 0. | 0. | 0. | 0. | 3. | 0. | 0. | 0. | 3. | 0. | 0. | 2E |
| 63.00 | 0. | 0. | 6. | 0. | 0. | 0. | 0. | 0. | 3. | 0. | 3. | 0. | 3. | 0. | 0. | 0. | 0. | 0. | 3A |
| 60.50 | 0. | 0. | 0. | 6. | 0. | 0. | 0. | 0. | 0. | 0. | 3. | 0. | 3. | 3. | 0. | 0. | 0. | 0. | 3B |
| 59.42 | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 4. | 0. | 0. | 0. | 0. | 0. | 3. | 3. | 3. | 0. | 0. | 3C |
| 63.84 | 0. | 0. | 0. | 0. | 0. | 0. | 4. | 0. | 0. | 0. | 0. | 3. | 0. | 0. | 3. | 3. | 0. | 0. | 3D |
| 59.33 | 0. | 0. | 0. | 0. | 0. | 5. | 0. | 0. | 0. | 0. | 0. | 3. | 0. | 3. | 0. | 3. | 0. | 0. | 3E |
| 69.00 | 0. | 0. | 0. | 6. | 0. | 0. | 0. | 0. | 3. | 0. | 3. | 0. | 3. | 3. | 0. | 0. | 0. | 0. | 4A |
| 63.33 | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 4. | 0. | 0. | 0. | 3. | 0. | 3. | 3. | 0. | 3. | 0. | 4B |

IRRIGATION REGIME DATA FOR SUNFLOWERS(J,20) PAGE 5

| YIELD | WJNFB | WMA | WAP | WMA1 | WMA2 | WJU1 | WJU2 | WJU3 | WJL1 | WJL2 | WJL3 | WAU1 | WAU2 | WAU3 | WSE1 | WSE2 | WOC | WNODC | CODE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8.04 | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | DY |
| 15.48 | 0. | 6. | 0. | 0. | 0. | 0. | 0. | 0. | 3. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 1A |
| 17.97 | 0. | 6. | 0. | 0. | 0. | 0. | 3. | 0. | 0. | 3. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 2A |
| 19.60 | 0. | 6. | 0. | 0. | 0. | 0. | 3. | 0. | 3. | 0. | 3. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 3A |
| 20.78 | 0. | 6. | 0. | 0. | 0. | 0. | 3. | 0. | 3. | 0. | 3. | 3. | 0. | 0. | 0. | 0. | 0. | 0. | 4A |
| 15.48 | 0. | 0. | 6. | 0. | 0. | 0. | 0. | 0. | 0. | 3. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 1M |
| 17.97 | 0. | 0. | 6. | 0. | 0. | 0. | 0. | 3. | 0. | 0. | 3. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 2M |
| 19.60 | 0. | 0. | 6. | 0. | 0. | 0. | 0. | 3. | 0. | 3. | 0. | 3. | 0. | 0. | 0. | 0. | 0. | 0. | 3M |
| 20.78 | 0. | 0. | 6. | 0. | 0. | 0. | 0. | 3. | 0. | 3. | 0. | 3. | 3. | 0. | 0. | 0. | 0. | 0. | 4M |
| 15.48 | 0. | 0. | 0. | 6. | 0. | 0. | 0. | 0. | 0. | 0. | 3. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 1Y |
| 17.97 | 0. | 0. | 0. | 6. | 0. | 0. | 0. | 0. | 3. | 0. | 0. | 3. | 0. | 0. | 0. | 0. | 0. | 0. | 2Y |
| 19.60 | 0. | 0. | 0. | 6. | 0. | 0. | 0. | 0. | 3. | 0. | 3. | 0. | 3. | 0. | 0. | 0. | 0. | 0. | 3Y |
| 20.78 | 0. | 0. | 0. | 6. | 0. | 0. | 0. | 0. | 3. | 0. | 3. | 0. | 3. | 3. | 0. | 0. | 0. | 0. | 4Y |

IRRIGATION REGIME DATA FOR SOYBEANS(J,20) PAGE 6

| YIELD | WJNFB | WMA | WAP | WMA1 | WMA2 | WJU1 | WJU2 | WJU3 | WJL1 | WJL2 | WJL3 | WAU1 | WAU2 | WAU3 | WSE1 | WSE2 | WOC | WNODC | CODE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 32.60 | 0. | 0. | 6. | 0. | 0. | 0. | 0. | 0. | 0. | 3. | 0. | 0. | 3. | 0. | 0. | 0. | 0. | 0. | 2A |
| 28.40 | 0. | 0. | 0. | 6. | 0. | 0. | 0. | 0. | 0. | 3. | 0. | 3. | 0. | 0. | 0. | 0. | 0. | 0. | 2B |
| 44.60 | 0. | 0. | 0. | 6. | 0. | 0. | 0. | 0. | 0. | 3. | 0. | 3. | 3. | 0. | 0. | 0. | 0. | 0. | 3A |
| 39.70 | 0. | 0. | 6. | 0. | 0. | 0. | 0. | 0. | 3. | 0. | 0. | 3. | 3. | 0. | 0. | 0. | 0. | 0. | 3B |
| 33.80 | 0. | 0. | 0. | 4. | 0. | 0. | 3. | 0. | 0. | 3. | 0. | 0. | 3. | 0. | 0. | 0. | 0. | 0. | 3C |
| 49.00 | 0. | 0. | 6. | 0. | 0. | 0. | 0. | 0. | 3. | 3. | 0. | 3. | 3. | 0. | 0. | 0. | 0. | 0. | 4A |

IRRIGATION REGIME DATA FOR WHEAT(J,20) PAGE 7

| YIELD | WJNFB | WMA | WAP | WMA1 | WMA2 | WJU1 | WJU2 | WJU3 | WJL1 | WJL2 | WJL3 | WAU1 | WAU2 | WAU3 | WSE1 | WSE2 | WOC | WNODC | CODE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 16.20 | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | DY |
| 38.80 | 0. | 0. | 3. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 6. | 0. | 0. | 1A |
| 31.20 | 0. | 0. | 0. | 3. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 6. | 0. | 1B |
| 56.80 | 0. | 3. | 3. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 6. | 0. | 0. | 2A |
| 56.10 | 0. | 3. | 0. | 3. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 6. | 0. | 2B |
| 66.00 | 0. | 3. | 0. | 3. | 3. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 6. | 0. | 0. | 3A |
| 62.70 | 0. | 0. | 3. | 3. | 3. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 6. | 0. | 3B |
| 72.70 | 0. | 3. | 3. | 3. | 3. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 6. | 0. | 0. | 4A |
| 73.00 | 3. | 0. | 3. | 3. | 3. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 6. | 0. | 4B |

MIXED, LID AND DRYLAND ROTATIONS ARE ALSO CONSIDERED IN THE MODEL. THESE OPTIONS CAN BE REMOVED IF OPTION CODES 7 AND 8 ARE SET TO "1". THE FOLLOWING TABLE SHOWS WHICH ROTATIONS ARE IN THE MODEL, THE CROPS INVOLVED, AND HOW THEIR YIELD CHANGES. NOTE: ROTATION 20 IS A WHEAT-FALLOW ROTATION SO THE 2ND YEAR WHEAT YIELD IS 0.

CODES FOR MIXED, DRYLAND ROTATIONS

| | | 1ST CROP | | | 2ND CROP | |
|---|---|---|---|---|---|---|
| ROT NO. | YEARS | CROP | I-REG | % CHA YLD | CROP | % CHA YLD |
| FIRST CROP IRRIGATED, SECOND CROP DRY | | | | | | |
| 1 | 2 | WT | 8 | | CT | 15 |
| 2 | 2 | WT | 9 | | CT | 15 |
| 3 | 2 | WT | 7 | | GS | 11 |
| 4 | 2 | WT | 8 | | GS | 15 |
| 5 | 2 | WT | 9 | | GS | 15 |
| 6 | 2 | WT | 7 | | SU | 9 |
| 7 | 2 | WT | 8 | | SU | 12 |
| 8 | 2 | WT | 9 | | SU | 12 |
| 9 | 2 | GS | 8 | | WT | 5 |
| 10 | 2 | GS | 13 | | WT | 8 |
| 11 | 2 | SU | 5 | | WT | 18 |
| 12 | 2 | SU | 9 | | WT | 15 |
| 13 | 2 | SU | 13 | | WT | 13 |
| 14 | 2 | SO | 3 | | WT | 18 |
| 15 | 2 | SO | 6 | | WT | 18 |
| LIMITED IRRIG. DRYLAND SYSTEMS (LIDS) | | | | | | |
| 16 | 1 | WT | 8 | | WT | 55 |
| 17 | 1 | WT | 9 | | WT | 55 |
| 18 | 1 | GS | 13 | | GS | 55 |
| 19 | 1 | GS | 14 | | GS | 55 |
| DRYLAND ROTATIONS | | | | | | |
| 20 | 2 | WT | 1 | 60 | WT | -100 |
| 21 | 2 | WT | 1 | 30 | GS | 0 |
| 22 | 2 | WT | 1 | 25 | SU | 0 |
| 23 | 3 | WT | 1 | 60 | GS | 40 |
| 24 | 3 | WT | 1 | 50 | SU | 30 |

OPTION CODE 3 ALSO CAUSES THE INTERNALLY STORED CROP INPUT DATA TO BE PRINTED (SAME AS TABLES 8 AND 9).

IRR CROP INPUTS BY CROP, TILL (CPIC)

| | COTTON | | CORN | | SORGHUM | | SUNFLOWER | | SOYBEAN | | WHEAT | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CONV | LIMIT | CONV | LIMIT | CONV | LIMIT | CONV | LIMIT | CONV | LIMIT | CONV | LIMIT |
| LABOR HRS | 6.13 | 4.64 | 4.61 | 2.73 | 5.39 | 3.72 | 5.40 | 3.14 | 4.55 | 2.83 | 3.10 | 1.88 |
| SEED COST | 9.00 | 9.00 | 17.20 | 17.20 | 3.60 | 3.60 | 10.00 | 10.00 | 13.80 | 13.80 | 9.75 | 9.75 |
| BIOCIDE $ | 0.0 | 6.00 | 28.00 | 42.00 | 10.50 | 17.00 | 12.00 | 20.00 | 7.00 | 12.00 | 5.62 | 17.00 |
| DIESL GAL | 14.63 | 10.70 | 12.76 | 9.65 | 20.62 | 14.22 | 19.90 | 14.11 | 12.85 | 8.86 | 8.74 | 6.03 |
| MACH VARC | 9.16 | 7.07 | 6.62 | 4.57 | 7.21 | 4.97 | 5.61 | 3.87 | 7.49 | 5.24 | 6.66 | 4.59 |
| MACH FIXC | 37.21 | 30.38 | 36.31 | 27.44 | 23.42 | 16.15 | 22.66 | 15.63 | 21.91 | 15.35 | 26.53 | 20.41 |
| IRR USE EFF | 1.00 | 0.97 | 1.00 | 0.97 | 1.00 | 0.89 | 1.00 | 0.91 | 1.00 | 0.98 | 1.00 | 0.92 |

DRY CROP INPUTS BY CROP, TILL (CPDC)

| | COTTON | | BLNK | | SORGHUM | | SUNFLOWER | | FALLOW | | WHEAT | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CONV | LIMIT | CONV | LIMIT | CONV | LIMIT | CONV | LIMIT | CONV | LIMIT | CONV | LIMIT |
| LABOR HRS | 5.28 | 2.92 | 0.0 | 0.0 | 2.31 | 1.39 | 1.49 | 0.86 | 1.84 | 1.07 | 2.18 | 1.32 |
| SEED COST | 4.75 | 6.75 | 0.0 | 0.0 | 1.80 | 1.80 | 6.00 | 6.00 | 0.0 | 0.0 | 3.00 | 3.00 |
| BIOCIDE $ | 6.00 | 6.00 | 0.0 | 0.0 | 0.0 | 6.00 | 8.00 | 15.00 | 0.0 | 7.50 | 0.0 | 4.00 |
| DIESL GAL | 14.15 | 8.53 | 0.0 | 0.0 | 9.47 | 5.69 | 8.14 | 5.61 | 5.10 | 2.34 | 8.19 | 5.65 |
| MACH VARC | 6.74 | 5.12 | 0.0 | 0.0 | 4.01 | 2.41 | 2.21 | 1.28 | 3.19 | 1.81 | 3.58 | 2.47 |
| MACH FIXC | 31.16 | 28.73 | 0.0 | 0.0 | 17.37 | 13.36 | 16.20 | 11.17 | 15.63 | 9.09 | 19.63 | 15.10 |
| YLD CHANGE | 1.00 | 1.04 | 0.0 | 0.0 | 1.00 | 1.12 | 1.00 | 1.09 | 1.00 | 1.00 | 1.00 | 1.08 |

IF OPTION CODE 5 IS SET TO "1" THE LP SOLUTION FILE FOR EACH ITERATION IS PRINTED (ONLY VECTORS IN THE BASIS ARE FILED). THIS IS A VALUABLE CHECK ON THE MODEL OPERATION, ESPECIALLY FOR DEBUGGING AFTER MAKING CHANGES IN THE REPORT WRITER.

PRINTOUT OF THE LP ROW SECTION FOR HPT1

| * | STATUS | ACTIVITY | SLACK | LLIMIT | ULIMIT | DUALACT | NUMBER |
|---|---|---|---|---|---|---|---|
| VAR | BS | 165228. | -165228.3125 | -0.4523D+75 | *************** | 0.0 | 1. |
| FIX | BS | 107359. | -107359.0625 | -0.4523D+75 | *************** | 1.0000 | 2. |
| TWATER | UL | 6936. | 0.0 | -0.4523D+75 | 6936. | -3.7634 | 3. |
| WJN-FB | BS | 0. | 8919.9961 | -0.4523D+75 | 8920. | 0.0 | 4. |
| WMAR | BS | 1548. | 3139.2812 | -0.4523D+75 | 4687. | 0.0 | 5. |
| WAPR | BS | 3024. | 1510.8450 | -0.4523D+75 | 4535. | 0.0 | 6. |
| WMAY1 | BS | 0. | 2267.9998 | -0.4523D+75 | 2268. | 0.0 | 7. |
| WMAY2 | BS | 0. | 2418.9998 | -0.4523D+75 | 2419. | 0.0 | 8. |
| WJUN1 | BS | 0. | 1511.9998 | -0.4523D+75 | 1512. | 0.0 | 9. |
| WJUN2 | BS | 0. | 1511.9998 | -0.4523D+75 | 1512. | 0.0 | 10. |
| WJUN3 | BS | 0. | 1511.9998 | -0.4523D+75 | 1512. | 0.0 | 11. |
| WJLY1 | BS | 0. | 1511.9998 | -0.4523D+75 | 1512. | 0.0 | 12. |
| WJLY2 | BS | 854. | 808.9900 | -0.4523D+75 | 1663. | 0.0 | 13. |
| WJLY3 | BS | 0. | 1511.9998 | -0.4523D+75 | 1512. | 0.0 | 14. |
| WAUG1 | UL | 1512. | 0.0 | -0.4523D+75 | 1512. | -3.5527 | 15. |
| WAUG2 | BS | 0. | 1662.9998 | -0.4523D+75 | 1663. | 0.0 | 16. |
| WAUG3 | BS | 0. | 1511.9998 | -0.4523D+75 | 1512. | 0.0 | 17. |
| WSEP1 | BS | 0. | 2267.9998 | -0.4523D+75 | 2268. | 0.0 | 18. |
| WSEP2 | BS | 0. | 2267.9998 | -0.4523D+75 | 2268. | 0.0 | 19. |
| WOCT | BS | 0. | 4686.9961 | -0.4523D+75 | 4687. | 0.0 | 20. |
| WNO-DC | BS | 0. | 9222.0000 | -0.4523D+75 | 9222. | 0.0 | 21. |
| ESTOLO1 | UL | 30. | 0.0 | -0.4523D+75 | 30. | -94.5456 | 22. |
| ESTOL13 | UL | 30. | 0.0 | -0.4523D+75 | 30. | -62.6780 | 23. |
| LOFCLO1 | UL | 50. | 0.0 | -0.4523D+75 | 50. | -78.1400 | 24. |
| OLTNLO1 | UL | 160. | 0.0 | -0.4523D+75 | 160. | -99.2556 | 25. |
| OLTNL13 | UL | 80. | 0.0 | -0.4523D+75 | 80. | -83.8156 | 26. |
| PULCLO1 | UL | 650. | 0.0 | -0.4523D+75 | 650. | -68.7300 | 27. |

PRINTOUT OF THE LP COLUMNS SECTION FOR HPT1

| * | STATUS | ACTIVITY | ICOST | LLIMIT | ULIMIT | RCOST | NUMBER |
|---|---|---|---|---|---|---|---|
| CTDY--LL | BS | 332. | 68.7300 | 0.0 | **************** | 0.0 | 51. |
| CTOA-XLL | BS | 213. | 96.0900 | 0.0 | **************** | 0.0 | 99. |
| CT1C-XLG | BS | 50. | 132.1200 | 0.0 | **************** | 0.0 | 358. |
| CT1C-XLL | BS | 105. | 122.7100 | 0.0 | **************** | 0.0 | 363. |
| CT1C-ZLD | BS | 30. | 109.6300 | 0.0 | **************** | 0.0 | 397. |
| CT2B-ZLA | BS | 30. | 153.3900 | 0.0 | **************** | 0.0 | 570. |
| CT2B-ZLH | BS | 160. | 158.1000 | 0.0 | **************** | 0.0 | 576. |
| CT2B-ZLI | BS | 80. | 142.6600 | 0.0 | **************** | 0.0 | 577. |

OPTION CODE 5 ALSO CAUSES THE ECONOMIC DATA (STORED ON DIRECT ACCESS FILE 1) FOR THE SELECTED PRODUCTION ACTIVITIES TO BE PRINTED. OPTION CODE 4 IS USED IF THE STORED DATA FOR ALL LP PRODUCTION ACTIVITIES IS WANTED.
HOWEVER, CARE MUST BE USED SINCE OPTION CODE 4 CAUSES ALL PRODUCTION ACTIVITIES GENERATED TO BE PRINTED AND THAT CAN BE UP TO 10,000 LINES OF OUTPUT.

ACTIVITIES GENERATED

| ACT CODE | YLD | YLD2 | RETURN | T.WAT | LAB | DSL | NIT | PHOS | FUEL$ | VMACH$ | HARV$ | T VAR$ | NETV$ | FMACH$ | NETF$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CTDY--LL | 239.20 | 0.0 | 206.00 | 0.0 | 2.9 | 8.5 | 12.7 | 12.7 | 10.88 | 5.12 | 52.62 | 108.54 | 97.46 | 28.73 | 68.73 |
| CTOA-XLL | 420.00 | 0.0 | 361.71 | 7.3 | 5.8 | 10.7 | 22.4 | 22.4 | 34.61 | 9.03 | 92.40 | 208.97 | 152.74 | 56.65 | 96.09 |
| CT1C-XLG | 532.73 | 0.0 | 458.80 | 10.9 | 6.4 | 10.7 | 28.4 | 28.4 | 45.08 | 10.02 | 117.20 | 256.90 | 201.91 | 69.79 | 132.12 |
| CT1C-XLL | 517.00 | 0.0 | 445.25 | 10.9 | 6.4 | 10.7 | 27.6 | 27.6 | 45.08 | 10.02 | 113.74 | 252.75 | 192.50 | 69.79 | 122.71 |
| CT1C-ZLD | 485.53 | 0.0 | 418.15 | 9.5 | 5.1 | 10.7 | 25.9 | 25.9 | 42.14 | 12.72 | 106.82 | 236.19 | 181.96 | 72.33 | 109.63 |
| CT2B-ZLA | 607.96 | 0.0 | 523.59 | 12.7 | 5.2 | 10.7 | 32.4 | 32.4 | 51.64 | 14.58 | 133.75 | 283.89 | 239.69 | 86.30 | 153.39 |
| CT2B-ZLH | 615.65 | 0.0 | 530.21 | 12.7 | 5.2 | 10.7 | 32.8 | 32.8 | 51.64 | 14.53 | 135.44 | 285.87 | 244.34 | 86.25 | 158.10 |
| CT2B-ZLI | 590.00 | 0.0 | 508.12 | 12.7 | 5.2 | 10.7 | 31.4 | 31.4 | 51.64 | 14.58 | 129.80 | 279.16 | 228.96 | 86.30 | 142.66 |

PAGE ONE OF THE REPORT INCLUDES THE INPUTTED TITLE, THE ITERATION NUMBER AND YEARS COVERED, AS WELL AS THE CURRENT PRICE AND EFFICIENCY INDEX VALUES. THE ACTUAL PRICES FOR THE ITERATION (INPUTTED INDEX TIMES THE STORED BASE PRICE) ARE ALSO LISTED FOR EASY REFERENCE AND ERROR DETECTION.

HALE CO, AVE PRICE, GWL= 3FT,FIX,11/2/83 ITERATION 1 YEARS 1980 TO 1985 PAGE 16

| PRICE CHANGE | | | CURRENT PRICE | | | EFFICIENCY & YIELD | | |
|---|---|---|---|---|---|---|---|---|
| NGAS | INDEX | 1.000 | ELEC | KWH | 0.04 | P-EF | INDEX | 0.550 |
| DESL | INDEX | 1.000 | NGAS | MCF | 3.85 | P-% | INDEX | 0.800 |
| LAB | INDEX | 1.000 | DESL | GAL | 1.16 | LAB | INDEX | 1.000 |
| MACH | INDEX | 1.000 | NIT | LB | 0.28 | MACH | INDEX | 1.000 |
| CHEM | INDEX | 1.000 | PHOS | LBS | 0.30 | Y-CT | INDEX | 1.000 |
| CAPL | INDEX | 1.000 | LAB | HRS | 5.00 | Y-CO | INDEX | 1.000 |
| WHET | INDEX | 1.000 | CAPL | DEC | 0.10 | Y-GS | INDEX | 1.000 |
| COTN | INDEX | 1.000 | BIOC | IDEX | 1.00 | Y-SU | INDEX | 1.000 |
| FEED | INDEX | 1.000 | MACH | IDEX | 1.00 | Y-SO | INDEX | 1.000 |
| OILS | INDEX | 1.000 | HARV | IDEX | 1.00 | Y-WT | INDEX | 1.000 |
| | | | COTN | LBS | 0.74 | | | |
| | | | CORN | BU. | 3.95 | | | |
| | | | SORG | CWT | 5.95 | | | |
| | | | SUNF | CWT | 15.17 | | | |
| | | | SOYB | BU. | 8.08 | | | |
| | | | WHET | BU. | 4.71 | | | |
| | | | COTS | TON | 151.53 | | | |
| | | | WGRZ | AUM | 9.00 | | | |
| | | | - | - | 0.0 | | | |
| | | | - | - | 0.0 | | | |

PAGE TWO DETAILS THE GROUNDWATER AND IRRIGATION RESULTS FOR THE ITERATION. THIS INCLUDES THE STARTING AND ENDING SATURATED THICKNESS, PUMP LIFT AND WELL YIELD, AS WELL AS, THE TOTAL PUMPAGE LIMIT, IF ANY, THE ACTUAL AMOUNT PUMPED AND THE SHADOW PRICE OF THE IRRIGATION WATER IF THE LIMIT IS REACHED. THE AMOUNT OF IRRIGATION WATER AVAILABLE, THE ACTUAL USAGE, AND SHADOW PRICES FOR EACH OF THE 18 IRRIGATION PERIODS IS LISTED NEXT. THIS MAKES IT EASIER TO IDENTIFY THE CRITICAL WATER PERIODS AND THE MARGINAL VALUE OF WATER DURING TIMES OF PEAK DEMAND. INFORMATION ON THE COSTS ASSOCIATED WITH EACH IRRIGATION DISTRIBUTION SYSTEM AND THE ACREAGE IRRIGATED BY EACH MAKES UP THE LAST TABLE ON PAGE TWO.

GROUND WATER SITUATION

| | SATURATED THICKNESS | PUMP LIFT | CAPACITY (GPM) |
|---|---|---|---|
| START | 139.00 | 281.00 | 390.30 |
| END | 123.99 | 296.01 | 347.39 |
| CHANGE | -15.01 | 15.01 | -42.91 |

| ANNUAL AC-FT | |
|---|---|
| AVAIL | 578.00 |
| PUMPED | 578.00 |
| S. PRICE | 45.16 |

WATER USE PER PERIOD (AC-IN)

| | WJN-FB | WMAR | WAPR | WMAY1 | WMAY2 | WJUN1 | WJUN2 | WJUN3 | WJLY1 |
|---|---|---|---|---|---|---|---|---|---|
| WATER AVAIL | 8920. | 4687. | 4535. | 2268. | 2419. | 1512. | 1512. | 1512. | 1512. |
| WATER USED | 0. | 1548. | 3024. | 0. | 0. | 0. | 0. | 0. | 0. |
| SHADOW PRICE | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

WATER USE PER PERIOD (AC-IN)

| | WJLY2 | WJLY3 | WAUG1 | WAUG2 | WAUG3 | WSEP1 | WSEP2 | WOCT | WNO-DC |
|---|---|---|---|---|---|---|---|---|---|
| WATER AVAIL | 1663. | 1512. | 1512. | 1663. | 1512. | 2268. | 2268. | 4687. | 9222. |
| WATER USED | 854. | 0. | 1512. | 0. | 0. | 0. | 0. | 0. | 0. |
| SHADOW PRICE | 0.0 | 0.0 | 3.55 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

IRRIGATION PUMPING & DISTRIBUTION

| PER ACIN | FURROW | IMP FURROW | SPRINKLER | IMP SPRINKLER |
|---|---|---|---|---|
| ANN FIX C | 3.53 | 3.61 | 4.17 | 4.42 |
| ANN VAR C | 3.95 | 4.01 | 5.39 | 4.49 |
| LABOR HRS | 0.105 | 0.157 | 0.035 | 0.045 |
| IRR EFFIC | 0.690 | 0.800 | 0.800 | 0.920 |
| NGAS COST | 2.880 | 2.880 | 4.051 | 3.002 |
| ACRES | 0. | 368. | 0. | 300. |
| WATER USED | 0. | 3241. | 0. | 3714. |

PAGE THREE LISTS THE COSTS AND RETURNS FOR EACH PRODUCTION ACTIVITY ON A PER ACRE AND TOTAL AREA PLANTED BASIS. USE LEVELS FOR THE MAJOR INPUTS ARE GIVEN BOTH TO ALLOW CHECKING FOR PLAUSIBILITY AND FOR COMPARISON ACROSS CROP, TILLAGE METHOD AND SOIL TYPES. AFTER ALL PRODUCTION ACTIVITIES ARE LISTED, TOTALS FOR THE WHOLE FARM OR REGION BEING MODELED ARE REPORTED.

HALE CO, AVE PRICE, GWL= 3FT,FIX,11/2/83 ITERATION 1 YEARS 1980 TO 1985 PAGE 3

CROP COSTS AND PRODUCTION

| ACT CODE | RETURN | T.WAT | LAB | DSL | NIT | PHOS | FUEL$ | VMACH$ | HARV$ | T VAR$ | NETV$ | FMACH$ | NETF$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CTDY--LL | | | | | | | | | | | | | |
| PER AC | 206.00 | 0.0 | 2.9 | 8.5 | 12.7 | 12.7 | 10.88 | 5.12 | 52.62 | 108.54 | 97.46 | 28.73 | 68.73 |
| TOTAL | 68481. | 0. | 964. | 2826. | 4222. | 4222. | 3617. | 1702. | 17492. | 36082. | 32399. | 9551. | 22848. |
| CTOA-XLL | | | | | | | | | | | | | |
| PER AC | 361.71 | 7.3 | 5.8 | 10.7 | 22.4 | 22.4 | 34.61 | 9.03 | 92.40 | 208.97 | 152.74 | 56.65 | 96.09 |
| TOTAL | 76952. | 1553. | 1234. | 2276. | 4765. | 4765. | 7363. | 1921. | 19658. | 44457. | 32495. | 12052. | 20443. |
| CT1C-XLG | | | | | | | | | | | | | |
| PER AC | 458.80 | 10.9 | 6.4 | 10.7 | 28.4 | 28.4 | 45.08 | 10.02 | 117.20 | 256.90 | 201.91 | 69.79 | 132.12 |
| TOTAL | 22940. | 545. | 320. | 535. | 1420. | 1420. | 2254. | 501. | 5860. | 12845. | 10096. | 3489. | 6606. |
| CT1C-XLL | | | | | | | | | | | | | |
| PER AC | 445.25 | 10.9 | 6.4 | 10.7 | 27.6 | 27.6 | 45.08 | 10.02 | 113.74 | 252.75 | 192.50 | 69.79 | 122.71 |
| TOTAL | 46674. | 1143. | 671. | 1122. | 2893. | 2893. | 4726. | 1050. | 11923. | 26495. | 20179. | 7316. | 12863. |
| CT1C-ZLD | | | | | | | | | | | | | |
| PER AC | 418.15 | 9.5 | 5.1 | 10.7 | 25.9 | 25.9 | 42.14 | 12.72 | 106.82 | 236.19 | 181.96 | 72.33 | 109.63 |
| TOTAL | 12544. | 285. | 153. | 321. | 777. | 777. | 1264. | 382. | 3205. | 7086. | 5459. | 2170. | 3289. |
| CT2B-ZLA | | | | | | | | | | | | | |
| PER AC | 523.59 | 12.7 | 5.2 | 10.7 | 32.4 | 32.4 | 51.64 | 14.58 | 133.75 | 283.89 | 239.69 | 86.30 | 153.39 |
| TOTAL | 15708. | 381. | 156. | 321. | 972. | 972. | 1549. | 437. | 4013. | 8517. | 7191. | 2589. | 4602. |
| CT2B-ZLH | | | | | | | | | | | | | |
| PER AC | 530.21 | 12.7 | 5.2 | 10.7 | 32.8 | 32.8 | 51.64 | 14.53 | 135.44 | 285.87 | 244.34 | 86.25 | 158.10 |
| TOTAL | 84834. | 2032. | 832. | 1712. | 5248. | 5248. | 8262. | 2325. | 21670. | 45739. | 39094. | 13800. | 25296. |
| CT2B-ZLI | | | | | | | | | | | | | |
| PER AC | 508.12 | 12.7 | 5.2 | 10.7 | 31.4 | 31.4 | 51.64 | 14.58 | 129.80 | 279.16 | 228.96 | 86.30 | 142.66 |
| TOTAL | 40650. | 1016. | 416. | 856. | 2512. | 2512. | 4131. | 1166. | 10384. | 22333. | 18317. | 6904. | 11413. |
| TOT | 368781. | 6955. | 4746. | 9969. | 22810. | 22810. | 33166. | 9485. | 94204. | 203553. | 165228. | 57871. | 107359. |

PAGE FOUR CONTAINS 4 TABLES. THE FIRST SUMMARIZES ACREAGE, PRODUCTION AND VALUE OF PRODUCTION FOR EACH OF THE SIX POSSIBLE CROPS. THE NEXT LISTS THE SOILS INPUTTED, THE ACREAGE OF EACH USED FOR CROP PRODUCTION AND THE SHADOW PRICE ON THE LAST ACRE AVAILABLE, IF THE SOIL IS COMPLETELY PLANTED. THE THIRD SHOWS AVAILABLE CROPLAND, AND HOW IT IS DIVIDED AMONG DRYLAND, IRRIGATED, AND FALLOW ACREAGE. THE FINAL TABLE ON PAGE FOUR AGAIN LISTS THE PRODUCTION ACTIVITIES AND SHOWS THE SOIL INVOLVED, WHETHER TERRACES ARE EMPLOYED, ACREAGE PLANTED, CROPS GROWN AND THEIR PER ACRE YIELD.

HALE CO. AVE PRICE, GWL= 3FT,FIX,11/2/83 ITERATION 1 YEARS 1980 TO 1985 PAGE 4

CROP PRODUCTION AND VALUE

| | COTTON | | SORGHUM | | SUNFLOWER | | WHEAT | | CORN | SOYBEAN |
|---|---|---|---|---|---|---|---|---|---|---|
| | DRY | IRR | DRY | IRR | DRY | IRR | DRY | IRR | | |
| ACREAGE | 332. | 668. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| PROD | 79517. | 348693. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| VALUE | 68482. | 300302. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |

LAND USE

| SOIL | ACRES | SHADOW PRICE |
|---|---|---|
| ESTOL01 | 30.00 | 94.55 |
| ESTOL13 | 30.00 | 62.68 |
| LOFCL01 | 50.00 | 78.14 |
| OLTNL01 | 160.00 | 99.26 |
| OLTNL13 | 80.00 | 83.82 |
| PULCL01 | 650.00 | 68.73 |

| | | | |
|---|---|---|---|
| AVAIL CROPLAND | 1000. | AC. | |
| DRYLAND | 332. | AC | 33.2 % |
| IRRIG | 668. | AC | 66.8 % |
| FALLOW | 0. | AC | 0.0 % |

| ACTIVITY | SOIL | TERRACE | ACRES | CROP1 | YIELD | CROP2 | YIELD |
|---|---|---|---|---|---|---|---|
| CTDY--LL | PULCL01 | - | 332.43 | CT | 239.20 | - | 0.0 |
| CTOA-XLL | PULCL01 | - | 212.74 | CT | 420.00 | - | 0.0 |
| CT1C-XLG | LOFCL01 | - | 50.00 | CT | 532.73 | - | 0.0 |
| CT1C-XLL | PULCL01 | - | 104.83 | CT | 517.00 | - | 0.0 |
| CT1C-ZLD | ESTOL13 | - | 30.00 | CT | 485.53 | - | 0.0 |
| CT2B-ZLA | ESTOL01 | - | 30.00 | CT | 607.96 | - | 0.0 |
| CT2B-ZLH | OLTNL01 | - | 160.00 | CT | 615.65 | - | 0.0 |
| CT2B-ZLI | OLTNL13 | - | 80.00 | CT | 590.00 | - | 0.0 |

WHEN A MULTI-YEAR TEMPORAL SITUATION IS MODELED, THE REPORT WRITER PRINTS A FINAL SUMMARY. THE SUMMARY IS SIX PAGES IN LENGTH. THE FIRST PAGE LISTS THE PRICE, EFFICIENCY AND YIELD INDICES FROM THE INPUT DATA. THIS ALLOWS A QUICK CHECK ON THE ITERATION RELATED INPUT, BOTH FOR ERROR DETECTION AND AS A REMINDER OF TRENDS DESIGNED INTO A PARTICULAR RUN.

HALE CO, AVE PRICE, GWL= 3FT,FIX,11/2/83 SUMMARY PAGE 70

PRICE AND YIELD INDEX CHANGES

PRICES

| PERIOD | NGAS | DESL | LAB | MACH | CHEM | CAPL | WHET | COTN | FEED | OILS |
|---|---|---|---|---|---|---|---|---|---|---|
| 1980-1985 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 1985-1990 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 1990-1995 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 1995-2000 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 2000-2005 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 2005-2010 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 2010-2015 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 2015-2020 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

EFFICIENCY & YIELD

| PERIOD | P-EF | P-% | LAB | MACH | Y-CT | Y-CO | Y-GS | Y-SU | Y-SO | Y-WT |
|---|---|---|---|---|---|---|---|---|---|---|
| 1980-1985 | 0.55 | 0.80 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 1985-1990 | 0.55 | 0.80 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 1990-1995 | 0.55 | 0.80 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 1995-2000 | 0.55 | 0.80 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 2000-2005 | 0.55 | 0.80 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 2005-2010 | 0.55 | 0.80 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 2010-2015 | 0.55 | 0.80 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 2015-2020 | 0.55 | 0.80 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

THE SECOND PAGE DELINEATES THE CHANGE IN THE GROUNDWATER SITUATION OVER THE TIME HORIZON. THE DECLINE IN AQUIFER SATURATED THICKNESS AND SUBSEQUENT WELL YIELD CAPACITY IS SHOWN BY ITERATION, ALONG WITH THE INCREASING PUMP LIFT. ACRE-FEET OF WATER PUMPED PER PERIOD IS ALSO GIVEN, AS WELL AS, THE LIMIT ON TOTAL PUMPAGE, IF ANY. FOR THOSE ITERATIONS WHERE THE TOTAL PUMPAGE CONSTRAINT IS BINDING, THE SHADOW PRICE ON THE MARGINAL ACRE FOOT PUMPED IS REPORTED.

HALE CO, AVE PRICE, GWL= 3FT,FIX,11/2/83 SUMMARY PAGE 71

GROUND WATER SITUATION

| PERIOD | SATURATED THICKNESS FT | PUMP LIFT FT | CAPACITY GPM | | TOTAL WATER (ACFT) PUMPED | AVAIL | S. PRICE |
|---|---|---|---|---|---|---|---|
| 1980-1985 | 139.00 | 281.00 | 390.30 | | 2890. | 2890. | 45.16 |
| 1985-1990 | 123.99 | 296.01 | 347.39 | | 2890. | 2890. | 35.70 |
| 1990-1995 | 108.99 | 311.01 | 303.29 | | 2890. | 2890. | 28.65 |
| 1995-2000 | 93.98 | 326.02 | 258.56 | | 2890. | 2890. | 24.02 |
| 2000-2005 | 78.98 | 341.02 | 213.78 | | 2552. | 2890. | 0.0 |
| 2005-2010 | 65.73 | 354.27 | 174.64 | | 2085. | 2890. | 0.0 |
| 2010-2015 | 54.90 | 365.10 | 143.24 | | 1641. | 2890. | 0.0 |
| 2015-2020 | 46.38 | 373.62 | 119.04 | | 1327. | 2890. | 0.0 |
| END | 39.49 | 380.51 | 99.89 | TOTAL | 19165. | | |

THE THIRD AND FOURTH PAGES OF THE SUMMARY GIVE THE ANNUAL ACREAGE, PRODUCTION, YIELD AND VALUE BY IRRIGATED AND DRYLAND CROPPING FOR EACH ITERATION. THIS OVERVIEW OF THE SHIFTS IN CROPPING PATTERN AND INTENSITY OF PRODUCTION IS HELPFUL WHEN ANALYZING THE RESPONSE TO DECREASING WATER SUPPLIES UNDER DIFFERENT SCENARIOS.

HALE CO, AVE PRICE, GWL= 3FT,FIX,11/2/83 SUMMARY PAGE 72

ANNUAL IRRIG. ACREAGE AND CROP PRODUCTION

| | COTTON | | CORN | | SORGHUM | | SUNFLOWER | | SOYBEAN | | WHEAT | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ACRE | PROD 000LB | ACRE | PROD 000BU | ACRE | PROD TON | ACRE | PROD TON | ACRE | PROD 000BU | ACRE | PROD 000BU |
| 1980-1985 | 668. | 348.69 | 0. | 0.0 | 0. | 0.0 | 0. | 0.0 | 0. | 0.0 | 0. | 0.0 |
| 1985-1990 | 690. | 353.86 | 0. | 0.0 | 0. | 0.0 | 0. | 0.0 | 0. | 0.0 | 0. | 0.0 |
| 1990-1995 | 714. | 359.19 | 0. | 0.0 | 0. | 0.0 | 0. | 0.0 | 0. | 0.0 | 0. | 0.0 |
| 1995-2000 | 738. | 364.47 | 0. | 0.0 | 0. | 0.0 | 0. | 0.0 | 0. | 0.0 | 0. | 0.0 |
| 2000-2005 | 642. | 320.06 | 0. | 0.0 | 0. | 0.0 | 0. | 0.0 | 0. | 0.0 | 0. | 0.0 |
| 2005-2010 | 532. | 265.33 | 0. | 0.0 | 0. | 0.0 | 0. | 0.0 | 0. | 0.0 | 0. | 0.0 |
| 2010-2015 | 428. | 214.09 | 0. | 0.0 | 0. | 0.0 | 0. | 0.0 | 0. | 0.0 | 0. | 0.0 |
| 2015-2020 | 350. | 176.03 | 0. | 0.0 | 0. | 0.0 | 0. | 0.0 | 0. | 0.0 | 0. | 0.0 |

ANNUAL IRRIG. YIELDS AND VALUE

| | COTTON | | CORN | | SORGHUM | | SUNFLOWER | | SOYBEAN | | WHEAT | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | YLD LB | VALU 000$ | YLD BU | VALU 000$ | YLD CWT | VALU 000$ | YLD CWT | VALU 000$ | YLD BU | VALU 000$ | YLD BU | VALU 000$ |
| 1980-1985 | 522.3 | 300.30 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 1985-1990 | 512.5 | 304.76 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 1990-1995 | 503.1 | 309.34 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 1995-2000 | 494.0 | 313.89 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2000-2005 | 498.2 | 275.64 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2005-2010 | 498.8 | 228.51 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2010-2015 | 500.0 | 184.38 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2015-2020 | 502.9 | 151.60 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

ANNUAL DRYLAND ACREAGE AND CROP PRODUCTION

| | COTTON | | SORGHUM | | SUNFLOWER | | WHEAT | |
|---|---|---|---|---|---|---|---|---|
| | ACRE | PROD 000LB | ACRE | PROD TON | ACRE | PROD TON | ACRE | PROD 000BU |
| 1980-1985 | 332. | 79.52 | 0. | 0.0 | 0. | 0.0 | 0. | 0.0 |
| 1985-1990 | 310. | 74.05 | 0. | 0.0 | 0. | 0.0 | 0. | 0.0 |
| 1990-1995 | 286. | 68.42 | 0. | 0.0 | 0. | 0.0 | 0. | 0.0 |
| 1995-2000 | 262. | 62.72 | 0. | 0.0 | 0. | 0.0 | 0. | 0.0 |
| 2000-2005 | 358. | 85.53 | 0. | 0.0 | 0. | 0.0 | 0. | 0.0 |
| 2005-2010 | 468. | 111.97 | 0. | 0.0 | 0. | 0.0 | 0. | 0.0 |
| 2010-2015 | 572. | 136.79 | 0. | 0.0 | 0. | 0.0 | 0. | 0.0 |
| 2015-2020 | 650. | 155.48 | 0. | 0.0 | 0. | 0.0 | 0. | 0.0 |

ANNUAL DRYLAND YIELDS AND VALUE

| | COTTON | | SORGHUM | | SUNFLOWER | | WHEAT | |
|---|---|---|---|---|---|---|---|---|
| | YLD LB | VALU 000$ | YLD CWT | VALU 000$ | YLD CWT | VALU 000$ | YLD BU | VALU 000$ |
| 1980-1985 | 239.20 | 68.48 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 1985-1990 | 239.20 | 63.77 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 1990-1995 | 239.20 | 58.92 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 1995-2000 | 239.20 | 54.02 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2000-2005 | 239.20 | 73.66 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2005-2010 | 239.20 | 96.43 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2010-2015 | 239.20 | 117.81 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2015-2020 | 239.20 | 133.90 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

THE FIFTH PAGE REPEATS THE CROP COSTS TOTALS FOR EACH ITERATION AS A TREND OVERVIEW.

HALE CO. AVE PRICE, GWL= 3FT,FIX,11/2/83 SUMMARY PAGE 74

ANNUAL CROP COSTS AND PRODUCTION

| PERIOD | RETURN $000 | T.WAT AC-FT | LAB HRS | DSL GAL | NIT TON | PHOS TON | FUEL$ $000 | VAR MA $000 | HARVT $000 | TOT VAR $000 | REV-VAR $000 | FX MA $000 | REV-TOT $000 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 80-85 | 369. | 580. | 4746. | 9969. | 11. | 11. | 33. | 9. | 94. | 204. | 165. | 58. | 107. |
| 85-90 | 369. | 580. | 4785. | 10019. | 11. | 11. | 34. | 10. | 94. | 205. | 164. | 62. | 101. |
| 90-95 | 368. | 580. | 4825. | 10071. | 11. | 11. | 35. | 10. | 94. | 206. | 162. | 65. | 97. |
| 95- 0 | 368. | 580. | 4865. | 10123. | 11. | 11. | 37. | 10. | 94. | 208. | 160. | 67. | 93. |
| 0- 5 | 349. | 512. | 4583. | 9913. | 11. | 11. | 34. | 9. | 89. | 197. | 152. | 63. | 89. |
| 5-10 | 325. | 418. | 4241. | 9670. | 10. | 10. | 31. | 9. | 83. | 182. | 143. | 58. | 84. |
| 10-15 | 302. | 329. | 3924. | 9442. | 9. | 9. | 27. | 8. | 77. | 168. | 134. | 54. | 80. |
| 15-20 | 286. | 266. | 3689. | 9270. | 9. | 9. | 24. | 8. | 73. | 157. | 128. | 52. | 76. |

THE LAST PAGE OF THE SUMMARY SHOWS CROPLAND USE BY ITERATION AND NET PRESENT VALUE AT THE CHOSEN DISCOUNT RATES.

PAGE 75

CROPLAND USAGE FOR 1000. AVAIL ACRES

| PERIOD | DRY | % | IRRIG | % | FALLOW | % |
|---|---|---|---|---|---|---|
| 1980-1985 | 332. | 33.2 | 668. | 66.8 | 0. | 0.0 |
| 1985-1990 | 310. | 31.0 | 690. | 69.0 | 0. | 0.0 |
| 1990-1995 | 286. | 28.6 | 714. | 71.4 | 0. | 0.0 |
| 1995-2000 | 262. | 26.2 | 738. | 73.8 | 0. | 0.0 |
| 2000-2005 | 358. | 35.8 | 642. | 64.2 | 0. | 0.0 |
| 2005-2010 | 468. | 46.8 | 532. | 53.2 | 0. | 0.0 |
| 2010-2015 | 572. | 57.2 | 428. | 42.8 | 0. | 0.0 |
| 2015-2020 | 650. | 65.0 | 350. | 35.0 | 0. | 0.0 |

1980 PRESENT VALUE OF RETURNS OVER VARIABLE COST UPTO 2020 AT A DISCOUNT RATE OF 2.00 = $ 4208393.

4.00 = $ 3093372.

6.00 = $ 2381897.

OVER VARIABLE AND FIXED COST (EXCLUDING LAND, WATER AND MANAGEMENT) AT A RATE OF 2.00 = $ 2551133.

4.00 = $ 1887247.

6.00 = $ 1462474.

# IV

# FORTRAN SOURCE PROGRAM

```
C
C  FORTRAN FOR RECURSIVE PROGRAMMING MODEL OF HIGH PLAINS CROP AGRICULTURE
C
C**********************************************************************
C*      ORIGINAL CREATED JAN 1983 BY DUANE RENEAU                    **
C*      REPORT WRITER REVISED BY JOHN ELLIS JUNE 1983                **
C*      VERSION NOVEMBER 1983                                        **
C**********************************************************************
C
C** INTERNAL DATA FILES
C
      BLOCK DATA
C
      COMMON /COST/ PRIC(20),DSYS ( 4,6),SOAM(3,3,6)
C
C  PRIC = INITIAL PRICES
C  DSYS = IRR DISTRIBUTION SYSTEMS DATA
C  SOAM = SOIL TOPOGRAPHY AMELIORATION (TERRACES) DATA
C
      DATA PRIC /.04,3.85,1.16,.28,.30,5.,.1,1.,1.,1.,
     1          .74,3.95,5.95,15.17,8.08,4.71,151.53,9.,0.,0./
      DATA DSYS /1.06,1.14,1.61,1.93,  .21,.27,.46,.59,
     1            32.1,32.1,43.5,34.6,  .1,.15,.033,.043,
     2            2.,2.,117.,14.,    .69,.80,.80,.92/
      DATA SOAM /1.,1.02,1.01,1.,1.03,1.02,1.,1.05,1.03,
     *    0.,5.1,1.74,0.,7.8,2.88,0.,8.94,3.84,
     *    0.,4.43,1.52,0.,6.78,2.5,0.,7.76,3.34,
     *    1.,1.05,1.03,1.,1.07,1.05,1.,1.1,1.07,
     *    1.,1.1,1.05,1.,1.15,1.09,1.,1.2,1.12,
     *    1.,.95,.967,1.,.92,.96,1.,.9,.93/
C
      COMMON /C6PI/  CTI (7,20),COI (10,20),GSI(14,20),SUI(13,20),
     1   SOI(6,20),WTI(9,20),MX(4,24),MYRS(5),MY1CHA(5),MFAL(5)
C
C   CTI = COTTON (IRR) YIELD, WATER REQUIREMENT BY PERIOD,IRREG CODE
C   COI = CORN, GSI = GRAIN SORGHUM, SUI = SUNFLOWERS, SOI = SOYBEANS
C  MX = MATRIX OF ROTATION INFO
C        24 MIXED OR DRYLAND ROTATIONS
C        MX(1,IM) = FIRST CROP NO.
C        MX(2,IM) = FIRST CROP IRRIG REGIME NO.
C        MX(3,IM) = SECOND CROP NO.
C        MX(4,IM) = SECOND CROP % YIELD CHANGE
C  MFAL = PERCENT FALLOW IN DRYLAND ROTATIONS
C  MYRS = NO. YEARS IN EACH DRYLAND ROTATION
C  MY1CHA = PERCENT CHANGE IN 1ST CROP YIELD DUE TO ROTATION
```

```
C
       DATA  CTI /230.,420.,450.,470.,517.,588.,590.,8*0.,2*6.,2*0.,6.,
     1  4*0.,2*6.,0.,6.,30*0.,3.,2*0.,3.,11*0.,3.,2*0.,3.,11*0.,3*3.,
     2  42*0.,'DY','0A','1C','1B','1A','2B','2A' /
       DATA COI  /116.,107.,102.,120.,122.,126.,146.,136.,137.,148.,
     1  10*0.,6.,2*0.,6.,2*0.,6.,0.,2*6.,0.,2*6.,0.,2*6.,0.,6.,
     *  55*0.,3.,0.,0.,16*3.,0.,5*3.,0.,3.,3.,0.,8*3.,
     2  11*0.,3.,3.,0.,3.,0.,3.,0.,3.,3.,5*0.,3.,0.,3*3.,30*0.,
     3  '3A','3B','3C','4C','4B','4A','5A','5B','5C','6A' /
       DATA GSI /15.,45.1,50.4,53.7,51.9,45.39,47.18,63.,60.5,59.42,
     1  63.84,59.33,69.,63.33, 30*0.,2*6.,3*0.,6.,7*0.,6.,2*0.,6.,
     2  3*0.,6.,3*0.,6.,26*0.,5.,8*0.,4.,3*0.,4.,8*0.,4.,3*0.,4.,3*0.,
     *  4.,2*0.,3.,4*0.,3.,4*0.,3.,18*0.,2*3.,2*0.,
     32*3.,3*0.,3.,7*0.,3.,3*0.,2*3.,0.,3.,0.,3*3.,3*0.,2*3.,3*0.,3.,5*0
     4.,3.,3*0.,2*3.,0.,3*3.,5*0.,3.,3*0.,2*3.,2*0.,3.,5*0.,2*3.,
     5  2*0.,3*3.,15*0.,3.,14*0.,'DY','1A','2C','2A','2B','2E','2D',
     6  '3B','3C','3D','3A','3E','4A','4B'/
       DATA SUI /8.04,15.48,17.97,19.60,20.78,15.48,17.97,19.60,20.78,
     1 15.48,17.97,19.6,20.78, 14*0.,4*6.,13*0.,4*6.,13*0.,4*6.,28*0.,
     2 3*3.,14*0.,3*3.,5*0.,3.,0.,2*3.,5*0.,3*3.,2*0.,3.,2*0.,3.,0.,
     3 2*3.,7*0.,2*3.,0.,3.,2*0.,3.,0.,2*3.,4*0.,3.,2*0.,2*3.,0.,3.,
     4 10*0.,3.,2*0.,2*3.,12*0.,3.,52*0., 'DY','1A','2A','3A','4A','1M',
     5 '2M','3M','4M','1Y','2Y','3Y','4Y' /
       DATA SDI /32.6,28.4,44.6,39.7,33.8,49.,12*0.,6.,2*0.,6.,0.,6.,
     1  0.,2*6.,0.,4.,17*0.,3.,10*0.,3.,0.,4*3.,0.,2*3.,7*0.,3*3.,0.,
     2  2*3.,0.,4*3.,30*0.,'2A','2B','3A','3B','3C','4A' /
       DATA WTI /16.2,38.8,31.2,56.8,56.1,66.,62.7,72.7,73.,8*0.,3.,3*0.,
     1  3*3.,0.,3.,2*0.,3.,0.,3.,2*0.,3*3.,2*0.,3.,0.,5*3.,5*0.,4*3.,
     2  91*0.,6.,0.,6.,0.,6.,0.,6.,3*0.,6.,0.,6.,0.,6.,0.,6., 9*0.,
     3  'DY','1A','1B','2A','2B','3A','3B','4B','4A'/
       DATA MX /6,8,1,15,6,9,1,15,6,7,3,11, 6,8,3,15, 6,9,3,15,6,7,4,9,
     1    6,8,4,12, 6,9,4,12,  3,8,6,5, 3,13,6,8, 4,5,6,18, 4,9,6,15,
     2 4,13,6,13, 5,3,6,18, 5,6,6,18, 6,8,6,55, 6,9,6,55, 3,13,3,55,
     3 3,14,3,55, 6,1,6,-100, 6,1,3,0, 6,1,4,0, 6,1,3,40, 6,1,4,30 /
       DATA   MFAL /50,33,33,50,50 /,MYRS /2,2,2,3,3/
       DATA MY1CHA /60,30,25,60,50 /
C
       COMMON /CROPI/ CPIC(7,2,6),CPDC(7,2,6)
C
C  CPIC  = IRRIGATION CROP PRODUTION INPUT COSTS BY CROP, TILLAGE
C  CPDC  = DRYLAND CROP PROD INPUT COSTS BY CROP, TILLAGE
C
       DATA CPIC /6.13,9.,0.,14.63,9.16,37.21,1.,4.64,9.,6.,10.70,
     1  7.07,30.38,.97,  4.61,17.2,28.,12.76,6.62,36.31,1.,  2.73,
     2  17.2,42., 9.65,4.57,27.44,.97,  5.39,3.6,10.5,20.62,7.21,
     3  23.42,1.,  3.72,3.6,17.,14.22,4.97,16.15,.89,5.40,10.,12.,19.9,
     *  5.61,22.66,1.,  3.14,10.,20.,14.11,3.87,15.63,.91,
     4          4.55,13.8,7.,12.85,7.49,21.91,1.,  2.83,13.8,12.,8.86,
     5  5.24,15.35,.98,  3.1,9.75,5.62, 8.74,6.66,26.53,1., 1.88,
     6  9.75,17.,6.03,4.59,20.41,.92 /
       DATA CPDC /5.28,4.75,6.,14.15,6.74,31.16,1., 2.92,6.75,6.,8.53,
     1 5.12,28.73,1.04, 14*0., 2.31,1.8,0., 9.47,4.01,17.37,1., 1.39,
     2 1.8,6.,5.69,2.41,13.36,1.12,  1.49,6.,8., 8.14,2.21,16.20,1.,
     * .86,6.,15.,5.61,1.28,11.17,1.09,  1.84,0.,0.,5.10,
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```
     3 3.19,15.63,1., 1.07,0.,7.5,2.34,1.81,9.09,1.,2.18,3.0,0.,8.19,
     4 3.58,19.63,1., 1.32,3.0,4.,5.65,2.47,15.10,1.08 /
C
      COMMON /NAM/  COD(21),WPER(2,18),CLD(20),TCOD(3,3),LPNM(20)
C
C   COD = CROP, TILLAGE, IRR DIST SYSTEMS ID CODES
C  WPER  = IRRIGATION WATER PERIODS CODES
C  CLD = CODE FOR LAND CLASSES A THRU T FOR LC 1-20
C  TCOD = TERRACING TYPE, SLOPE CODE
C  LPNM = NAME FOR LP INPUT DATA FOR EACH ITERATION
C
      DATA  COD /' CT',' CO',' GS',' SU',' SO',' WT','DY','-F','G','S',
     1  '-','W','V','X','Y','Z','C','L','-','F','F' /
      DATA WPER /'WJN-','FB  ','WMAR',' ','WAPR',' ','WMAY','1   ',
     1 'WMAY','2   ','WJUN','1   ','WJUN','2   ','WJUN','3   ',
     2 'WJLY','1   ','WJLY','2   ','WJLY','3   ','WAUG','1   ',
     3 'WAUG','2   ','WAUG','3   ','WSEP','1   ','WSEP','2   ',
     4 'WOCT',' ',    'WNO-','DC  ' /
      DATA CLD /'A','B','C','D','E','F','G','H','I','J','K','L','M',
     1   'N','O','P','Q','R','S','T' /
      DATA TCOD /'-  ','BNCH','CBT','-  ','BNCH','CBT','-  ',
     *          'BNCH','CBT' /
      DATA LPNM /'HPT1','HPT2','HPT3','HPT4','HPT5','HPT6','HPT7',
     1  'HPT8','HPT9','HP10','HP11','HP12','HP13','HP14','HP15',
     2  'HP16','HP17','HP18','HP19','HP20' /
C
      COMMON /INAM/ IPRICN(2,20),IPCHAN(10),IECHAN(10),IENEWN(20)
C
C  IPRICN = NAMES & UNITS FOR INPUTS, COMMODITIES
C  IPCHAN = NAMES FOR INPUT & COMMODY CHANGE INDICES
C  IECHAN = NAMES FOR EFFICENCY CHANGE INDICES
C  IENEWN = NAMES OF UPDATED EFFICENCIES
C
      DATA IPRICN /'ELEC','KWH','NGAS','MCF','DESL','GAL','NIT','LB',
     1'PHOS','LBS','LAB','HRS','CAPL','DEC','BIOC','IDEX','MACH','IDEX',
     2 'HARV','IDEX','COTN','LBS','CORN','BU.','SORG','CWT','SUNF',
     3 'CWT','SOYB','BU.','WHET','BU.','COTS','TON','WGRZ','AUM','-',
     4 '-','-','-' /
      DATA IPCHAN / 'NGAS','DESL','LAB','MACH','CHEM','CAPL','WHET',
     1 'COTN','FEED','OILS'  /
      DATA IECHAN / 'P-EF','P-%','LAB','MACH','Y-CT','Y-CO','Y-GS',
     1 'Y-SU','Y-SO','Y-WT' /
      DATA IENEWN / 'P-EF','P-%','-','-','-','LAB','-','-','MACH','-',
     1 'Y-CT','Y-CO','Y-GS','Y-SU','Y-SO','Y-WT','-    ','-    ','-','-'/
      END
C
C  MMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMM
C  MAIN PROGRAM
C
      INTEGER MCHP(20) /2,1,2,5,5,3,6,5,4,10,8,9,9,10,10,7,10,9,1,1/
      INTEGER MCHE(20) /1,2,1,1,1,3,1,1,4,1,5,6,7,8,9,10,1,1,1,1/
      COMMON /COST/ PRIC(20),DSYS ( 4,6),SOAM(3,3,6)
      COMMON /MISC/ NBUG(10),NX1,NX9,NX10,TITL(10),NP
      COMMON /BAS/ SCLA(20,13),WAT(4,5)
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      COMMON /VAL/ PNEW(20),ENEW(20),PCHA(10),ECHA(10)
      COMMON /C6PI/  CTI (7,20),COI (10,20),GSI(14,20),SUI(13,20),
     1   SOI(6,20),WTI(9,20),MX(4,24),MYRS(5),MY1CHA(5),MFAL(5)
      COMMON /NAM/  COD(21),WPER(2,18),CLD(20),TCOD(3,3),LPNM(20)
      COMMON /CROPI/ CPIC(7,2,6),CPDC(7,2,6)
      COMMON /INAM/ IPRICN(2,20),IPCHAN(10),IECHAN(10),IENEWN(20)
      COMMON /CTROL/ NCROP(6),NR(6),NDSYS(4),NTIL(2),PVR,DRYNR
      DEFINE FILE 9(50,80,U,NX9),10(110,100,U,NX10)
      DEFINE FILE 1(10000,133,E,NX1)
C
C  FILE 9 LP ROWS ETC ACROSS ITERATIONS
C  FILE 10 RECORDS FOR REPORT WRITER ACROSS ITERATIONS
C  FILE 1 ECONOMIC DATA FOR EACH PRODUCTION ACTIVITY GENERATED
C
C
C
      CALL GETARG(ITER,ITBLK,LZ)
C  GETARG IS A READCOMM SUBROUTINE (ITERATION NO & LP DATA NAME)
      NP=0
C  NP = PAGE NUMBER FOR REPORT
      IF(ITER.GT.1) READ(10' 7) NP,DRYNR
      ITOLD = ITER - 1
C  ITER= NEW ITERATION NUMBER (1-FIRST PASS )
C  ITOLD = ITERATION JUST SOLVED BY LP, READY FOR REPORT WRITER
C  IFYR = FIRST YEAR OF ITERATION
C  IEYR = LAST YEAR OF ITERATION
      NX1 = 1
      NX9 = 1
      IF(ITER.GT. 1) GO TO 1
      READ(5,1000) NBUG,TITL
C
C  NBUG -OPTION CONTROL CODES
C    IF NBUG (I) EQ 1 THEN FOR I=
C  1)  PRINT INPUT DATA, LAND CLASS INFO
C  2)  HOLD GW SAT THICK, PLIFT TO INITIAL VALUES (STATIC,PARAM ANAL)
C  3)  PRINT BLOCK DATA MATRICES OF INTEREST
C  4)  PRINT ALL PROD ACT GENERATED (CAUTION UPTO 10000 LINES)
C  5)  PRINT LP SOLUTION OUTPUT, CORRESPONDING FILE 1 RECORDS
C  6)  DELETE OFF-OPTIMAL IRRIGATION TIMING REGIMES FROM RUN
C  7)  DELETE MIXED AND LID ROTATIONS FROM RUN
C  8)  DELETE DRY ROTATIONS FROM RUN
C  9)  DELETE TERRACING OPTIONS
C 10)  DELETE ACT WITH REV-TCOST LE 0 (USE FOR OBJ=FIX OR SPECIAL CONSTRAINT)
C TITL = 40 CHARACTER TITLE PRINTED AT TOP OF EACH REPORT PAGE
      WRITE(10'1    ) TITL,NBUG
C
      READ(5,400) NCROP,NDSYS,NTIL,NR,ITEND,PVR
C
C  CONTROL FOR LP CROP PROD GENERATION, ITERATION NO, AND PRESENT VALUE
C   NCROP(6) = '0' IF CROP NOT ALLOWED FOR RUN
C   NR(I)     = NO. OF IRREG AVAILABLE FOR CROP I
C   NDSYS(K) = PERCENT EFFICIENCY OF IRR DIST SYS (IF 00 NOT AVAILABLE)
C   NTIL(J)  = '0' IF TILLAGE SYSTEM J NOT AVAILABLE FOR RUN
C  ITEND = TOTAL NO. OF ITERATIONS IN MODEL RUN
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C  PVR = PRESENT VALUE DISCOUNT RATE (%) FOR REPORT SUMMARY
C
 400  FORMAT(4X,6I1,4X,4I2,4X,2I1,5X,6I2,10X,I2,4X,F5.2)
      WRITE(10'4) NCROP,NDSYS,NTIL,NR,PVR
      READ (5,500) SAT,PLIFT,COEF,AQSURF,WELL,TWATER,DRYNR
 500  FORMAT (8F10.3)
C
C  SAT = INITIAL SATURATED THICKNESS
C  PLIFT = INITIAL PUMP LIFT
C  COEF = COEFICIENT OF STORAGE (FT OF WATER PER FT SAT)
C  AQSURF = ACRES OF AQUIFER (AQSURF * SAT * COEF = VOLUME OF GROUNDWATER)
C  WELL = NUMBER OF WELLS
C  TWATER = AC-FT ANNUAL GROUNDWATER WITHDRAWAL CONSTRAINT
C  DRYNR = DRYLAND NET RETURNS (USED TO DECIDE WHEN TO STOP IRRIGATING)
C
      WRITE(10'5)  SAT,PLIFT,COEF,AQSURF,WELL,TWATER
      NX10 = 11
  3   READ(5,1001) ILAST,IFYR,IEYR,(PCHA(K),K=1,10)
      READ(5,1001) ILAST,IFYR,IEYR,(ECHA(J),J=1,10)
C
C  ILAST = CODE FOR LAST ITERATION DATA (TO CONTROL NO. OF CARDS READ)
C  IFYR = FIRST YEAR IN ITERATION
C  IEYR = LAST YEAR IN ITERATION
C  PCHA(I) = PRICE CHANGE INDICES
C  ECHA(I) = EFFICENCY AND YIELD CHANGE INDICES
C
      WRITE(10'NX10) IFYR,IEYR,ITEND,ITER,PCHA,ECHA
      IF(ILAST .EQ. 0) GO TO 3
 1000 FORMAT(10I1,10A4)
 1001 FORMAT(I1,I4,1X,I4,13F5.2)
C
C PRINT THE BLOCK  DATA FILES FOR CHECKING
C
      IF(NBUG(3)  .NE. 1 ) GO TO 110
      NP=NP +1
      WRITE (6,5000) NP
 5000 FORMAT(1H1,110X,' PAGE ',I3,/,20X,'DATA SOAM(J,K,6)  TERRACES'
     * ///,T33,'0-1%',T63,'1-3%',T93,'>3%',/,20X,3(2X,26('_'),2X),/,20X,
     *  3(3X,'NONE',5X,'BENCH',7X,'CBT',3X),/110('_'))
      WRITE (6,5010) SOAM
 5010 FORMAT(1H0,4X,'LAND USED ',9F10.2,//,5X,'ANN FIX C ',9F10.2,//,
     *  5X,'ANN VAR C ',9F10.2,//,5X,'L&M MULT  ',9F10.2,//,
     *  5X,'YLD D MULT',9F10.2,//,5X,'IRRIG MULT',9F10.2 )
C
      DO 2 I=1,6
      NP=NP + 1
      WRITE(6,5020)  COD(I),NP,WPER
 5020 FORMAT(1H1,20X,'IRRIGATION REGIME DATA FOR',A3,'I(J,20)',
     *T110,'PAGE',I4,///,6X,'YIELD  ',18(1X,A3,A2),'  CODE ',/,125('_'))
      IF(I .EQ. 1) WRITE(6,5031) ((CTI(J,K),K=1,20),J=1,7)
      IF(I .EQ. 2) WRITE(6,5031) ((COI(J,K),K=1,20),J=1,10)
      IF(I .EQ. 3) WRITE(6,5031) ((GSI(J,K),K=1,20),J=1,14)
      IF(I .EQ. 4) WRITE(6,5031) ((SUI(J,K),K=1,20),J=1,13)
      IF(I .EQ. 5) WRITE(6,5031) ((SOI(J,K),K=1,20),J=1,6)
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```
      IF(I .EQ. 6) WRITE(6,5031) ((WTI(J,K),K=1,20),J=1,9)
 5031 FORMAT(1H0,F10.2,18F6.0,3X,A4)
  2   CONTINUE
C
C
      NP=NP+1
      WRITE(6,5040) NP
 5040 FORMAT(1H1,110X,'PAGE ',I4,
     * /,20X,'IRR CROP INPUTS BY CROP, TILL (CPIC)',///,
     *T24,'COTTON',T43,'CORN',T62,'SORGHUM',T81,'SUNFLOWER',T102,
     *'SOYBEAN',T124,'WHEAT'/13X,6(3X,16('_'),1X),/15X,5(3X,'CONV',
     *5X,'LIMIT',3X),3X,'CONV',5X,'LIMIT'/2X,131('_') )
      WRITE(6,5050) (((CPIC(I,J,K),J=1,2),K=1,6),I=1,7)
 5050 FORMAT('O LABOR HRS ',12F10.2,//'  SEED COST ',12F10.2,//
     *         '  BIOCIDE $ ',12F10.2,//'  DIESL GAL ',12F10.2,//
     *         '  MACH VARC ',12F10.2,//'  MACH FIXC ',12F10.2,//
     *         '  IRR USE EFF',F9.2,11F10.2 )
C
C
      WRITE(6,5060)
 5060 FORMAT(///,21X,'DRY CROP INPUTS BY CROP, TILL (CPDC)',///,
     *T24,'COTTON',T43,'BLNK',T62,'SORGHUM',T81,'SUNFLOWER',T102,
     *'FALLOW ',T124,'WHEAT'/13X,6(3X,16('_'),1X),/15X,5(3X,'CONV',
     *5X,'LIMIT',3X),3X,'CONV',5X,'LIMIT'/2X,131('_') )
      WRITE(6,5070) (((CPDC(I,J,K),J=1,2),K=1,6),I=1,7)
 5070 FORMAT('O LABOR HRS ',12F10.2,//'  SEED COST ',12F10.2,//
     *         '  BIOCIDE $ ',12F10.2,//'  DIESL GAL ',12F10.2,//
     *         '  MACH VARC ',12F10.2,//'  MACH FIXC ',12F10.2,//
     *         '  YLD CHANGE ',F9.2,11F10.2 )
C
C
       NP=NP + 1
      WRITE(6,5080)  NP
 5080 FORMAT(1H1,110X,'PAGE ',I4,
     * / ,15X,'CODES FOR MIXED, DRYLAND ROTATIONS',///34X,
     *'1ST CROP',16X ,'2ND CROP',/26X,24('_'),6X,16('_'),/10X,'ROT NO.',
     *  '  YEARS',2X,'CROP   I-REG   % CHA YLD      CROP   % CHA YLD',
     *  /10X,62('_'))
      DO 4 J=1,24
      IF(J .EQ. 1) WRITE(6,5083)
 5083 FORMAT(1H0,10X,'FIRST CROP IRRIGATED, SECOND CROP DRY')
C
      KYR = 2
      IF(J .GT. 15 .AND. J .LT. 20) KYR = 1
      IF(J .GT. 22) KYR = 3
C
      IF(J .EQ. 16) WRITE(6,5081)
 5081 FORMAT(1H0,10X,'LIMITED IRRIG, DRYLAND SYSTEMS (LIDS)')
      IF(J .EQ. 20) WRITE(6,5082)
 5082 FORMAT(1H0,10X,'DRYLAND ROTATIONS')
      IF(J .LE. 19)
     *WRITE(6,5090)J,KYR,COD(MX(1,J)),MX(2,J),COD(MX(3,J)),MX(4,J)
 5090 FORMAT(1H0,8X,I4,6X,I3,4X,A4,2X,I4,20X,A4,4X,I4)
  4   IF(J .GT. 19)WRITE(6,5095)J,KYR,COD(MX(1,J)),MX(2,J),
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     *  MY1CHA(J-19),COD(MX(3,J)),MX(4,J)
 5095 FORMAT(1H0,8X,I4,6X,I3,4X,A4,2X,I4, 6X,I4,10X,A4,4X,I4)
C
C
  110 IF(NBUG(1) .NE. 1) GO TO 1
       NP=NP + 1
      WRITE(6,5100) NP,NBUG,TITL
 5100 FORMAT(1H1,110X,'PAGE ',I4,
     *///'  OPTION CODES= ',10I1,'  TITLE= ',10A4)
      WRITE(6,5110) NCROP,NDSYS,NTIL,NR,ITEND,PVR
 5110 FORMAT(1H0, '  CONTROL CODES CROPS ',6I1,'  DSYS ',4I2,'  TILL ',
     * 2I1,'  IRREG ',6I2,'  ITERATIONS ',I2,' DISCOUNT RATE',F5.2,' %')
      WRITE(6,5120)
 5120 FORMAT('OINITIAL GROUNDWATER DATA'//'   SAT THK',4X,'PLIFT',
     *'   COEF-STR   AQ-SURF    NO. WELLS  TWATER (ACFT)' )
      WRITE (6,5130)SAT,PLIFT,COEF,AQSURF,WELL,TWATER
 5130 FORMAT (1X, 2(F7.2,1X),4X,F4.2,4X,3(F10.1,1X))
C  WRITE THE PRICE YIELD CHANGE INDICES
C
      WRITE(6,1300)
 1300 FORMAT(1H0, /10X,'PRICE AND YIELD INDEX',
     * ' CHANGES'//T38,'PRICES',T91,'EFFICIENCY & YIELD'/11X,
     *  58('_'),4X,58('_') )
      WRITE(6,1310) IPCHAN,IECHAN
 1310 FORMAT('O PERIOD  ',10(1X,A4,1X),2X,10(1X,A4,1X) )
      DO 85 J=1,ITEND
      READ(10'J+10) IFYR,IEYR,I1,I2,PCHA,ECHA
   85 WRITE(6,1320) IFYR,IEYR,PCHA,ECHA
 1320 FORMAT(1H0,I4,'-',I4,F5.2,9F6.2,2X,10F6.2)
C
    1 READ (10'1) TITL,NBUG
      READ (10'4) NCROP,NDSYS,NTIL,NR,PVR
C
C
      IF (ITER .EQ. 1) GO TO 20
C
      READ(10'ITOLD+10)IFYR,IEYR,ITEND,IBLK,PCHA,ECHA
C
C GET PRICES,EFFICENCIES FOR ITERATION ITOLD
C
      DO 15 J=1,20
      PNEW(J) = PRIC(J) * PCHA(MCHP(J))
   15 ENEW(J) = ECHA(MCHE(J))
      PNEW(10) = PRIC(10) * (PCHA(2)+PCHA(4) )/2.
C
C  FILE 4 SHOULD CONTAIN LP SOLUTION OUTPUT
C
      IFILE = 4
C
      CALL RLPFIL (IFILE,ITOLD,NAC,TWATUS)
C
      ITO = 1
C  ITO = CONTROL FOR START (=0) OR END OF ITERATION (=1)
C
```

```
      CALL WATER (ITER,ITO,TWATUS,TACRE,L,N,IFYR,IEYR)
C
      CALL RWRIT (ITOLD,NAC,TWATUS,ITEND)
C
C
C
      IF (ITER .GT. ITEND) GO TO 99
C
 20   READ(10'ITER+10)IFYR,IEYR,ITEND,IBLK,PCHA,ECHA
C
C UPDATE PRICES, EFFIC  FOR NEW ITERATION
C
      DO 5 J=1,20
      PNEW(J) = PRIC(J) * PCHA(MCHP(J))
    5 ENEW(J) = ECHA(MCHE(J))
      PNEW(10) = PRIC(10) * (PCHA(2)+PCHA(4) )/2.
C
C  CHECK ITERATION
C
      IF(ITER.GT. 1) GO TO 10
C
      CALL SCGEN
C
   10 CONTINUE
C
C  READ SOIL INFO
C
C
      ITO = 0
C
      CALL WATER(ITER,ITO,TWATUS,TACRE,L,N,IFYR,IEYR)
C
C   CALL LP IRR CROP ACTIVITY GEN
C
      CALL CPIGEN(N,L,2,4,ITER)
C
C
C
C  SET NEW ITERATION NO.
   99 IZ = ITER
      ITER = ITER + 1
C
      ITOUT = ITEND + 1
         WRITE(10'7) NP,DRYNR
      CALL PUTARG(ITER,ITOUT,LPNM(IZ))
C
C  ITER IS THE ITERATION CONTROL FOR MPSX
C   ITOUT CONTROLS END OF ITERATIONS IN MPSX
C  LPNM(IZ) PASSES THE NAME OF THE NEWLY CREATED LP DATA
C
C
      RETURN
      END
C
```

```
C   MMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMM
C   GEN SOIL CLASS DATA
      SUBROUTINE SCGEN
      COMMON /COST/ PRIC(20),DSYS ( 4,6),SOAM(3,3,6)
      COMMON /NAM/  COD(21),WPER(2,18),CLD(20),TCOD(3,3),LPNM(20)
      COMMON /MISC/ NBUG(10),NX1,NX9,NX10,TITL(10),NP
      COMMON /BAS/ SCLA(20,13),WAT(4,5)
      N = 0
      TACRE = 0.
      L = 0
      END = 0.
 10   IF(END .NE. 0) GO TO 30
      N =N +1
      READ(5,100)SOID1,SOID2,SOAC,SOTX,SOSL,SOYC,SOYW,SOYS,END
 100  FORMAT(A4,A4,2X,7F10.2)
C
C  DEBUG CHECK INPUT
C
      IF(NBUG(1).EQ.1 .AND. N .EQ. 1) NP=NP + 1
      IF(NBUG(1) .EQ. 1 .AND. N .EQ. 1) WRITE(6,3000) NP
 3000 FORMAT(1H1,110X,'PAGE ',I4,/,
     * 20X,'SOIL DATA'///'  NAME      ACREAGE',T23,'TEXTURE',T
     *35,'SLOPE',T44,'YLD-COT',T55,'WHT',T65,'SORG',T75,'E COD'/80('_'))
C
      IF(NBUG(1) .EQ. 1.)
     *WRITE(6,110)SOID1,SOID2,SOAC,SOTX,SOSL,SOYC,SOYW,SOYS,END
 110  FORMAT(1H0,2A4,8F10.2)
C
      TACRE = TACRE + SOAC
C     WRITE SOIL NAMES, ACERAGES TO FILE 9 FOR ROW, RHS USE
C
      WRITE(9'N+18) SOID1,SOID2,SOAC
C LAND IMPROV SET TERR INTERVAL
      IF(SOSL .LE. 1) J=1
      IF(SOSL .GT. 1 .AND. SOSL .LT. 3) J=2
      IF(SOSL .GE. 3) J=3
C SOIL TEXTURE LAB&MACH ,YIELD OR WATER USE ADJ.
      TXM = 1
      IF(SOTX .EQ. 2) TXM = .95
      IF (SOTX .EQ. 3) TXM = .9
C GEN IMPROVED LAND CLASSES
      DO 20 K=1,3
      L =L +1
      SCLA(L,1) = SOID1
      SCLA(L,2) = SOID2
      SCLA(L,3) = SOTX
      SCLA(L,4) = SOAM(K,J,1)
C
C  K = TERRACE TYPE
C  J = SLOPE CLASS
C
      SCLA(L,5) = 1. +(SOAM(K,J,2)-1.) * TXM
      SCLA(L,6) = 1. + (SOAM(K,J,3) -1.) * TXM
C
```

```
      SCLA(L,7) = 1. +( SOAM(K,J,4) -1. ) * TXM
      SCLA(L,8) = 1. +( SOAM(K,J,5) -1. ) * TXM
      SCLA(L,9) = 1. +( SOAM(K,J,6) -1. ) * TXM
C
C  IF NO TERRACES TEXTURE EFFECT SPECIFIED WITHIN YIELD
      IF(SOSL .LT. .5) SCLA(L,5) = SOAM(K,J,2)
      IF(SOSL .LT. .5) SCLA(L,6) = SOAM(K,J,3)
      IF(SOSL .LT. .5) SCLA(L,7) = SOAM(K,J,4)
      IF(SOSL .LT. .5) SCLA(L,8) = SOAM(K,J,5)
      IF(SOSL .LT. .5) SCLA(L,9) = SOAM(K,J,6)
C DRYLAND BASE YIELD COT-230 LBS/AC, WHT-15 BU/AC, SORG-15 CWT/AC
C
      SCLA(L,10)= SOYC/230.
      SCLA(L,11) = SOYW/15.
      SCLA(L,12) = SOYS/15.
      SCLA(L,13) = TCOD(K,J)
C
C NO IMPROV FOR LEVEL LAND
C IF NBUG(9) = 1 DELETE ALL TERRACED LAND
      IF(SOSL .LT. .5 .OR. NBUG(9) .EQ. 1) GO TO 10
 20   CONTINUE
      GO TO 10
C
C  WRITE SOIL INFO TO FILE 10
C
 30   WRITE(10'2 ) L,N,TACRE
      DO 34 I=1,L
 34   WRITE(10'I+30) (SCLA(I,J),J=1,13)
C
C  FOR DEBUG
C
      IF(NBUG(1).NE.1 ) GO TO 40
       NP=NP+1
      WRITE(6,1199) NP
 1199 FORMAT(1H1,110X,'PAGE ',I4,/,
     * 20X,'LAND CLASS INFORMATION (SCLA(L,13) )',///,12X,
     * 'SOIL      TERRACE    TEXTURE   LD-USE    AFIX    AVAR   L&M MULT ',
     * 'YD MULT I MULT    YLD-COT   WHT     GSORG   CODE'/11X,106('_') )
      DO 1190 I=1,L
1190  WRITE(6,1200)SCLA(I,1),SCLA(I,2),SCLA(I,13),(SCLA(I,J),J=3,12),
     *  CLD(I)
 1200 FORMAT (1HO,    10X,A4,A4,3X,A4,3X,4F8.2, 6F8.3,4X,A1)
 40   RETURN
      END
C
C  WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
C
C GENERATE WATER PUMPING CONSTRAINTS, COSTS
C
      SUBROUTINE WATER(IT,ITO,WAUSE,TACRE,L,N,IFYR,IEYR)
      DIMENSION WPDAY(18),           WPUMP(18)
      COMMON /COST/ PRIC(20),DSYS ( 4,6),SOAM(3,3,6)
      COMMON /NAM/  COD(21),WPER(2,18),CLD(20),TCOD(3,3),LPNM(20)
      COMMON /VAL/ PNEW(20),ENEW(20),PCHA(10),ECHA(10)
```

```
      COMMON /BAS/ SCLA(20,13),WAT(4,5)
      COMMON /CTROL/ NCROP(6),NR(6),NDSYS(4),NTIL(2),PVR,DRYNR
      COMMON /MISC/ NBUG(10),NX1,NX9,NX10,TITL(10),NP
      DATA WPDAY / 59.,31.,30.,15.,16.,10.,10.,10.,10.,11.,
     1             10.,10.,11.,10.,15.,15.,31.,61. /
C
      READ(10'      2) L,N,TACRE
      IF((IT .GT. 1 .AND. NBUG(2) .NE. 1).OR. ITO .EQ.1)  GO TO 10
      WAUSE = O.
      READ (10'5)  SAT,PLIFT,COEF,AQSURF,WELL
      AVACIN = TACRE * 12.
C  ASSUMED AVERAGE IRRIGATION APPLICATION IS 12 AC-IN AT START OF RUN
   10 IF((IT .GT. 1 .AND. NBUG(2) .NE. 1 ).OR. ITO.EQ.1)
     *READ(10'IT+49) SAT,PLIFT,COEF,AQSURF,AVACIN,GPM,WELL
C
C CALC NEW SATURATED THICKNESS
C
      IYR = IEYR-IFYR
      DECL = WAUSE*IYR /(AQSURF * COEF)
      SAT = SAT - DECL
      IF(SAT .GT. 10.) GO TO 15
      DO 12 K=1,6
   12 NR(K) = 1
      NCROP(2) = O
      NCROP(5) = O
C
C IF SAT THICK IS O ONLY DRYLAND CROPS NEED BE CONSIDERED
C
      SAT = O.
C
C IF SAT THICK IS LT 10 FT = EFFECTIVELY NONE
C
C  CALC NEW LIFT
C
   15 PLIFT = PLIFT + DECL
      IF(IT  .NE. 1) AVACIN = (AVACIN + WAUSE*12.)/2.
C
C  CALC NEW PUMPING RATE
C
      GPM = 800. * (SAT/210.)**2.
      IF(SAT .LE. 155.) GPM=2.264*SAT+.007833*SAT**2.-.0000282*SAT**3.
      IF(SAT .GE. 210) GPM = 800.
C
C
      IF(ITO .EQ. 1) WRITE(10'6) SAT,PLIFT,GPM,DECL
      IF(ITO .EQ. 1) RETURN
C   FOR VARIABLE TIME PERIODS IYR WILL BE WRONG FOR SECOND PASS
      IF(IT .NE. 1.AND. NBUG(2).NE.1) READ (10'6) SAT,PLIFT,GPM,DECL
      WRITE(10'IT+50)SAT,PLIFT,COEF,AQSURF,AVACIN,GPM,WELL
     *   ,IFYR,IEYR,DECL,WAUSE
C
C   CALC MAX PUMPING PER PERIOD
C      .0528  = CONVERSION FACTOR GPM TO AC-IN-DAY
      DO 20 I=1,18
```

```
      WPUMP(I) = .0528 * GPM* ENEW(2) *WPDAY(I) *  WELL
C
C  WRITE RHS WATER VALUES TO FILE
C
 20   WRITE(9'I   ) WPER(1,I),WPER(2,I),WPUMP(I)
C
C   CALC COST PER AC-IN WATER PUMPED
C        FIXED COSTS
C
      WDEP = PLIFT + SAT
      WELLFX = (230.31 + 4.22 * WDEP ) *  WELL
      DO 30 J=1,4
      HEAD = PLIFT + DSYS(J,5)
      PUMPFX = (-429.5+4.5*HEAD+2.82*GPM-.0051*HEAD**2.-.002*GPM**2.)
     *      * WELL
C   SUM FIXED COSTS
      WAT(J,1) = (WELLFX + PUMPFX)/AVACIN + DSYS(J,1)
      IF(DRYNR.GT.O.) WAT(J,1)=PUMPFX
C
C  WHEN USING DRYLAND NET RETURNS, TOTAL PUMP FIXED COST IS A DECISION VARIABLE
C
C   VARIABLE COSTS
C
      FUELC = (.0014539*HEAD * PNEW(2) ) /ENEW(1)
C  LUBE AND MAIN = 10% OF SYSTEM VARIABLE COST
C
      WAT(J,2) = 1.1 * DSYS(J,2) + FUELC
C  LABOR FOR IRR SYS = DIST SYS PLUS 5% FOR PUMP MAINT
      WAT(J,3) = 1.05 * DSYS(J,4)
C  WATER DELIVERY EFF
      WAT(J,4) = FLOAT(NDSYS(J))/100.
 30   WAT(J,5) = FUELC
      WRITE(10'3) WAT
C
C DEBUG FOR WATER INFO
C
      IF(IT .GT. 1 .OR. NBUG( 3) .NE. 1) RETURN
       NP=NP  + 1
      WRITE(6,96) NP
  96  FORMAT(1H1,110X,'PAGE ',I4,/,
     * 20X,'IRRIGATION DIST SYS DATA (DSYS)',///,28X,
     *  '  FURROW',T42,'IMP FURROW',T60,'SPRINKLER',T72,'IMP SPRINKLER'
     *  /82('_') )
      WRITE(6,97) DSYS
 97   FORMAT (1HO, 9X,'ANN FIX C ',4F15.3,//,10X,'ANN VAR C ',
     *4F15.3,//,10X,'ELEC USED ',4F15.3,//,10X,'LABOR HRS ',4F15.3,
     *  //,10X,'HEAD (FT) ',4F15.3,//10X,'DELIV EFF ',4F15.3,///)
      WRITE(6,98)
  98  FORMAT(1HO,20X,'PUMPING & DIST SYSTEM INFO (WAT)',///,27X,
     *  '  FURROW',T42,'IMP FURROW',T60,'SPRINKLER',T74,'IMP SPRINKLER'
     *  / 82('_') )
      WRITE(6,99) WAT
 99   FORMAT (1HO, 9X,'ANN FIX C ',4F15.3,//,10X,'ANN VAR C ',
     *4F15.3,//,10X,'LABOR HRS ',4F15.3,//,10X,'IRR EFFIC ',4F15.3,
```

```
     *  //,10X,'NGAS $/ACIN',F14.3,3F15.3)
C
C
        RETURN
       END
C GGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGGG
C
C  IRRIGATED CROP PRODUCTION ACTIVITY GENERATOR
C
      SUBROUTINE CPIGEN( N,NLC,NTL ,NDS,IT)
      DIMENSION  NOOPT(14,6),  CPI(14,20,6)
      COMMON /COST/ PRIC(20),DSYS ( 4,6),SOAM(3,3,6)
      COMMON /NAM/  COD(21),WPER(2,18),CLD(20),TCOD(3,3),LPNM(20)
      COMMON /CROPI/ CPIC(7,2,6),CPDC(7,2,6)
      COMMON /MISC/ NBUG(10),NX1,NX9,NX10,TITL(10),NP
      COMMON /BAS/ SCLA(20,13),WAT(4,5)
      COMMON /VAL/ PNEW(20),ENEW(20),PCHA(10),ECHA(10)
      COMMON /C6PI/  CTI (7,20),COI (10,20),GSI(14,20),SUI(13,20),
     1   SOI(6,20),WTI(9,20),MX(4,24),MYRS(5),MY1CHA(5),MFAL(5)
      COMMON /CPD/ WUS(18),MC(5,6),TC
      COMMON /CTROL/ NCROP(6),NR(6),NDSYS(4),NTIL(2),PVR,DRYNR
      DATA NOOPT /1,1,0,0,1,0,1,7*0, 1,4*0,1,1,0,0,1,4*0, 1,1,0,1,
     * 6*0,1,0,1,0, 5*1,9*0, 1,0,1,0,0,1,8*0, 2*1,0,1,0,1,2*0,1,5*0 /
C
C   READ FILE 10 RECORD 4 (CONTROLS FOR CROP, IRREG, IRR DSYS, AND TILLAGE)
C
C  GEN FILE NAME, ROWS, OBJ
C
      NX1 = 1
C
      REWIND 3
      WRITE(3    ,3000) LPNM(IT)
 3000 FORMAT ('NAME',T15,A4/'ROWS'/'  N VAR'/'  N FIX'/'  L TWATER')
C WRITE WATER PERIOD, SOIL ROW NAMES ON LP INPUT FILE
C
      N18 = N+18
      DO 3010 L1 = 1,N18
      READ(9'L1) R1,R2,R3
 3010 WRITE(3    ,3020) R1,R2
 3020 FORMAT ('  L ',A4,A4)
C
C  WRITE COLUMN HEADER
      WRITE(3    ,3040)
 3040 FORMAT ('COLUMNS' )
C
      TC = 0.
      DO  2 I= 1,6
      NR1 = NR(I)
      DO  1 J = 1,NR1
C
C  PLACE IRRIGATION REGIME DATA IN ONE MATRIX
      DO 5 IR=1,20
      IF(I .EQ. 1 ) CPI(J,IR,I) = CTI (J,IR)
      IF(I .EQ. 2 ) CPI(J,IR,I) = COI (J,IR)
```

```
      IF(I .EQ. 3 ) CPI(J,IR,I) = GSI (J,IR)
      IF(I .EQ. 4 ) CPI(J,IR,I) = SUI (J,IR)
      IF(I .EQ. 5 ) CPI(J,IR,I) = SOI (J,IR)
      IF(I .EQ. 6 ) CPI(J,IR,I) = WTI (J,IR)
 5    CONTINUE
 1    CONTINUE
 2    CONTINUE
      DO 99 I=1,6
      IF( NCROP(I) .EQ. O) GO TO 99
      NR1 = NR(I)
      DO 98 J = 1,NR1
      IF(NBUG(6) .EQ. 1 .AND. NOOPT(J,I) .EQ. O) GO TO 98
      DO 97 IS= 1,NDS
      IF( NDSYS (IS) .EQ. O ) GO TO 97
      DO 96 K = 1,NTL
      IF(NTIL(K) .EQ. O ) GO TO 96
      DO 95 L  = 1,NLC
C
C  CHECK IF DRYLAND ROTATION
C
      IF(CPI(J,20,I) .NE. COD(7) ) GO TO 6
C
C NO IRRIG SYSTEMS FOR DRYLAND (GEN ONLY 1 DRY CROP OVER IRR SYS)
      IF(IS .GT. 1 .AND. NDSYS(1) .NE. O) GO TO 95
      IF(IS .GT. 2 .AND. NDSYS(2) .NE. O) GO TO 95
      IF(IS .GT. 3 .AND. NDSYS(3) .NE. O) GO TO 95
      NCK = NX1
C
C  UNPROFITABLE DRYLAND CROP NOT USED IN DRY ROT
C
      CALL CPDGEN (O,CPI(J,1,I),I     ,K,L,O )
      IF(I .EQ. 6 .AND. NX1 .GT. NCK ) GO TO 70
      GO TO 95
C  GO TO 70 FOR DRYLAND ROTATIONS (WHEAT ALWAYS 1ST CROP)
C
  6   CONTINUE
C
C  IF SOIL IS SANDY NO FURROW IRRIGATION
      IF(IS .LE. 2 .AND. SCLA(L,3) .EQ. 3) GO TO 95
C IF HARDLAND SOIL NO SPRINKLER OR LEPA IRRIGATION
      IF(IS .GE. 3 .AND. SCLA(L,3) .EQ. 1) GO TO 95
C
C CALC YIELD
C
      Y = CPI(J,1,I)*SCLA(L,12)*ENEW(I+10)
      IF (I .EQ. 1) Y = CPI(J,1,I)*SCLA(L,10)*ENEW(I+10)
      IF (I .EQ. 6) Y = CPI(J,1,I)*SCLA(L,11)*ENEW(I+10)
      RETURN = Y * PNEW(I+10)
      IF(I .EQ. 1) RETURN = RETURN + Y*1.6*PNEW(17)/2000.
      IF(I .EQ. 6) RETURN = RETURN+4. *PNEW(18)
C   CALC IRR WATER USAGE
C
      TWUS = O.
      DO 10 IR = 1,18
```

```
      WUS(IR) = CPI(J,IR+1,I)* SCLA(L,9)*CPIC(7,K,I)/WAT(IS,4)
 10   TWUS = TWUS + WUS(IR)
C
C   CALC INPUT USE, COSTS
C
C   LABOR
C
      HLAB= (CPIC(1,K,I)+TWUS*WAT(IS,3))*SCLA(L,7)*ENEW(6)
      CLAB = HLAB * PNEW(6)
C   MACHINERY VAR & FIX COST
C
      VMA = (CPIC(5,K,I)*SCLA(L,7)+TWUS     *DSYS(IS,2) +SCLA(L,6))
     *       *ENEW(9)*PNEW(9)
      FMA = (CPIC(6,K,I)*SCLA(L,7)+TWUS*WAT(IS,1)+SCLA(L,5))
     *       *ENEW(9)*PNEW(9)
      IF(DRYNR.GT.O.)FMA = (CPIC(6,K,I)*SCLA(L,7)+TWUS*DSYS(IS,1)
     *  +SCLA(L,5))*ENEW(9)*PNEW(9)
C   FUEL
C
      DIESL = CPIC(4,K,I)*SCLA(L,7)*ENEW(9)
      GASNC = TWUS*WAT(IS,5)
      FUELC = 1.1* DIESL *PNEW(3) +GASNC
C   BIOCIDES
C
      BIOC = CPIC(3,K,I)*PNEW(8)
C   SEED AND OTHER VAR COSTS
C
      SEDC = CPIC(2,K,I)*PNEW(10)
C   FERTILIZER & HARVEST COSTS (FCN OF YIELD)
C
      GO TO (20,21,22,23,24,25),I
C  COTTON
C
 20   FN = .0533 * Y
      FP = .0533 * Y
      HAVC = 5.5 *Y *.04*PNEW(10) * SCLA(L,7)
      GO TO 30
C  CORN
C
 21   IF(Y .LT. 100.) FN = Y
      IF(Y .LT. 100.) FP = .6 * Y
      IF(Y .GE. 100.) FN = 100.+.8*(Y-100.)
      IF(Y .GE. 100.) FP = 60.
      HAVC = .62*Y * PNEW(10) * SCLA(L,7)
      GO TO 30
C  SORGHUM
C
 22   FN = 60. + 2. * (Y-40.)
      FP = 40.
      IF(Y .LT. 40.) FN = 1.5 * Y
      IF(Y .LT. 40.) FP = Y
      IF(Y .GE. 60.) FN = 100.+2.*(Y-60.)
      IF(Y .GE. 60.) FP =  40.+   (Y-60.)
      HAVC = .6 * Y * PNEW(10)* SCLA(L,7)
```

```
      GO TO 30
C   SUNFLOWERS
C
 23    FN = 1.5   * Y
       FP =   .5   * Y
       IF(Y .GE. 15) FN = 3.5 * Y
       IF(Y .GE. 15.) FP = 1.16 * Y
       HAVC = (12. +2.1*Y)*PNEW(10)*SCLA(L,7)
       GO TO 30
C   SOYBEANS
C
 24    FN = 20.
       FP = .5 * Y
       HAVC = (12.5+.1*Y) * PNEW(10) * SCLA(L,7)
       GO TO 30
C   WHEAT
C
 25    FN = 1.5*Y
       FP = .5*Y
       IF(Y .GE. 40.) FN = 60.+ 2.*(Y-40.)
       IF(Y .GE. 40.) FP = 20. + (Y-40.)
       HAVC = (12.  + .12 * Y) * PNEW(10) * SCLA(L,7)
       IF(Y .GT. 20.)HAVC=((12.+.12*Y)+.12*(Y-20.))* PNEW(10) * SCLA(L,7)
 30    FRTC = FN * PNEW(4) + FP * PNEW(5)
C TOTAL ALL VAR & FIXED COSTS
C
       TCOSTV = (1.+.5*PNEW(7)) * (CLAB+VMA+FUELC+BIOC+SEDC+FRTC+
     *  HAVC   )
       TCOST  = TCOSTV + FMA
       RNETV  = RETURN - TCOSTV
       RNETOT = RETURN - TCOST
C
C  WRITE INFO TO FILE FOR REPORT WRITER
C
       AC12 =  COD(I)
       AC34 = CPI(J,20,I)
       AC5 =  COD(11)
       AC6 =  COD(IS +12)
       AC7 =  COD(K + 16)
       AC8 = CLD(L)
C
C
C   CONTROL TO WRITE TITLE FOR FILE 1 OUTPUT
C
       TOPL = TC/50. - AINT(TC/50.)
       IF(NBUG(4) .NE. 1 ) GO TO 35
C
C  WRITE FILE 1 OUTPUT FOR DEBUG
       IF(TOPL. EQ. 0.) NP=NP + 1
       IF(TOPL .EQ. 0.) WRITE (6,990) NP
 990 FORMAT(1H1,110X,'PAGE ',I4,/,
     * 20X,'ACTIVITIES GEN'////' ACT CODE      YLD     YLD2    ',
     *'RETURN    T.WAT    LAB     DSL     NIT     PHOS     FUEL$    VMACH$',
     *  '      HARV$     T VAR$     NETV$     FMACH$     NETF$'/1X,132('_'))
```

```
      WRITE (     6,995 ) AC12,AC34,AC5,AC6,AC7,AC8,
     *  Y,RETURN,TWUS,HLAB,DIESL,FN,FP,FUELC,VMA,HAVC,
     *  TCOSTV,RNETV,FMA,RNETOT
  995 FORMAT(A3,A2,4A1,1X,F8.2,8X,F8.2,5F7.1,7F9.2)
 35   TC = TC + 1.
C
C  DON'T WRITE LP ACTIVITY IF NET REV IS NEG
C
      IF (RNETV .LE. O.) GO TO 95
C
C  DELETE NEG (REV-TCOST ) VALUES FOR SPECIAL (NBUG10=1) RUNS
C
      IF(NBUG(10) .EQ. 1 .AND. RNETOT .LE. O.) GO TO 95
      YB = O.
      WRITE (1'NX1,1000) AC12,AC34,AC5,AC6,AC7,AC8,
     *  Y,YB,RETURN,TWUS,HLAB,DIESL,FN,FP,FUELC,VMA,HAVC,
     *  TCOSTV,RNETV,FMA,RNETOT
1000  FORMAT(A3,A2,4A1,1X,3F8.2,5F7.1,7F9.2)
      WRITE(3     ,2000)  AC12,AC34,AC5,AC6,AC7,AC8,
     *  RNETV,RNETOT
 2000 FORMAT (3X,A3,A2,4A1,T15,'VAR',T25,F10.2,T40,'FIX',T50,F10.2)
      WRITE(3     ,2010)  AC12,AC34,AC5,AC6,AC7,AC8,
     *  SCLA(L,1),SCLA(L,2),SCLA(L,4),TWUS
 2010 FORMAT (3X,A3,A2,4A1,T15,A4,A4,T25,F10.3,T40,'TWATER',T50,F10.2)
      DO 90 IR = 1,18
      IF(WUS(IR) .GT. O.)
     *WRITE(3     ,2015)  AC12,AC34,AC5,AC6,AC7,AC8,
     *  (WPER(IA,IR),IA=1,2),WUS(IR)
 2015 FORMAT(3X,A3,A2,4A1,T15,2A4,T25,F10.3)
 90   CONTINUE
C
C  FOR MIXED OR DRYLAND ROTATIONS
C
 70   CONTINUE
      IF (I .EQ. 1 .OR. I .EQ. 2) GO TO 95
C NO MIXED, DRY ROTATIONS FOR CORN, ONLY DRYLAND COTTON IN ROTATIONS
      MCC = O
      DO 93 IM = 1,24
C
C  NBUG 7,8 ALLOWS DELETION OF MIXED&LIDS OR DRYLAND ROTATIONS RESPECTIVELY
C
      IF(NBUG(7) .EQ. 1 .AND. IM .LT. 20)GO TO 93
      IF(NBUG(8) .EQ. 1 .AND. IM .GE. 20)GO TO 93
C
C  24 MIXED OR DRYLAND ROTATIONS
C  MX = MATRIX OF ROTATION INFO
C        MX(1,IM) = FIRST CROP NO.
C        MX(2,IM) = FIRST CROP IRRIG REGIME NO.
C        MX(3,IM) = SECOND CROP NO.
C        MX(4,IM) = SECOND CROP % YIELD CHANGE
C
      IF(I .NE. MX(1,IM) .OR. J .NE. MX(2,IM) ) GO TO 93
C
C  CHECK IF 2ND CROP IS AVAILABLE IN THIS RUN
```

```
C
      IF(NCROP(MX(3,IM)) .EQ. 0) GO TO 93
C
C  NZ = NO. OF RECORD ON FILE 1 WHERE DATA FOR 1ST CROP IS STORED
      NZ = NX1-1
      MCC = MCC +1
C
C  MC(5,6) = MATRIX OF ROTATION INFO TO BE PASSED TO MIXED, DRYLAND GEN
C
      MC(MCC,1) = MX(3,IM)
      MC(MCC,2) =     IM
      MC(MCC,3) = MX(4,IM)
      MC(MCC,4) = 0
      MC(MCC,5) = 0
      MC(MCC,6) = 2
      IF( IM .LE. 19) GO TO 93
C DRY ROTATIONS ARE NO. 20-24
C FOR DRY ROTATIONS 1ST CROP ALSO HAS YIELD CHANGE
C FOR DRYLAND ROTATIONS NEED % FALLOW, NO. OF YEARS IN ROTATION
C
      MC(MCC,4) = MY1CHA(IM-19)
      MC(MCC,5) = MFAL  (IM-19)
      MC(MCC,6) = MYRS(IM-19)
 93   CONTINUE
C IF NO ROTATION ASSOCIATED WITH THIS IRRIG REGIME MCC = 0
C
      IF(MCC .EQ. 0) GO TO 95
C
C  CALL MIXED, DRY ROTATION GEN
C
      DO 94 MZ=1,MCC
C
C   ONLY IMPROVED FURROW IRR DIST SYS WITH LIDS
      IF(IS .NE. 2 .AND.(MC(MZ,2) .GT. 15 .AND. MC(MZ,2) .LT.20))GOTO 94
      IA = MC(MZ,1)
      YD = CPI(1,1,IA)
C
      CALL CPDGEN (NZ,YD,IA,K,L,MZ)
  94  CONTINUE
C
C
C
C
C  END OF LOOPS
 95   CONTINUE
 96   CONTINUE
 97   CONTINUE
 98   CONTINUE
 99   CONTINUE
C
C  ADD THE RHS INFO TO THE LP FILE (FILE 3)
C
      READ (10'5) S1,S2,S3,S4,S5,TWATER
      TWAT = TWATER * 12.
```

```
      IF (TWAT .EQ. O.) TWAT = 60000.
C  TWATER IS A CONSTRAINT ON TOTAL PUMPAGE PER YEAR
C  TWATER = O INDICATES UNBINDING CONSTRAINT
C
      WRITE(3    ,2020) TWAT
 2020 FORMAT ( 'RHS'/T5,'RHS1',T15,'TWATER',T25,F12.0)
      N18 = N+18
      DO 110 I=1,N18
      READ(9'I) R1,R2,R3
 110  WRITE(3    ,2030) R1,R2,R3
 2030 FORMAT(T5,'RHS1',T15,2A4,T25,F12.0)
      WRITE(3    .2040)
 2040 FORMAT('ENDATA')
      REWIND 3
      RETURN
      END
C
C  DDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDDD
C
C    DRYLAND CROP PRODUCTION ACTIVITY GENERATOR
C
      SUBROUTINE CPDGEN(NZ,YLD,I,K ,L ,MZ)
      COMMON /COST/ PRIC(20),DSYS ( 4,6),SOAM(3,3,6)
      COMMON /NAM/  COD(21),WPER(2,18),CLD(20),TCOD(3,3),LPNM(20)
      COMMON /CROPI/ CPIC(7,2,6),CPDC(7,2,6)
      COMMON /MISC/ NBUG(10),NX1,NX9,NX10,TITL(10),NP
      COMMON /BAS/ SCLA(20,13),WAT(4,5)
      COMMON /VAL/ PNEW(20),ENEW(20),PCHA(10),ECHA(10)
      COMMON /CPD/ WUS(18),MC(5,6),TC
C
C CALC YIELD
C
      Y = YLD*SCLA(L,12)*ENEW(I+10)*SCLA(L,8)*CPDC(7,K,I)
      IF (I .EQ. 1) Y =YLD*SCLA(L,10)*ENEW(I+10)*SCLA(L,8)*CPDC(7,K,I)
      IF (I .EQ. 6) Y =YLD*SCLA(L,11)*ENEW(I+10)*SCLA(L,8)*CPDC(7,K,I)
      IF(MZ .NE. O) Y = Y*(1.+FLOAT( MC(MZ,3))/100. )
C
C   YIELD CHA FOR 2ND CROP IN ROTATION
C
      RETURN = Y * PNEW(I+10)
      IF(I .EQ. 1) RETURN = RETURN + Y*1.6*PNEW(17)/2000.
      IF(I .EQ. 6) RETURN = RETURN+ PNEW(18)
C
C   CALC INPUT USE. COSTS
C   LABOR
C
      HLAB= CPDC(1,K,I)*SCLA(L,7)*ENEW(6)
      CLAB = HLAB * PNEW(6)
C   MACHINERY VAR & FIX COST
C
      VMA =(CPDC(5,K,I)*SCLA(L,7)+SCLA(L,6))
     *      *ENEW(9)*PNEW(9)
      FMA = (CPDC(6,K,I)*SCLA(L,7)+                SCLA(L,5))
     *      *ENEW(9)*PNEW(9)
```

```
C    FUEL
C
        DIESL = CPDC(4,K,I)*SCLA(L,7)*ENEW(9)
        FUELC = 1.1 * DIESL *PNEW(3)
C    BIOCIDES
C
        BIOC = CPDC(3,K,I)*PNEW(8)
C    SEED AND OTHER VAR COSTS
C
        SEDC = CPDC(2,K,I)*PNEW(10)
C    FERTILIZER & HARVEST COSTS (FCN OF YIELD)
C
        GO TO (20,21,22,23,24,25),I
C   COTTON
C
 20    FN = .0533 * Y
        FP = .0533 * Y
        HAVC = 5.5 *Y *.04*PNEW(10) * SCLA(L,7)
        GO TO 30
 21    GO TO 30
C   SORGHUM
C
 22    FN = 60. + 2. * (Y-40.)
        FP = 40.
        IF(Y .LT. 40.) FN = 1.5 * Y
        IF(Y .LT. 40.) FP = Y
        IF(Y .GE. 60.) FN = 100.+2.*(Y-60.)
        IF(Y .GE. 60.) FP =  40.+   (Y-60.)
        HAVC = .6 * Y * PNEW(10)* SCLA(L,7)
        GO TO 30
C   SUNFLOWERS
C
 23    FN = 1.5   * Y
        FP =   .5   * Y
        IF(Y .GE. 15.) FN = 3.5 * Y
        IF(Y .GE. 15.) FP = 1.16 * Y
        HAVC = (12. +2.10 * Y) * PNEW(10) * SCLA(L,7)
        GO TO 30
  24   GO TO 30
C   WHEAT
C
 25    FN = 1.5*Y
        FP = .5*Y
        IF(Y .GE. 40.) FN = 60.+ 2.*(Y-40.)
        IF(Y .GE. 40.) FP = 20. + (Y-40.)
        HAVC = (12.   + .12 * Y) * PNEW(10) * SCLA(L,7)
        IF(Y .GT. 20.)HAVC=((12.+.12*Y)+.12*(Y-20.))* PNEW(10) * SCLA(L,7)
 30    FRTC = FN * PNEW(4) + FP * PNEW(5)
C TOTAL ALL VAR & FIXED COSTS
C
        TCOSTV = (1.+.5*PNEW(7)) * (CLAB+VMA+FUELC+BIOC+SEDC+FRTC+HAVC)
        TCOST = TCOSTV + FMA
        RNETV = RETURN - TCOSTV
        RNETOT = RETURN - TCOST
```

```
C
C  NO IRRIG FOR DRYLAND CROPS
C
      TWUS = O.
      Y2 = O.
C
C  SET ACTIVITY CODE
      AC12 =  COD(I)
      AC34 =  COD(7)
      AC5 =  COD(11)
      AC6 =  COD(11)
      AC7 =  COD(K + 16)
      AC8 = CLD(L)
      IF (MZ .EQ. O) GO TO 85
C
C REDEFINE Y TO Y2 2ND CROP YIELD
C MAINTAIN CORRECT WRITE POINTER FOR FILE 1
      Y2 = Y
      NT = NX1
C
C  SET DIVISOR FOR USAGE 1 ACRE PER YR
C  D1,D2 = NO. OF YRS IN ROTATION
C  D1    = 4 FOR SPECIAL CASE 2 YR WT-FAL ROT. TO AVOID DOUBLE COUNTING
      D1 = FLOAT(MC(MZ,6))
      IF (MC(MZ,2) .EQ. 20) D1 = 4.
      D2 = FLOAT(MC(MZ,6))
C
C  5% INCREASE IN VARIABLE COSTS WITH LIDS
C
      XLID = 1.
      IF (MC(MZ,2) .GT. 15 .AND. MC(MZ,2) .LT. 20) XLID = 1.05
C
C   READ DATA FOR 1ST CROP IN ROTATION
C
      READ(1'NZ,950 ) AC12,AC34,AC5,AC6,AC7,AC8,Y,YB,RI,TWUS,HLI,DI,
     1   FNI,FPI,FCI,VI,HI,TVI,RVI,FI,RFI
950   FORMAT(A3,A2,4A1,1X,3F8.2,5F7.1,7F9.2)
C
C  CALC YIELDS, RETURN, AND COSTS FOR ROTATIONS
C
      Y = Y*(1. + FLOAT(MC(MZ,4))/100.) /D2
      Y2 = Y2/D2
      RI = RI * (1. + FLOAT(MC(MZ,4))/100.) /D2
      RETURN = RETURN/D2 + RI
C
C  FOR ROTATIONS WITHOUT FALLOW
C
      FLAB = O.
      FDIE = O.
      FFUEL = O.
      FVMA = O.
      FVAR = O.
      FFIX = O.
      IF(MC(MZ,2) .LT. 20 ) GO TO 80
```

```
C CALC COSTS DURING FALLOW PERIODS
C  FM = % OF FALLOW IN ROTATION
      FM = FLOAT(MC(MZ,5))/100.
C    LABOR
C
      FLAB= CPDC(1,K,5)*SCLA(L,7)*ENEW(6) * FM
      FCLA = FLAB * PNEW(6)
C    MACHINERY VAR & FIX COST
C
      FVMA=(CPDC(5,K,5)*SCLA(L,7)+SCLA(L,6))*ENEW(9)*PNEW(9)*FM
C
      FFIX= (CPDC(6,K,5)*SCLA(L,7)+                SCLA(L,5))
     *      *ENEW(9)*PNEW(9) * FM
C    FUEL
C
      FDIE  = CPDC(4,K,5)*SCLA(L,7)*ENEW(9) * FM
      FFUEL = FDIE  *PNEW(3)
C    BIOCIDES
C
      FBIO = CPDC(3,K,5)*PNEW(8) *FM
C    SEED AND OTHER VAR COSTS
C
      FSED = CPDC(2,K,5)*PNEW(10) * FM
      FVAR = (1. + .5*PNEW(7) ) *(FCLA+FVMA+FFUEL+FBIO+FSED)
C
C
 80   CONTINUE
      TWUS = TWUS/D2
      HLAB = XLID* (HLAB + HLI)/D1 + FLAB
      DIESL = XLID* (DIESL + DI) /D1 +FDIE
      FN = (FN + FNI) /D2
      FP = (FP + FPI) /D2
      FUELC = (FUELC + FCI) /D1 + FFUEL
      VMA = XLID * (VMA + VI) /D1 + FVMA
      HAVC = (HAVC + HI) /D2
      TCOSTV = XLID * (TCOSTV + TVI) /D1 + FVAR
      RNETV = RETURN - TCOSTV
      FMA = (FMA + FI) /D1 + FFIX
      RNETOT = RNETV - FMA
C
C  SET ACTIVITY NAME CODE
C
      IF (MC(MZ,2) .GE. 20) AC34 =  COD(8)
      AC5 =  COD(MC(MZ,1) + 6)
      IF(MC(MZ,2) .LE. 2) AC5 = COD(17)
      IF (MC(MZ,2) .EQ. 20) AC5 =  COD(21)
      IF (MC(MZ,2) .GE. 20) AC6 =  COD(MC(MZ,6) + 17)
      NX1 = NT
C
C
  85  CONTINUE
C
C  WRITE INFO TO FILE FOR REPORT WRITER
C
```

```
C
C   CONTROL TO WRITE TITLE FOR FILE 1 OUTPUT
C
      TOPL = TC/50. - AINT(TC/50.)
      IF(NBUG(4) .NE. 1 ) GO TO 35
C
C  WRITE FILE 1 OUTPUT FOR DEBUG
      IF(TOPL. EQ. O.) NP=NP + 1
      IF(TOPL .EQ. O.) WRITE (6,990) NP
  990 FORMAT(1H1,110X,'PAGE ',I4,/,
     * 20X,'ACTIVITIES GEN'///' ACT CODE      YLD     YLD2    ',
     *'RETURN    T.WAT    LAB     DSL     NIT     PHOS     FUEL$    VMACH$',
     * '     HARV$    T VAR$     NETV$     FMACH$     NETF$'/1X,132('_'))
      WRITE (     6,1000) AC12,AC34,AC5,AC6,AC7,AC8,
     *  Y,Y2,RETURN,TWUS,HLAB,DIESL,FN,FP,FUELC,VMA,HAVC,
     *  TCOSTV,RNETV,FMA,RNETOT
 35   TC = TC + 1.
C
C  DON'T WRITE LP ACTIVITY IF NET REV IS NEG
C
      IF (RNETV .LE. O.) GO TO 95
C
C  DELETE NEG (REV-TCOST ) VALUES FOR SPECIAL (NBUG10=1) RUNS
C
      IF(NBUG(10) .EQ. 1 .AND. RNETOT .LE. O.) GO TO 95
      WRITE (1'NX1,1000) AC12,AC34,AC5,AC6,AC7,AC8,
     *  Y,Y2,RETURN,TWUS,HLAB,DIESL,FN,FP,FUELC,VMA,HAVC,
     *  TCOSTV,RNETV,FMA,RNETOT
1000  FORMAT(A3,A2,4A1,1X,3F8.2, 5F7.1,7F9.2)
      WRITE(3     ,2000)  AC12,AC34,AC5,AC6,AC7,AC8,
     *  RNETV,RNETOT
 2000 FORMAT (3X,A3,A2,4A1,T15,'VAR',T25,F10.2,T40,'FIX',T50,F10.2)
      WRITE(3     ,2010)  AC12,AC34,AC5,AC6,AC7,AC8,
     *  SCLA(L,1),SCLA(L,2),SCLA(L,4),TWUS
 2010 FORMAT (3X,A3,A2,4A1,T15,A4,A4,T25,F10.3,T40,'TWATER',T50,F10.2)
C
C  SKIP IF DRY CROP OR ROTATION
C
      IF(TWUS .EQ. O.) GO TO 95
      DO 90 IR = 1,18
      IF(WUS(IR) .LE. O.) GO TO 90
      WUS(IR) = WUS(IR)/2.
C  FOR MIXED OR LIDS ONLY HALF OF ROTATION UNDER IRRIGATION
      WRITE(3     ,2015)  AC12,AC34,AC5,AC6,AC7,AC8,
     *  (WPER(IA,IR),IA=1,2),WUS(IR)
 2015 FORMAT(3X,A3,A2,4A1,T15,2A4,T25,F10.3)
 90   CONTINUE
  95  RETURN
      END
C
C  LLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLLL
C
C  READ THE LP FILE
C  THIS IS A READCOMM BASED SUBROUTINE (USES ARRAY, POSITN, VECTOR, ETC)
```

```
C
C
      SUBROUTINE RLPFIL(IF,IT,K,TWATUS)
      REAL*8 ANAM,COLNM/'CSECTION'/, COL(30),VAL(30),SOILNM(20)
      INTEGER ITYP(30)
C
C  IF=FILE NO., IT=ITERATION NO. (OF LPOUT), K=NO. OF ACTIVITIES
C
      COMMON /RLP/ WATUS(18),WATSP(18),SOLVL(20),TWAVL,TWATSP,
     *   WATAVL(18), SOILSP(20),ACTLVL(30),NACT(30),SOILNM
      COMMON /MISC/ NBUG(10),NX1,NX9,NX10,TITL(10),NP
      COMMON /NAM/  COD(21),WPER(2,18),CLD(20),TCOD(3,3),LPNM(20)
C
C  DEBUG OUTPUT LP SOLUTION
C
      IF(NBUG(5) .NE. 1) GO TO 50
C
C  SKIP TO ROWS SECTION
C
      CALL POSITN(IF,IND,2)
C
C   READ ROW AND COLUMN SECTIONS
C
  1   CALL ARRAY(IF,IND,ANAM)
      IF(IND  -1) 50,50,5
5     NP=NP + 1
      WRITE(6,1000) NP,ANAM,LPNM(IT)
 1000 FORMAT(1H1,110X,'PAGE',I4,/20X,'PRINTOUT OF THE LP ',A8,'FOR ',A4)
      CALL COLNAM(IF,ITYP,COL,NUM)
      WRITE(6,1010) (COL(N),N=1,NUM )
 1010 FORMAT(1HO/1H ,A8,1X,A8,4X,A8,12X,A8,12X,A8,8X,A8,8X,A8,11X,A8/)
  10  CALL VECTOR(IF,IND,VAL)
      IF(IND -1) 1,1,20
 20   WRITE(6,1020) (VAL(N),N=1,NUM )
 1020 FORMAT(A9,A12,F12.0,F18.4,6X,D16.4,F16.0,F15.4,F16.0)
      GO TO 10
C
C  READ LP FILE FOR REPORT WRITER
C
  50  CALL POSITN(IF,IND,2)
  51  CALL ARRAY(IF,IND,ANAM)
      IF(IND-1) 150,150,55
  55  K = 0
      IF(ANAM .EQ. COLNM) GO TO 70
  60  CALL VECTOR(IF,IND,VAL)
      IF(IND-1) 51,51,61
C  K = COUNTER FOR ROWS ACTIVITIES
  61  K = K + 1
C
C READ TOTAL WATER INFO
C
      IF(K .EQ. 3) TWATUS = VAL(3)/12.
      IF(K .EQ. 3) TWAVL = VAL(6) /12.
      IF(K .EQ. 3) TWATSP = VAL(7) * (-12.)
```

```
      IF(K .LE. 3 .OR. K .GT. 21) GO TO 65
      WATUS(K-3) = VAL(3)
      WATAVL(K-3) = VAL(6)
      WATSP(K-3) = VAL(7) * (-1.)
   65 IF(K .GT. 21) SOILSP(K-21) = VAL(7) * (-1.)
      IF(K .GT. 21) SOILNM(K-21) = VAL(1)
      IF(K .GT. 21) SOLVL (K-21) = VAL(3)
      GO TO 60
C COLUMNS SECTION
C
   70 CALL VECTOR(IF,IND,VAL)
      IF(IND-1) 51,51,71
   71 K = K+1
      ACTLVL(K) = VAL(3)
      NACT(K)    =IDINT(VAL(8) )
      GO TO 70
  150 RETURN
      END
C
C  RRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRRR
C
C  REPORT WRITER
C
      SUBROUTINE RWRIT(IT,NAC,WPUMP,ITEND)
      DIMENSION NYEAR(20,2)
      REAL*8 SOILNM(20)
      REAL*4 FIG(13),TFIG(13),CAP2(20,40),PVAL(6)/6*0.0/,PR(3)
      COMMON /COST/ PRIC(20),DSYS ( 4,6),SOAM(3,3,6)
      COMMON /MISC/ NBUG(10),NX1,NX9,NX10,TITL(10),NP
      COMMON /BAS/ SCLA(20,13),WAT(4,5)
      COMMON /VAL/ PNEW(20),ENEW(20),PCHA(10),ECHA(10)
      COMMON /NAM/  COD(21),WPER(2,18),CLD(20),TCOD(3,3),LPNM(20)
      COMMON /INAM/ IPRICN(2,20),IPCHAN(10),IECHAN(10),IENEWN(20)
      COMMON /RLP/ WATUS(18),WATSP(18),SOLVL(20),TWAVL,TWATSP,
     *   WATAVL(18), SOILSP(20),ACTLVL(30),NACT(30),SOILNM
      COMMON /CTROL/ NCROP(6),NR(6),NDSYS(4),NTIL(2),PVR,DRYNR
C
C READ FILE 10
C
      READ(10'2) NLC,NSOIL,TACRE
      READ(10'3) WAT
      DO 5 L =1,NLC
    5 READ(10'L+30) (SCLA(L,I),I=1,13)
C
C  CHECK IF READING RIGHT FILE 1 RECORDS
C
      IF(NBUG(5) .NE. 1 ) GO TO 7
      WRITE (6,1990)
 1990 FORMAT(1H0/20X,'ACTIVITIES GEN'///' ACT CODE      YLD     YLD2    ',
     *'RETURN    T.WAT    LAB     DSL     NIT     PHOS     FUEL$    VMACH$',
     * '      HARV$    T VAR$     NETV$    FMACH$     NETF$'/1X,132('_'))
      DO   6 K=1,NAC
      N1 = NACT(K)- (21+NSOIL)
      READ (1'N1,2000)    AC12,AC34,AC5,AC6,AC7,AC8,
```

```
     *  Y,Y2,RETURN,TWUS,HLAB,DIESL,FN,FP,FUELC,VMA,HAVC,
     *  TCOSTV,RNETV,FMA,RNETOT
C
C  WRITE FILE 1 OUTPUT FOR DEBUG
C
  6   WRITE (     6,2000) AC12,AC34,AC5,AC6,AC7,AC8,
     *  Y,Y2,RETURN,TWUS,HLAB,DIESL,FN,FP,FUELC,VMA,HAVC,
     *  TCOSTV,RNETV,FMA,RNETOT
  7   CONTINUE
      READ(10'IT+50) SAT,PLIFT,COEF,AQSURF,AVACIN,GPM,WELL
     *  ,IFYR,IEYR,DECL,TW
      NP=NP + 1
      WRITE(6,1995) TITL,IT,IFYR,IEYR,NP
 1995 FORMAT(1H1///10X,10A4,'  ITERATION',I3,'  YEARS',I5,' TO',I5,
     *   T110,'PAGE ',I4,
     *   ///12X,'PRICE CHANGE',T38,'CURRENT PRICE',T66,'EFFICIENCY',
     *' & YIELD',/7X,2(21('_'),5X),5X,21('_') )
      DO 12 I=1,10
 12   WRITE(6,1997)IPCHAN(I),PCHA(I),(IPRICN(K,I),K=1,2),PNEW(I),
     *  IECHAN(I),ECHA(I)
      DO 14 I=11,20
 14   WRITE(6,1998) (IPRICN(K,I),K=1,2),PNEW(I)
 1997 FORMAT(1H0,6X,A4,2X,'INDEX',F10.3,5X,A4,2X,A4,F10.2,10X,A4,2X,
     * 'INDEX',F10.3)
 1998 FORMAT(1H0,T34,A4,2X,A4,F10.2)
      IYR = IEYR - IFYR
C
C
C IRRIG WATER USE SECTION
C
      NP=NP + 1
      WRITE(6,1050) TITL,IT,IFYR,IEYR,NP
 1050 FORMAT(1H1  ,10X,10A4,'  ITERATION',I3,' YEARS',I5,' TO',I5,
     *   T110,'PAGE ',I4,
     *///10X,'GROUND WATER SITUATION'//16X,'SATURATED THICKNESS  PUMP',
     * ' LIFT  CAPACITY (GPM)     ANNUAL AC-FT'/9X,52('_'),4X,18('_'))
      READ(10'6) SATE,PLIFTE,GPME,DECL
C
      GPMD = GPME - GPM
      DN = - DECL
C
C  WRITE GWATER SITUATION
C
      WRITE(6,1055) SAT,PLIFT,GPM,TWAVL
      WRITE(6,1056) SATE,PLIFTE,GPME,WPUMP
      WRITE(6,1057) DN  ,DECL,GPMD,TWATSP
 1055 FORMAT(1H0,9X,'START',5X,F10.2,5X,F10.2,F12.2, 8X,'AVAIL',F13.2)
 1056 FORMAT(1H0,10X,'END ',5X,F10.2,5X,F10.2,F12.2, 8X,'PUMPED',F12.2)
 1057 FORMAT(1H0,8X,'CHANGE',2F15.2,F12.2, 8X,'S. PRICE',F10.2)
      WRITE(10'IT+50) SAT,PLIFT,COEF,AQSURF,AVACIN,GPM,WELL
     *  ,IFYR,IEYR,DECL,WPUMP,TWAVL,TWATSP
C
C  WATER USE PER PERIOD
C
```

```
      WRITE(6,1060) ((WPER(I,J),I=1,2),J=1,9)
 1060 FORMAT(1HO/10X,'WATER USE PER PERIOD (AC-IN)'//
     *  21X,           9(2X,A4,A3)/8X,96('_') )
      WRITE(6,1062)(WATAVL(I),I=1,9)
 1062 FORMAT(1HO,8X,'WATER AVAIL ',9F9.0)
      WRITE(6,1063) (WATUS(I),I=1,9  )
 1063 FORMAT(1HO,8X,'WATER USED  ',9F9.0)
      WRITE(6,1064) (WATSP(I),I=1,9)
 1064 FORMAT(1HO,8X,'SHADOW PRICE',F7.2,8F9.2)
      WRITE(6,1060) ((WPER(I,J),I=1,2),J=10,18)
      WRITE(6,1062)(WATAVL(I),I=10,18)
      WRITE(6,1063) (WATUS(I),I=10,18)
      WRITE(6,1064) (WATSP(I),I=10,18)
C
C IRRIGATION PUMPING AND DISTRIBUTION: COSTS AND ACREAGES
C
C
      FUR = 0.
      FA = 0.
      FURI = 0.
      FAI = 0.
      SPK = 0.
      SKA = 0.
      SPKI = 0.
      SKAI = 0.
      DO 30 K=1,NAC
      N1 = NACT(K)- (21+NSOIL)
      READ (1'N1,2000)   AC12,AC34,AC5,AC6,AC7,AC8,
     *  Y,Y2,RETURN,TWUS,HLAB,DIESL,FN,FP,FUELC,VMA,HAVC,
     *  TCOSTV,RNETV,FMA,RNETOT
      IF(AC6 .EQ. COD(13) ) FUR  = FUR  + TWUS * ACTLVL(K)
      IF(AC6 .EQ. COD(13) .AND. AC5 .EQ. COD(11)) FA = FA   + ACTLVL(K)
      IF(AC6 .EQ. COD(13) .AND. AC5 .NE. COD(11)) FA = FA + ACTLVL(K)/2.
      IF(AC6 .EQ. COD(14) ) FURI = FURI + TWUS * ACTLVL(K)
      IF(AC6 .EQ. COD(14) .AND. AC5 .EQ. COD(11)) FAI = FAI + ACTLVL(K)
      IF(AC6 .EQ. COD(14) .AND. AC5 .NE. COD(11))FAI = FAI+ ACTLVL(K)/2.
      IF(AC6 .EQ. COD(15) ) SPK  = SPK  + TWUS * ACTLVL(K)
      IF(AC6 .EQ. COD(15) .AND. AC5 .EQ. COD(11)) SKA = SKA + ACTLVL(K)
      IF(AC6 .EQ. COD(15).AND. AC5 .NE. COD(11))SKA = SKA +ACTLVL(K)/2.
      IF(AC6 .EQ. COD(16) ) SPKI = SPKI + TWUS * ACTLVL(K)
      IF(AC6 .EQ. COD(16) .AND. AC5 .EQ. COD(11))SKAI = SKAI + ACTLVL(K)
      IF(AC6 .EQ.COD(16) .AND. AC5 .NE. COD(11))SKAI=SKAI + ACTLVL(K)/2.
   30 CONTINUE
      WRITE(6,1070)
 1070 FORMAT(1HO/10X,'IRRIGATION PUMPING & DISTRIBUTION'//12X,'PER ACIN'
     *,9X,'FURROW',T42,'IMP FURROW',T60,'SPRINKLER',T74,'IMP SPRINKLER'
     */10X,76('_'))
      WRITE(6,1072) WAT,FA,FAI,SKA,SKAI,FUR,FURI,SPK,SPKI
 1072 FORMAT (1HO, 9X,'ANN FIX C ',4F15.2,//,10X,'ANN VAR C ',
     *4F15.2,//,10X,'LABOR HRS ',4F15.3,//,10X,'IRR EFFIC ',4F15.3,
     *  //,10X,'NGAS COST ',4F15.3,//10X,'ACRES',5X,4F15.0,
     *  //10X,'WATER USED',4F15.0)
C
C  CROPS SECTION
```

```
C
C  WRITE HEADER
C
        NP=NP + 1
       WRITE(6,1100) TITL,IT,IFYR,IEYR,NP
 1100 FORMAT(1H1///10X,10A4,'  ITERATION',I3,' YEARS',I5,' TO',I5,
     *   T110,'PAGE ',I4,
     * ///10X,'  CROP COSTS AND PRODUCTION'//' ACT CODE',5X,'RETURN',
     *'     T.WAT     LAB      DSL      NIT      PHOS      FUEL$     VMACH$',
     * '      HARV$     T VAR$      NETV$     FMACH$      NETF$'/1X,132('_'))
C
C
       DO 37 I=1,13
  37  TFIG(I) = 0.
       CTA = 0.
       CTP = 0.
       COA = 0.
       COP = 0.
       GSA = 0.
       GSP = 0.
       SUA = 0.
       SUP = 0.
       SOA = 0.
       SOP = 0.
       WTA = 0.
       WTP = 0.
       WTIA = 0.
       CTIA=0.
        CTIP=0.
         GSIA=0.
          GSIP=0.
           SUIA=0.
            SUIP=0.
              WTIP=0.
C
C
       DO 66 K=1,NAC
       N1 = NACT(K)- (21+NSOIL)
       READ (1'N1,2010)   AC12,AC34,AC5,AC6,AC7,AC8,
     * Y1,Y2,(FIG(J),J=1,13)
C
C   CALC CROP PRODUCTION, ACERAGE, VALUE BY CROP
C
C  WRITE PER ACRE COSTS
C
       WRITE(6,1110) AC12,AC34,AC5,AC6,AC7,AC8,FIG
 1110 FORMAT(1H ,2A2,4A1/'    PER AC',2X,F10.2,5F8.1,7F10.2)
C
       DO 50 J=1,13
       FIG(J) = FIG(J) * ACTLVL(K)
 50   TFIG(J) = TFIG(J) + FIG(J)
       WRITE(6,1120) FIG
 1120 FORMAT(1H ,4X,'TOTAL  ',F10.0,5F8.0,7F10.0)
C
```

```
      READ (1'N1,2000)   AC12,AC34,AC5,AC6,AC7,AC8,
     * Y1,Y2,(FIG(J),J=1,13)
C  COTTON
C
      IF(AC12 .EQ. COD(1 ) ) CTA = CTA + ACTLVL(K)
      IF(AC12 .EQ. COD(1 ) ) CTP = CTP + ACTLVL(K) *Y1
C  CORN
C
      IF(AC12 .EQ. COD(2 ) ) COA = COA + ACTLVL(K)
      IF(AC12 .EQ. COD(2 ) ) COP = COP + ACTLVL(K) * Y1
C  SORGHUM
C
      IF(AC12 .NE. COD(3 ) ) GO  TO 40
      IF(AC5  .EQ. COD(9 ) ) GSA = GSA + ACTLVL(K)
      IF(AC5  .EQ. COD(9 ) ) GSP = GSP + ACTLVL(K) *(Y1 + Y2)
      IF(AC5  .EQ. COD(11) ) GSA = GSA + ACTLVL(K)
      IF(AC5  .EQ. COD(11) ) GSP = GSP + ACTLVL(K) * Y1
      IF(AC5  .EQ. COD(12) ) GSA = GSA + ACTLVL(K) /2.
      IF(AC5  .EQ. COD(12) ) WTA = WTA + ACTLVL(K) /2.
      IF(AC5  .EQ. COD(12) ) GSP = GSP + ACTLVL(K) *Y1
      IF(AC5  .EQ. COD(12) ) WTP = WTP + ACTLVL(K) *Y2
C  SUNFLOWERS
C
   40 IF(AC12 .NE. COD(4 ) ) GO  TO 42
      IF(AC5  .EQ. COD(11) ) SUA = SUA + ACTLVL(K)
      IF(AC5  .EQ. COD(11) ) SUP = SUP + ACTLVL(K) *Y1
      IF(AC5  .EQ. COD(12) ) SUA = SUA + ACTLVL(K)/2.
      IF(AC5  .EQ. COD(12) ) SUP = SUP + ACTLVL(K) *  Y1
      IF(AC5  .EQ. COD(12) ) WTA = WTA + ACTLVL(K) /2.
      IF(AC5  .EQ. COD(12) ) WTP = WTP + ACTLVL(K) *Y2
C  SOYBEANS
C
   42 IF(AC12 .NE. COD(5 ) ) GO  TO 44
      IF(AC5  .EQ. COD(11) ) SOA = SOA + ACTLVL(K)
      IF(AC5  .EQ. COD(11) ) SOP = SOP + ACTLVL(K) *Y1
      IF(AC5  .EQ. COD(12) ) SOA = SOA + ACTLVL(K)/2.
      IF(AC5  .EQ. COD(12) ) SOP = SOP + ACTLVL(K) *  Y1
      IF(AC5  .EQ. COD(12) ) WTA = WTA + ACTLVL(K) /2.
      IF(AC5  .EQ. COD(12) ) WTP = WTP + ACTLVL(K) *Y2
C  WHEAT
C
   44 IF(AC12 .NE. COD(6 ) ) GO  TO 47
      IF(AC34 .EQ. COD(7) .OR. AC34 .EQ. COD(8) ) GO TO 45
      IF(AC5 .EQ. COD(11) ) WTIA =WTIA + ACTLVL(K)
      IF(AC5 .NE. COD(11) ) WTIA =WTIA + ACTLVL(K)/2.
   45 IF(AC5 .NE. COD(17) ) GO TO 46
      CTA = CTA + ACTLVL(K)/2.
      CTP = CTP + ACTLVL(K) * Y2
      WTA = WTA + ACTLVL(K) /2.
      WTP = WTP + ACTLVL(K) * Y1
   46 IF(AC5  .EQ. COD(21) ) WTA = WTA + ACTLVL(K) /2.
      IF(AC5 .EQ. COD(11) .OR. AC5 .EQ. COD(12))WTA=WTA+ ACTLVL(K)
      IF(AC5 .EQ. COD(9) .AND. AC6 .NE. COD(20))WTA=WTA+ ACTLVL(K)/2.
      IF(AC5 .EQ. COD(9) .AND. AC6 .EQ. COD(20))WTA=WTA+ ACTLVL(K)/3.
```

```
      IF(AC5 .EQ. COD(10).AND. AC6 .NE. COD(20))WTA=WTA+ ACTLVL(K)/2.
      IF(AC5 .EQ. COD(10).AND. AC6 .EQ. COD(20))WTA=WTA+ ACTLVL(K)/3.
      IF(AC5 .EQ. COD(9) .AND. AC6 .NE. COD(20))GSA=GSA+ ACTLVL(K)/2.
      IF(AC5 .EQ. COD(9) .AND. AC6 .EQ. COD(20))GSA=GSA+ ACTLVL(K)/3.
      IF(AC5 .EQ. COD(10).AND. AC6 .NE. COD(20))SUA=SUA+ ACTLVL(K)/2.
      IF(AC5 .EQ. COD(10).AND. AC6 .EQ. COD(20))SUA=SUA+ ACTLVL(K)/3.
      IF(AC5  .EQ. COD(9 ) ) WTP = WTP + ACTLVL(K) *Y1
      IF(AC5  .EQ. COD(10) ) WTP = WTP + ACTLVL(K) *Y1
      IF(AC5  .EQ. COD(12) ) WTP = WTP + ACTLVL(K) *(Y1+Y2)
      IF(AC5 .EQ. COD(11) .OR. AC5 .EQ. COD(21))WTP=WTP+ ACTLVL(K)*Y1
      IF(AC5  .EQ. COD(9 ) ) GSP = GSP + ACTLVL(K) *Y2
      IF(AC5  .EQ. COD(10) ) SUP = SUP + ACTLVL(K) *Y2
C
C **********************************************
C     CALCULATE DRYLAND AND IRRIG. ACREAGES,PROD.
C    INDIC=1 THEN DRYLAND
C         =2  THEN PURE IRR
C         =3   THEN MIXED
C **********************************************
47    INDIC=3
      IF(AC6.EQ.COD(19).OR.AC6.EQ.COD(20)) GO TO 66
      IF(AC5.EQ.COD(19)) GO TO 49
       GO TO 52
49    INDIC=2
52    DO 53 J=1,6
      IF(AC12.NE.COD(J)) GO TO 53
        GO TO (54,56,58,60,62,64),J
53      CONTINUE
C       COTTON ACREAGES
54    IF(INDIC.EQ.3) GO TO 55
       CTIA=CTIA + ACTLVL(K)
        CTIP=CTIP + ACTLVL(K)*Y1
         GO TO 66
55    CTIA=CTIA + ACTLVL(K)/2.
       CTIP=CTIP + ACTLVL(K)*Y1
        GO TO 66
C *** CORN ALREADY CALC
56    GO TO 66
C *** GRAIN SORGHUM
58    IF(INDIC.EQ.3) GO TO 59
       GSIA=GSIA + ACTLVL(K)
        GSIP= GSIP + ACTLVL(K)*Y1
         GO TO 66
59    GSIA=GSIA+ ACTLVL(K)/2.
       GSIP= GSIP + ACTLVL(K)*Y1
         GO TO 66
C  **** SUNFLOWER
60    IF(INDIC.EQ.3) GO TO 61
       SUIA=SUIA+ ACTLVL(K)
        SUIP=SUIP + ACTLVL(K)*Y1
         GO TO 66
61     SUIA=SUIA+ ACTLVL(K)/2.
        SUIP=SUIP + ACTLVL(K)*Y1
         GO TO 66
```

```
62        GO TO 66
C *** SOYBEANS ALREADY DONE ABOVE
C *** WHEAT BELOW
64      IF(INDIC.EQ.3) GO TO 65
          WTIP=WTIP+ACTLVL(K)*Y1
           GO TO 66
65      WTIP=WTIP + ACTLVL(K)*Y1
 66    CONTINUE
C
C    CALC COSTS AND TOTALS
C
       WRITE(6,1130) TFIG
 1130 FORMAT(1X,132('_')/ ' TOT',F10.0,1X,F8.0,1X,4(F9.0,1X),
      < F9.0,6F10.0)
C
C   CROP PRODUCTION AND VALUE
C
       DCTA=CTA-CTIA
       DCTP=CTP-CTIP
       DGSA=GSA-GSIA
       DGSP=GSP-GSIP
       DSUA=SUA-SUIA
       DSUP=SUP-SUIP
       DWTA=WTA-WTIA
       DWTP=WTP-WTIP
       DCOA=0.
       DSOA=0.
       DCOP=0.
       DSOP=0.
        TOTDRY=DCTA + DGSA+ DSUA+DWTA
        TOTIRR= CTIA+GSIA+SUIA+WTIA+COA+SOA
        FALLOW=TACRE-TOTDRY-TOTIRR
        NP=NP + 1
       WRITE(6,1140) TITL,IT,IFYR,IEYR,NP
 1140 FORMAT(1H1///20X,10A4,'   ITERATION',I3,' YEARS',I5,' TO',I5,
     *    T110,'PAGE ',I4,
     *           // 10X,'CROP PRODUCTION AND VALUE'//T20,'COTTON',
     *  T43,'SORGHUM',T64,'SUNFLOWER',T90,'WHEAT',T109,'CORN',
     * T119,'SOYBEAN',/,T12,4(19('_'),5X),T107,9('_'),T119,10('_'),/,
     * T14,4('DRY',9X,'IRR',9X),/,132('_'))
       WRITE(6,1150) DCTA,CTIA,DGSA,GSIA,DSUA,SUIA,DWTA,WTIA,COA,SOA
 1150 FORMAT(1H ,1X,'ACREAGE',T10,10(F10.0,2X))
       WRITE(6,1160) DCTP,CTIP,DGSP,GSIP,DSUP,SUIP,DWTP,WTIP,COP,SOP
 1160 FORMAT(1H0,1X,'PROD',T10,10(F10.0,2X))
       DCTV = DCTP*PNEW(11) + 1.6*DCTP*PNEW(17) /2000.
       DGSV = DGSP*PNEW(13)
       DSUV = DSUP*PNEW(14)
       DWTV = DWTP*PNEW(16) + DWTA * PNEW(18)
       CTIV = CTIP*PNEW(11) + 1.6*CTIP*PNEW(17) /2000.
       COV = COP*PNEW(12)
       GSIV = GSIP*PNEW(13)
       SUIV = SUIP*PNEW(14)
       SOV = SOP*PNEW(15)
       WTIV = WTIP*PNEW(16) + 4.*WTIA * PNEW(18)
```

```
      WRITE(6,1170) DCTV,CTIV,DGSV,GSIV,DSUV,SUIV,DWTV,WTIV,COV,SOV
 1170 FORMAT(1H0, 1X,'VALUE',T10,10(F10.0,2X))
C
C   SUMMARY INFO FILED ON FILE 10
C
      WRITE(10'IT+70) IFYR,IEYR,TFIG
      Z=0.
      WRITE(10'IT+90) IFYR,IEYR,CTIA,CTIP,COA,COP,GSIA,GSIP,SUIA,
     * SUIP,SOA,SOP,WTIA,WTIP,Z,CTIV,Z,COV,Z,GSIV,Z,SUIV,Z,SOV,Z,WTIV,
     * DCTA,DCTP,DGSA,DGSP,DSUA,DSUP,DWTA,DWTP,Z,DCTV,Z,DGSV,Z,
     * DSUV,Z,DWTV
C
C   LAND SECTION
C
      WRITE(6,1000)
 1000 FORMAT(1H0,  10X,'LAND USE'//
     *T 6,'SOIL',T18,'ACRES',T32,'SHADOW PRICE',/ 5X,40('_') )
      DO 10 N =1,NSOIL
   10 WRITE(6,1005) SOILNM(N),SOLVL(N),SOILSP(N)
 1005 FORMAT(1H0, 5X,A8,F9.2,F17.2)
C
C   CALCULATE CROPLAND USAGE PERCENTAGES
C
       PERDRY=TOTDRY/TACRE* 100.
       PERIRR=TOTIRR/TACRE* 100.
       PERFAL=100.-PERDRY-PERIRR
       WRITE(6,1006) TACRE,TOTDRY,PERDRY,TOTIRR,PERIRR,FALLOW,PERFAL
1006   FORMAT(' ',130('_'),/,' AVAIL CROPLAND',T18,F12.0,' AC.',
     *  /,' DRYLAND',T18,F12.0,' AC',1X,F5.1,' %',/,
     *  ' IRRIG',T18,F12.0,' AC',1X,F5.1,' %',/,
     *  ' FALLOW',T18,F12.0,' AC',1X,F5.1,' %')
       NP=NP + 1
      WRITE(6,1010) NP
 1010 FORMAT(1H1,110X,'PAGE',I4,/T6,'ACTIVITY',T19,'SOIL',T28,'TERRACE',
     * T39,'ACRES',T48,'CROP1  YIELD',T64,'CROP2  YIELD'/ 5X,70('_'))
      DO 20 K=1,NAC
      N1 = NACT(K)- (21+NSOIL)
      READ (1'N1,2010)   AC12,AC34,AC5,AC6,AC7,AC8,
     *  Y,Y2,RETURN,TWUS,HLAB,DIESL,FN,FP,FUELC,VMA,HAVC,
     *  TCOSTV,RNETV,FMA,RNETOT
2000  FORMAT(A3,A2,4A1,1X,3F8.2, 5F7.1,7F9.2)
2010  FORMAT(1X,A2,A2,4A1,1X,3F8.2, 5F7.1,7F9.2)
      DO 18 L=1,NLC
      IF(AC8 .NE. CLD(L) ) GO TO 18
      WRITE(6,1015) AC12,AC34,AC5,AC6,AC7,AC8,SCLA(L,1),SCLA(L,2),
     *              SCLA(L,13),ACTLVL(K),AC12,Y,AC5,Y2
 1015 FORMAT(1H0, 5X,2A2,4A1,2X,2A4,4X,A4,F11.2,6X,A2,F9.2,5X,A1,F9.2)
   18 CONTINUE
   20 CONTINUE
C
C   CHECK IF DRYNR GT LP SOL
C     IF SO THEN PRECLUDE ALL IRRIG. ACTIVITIES
C     FROM CONSIDERATION IN SUBSEQUENT RUNS
C      TEMP IS MAX PUMP FIXED COSTS FOR VARIOUS IRRIG. DIST SYS
```

```
C
          IF(DRYNR.EQ.O.) GO TO 84
           TEMP=O.
          DO 81 J=1,4
          IF(NDSYS(J).EQ.O) GO TO 81
          TEMP=AMAX1(TEMP,WAT(J,1))
81       CONTINUE
         IF((TFIG(13)-TEMP).GT.DRYNR) GO TO 84
         DO 83 J=1,6
83       NR(J)=1
         NCROP(2)=O
         NCROP(5)=O
84       CONTINUE
C
C   CHECK IF LAST ITERATION (GREATER THAN 1)
C   IF SO SUMMARY NEEDED OTHERWISE RETURN
C
       IF (IT .LT. ITEND) RETURN
       IF (ITEND .EQ. 1)  RETURN
C
C  WRITE THE PRICE YIELD CHANGE INDICES
C
         NP=NP + 1
       WRITE(6,1300) TITL,NP
 1300 FORMAT(1H1,///10X,10A4,' SUMMARY',T110,'PAGE ',I4,///,
     * 10X,'PRICE AND YIELD INDEX',
     * ' CHANGES'//T38,'PRICES',T91,'EFFICIENCY & YIELD'/11X,
     *  58('_'),4X,58('_') )
       WRITE(6,1310) IPCHAN,IECHAN
 1310 FORMAT('O PERIOD  ',10(1X,A4,1X),2X,10(1X,A4,1X) )
       DO 85 J=1,IT
       READ(10'J+10) IFYR,IEYR,I1,I2,PCHA,ECHA
   85  WRITE(6,1320) IFYR,IEYR,PCHA,ECHA
 1320 FORMAT(1HO,I4,'-',I4,F5.2,9F6.2,2X,10F6.2)
C
C  WRITE THE GROUNDWATER SITUATION SUMMARY
C
       NP=NP + 1
       WRITE(6,1200) TITL,NP
 1200 FORMAT(1H1///10X,10A4,' SUMMARY',T110,'PAGE ',I4,
     * //10X,'GROUND WATER SITUATION'//10X,'PERIOD',T22,'SATURATED',
     *   ' THICKNESS  PUMP LIFT  CAPACITY',T77,'TOTAL WATER (ACFT)',
     */T30,'FT',T45,'FT',T56,'GPM',T72,'PUMPED     AVAIL     S. PRICE'
     *  /9X,52('_'),6X,32('_') )
       TOTTW = O.
       DO 70 J=1,IT
       READ(10'J+50)  SAT,PLIFT,COEF,AQSURF,AVACIN,GPM,WELL
     *  ,IFYR,IEYR,DECL,TW,TWA,TWSP
       TW = TW * (IEYR-IFYR)
       TWA = TWA * (IEYR-IFYR)
       TOTTW = TOTTW + TW
   70  WRITE(6,1210) IFYR,IEYR,SAT,PLIFT,GPM,TW,TWA,TWSP
 1210 FORMAT(1HO, 8X,I4,'-',I4,    2F15.2,F12.2,7X,2F10.O,F10.2)
       WRITE(6,1215) SATE,PLIFTE,GPME,TOTTW
```

```
 1215 FORMAT(1HO,8X,'END    ',3X,2F15.2,F12.2,'  TOTAL',F10.0)
C
C READ INTO MATRIX,CALC. YIELDS AND SCALE  VALUE AND PROD.
C
      DO 100 J=1,IT
100   READ(10'J+90) (NYEAR(J,L),L=1,2),(CAP2(J,K),K=1,40)
C   CALC. IRR. YIELDS
      DO 130 K=1,IT
       DO 101 JK=13,23,2
       IF(CAP2(K,JK-12).EQ.O.) GO TO 101
        CAP2(K,JK)=CAP2(K,JK-11)/CAP2(K,JK-12)
101    CONTINUE
C
C   SCALE IRR. VALUES
C
       DO 102 JK=14,24,2
102    CAP2(K,JK)=CAP2(K,JK)/1000.
C
C   CALC. DRYLAND YIELDS
C
       DO 103 JK=33,39,2
       IF(CAP2(K,JK-8).EQ.O) GO TO 103
       CAP2(K,JK)=CAP2(K,JK-7)/CAP2(K,JK-8)
103     CONTINUE
C
C   SCALE DRYLAND VALUES
C
        DO 104 JK=34,40,2
104     CAP2(K,JK)= CAP2(K,JK)/1000.
C
C
C   SCALE PRODUCTION
C
C
      DO 125 J=1,6
      DIV=1000.
      INDIC=2
       GO TO (111,112,113,114,115,116),J
111    J1=2
       J2=4
        GO TO 118
112   J1=6
      J2=8
      DIV=20.
       GO TO 118
113    J1=10
       J2=12
        GO TO 118
114   J1=26
      J2=26
      INDIC=1
       GO TO 118
115    J1=28
       J2=30
```

```
        DIV=20.
          GO TO 118
116    J1=32
       J2=32
       INDIC=1
C
C
118    DO 120 JK=J1,J2,INDIC
120     CAP2(K,JK)=CAP2(K,JK)/DIV
C
C
125    CONTINUE
130    CONTINUE
C
C
C
C   CROP PRODUCTION LEVELS
C
         NP=NP + 1
       WRITE(6,1240) TITL,NP
 1240 FORMAT(1H1/10X,10A4,' SUMMARY',T110,'PAGE ',I4,/,
     *  /10X,'ANNUAL IRRIG. ACREAGE AND CROP PRODUCTION '/,132('*'),
     */,T24,'COTTON',T43,'CORN',T62,'SORGHUM',T81,'SUNFLOWER',T102,
     *'SOYBEAN',T124,'WHEAT'/13X,6(3X,16('_'),1X),/15X,5(3X,'ACRE',
     *5X,'PROD ',3X),3X,'ACRE',5X,'PROD '/T27,'000LB',T47,'000BU',
     *T68,'TON',T88,'TON',T107,'000BU',T127,'000BU'/1X,132('_'))
C
       DO 135 J=1,IT
135    WRITE(6,1250) (NYEAR(J,L),L=1,2),(CAP2(J,K),K=1,12)
1250    FORMAT(' ',I5,'-',I4,2X,6(F10.0,F10.2))
C
       WRITE(6,1251)
 1251 FORMAT(1H0/,
     *  10X,'ANNUAL IRRIG. YIELDS AND VALUE  '/,132('*'),/,
     *T21,'COTTON',T40,'CORN',T59,'SORGHUM',T78,'SUNFLOWER',T99,
     *'SOYBEAN',T121,'WHEAT'/10X,6(3X,16('_'),1X),/12X,5(3X,'YLD ',
     *5X,'VALU ',3X),3X,'YLD ',5X,'VALU '/T14,'   LB',T25,'000$',
     * T34,'   BU',T45,'000$',T56,'CWT',T65,'000$',T76,'CWT',
     * T85,'000$',T94,'   BU',T105,'000$',T117,'BU',T125,'000$',
     * /1X,132('_'))
C
       DO 136 J=1,IT
136    WRITE(6,1252) (NYEAR(J,L),L=1,2),(CAP2(J,K),K=13,24)
1252   FORMAT(' ',I5,'-',I4,T14,F6.1,1X,F11.2,2X,5(1X,F5.1,1X,F11.2,2X))
C
         NP=NP + 1
       WRITE(6,1253) TITL,NP
 1253 FORMAT(1H1/10X,10A4,' SUMMARY',T110,'PAGE ',I4,/,
     *  /10X,'ANNUAL DRYLAND ACREAGE AND CROP PRODUCTION '/,132('*'),
     * /,T24,'COTTON',T43,'SORGHUM',T62,'SUNFLOWER',T81,
     * 'WHEAT'/13X,4(3X,16('_'),1X),/15X,4(3X,'ACRE',
     *5X,'PROD ',3X),/T27,'000LB',T48,
     *'TON',T68,'TON',T88,'000BU'/1X,132('_'))
C
```

```
      DO 137 J=1,IT
137   WRITE(6,1254) (NYEAR(J,L),L=1,2),(CAP2(J,K),K=25,32)
1254   FORMAT(' ',I5,'-',I4,2X,4(F10.0,F10.2))
C
      WRITE(6,1255)
 1255 FORMAT(1HO/,
     *  /10X,'ANNUAL DRYLAND YIELDS AND VALUE  '/,132('*'),/,
     *T24,'COTTON',T43,'SORGHUM',T62,'SUNFLOWER',T81,
     * 'WHEAT'/13X,4(3X,16('_'),1X),/15X,4(3X,'YLD ',
     *5X,'VALU ',3X),/T17,'    LB',T28,'000$',T39,
     *'CWT',T48,'000$',T59,'CWT',T68,'000$',T77,'    BU',T88,'000$',/,
     * 1X,132('_'))
C
      DO 138 J=1,IT
138   WRITE(6,1256) (NYEAR(J,L),L=1,2),(CAP2(J,K),K=33,40)
1256  FORMAT(' ',I5,'-',I4,4X,4(F6.2,1X,F12.2,1X))
C
C
C  CROP COSTS
C
      PR(1) = PVR/200.
      PR(2) = PVR/100.
      PR(3) = PR(1) + PR(2)
C
C  PR = THE PRESENT VALUE RATE AT .5, 1, 1.5 ENTERED RATE
C
        NP=NP + 1
      WRITE(6,1220) TITL,NP
 1220 FORMAT(1H1///10X,10A4,' SUMMARY',T110,'PAGE ',I4,///10X,
     *  'ANNUAL CROP COSTS AND PRODUCTION'//' PERIOD',T9,'RETURN',T18,
     * 'T.WAT',T28,'LAB',T38,'DSL',T47,'NIT',T54,'PHOS',T63,'FUEL$',
     * T72,'VAR MA',T83,'HARVT',T92,'TOT VAR',T100,'REV-VAR',T111,
     * 'FX MA',T120,'REV-TOT',/,T11,'$000',T18,'AC-FT',T28,'HRS',
     * T38,'GAL',T47,'TON',T55,'TON',T64,'$000',T73,'$000',T84,
     * '$000',T94,'$000',T102,'$000',T112,'$000',T121,'$000',/,
     * 1X,132('_'))
      DO 250 J=1,IT
      READ(10'J+70) IFYR,IEYR,TFIG
      IF(J .EQ. 1) IYR1 = IFYR
      IF(J .EQ. IT) IYRL = IEYR
      TFIG(1) = TFIG(1)/1000.
      TFIG(2) = TFIG(2)/12.
      TFIG(5) = TFIG(5)/2000.
      TFIG(6) = TFIG(6)/2000.
C
      IYR = IEYR-IFYR
      DO 240 K=1,3
      DO 230 K1=1,IYR
      PVAL(K)=PVAL(K)+ TFIG(11) /(1.+PR(K))**(K1+(IFYR-IYR1))
  230  PVAL(K+3)=PVAL(K+3)+ TFIG(13) /(1.+PR(K))**(K1+(IFYR-IYR1))
  240  CONTINUE
C
C
      DO 72 I=7,13
```

```
   72  TFIG(I) = TFIG(I)/1000.
C
C
      IFYR=IFYR-1900
      IEYR=IEYR-1900
       IF(IFYR.GE.100) IFYR=IFYR-100
        IF(IEYR.GE.100) IEYR=IEYR-100
  250  WRITE(6,1230) IFYR,IEYR,TFIG
 1230 FORMAT(1H0,I2,'-',I2,3X,F7.0,F8.0,2(1X,F9.0),1X,F7.0,1X,F7.0,
     *  2F9.0,2X,F9.0,2X,2F8.0,1X,F8.0,1X,F10.0)
C
C   CALCULATE CROPLAND USAGE PERCENTAGE SUMMARY
C
        NP=NP + 1
        WRITE(6,1225) NP, TACRE
1225   FORMAT(1H1,//,110X,'PAGE ',I4,/,' CROPLAND USAGE FOR ',
     *  F12.0,' AVAIL ACRES',/,130('_'),/,T4,'PERIOD',T18,'DRY',
     *  T29,'%',T39,'IRRIG',T50,'%',T61,'FALLOW',T72,'%',
     *  /,130('_'))
        DO 280 J=1,IT
        TOTIRR=0.
        TOTDRY=0.
        DO 275 I=1,11,2
275    TOTIRR=TOTIRR + CAP2(J,I)
        DO 276 I=25,31,2
276     TOTDRY=TOTDRY + CAP2(J,I)
          PERDRY=TOTDRY/TACRE*100.
           PERIRR=TOTIRR/TACRE*100.
            FALLOW=TACRE-TOTDRY-TOTIRR
             PERFAL=FALLOW/TACRE*100.
        WRITE(6,1226) (NYEAR(J,I),I=1,2),TOTDRY,PERDRY,TOTIRR,PERIRR,
     *  FALLOW,PERFAL
1226   FORMAT(' ',I5,'-',I4,1X,3(F12.0,2X,F5.1,2X))
280    CONTINUE
C
C  NO PRESENT VALUE FOR STATIC RUNS
C
       IF(NBUG(2) .EQ. 1 ) RETURN
       PR(1) =PR(1)*100.
       PR(2) = PR(2) * 100.
       PR(3) = PR(3) * 100.
C
       WRITE(6,1235) IYR1,IYRL,(PR(J),PVAL(J),J=1,3)
 1235 FORMAT(1H0/  1X,I4,' PRESENT VALUE OF RETURNS OVER VARIABLE',
     * ' COST UPTO ',I4,' AT A DISCOUNT RATE OF',F5.2,' = $',F15.0,
     * //81X,F5.2,' = $',F15.0//81X,F5.2,' = $',F15.0 )
       WRITE(6,1237) (PR(J),PVAL(J+3),J=1,3)
 1237 FORMAT(1H0/ 1X,'OVER VARIABLE AND FIXED COST (EXCLUDING LAND',
     * ', WATER AND MANAGEMENT) AT A RATE OF',F5.2,' = $',F15.0,
     * //81X,F5.2,' = $',F15.0//81X,F5.2,' = $',F15.0 )
       RETURN
       END
```

# V

# JCL TO COMPILE FORTRAN

```
 1) //FORTEL  JOB (L660,4B,05,09,DR),'RENEAU'
 2) //*FORMAT PR,DDNAME=,DEST=XEROX,COPIES=1,
 3) //*JDE=JFMT6,FORMS=1100
 4) //STEP1   EXEC FORTXCL
 5) //FORT.SYSIN DD *
    *****************************************************************
    *****************************************************************
    FORTRAN PROGRAM GOES HERE
    *****************************************************************
 6) //LKED.SYSLIB DD
 7) //        DD
 8) //        DD DSN=SYSDPC.MPSX,DISP=SHR
 9) //LKED.SYSLMOD DD DSN=USR.L660.DR.MSYS3(FORTELX),DISP=OLD
10) //LKED.SYSIN DD *
11)  INSERT  READCOMM
12)  ENTRY   MAIN
13)  NAME    FORTELX(R)
14) /*END
```

1 is the job card.

2,3 controls printing (optional)

4 compiles the program using Fortran H Extended.

5 designates the start of the source program.

6,7,8 link the MPSX system library.

9 gives the name of the WYLBUR file where the compiled Fortran will be stored. This file must have been previously created and contain at least 8 tracks of disk space.

10,11,12, and 13 set the name of the Fortran program in READCOMM so that MPSX will know how to access it.

# VI

## JCL TO RUN MODEL: INCLUDING MPSX PROGRAM

### JCL Listing

```
//NLF50PL  JOB (L660,4B,05,09,DR),'RENEAU'
//STEP1   EXEC MPSX,REGION.EXEC=256K
//CPC.SYSIN DD *
          PROGRAM('ND')
          INITIALZ
          MVADR(XDONFS,L2)
          MVADR(XMAJERR,L2)
          MVADR(XIOERR,L2)
L1        FORTELX(ITER,ITOUT,LPNAM)
          IF(ITER .GT. ITOUT, L2)
          MOVE(XDATA,LPNAM)
          MOVE(XPBNAME,'TEST1')
          MOVE(XOBJ,'FIX')
          MOVE(XRHS,'RHS1')
          ASSIGN('FT04F001','FT04F001','COMM')
          CONVERT('FILE','FT03F001')
          PREPOUT('FT04F001')
          SETUP('MAX')
          OPTIMIZE
          SOLUTION('FILE','FT04F001','ACTIVE')
          FREECORE
          GOTO(L1)
L2        EXIT
ITER      DC(1)
ITOUT     DC(3)
LPNAM     DC('HPT1')
          PEND
/*
//EXEC.STEPLIB DD
//      DD DSN=USR.L660.DR.MSYS3(FORTELX),DISP=SHR
//EXEC.FT04F001 DD UNIT=SYSDA,SPACE=(TRK,(1,1)),DISP=(NEW,DELETE)
//EXEC.FT06F001 DD SYSOUT=A
//EXEC.FT01F001 DD UNIT=SYSDA,SPACE=(TRK,(100,100)),DISP=(NEW,DELETE),
//   DCB=(RECFM=F,LRECL=133,BLKSIZE=133)
//EXEC.FT03F001 DD UNIT=SYSDA,SPACE=(TRK,(100,100)),DISP=(NEW,DELETE),
//   DCB=(RECFM=F,LRECL=80,BLKSIZE=80)
//EXEC.FT09F001 DD UNIT=SYSDA,SPACE=(TRK,(1,1)),DISP=(NEW,DELETE),
//   DCB=(RECFM=F,LRECL=80,BLKSIZE=80)
//EXEC.FT10F001 DD UNIT=SYSDA,SPACE=(TRK,(1,1)),DISP=(NEW,DELETE),
//   DCB=(RECFM=F,LRECL=80,BLKSIZE=80)
//EXEC.FT05F001 DD  DSN=USR.L660.DR.NLF50PL,DISP=SHR
```

## Explanation of JCL and MPSX Program

1) Job card

2) Compiles MPSX program and runs model under control of the MPSX

3) Indicates MPSX program follows

4) Start of MPSX control cards (ND necessary due to imbedded Fortran)

6-8) End run if non-feasible, major error, or IO error encountered

9) Fortran program; name must be the same as that passed to READCOMM (Section V line 13). ITER = iteration no., ITOUT = last iteration no., LPNAM = current name of the LP input data for a particular iteration.

10) Checks if last iteration

11-14) sets up the current LP problem

13) Sets the objective function row name. Can be changed to "VAR" for static runs or when maximization over only variable costs is desired.

15, 17) Assigns file 4 as the solution output file in COMM format.

16) Reads the current LP input data from file 3

18, 19) Sets up and solves the current LP problem

20) Writes the vectors in the optimal solution to file 4

21) Frees internal temporary disk space for the next iteration

22) Starts the next iteration

23-26) Initializes variables to be passed between the MPSX and Fortran

30) Gives the location of the compiled Fortran program

31-40) Creates temporary disk storage for LP Input (file 3), LP Output (file 4), and three direct access files used by the Fortran (file 1 - for production activities economic data), and files 9, 10.

41) Gives the location of the input data (see Section II for example file).

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