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USE OF APPLIED ECONOMICS IN
THE ARKANSAS-WHITE-RED
COOPERATIVE RIVER BASIN STUDY

by

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October, 1978

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Summary

The objectives of the Arkansas-White-Red Cooperative Basin Study were:

- (1) To identify present and impending problems pertaining to natural resource supply and quality, particularly as they affect agricultural production, farm revenues, and income and employment in agriculture and service industries.
- (2) To examine U.S. Department of Agriculture program potentials for overcoming natural-resource-related problems. This included estimating the economic and environmental effects of various potential program measures.

The economic analysis described here centered mainly on projecting future economic conditions in the event that USDA programs remain at their status quo level of intensity, and also on projecting future economic effects produced by potential increases in the intensity of programs.

The economic projections method for the status quo level was essentially an extrapolation of past crop acreage trends, altered by locally-obtained information concerning institutional factors influencing those acreage trends. The projections method used to estimate program effects was essentially to define the scale and intensity of change on the acreages to be affected and to estimate the changes in costs and productivity that would result, for each of several unique soil-vegetation types found in the Study Area.

The finding of the economic analysis was that an acceleration of the ongoing USDA land treatment program would increase farm production and revenue by an amount several times the public and private cost of such an acceleration. The additional production thus created would, in general, not cause dislocation and displacement of production elsewhere in the Nation through competitive market effects.

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Use of Applied Economics in
the Arkansas-White-Red
Cooperative River Basin Study

Introduction

The Arkansas-White-Red Cooperative River Basin Study was basically an inquiry into the condition and supply of natural resources in the AWR Basin with the intention of uncovering shortages, impending shortages, or deterioration, of natural resources that may result in a lessening of economic, environmental, or social well-being of AWR residents and residents outside of the Basin. The AWR Cooperative River Basin Study (AWR-CRBS) also included an appraisal of the potential for public action to overcome the economic, social, and/or environmental effects of natural resources deterioration and shortages.

The AWR-CRBS was made at the request of State officials representing the citizens of New Mexico. Main participants in this study were: (1) the New Mexico State Engineer Office (SEO), a principal water regulating agency representing the citizens of the State and of the AWR region; (2) the U.S. Soil Conservation Service (SCS); (3) the U.S. Forest Service (FS); and (4) the Economics, Statistics, and Cooperatives Service (ESCS). The latter three agencies are parts of the U.S. Department of Agriculture (USDA). SCS was designated by USDA as the agency to provide general leadership responsibility for conducting the study.

ESCS had the main responsibility for projecting the future economic

conditions in the AWR Basin, (particularly as affected by supplies, shortages, and/or deterioration of natural resources) and the economic and environmental effects of potential public actions, such as investments in programs to conserve, develop, or better utilize natural resources.

All three of the USDA agencies involved were responsible for providing basic information for and, to some extent, analyzing the effects of potential State and USDA program actions on the economy, social well-being, and environment of the AWR Basin and the rest of the Nation. ESCS had the major responsibility (in analyzing potential public programs' effects) for estimating the economic effects on the Basin and the rest of the Nation and for showing the extent that economic-environmental trade-off relationships (if any) would be affected by potential USDA programs.

SCS had the main responsibility for identifying natural resource problems mainly on a physical level, and especially problems centering on quality and amount of land and water resources, as these affect agricultural industry and other rural-sited industries, such as service industries. SCS also was responsible for gauging the extent to which publicly financed structural measures and non-structural measures could be instituted to lessen or overcome the problems identified in the study.

The Forest Service was mainly responsible for identifying natural resource problems affecting the forestry industry and forestry-based industry and grazing on public lands. Also, FS was responsible for identifying potential public actions that might relieve such problems.

The Forest Service and SCS had the responsibility of supplying ESCS with the basic physical data essential to economic analysis and the economic effects of various potential public project or program actions. These data included a classified inventory of water and soil resources, the nature and trend in soil productivity for various crop types, and the extent and trend of timber growth. They also included estimates of the size of production response to be expected from measured changes in the development and management of water, cropland, range, and forest resources.

SCS and the Forest Service were also responsible for reporting basic money costs of potential USDA project and program features, either in terms of cost per acre benefited or in other units.

A team approach was employed for the study; and the team, known as the AWR Basin Field Party, consisted of members from SCS, FS, ESCS, and SEO. It included agronomists, range conservationists, economists, civil engineers, a geologist and a forester.

The objectives of the AWR Basin Study for the State of New Mexico were to achieve, (A) an inventorying of natural resources and problems, both present and impending, centering around natural resource scarcity and quality, and (B) an analysis of USDA program potentials that could be applied to and conserve natural resources and alleviate the problems. The type of problems that were of interest were essentially ones involving a diminution of the economic, environmental, and social well-being of AWR and New Mexico residents.

The USDA objectives included those of the State and also some

National concerns. These were to determine the positive and negative future effects of the USDA program potentials on the U.S. public, both in the area of Federal expenditures' "taxpayer cost" to the rest of the Nation and in the area of National effects of increased AWR production due to USDA programs' improvement of natural resources used by agriculture.

General description of the AWR Basin

The AWR Basin area is 11,300,000 acres (17,800 mi.²). Average precipitation amounts range from about 12 inches to 35 inches annually. Mean annual temperatures range from 36 to 58 degrees F. Frost-free period ranges from about 85 days at high elevations to more than 190 days at low elevations.

The Basin is located in the northeast corner of the State. It is bounded on the north by Colorado, and on the east by Oklahoma and Texas. The Basin includes all of Union, Colfax, Mora, and Harding Counties, but only part of San Miguel, Quay, Curry, and Guadalupe Counties. The principal drainages are the Cimarron and Canadian Rivers and their tributaries.

Land ownership is about 85 percent private, 13 percent State land, and 2 percent Federal. About 70 percent of the land is range land used primarily for grazing beef cattle, 11 percent is commercial forest, 11 percent is other woodlands, 6 percent is cropland, and 2 percent is in roads, cities and towns, and miscellaneous uses.

The development of land and water resources has occurred at a fairly steady rate, with irrigated agriculture expanding to the limit of available

surface water. There are 683,567 acres of cropland in the Basin, of which 155,780 acres have been developed for irrigation. Irrigated lands are generally developed along major streams where suitable surface water supply is available. Pump irrigation is used primarily on the eastern side of the Basin.

Non-irrigated cropland generally is found in the semi-arid southeastern portion of the Basin, in southern Quay and Northern Curry Counties. Small tracts of dry farming are scattered throughout the eastern parts. The major limiting factor to dryland crop production is low precipitation.

Urban and built-up areas include lands subdivided for residential and industrial uses and occupy about 77,600 acres. Communities range from small villages to small cities, such as Raton, Clayton, and Tucumcari.

Basin population, industry, and employment

The Basin's population declined from 49,900 to 34,000 in the period 1950 to 1970. However, 1975 U.S. Census data show a rise in population to 35,200 persons.

The Basin's economy has an agricultural and tourist orientation. This affects mainly three industry categories (agriculture, trade, and services) which accounted for 66 percent of Basin employment in 1970. Agriculture alone accounted for about 17 percent of Basin employment.

Growth in nonagricultural sectors of the economy has not been sufficient to offset losses in agricultural employment opportunities. Five major industry categories experienced an employment decline between 1950 and 1970: Construction, Mining, Wholesale and retail trade,

Agriculture, and Transportation-utilities-communications. The latter two categories accounted for 86 percent of the lost jobs. The employment decline in Agriculture was caused by technological changes that allowed fewer persons to produce more products. The decline in the transportation-utilities-communications category was also caused by technological changes.

As of 1975 the Basin's average annual unemployment rate was 10.2 percent, with 3,824 persons unemployed. In 1969 the Basin's proportion of families with incomes rated at less than poverty level was 25.7 percent, --- as compared to the State's proportion of 18.5 percent of families below poverty level.

Resource problems addressed

The main problem in irrigated cropland areas is largely one of securing sufficient water for crop production and of improving irrigation efficiency. Much information is available at present which, if practiced by irrigators, would result in considerable savings in water, a thing that would make the saved water available for more irrigated production.

Native rangeland has been generally overgrazed. Most has deteriorated to the point that its production is only a portion of what it is capable of producing. Overuse and improper seasonal use, compounded by erratic precipitation and fragile soils, accounts for accelerated erosion in some areas.

Water erosion is a problem mainly in some range land areas. Sediment resulting from water erosion is deposited on cropland, in irrigation

canals, highway culverts, and reservoirs. Wind erosion damages roughly 10,000 acres of dry cropland annually. Estimated crop production after wind-damage is about 50 percent of normal.

There are about 1.2 million acres of commercial timber stands. Small landowners, having harvested natural-growth timber, generally do not have sufficient management knowledge to invest in reforestation or other practices that would increase timber yields. They tend to lack the necessary knowledge to obtain maximum utilization of their forest products as they are harvested. Inadequate slash disposal, coupled with a lack of fire detection and poor access to timber and brush areas, lends to the occurrence of large wildfires.

Other localized problems, such as flood damage, lack of sufficient outdoor recreation opportunities, inadequate solid waste disposal, and industrial and auto air pollution also exist. The USDA river basin study staff reviewed the latter problems and reached the conclusion that USDA program authority and/or degree of feasibility of local projects to relieve the problems was insufficient to warrant addressing them in the AWR Study.

At the same time, however, it became apparent that the problem of productivity declines due to erosion, sedimentation, decline of range vegetation, irrigation water use inefficiency, wildfires, and low forest productivity could be favorably affected by USDA programs that fall mainly into the class of land treatment programs. Therefore, both the potential for relieving productivity problems through USDA land treatment programs and the cost of the programs were studied more intensively.

The objectives of the ESCS economic analyses were (A) to find the extent to which production and farm income (and other industry incomes) could be improved by more intensive application (consistent with farm-firm owners' willingness to cooperate) of existing public-sponsored land treatment program efforts and expenditures; (B) to determine how much the increase in productivity would cost in terms of land-treatment costs; and (C) to get an indication of whether the resulting increased production would cause production dislocations and displacements (a type of cost to society) outside of the Study Area.

The items sought in projecting the future economic conditions of the AWR Basin, under both a status quo regime of USDA programs and a condition of increased intensity of USDA program efforts were as follows: (1) estimates of the levels of future agricultural production, land and water use, and agricultural employment and earnings, assuming the continuation of the ongoing USDA programs at their current levels; (2) estimates of the future levels of employment and earnings in other industries of the Study Area whose activity is affected by the level of agricultural production; (3) estimates of the future effects (if any) on commodity prices, agricultural production costs, returns, incomes, and employment (and other industries' income and employment) of a potential increase in investments in USDA-sponsored program efforts in the Study Area; (4) estimates of the cost of the USDA potential investments mentioned in (3) above, and their potential for causing dislocation and displacements of production in the rest of the Nation

due to their effect of increasing AWR Basin production.^{1/}

1/ Originally, another objective was to estimate trade-off relationships between environmental values lost due to USDA program efforts and the pecuniary returns resulting from those program efforts. For the few examples found of environmental values' conflicting with USDA program effects, sufficient quantitative measures of environmental damage could not be obtained within the budget scope of the study. Generally, land-treatment programs improve the environment. Irrigation efficiency efforts are expected to result in a reduction of phreatophyte vegetation, which would cause a loss of some wildlife cover. However, there is presently no suitable measure of the extent to which alternative forms of wildlife cover are scarce or abundant, or of whether irrigators or the general public desire to have much wildlife cover in close proximity to irrigated crops.

Rationale for the crop projections method used

In the Study Area, there tends to be little competition between crops and livestock for land use, and much of crop production is utilized as cattle feed.

Dryland wheat is often grazed by beef cattle when the wheat plants are in the early growth stage. This is of mutual benefit to both wheat and beef production and is the opposite of the case of competition between crops and livestock for land use.

Although there are nearly 7 million acres suitable for irrigated farming, there is only enough water available to supply 162,700 acres for Year 1980. Thus, the supply of irrigable land is not significant as a limit on production; and the supply of water is a significant limiting factor.

As water rights tend to be "tied" to certain AWR Basin land holdings, irrigation water's distribution cannot be simulated well by a mathematical optimizing model.

Because of this and the fact that the cropping pattern and geographic soils pattern are not complex, the use of a mathematical optimizing model was not warranted. The basic projections method used was the extrapolation of the past trends of the various crop types' acreage by county. Crop acreage data series show much more stability than crop production data series. Furthermore, crop acreage trends embody long-term trends in National and export demand for production, along with the effect of rising crop yields.

Much of past and present economic projections of all kinds employ

a trend-analysis method. Usually, a trend line is determined from past time-series data, and the trend line is then extrapolated into the future to indicate projection values for one or more future dates.

Time is the chief independent variable in time-trend analysis, but multiple regression techniques allow for use of other independent variables, too. The main strength of the time variable is that its value requires no prediction process in time-trend projections, whereas other independent variables themselves must be predicted (or assumed) to be of a certain future magnitude before they can be used to predict the future value of the dependent variable.

Past time-series data, in terms of simple crop acreage amounts, (as opposed to several causal variables affecting acreage) embody the effects of changes occurring in a nation's population size, food preferences, and amounts of exported food and fiber, as well as the net effects of USDA programs, such as land retirement.

Projections of future divergences from present conditions must rely on what is known about the speed and direction of past changes and on the assumption that institutions of the past and present will continue to exist to some extent into the future.

Projections of the future trend of net returns to land were not emphasized in the AWR Basin study. To project net returns much knowledge would be needed of the component variables that affect them. Some of those component variables are the trends in prices and yields of various crops and the unit cost of producing them. One relevant trend would be in the relation between production costs per unit of output

and the trend in output's unit price. (This relation differs among crop types.) This is a relationship that is difficult to predict well very far in the future. Although the cost per unit of various factors purchased has been generally increasing in relation to unit product price over time, units of output per unit of the various inputs have also been trending upward over time, due to technological changes.

Generally, unit cost of output and unit price of output have not shifted consistently relative to each other. It is difficult to generalize about their future relationship. A future positive or negative trend for farm firms' net returns is therefore a very speculative thing to predict. A neutral projection assumption would be that for a given crop type the present relationship between the average value of aggregate production and aggregate net returns will persist into the future indefinitely. That assumption was adopted for this study.

The differentials in net returns among crop types show an ever-changing pattern in their movement over time, with some crops showing alternately higher and lower net returns relative to other crops. The changes in relative crop profitabilities must depend on: (1) year-to-year and long-term commodity price behavior and Federal price supports; (2) factor cost fluctuations; (3) long-term climatic trends; and (4) yield-increasing and cost-reducing technological changes. Predicting the future course of the first three phenomena has not been the subject of much research, especially research that distinguishes between crop types.

Technological improvement is also difficult to predict. Prediction of future yield changes for the various crop types is one very speculative

form of technological-change prediction. Yields do trend upward over the long term (although recent events suggest that fertilizer and pesticide cost and concerns may serve to dampen those trends.)

Various crops' yields have risen faster than others for certain time periods and slower in other time periods.

Recent surprising yield-increasing discoveries typically affect agricultural products selectively and unpredictably. An example is the alfalfa-cell-compound fertilizer, now successfully synthesized.

Yield increases also seem to be affected by occasional changes in research emphasis on the part of agronomists. Agronomists, in turn, may be partly motivated by the economic importance of raising currently lagging yield trends of various important crop types. Thus, it is conceivable that crop yields that are rising relatively slowly during a given decade may be rising relatively quickly in the following decade, and vice versa.

The effect of institutions on crop yields is also felt in other ways. For example, as a national government imposes or abolishes a system of acreage allotments, yields of certain crops may be expected to rise or fall due to legislatively induced changes in intensiveness of cropland use. (Allotment acreage tends to include a given farm's better soils, and it also tends to receive more fertilizer, labor, water, etc. than it would in the absence of allotments.)

Aside from the difficulty of predicting definite divergent courses for various crops' distant-future yields, there is another problem with basing projections of future individual crop revenues on projections of individually divergent crop-yield trends: Future yield changes' effects

upon net return to land are essentially unpredictable and can be expected to differ between crop types. This is mainly because it is not known to what extent the benefits from a given crop type's yield increases over time actually accrue to landowners, --- or to consumers, retailers, wholesalers, or other factor suppliers. (Here the reader should be reminded that the net return to land is the main motivating force that actually and conceptually causes comparative-advantage-induced shifts in cropping patterns to occur.)

It would be too speculative to project a commodity's long-term price changes that would result from a given degree of the commodity's long-term yield rise, based on the currently estimated demand curve price elasticity, especially when the commodities demand tends to be inelastic, as in the AWR Basin. The demand curve cannot be safely assumed to remain unchanged with the passage of time. Also, a commodity's supply-demand nexus cannot be safely assumed to remain at the same slope area of the future demand curve, even if it were known that the curve's shape might remain similar over time. (Production functions' shapes change as technology increases yields.)

Yield estimates were called for in the projections of future agricultural land use, production, and income. However, because of the general uncertainty inherent in projections of future divergent yield trends for the individual crop types, yield projections were merely able to provide (in the case of Years 2000 and 2020) an approximation of the future levels of various crops' production.

Time-trend considerations

As an economist observes past crop acreage trends in a region and extrapolates them into the future, he has considerable opportunity to inject recently available information (aside from simple crop-acreage series observations) into the process of formulating trend lines. In fact, there is considerable potential for creating unrealistic trend lines by not utilizing enough of the available information. As was mentioned previously, time is often not the only suitable independent variable. On the other hand, not every relevant variable can be entered in readily quantifiable form. Often the most legitimate method of embodying important independent variables is to alter the length of the historic time series of observations. This is not the unusually subjective and arbitrary procedure that it appears to be on the surface.

Choosing where in time to begin and end any historic-data time series (to fit a trend line) has an inherent arbitrariness. This is true of time series of yields, costs, prices, weather, etc.

The cases in which the choice of beginning and ending dates of a time series is most critical are ones in which the time-series observations have abnormally high or low values near either end of the data series. Choosing series-limiting dates that include unusually high values toward the beginning of a data series tends to produce a (more) negative slope. If the preceding measure happened to be an unusually low value, a trend line from the same series, when extended back one time period might switch over to a positive slope. In short, the end values to a time series have great moment in determining the slope of a fitted trend line; and the process of choosing which dates will mark the beginning and end of the

series is inherently an arbitrary one, as was mentioned above.

Simply extending the data series as far back in time as data are available may cause the trend line to be unrealistically warped, because a different, outdated set of institutions (e.g., World War II) may have influenced what happened at the earlier dates.

The effect of institutions on trend analysis


Uncharted, changing institutional phenomena are some of the main interferences with the validity of projections that are extrapolations of past trends. Even the identifiable, documented institutions' effects on time-trend values are very difficult to quantify or to introduce in a purely objective fashion. Furthermore, they cannot all be treated legitimately as being fully present or fully absent. Institutions gradually come into and go out of existence, and their effects are felt in varying magnitudes between presence and absence.


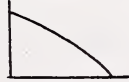
At present, making crop acreage projections by extrapolating past trends is not a science. Much of the relevant institutional information must be either translated into numbers by presently non-standardized means or made to influence trend measures by altering the time interval of the historic data series. This methodology may possibly be subject to standardization, and to the elimination of unique forecasters' judgments.


Throughout this study the economic projections process did not constitute scientific research because it was not aimed at developing or testing generalizations or hypotheses. It was a process of applied economics, in which considerable thought and care was directed at avoiding the illegitimate use of statistics and economics principles.

Applying economics principles to predict or project future crop acreages is (like crop-yield predictions or weather predictions) more of an art than a science.

Trend equations for crop acreages

Crop acreages that have trended upward over time must be affected by an upper limit of available resources. Therefore, an equation for a curvilinear, non-reversing trend line, concave downward,  is the appropriate type of trend equation to fit to the data where the past data series has trended upward in a long-developed agricultural region. This reflects the accepted proposition that growth in utilization of a finite amount of a given resource usually is dampened increasingly as the upper limit of the resource is approached.

Crop acreages that trend downward over time are also approaching a limit, but resistance to such a decline may not increase as the zero level is approached. Therefore, it is not obvious that a concave-upward  curvilinear trend-line equation should be fitted to a descending series of crop acreage data. The main rationale for not using a curvilinear concave-downward  or a straight-line equation to fit a declining data series is that this may cause it to decline to zero too abruptly to be consistent with past observed declines in the time-series.

For a crop-acreage series, if the fitted equation happens to be a rising trend, concave upward,  the equation would call for explosive growth. This rarely happens in long-developed cropland areas unless a new discernable institutional change has occurred. Therefore, in such cases the equations with the best fit are legitimately ignored;

and adjustments must be made.

Significance measures serve to guide our choice between one trend equation and another, in the process of fitting trend lines to existing series of crop acreage data. They are not always a useful guide in showing if there is no trend present, however.

Whenever the fitted trend-line characteristics consist of a combination of very slight slope and a high degree of variation from the trend line, accuracy considerations require that the lack of trend be recognized. In such cases, future extrapolation of the past data series is logically a horizontal straight line.

It is almost certain that at least some future institutional factors will not be the same as in the past time-series period. Thus, it is not warranted to achieve a precise formulation of when to consider slope and variation sufficiently small and large, respectively, to declare no predictably constant slope to be present. The surrounding observed institutional changes must be considered and used to make the decision to predict "no future slope."

To a great extent, the same type of knowledge about changing institutions must be used to accept or rule out the use of various fitted trend-line equations that suit the past time-series observations well or poorly in only a purely mathematical sense. An example would be a case in which a crop's past series of annual acreage values has formed a configuration consisting of two separate plateaus, with identified institutional changes accounting for an upward shift from the old plateau to a new plateau. The trend line of best fit would call for future values far above the recent plateau's values.

Effect of institutions on farming operations

Institutions have an effect on crop choices. The most notable of such institutions, perhaps because they occur on such a large scale, are national government programs that have the effect of encouraging or discouraging production of certain crops on given parcels of cropland. As such institutions change with changing national agricultural legislation, it is possible to trace the effects of the legislated changes by observing the consistent patterns of acreage changes in the various affected crops.

Other less formal and documented institutions also affect various crops' acreages and farm firms' choices of products. Ideally, interviewing representative samplings of farm operators would be employed to cast more light upon these latter institutions. However, that type of information was obtained by alternate means in this study. This consisted mainly of gathering information among local agricultural observers who are aware of production decisions made by many local farm firms. The observers were (1) SCS district conservationists and staff, and (2) USDA Extension Service county agents. Their responses are recorded in Appendix A.

Procedures for AWR Study economic projections

The process of projecting AWR Basin crop acreages with a continuation of the existing USDA land-treatment program at its present level ("without-plan" level) is essentially an extension of past county crop acreage trends into the future.

Projecting the changes that would take place under an acceleration

of the land-treatment program is a process of projecting changes in acreage from different levels of land treatment (each with its average yields and cost characteristics) to higher levels.

As was mentioned previously, the Study Area consisted of certain whole counties, plus portions of certain counties. At this point it is appropriate to explain that, in all cases in which it was necessary to derive crop acreages or production amounts for partial counties from whole-county statistics, SCS field specialists were consulted and asked to estimate the proportion (of a given county's production of each major crop) that usually occurs within the Study Area portion of the county.

These partial-county crop-production estimates were used in conjunction with statistical data for counties wholly within the Study Area for various projection and comparison purposes in performing the economic analyses for the AWR Cooperative River Basin Study.

Crop acreage, without plan

The process of projecting AWR without-plan acreages is described as follows:

1. In the AWR counties the harvested crops having 2,000 or more acres were determined by inspecting a series of counties' annual statistics published by the USDA Statistical Reporting Service and the New Mexico Crop and Livestock Reporting Service.^{2/} (Minor crops accounted for about 5,500 acres, or 6.6% of harvested acreage in 1974).

^{2/} New Mexico Agricultural Statistics, 1959-74.

2. For each of the significant crops (cotton, sorghum, corn, wheat, barley, alfalfa, and other hay), the historical time series of annual acreage values for each AWR county was transcribed, coded, and recorded on punched cards. (Crops were subdivided into "irrigated" or "not irrigated.")

3. The recorded crop-acreage series were individually inspected for discontinuities and aberrations. If discontinuities were discovered in a crop's annual acreage value series, county field specialists in the U.S. Department of Agriculture were consulted. They were asked to try to account for the discontinuities in terms of their familiarity with local farm operators' decisions, institutional changes, and other conditions that could logically bear upon changes in a given crop's acreage trend within their own individual counties. (See Appendix A).

4. Certain data series were curtailed by eliminating one or more year's values from one end of the series of annual values (usually the latter end). This was done where such annual values represented discontinuities in a crop's acreage trend, --- discontinuities that were described by the specialists mentioned in #3 above as caused by phenomena which are not expected to be necessarily permanent departures from the conditions prevailing over most of the time period 1959-1974. The eliminated segments are shown in Table 1 in parentheses. They are primarily sigments that represent sharp accelerations in the crop acreage trends. Because most are located near the end of a series, they would exert great moment in altering the slopes of trend lines.

USDA local specialists familiar with crop farmers' decisions concerning land use accounted for most of the discontinuity of trends by referring to a partly institutional change consisting of a reduction of acreage included in the USDA "set-aside" program. That reduction was not thought to be a permanent one, but instead was viewed as an unusual accentuation of one phase of a cycle. Another phenomenon cited was a marked reduction of silage production in certain counties in the Study Area. Again, this was not expected to be a permanent diminution. (If the annual crop-acreage values that were affected by the temporary phenomena cited were left in all crop acreage series, the end values of many series would have been abnormally great and would have caused unduly positive slopes in the series' calculated trends.)

5. Each county-crop combination's complete or shortened series of annual acreage values was fitted with (a) Spillman function equation of the form $y = M - ab^x$, where M is a maximum value^{3/}, x is time, and a and b are regression coefficients (i.e., positive slope, concave downward), (b) an equation of the Cobb-Douglas family of functions, having the form $y = \frac{-a}{xb}$ (i.e., negative slope concave upward), and (c) a straight-line function, used where no definite trend was apparent.

The Spillman equation was employed only for crop-acreage trends of positive slope, and the Cobb-Douglas equation was employed only for negative-sloping trends.

^{3/} Namely, the Year 2020 value of a linear regression equation fitted to a given data time series.

TABLE 1. ACREAGES OF MAJOR HARVESTED CROPS, ARKANSAS-WHITE-RED BASIN COUNTIES,
NEW MEXICO; 1959-1974

(Parenthetical figures were eliminated from trend calculations.)

Crop type	:	Irrig. cotton			:	Irrigated corn for grain				
County	:	Curry	Quay	:	Colfax	Curry	Harding	Mora	Quay	Union
1959	:	1510	2670	:	3000	800	100	650	550	250
60	:	1510	2830	:	2000	500	100	400	300	150
61	:	1440	3050	:	1500	400	100	350	200	100
62	:	1450	3270	:	500	500	100	400	150	100
63	:	1340	2770	:	500	300	100	150	150	250
64	:	1310	2880	:	150	100	0	100	50	0
65	:	1390	2575	:	1200	100	40	60	70	10
66	:	990	1850	:	850	50	40	30	30	10
67	:	880	1760	:	1000	30	40	10	70	20
68	:	1110	1840	:	750	50	30	70	100	2100
69	:	1110	2180	:	350	450	50	90	50	2300
70	:	1160	2100	:	500	300	160	20	0	2700
71	:	1200	2000	:	0	200	50	0	100	2500
72	:	1120	1900	:	0	400	100	50	300	3600
73	:	550	1690	:	0	6850	0	50	250	(6100)
74	:	750	1720	:	30	(13000)	0	20	1000	(8000)
	:			:						
	:			:						

TABLE 1. (Continued)

Crop type	:	Irrigated corn for silage						:	Irrigated sorghum for grain					
County	:	Colfax	Curry	Harding	Mora	Quay	Union	:	Colfax	Curry	Harding	Mora	Quay	Union
1959	:	1200	800	100	350	(250)	350	:	50	39000	1000	10	12500	(1900)
60	:	2000	1500	150	500	(300)	350	:	50	38000	900	20	10400	(1900)
61	:	1800	1200	100	450	(300)	300	:	50	35000	700	50	9000	(1500)
62	:	2100	900	50	300	(300)	200	:	50	35000	370	20	9500	(1300)
63	:	2500	1450	50	350	(150)	150	:	100	53000	760	20	12900	(1300)
64	:	2550	2600	100	400	(150)	600	:	100	46000	520	0	8600	(2600)
65	:	1700	2000	0	40	(130)	370	:	200	59000	540	200	8500	(3000)
66	:	2050	2950	10	170	470	490	:	500	60570	100	200	9960	3600
67	:	1500	3470	10	70	1430	480	:	500	68000	260	100	9000	3700
68	:	1750	4150	20	30	1400	300	:	400	56000	300	100	8600	13000
69	:	1950	2950	50	130	2950	1900	:	500	54000	300	0	8000	11000
70	:	1900	2200	140	230	1300	1200	:	500	59000	450	0	8000	12100
71	:	800	3700	50	200	2000	1600	:	0	75000	800	0	9200	15000
72	:	500	3400	280	300	1300	3800	:	0	60000	1170	0	7400	7650
73	:	760	3300	60	300	1770	3000	:	0	65200	1180	0	7500	4350
74	:	270	(4800)	0	210	380	330	:	0	53000	800	10	8000	3800
	:							:						
	:							:						

TABLE 1. (Continued)

Crop type	:	Irrigated sorghum for Silage						:	Irrigated wheat					
		Colfax	Curry	Harding	Mora	Quay	Union		Colfax	Curry	Harding	Mora	Quay	Union
1959	:	300	2300	300	90	3000	450	:	1400	47400	300	300	3600	600
60	:	250	1000	200	130	1100	500	:	1400	39000	300	200	3500	500
61	:	550	3000	700	50	3000	400	:	1500	45000	0	300	3500	500
62	:	550	3000	830	80	1600	600	:	1500	44000	150	200	3700	500
63	:	400	3000	1240	180	3200	300	:	1600	47000	250	350	4000	400
64	:	400	8000	880	100	2900	900	:	1100	47000	250	350	3500	400
65	:	200	1000	260	0	2500	400	:	1000	59500	470	300	5600	900
66	:	0	430	300	0	440	400	:	2500	65000	500	300	7000	1800
67	:	0	2000	290	50	2000	500	:	2000	80000	500	300	6300	1800
68	:	50	1000	250	50	2400	(4600)	:	1500	64000	500	300	9000	3600
69	:	150	1000	100	0	1100	(4000)	:	760	55000	200	100	7000	2200
70	:	150	6000	50	0	1500	(8600)	:	800	56000	200	100	7000	4700
71	:	200	1000	200	0	800	(6000)	:	400	60000	1000	100	8000	4000
72	:	50	4000	630	0	2600	50	:	1200	61200	1000	0	10000	2580
73	:	30	1800	120	0	2500	150	:	1200	61200	650	0	10000	4000
74	:	0	(12000)	350	40	(4500)	200	:	1200	65000	2600	0	10000	(8500)
:	:							:						
:	:							:						

TABLE 1. (Continued)

Crop type :		Irrigated alfalfa						:	Irrigated other hay					
County	:	Colfax	Curry	Harding	Mora	Quay	Union	:	Colfax	Curry	Harding	Mora	Quay	Union
1959	:	6500	(300)	500	4100	(3500)	2200	:	12500	700	5700	6900	500	4500
60	:	5800	(300)	600	3900	(3900)	2200	:	11700	1200	5800	7400	500	4800
61	:	6600	(300)	400	3800	(4400)	2000	:	14000	1700	7000	8000	1000	5500
62	:	7200	(400)	400	3600	(4800)	2200	:	12800	2100	3100	8900	1300	6300
63	:	8500	(400)	200	3600	(5500)	2200	:	11900	2300	800	10100	2400	6300
64	:	7200	(600)	200	2800	(5000)	2000	:	10000	1600	400	9500	1200	7600
65	:	6200	(700)	600	3200	(5800)	2300	:	13800	4800	6600	8800	2200	5700
66	:	5800	(1000)	600	2900	(5600)	2300	:	10200	4000	5400	10400	1200	5700
67	:	5900	(1100)	600	3000	(6000)	2300	:	10600	4200	5800	10800	1300	6400
68	:	5600	2200	700	3200	(5600)	2500	:	10600	3800	5800	10800	1500	6300
69	:	10000	2500	1800	4300	(7600)	2600	:	16000	2700	3800	7100	1900	6800
70	:	11100	2800	2000	4000	8700	3100	:	7900	2600	3800	7800	1000	6600
71	:	9000	2400	800	3400	8000	3200	:	5000	3000	4800	5000	4000	6500
72	:	8700	2400	700	3300	8500	3300	:	4500	3000	6400	4700	4800	7800
73	:	8800	2400	300	3300	8500	3200	:	4700	3000	2900	5200	5000	7900
74	:	8800	2400	300	3000	8000	3100	:	3100	2500	710	3200	4300	4000
	:							:						
	:							:						

TABLE 1. (Continued)

Crop type	:	Non-irrigated wheat						:	Non-irrigated sorghum for grain					
		Colfax	Curry	Harding	Mora	Quay	Union		Colfax	Curry	Harding	Mora	Quay	Union
1959	:	2100	91100	11700	1200	68500	2100	:	270	46000	200	0	10500	14100
60	:	2000	103500	10700	700	65500	1900	:	200	46000	300	0	15600	14900
61	:	2700	100000	11000	600	66500	2200	:	150	33000	100	0	7500	13500
62	:	2500	87000	8850	400	63300	2300	:	100	32000	300	0	5500	15700
63	:	2800	92000	8450	450	66000	2400	:	100	37000	300	0	8900	15700
64	:	3600	99000	8750	650	66500	2300	:	0	23000	0	0	400	5000
65	:	3500	85500	8330	700	71400	2100	:	0	26000	460	0	4500	12000
66	:	2500	85000	8500	700	66000	2600	:	0	29430	400	0	9040	14400
67	:	3000	105000	10500	700	83700	2700	:	0	47000	340	50	10500	20300
68	:	2500	100000	8800	600	81000	1000	:	100	24000	800	50	8600	9000
69	:	2440	86000	5800	500	64500	800	:	50	38000	500	0	13100	15000
70	:	2500	88000	5800	500	67000	1100	:	0	35000	650	0	16000	8000
71	:	1600	113000	8800	550	74900	2500	:	0	40000	2300	0	23800	15000
72	:	1830	127500	10000	550	81200	1440	:	0	36000	1100	0	13000	12000
73	:	2600	118800	11350	550	84000	4700	:	0	50000	4030	0	20700	13200
74	:	3000	120000	11000	600	(104300)	(5700)	:	0	(5000)	0	0	5000	8000
:	:							:						
:	:							:						

TABLE 1. (Continued)

County	:	Non-irrigated sorghum for silage					Union
		Colfax	Curry	Harding	Mora	Quay	
1959	:	1780	(15200)	700	200	8000	11850
60	:	1900	(18000)	800	150	9900	12000
61	:	1150	(8000)	200	100	7500	9600
62	:	1100	(11000)	0	100	1500	9600
63	:	1900	(10000)	600	200	9000	10200
64	:	2000	(14000)	600	200	5500	9500
65	:	1100	(9000)	240	200	7500	10900
66	:	1500	(7570)	200	300	15160	8600
67	:	1600	28000	310	200	18500	8500
68	:	950	29000	250	300	15600	10400
69	:	1150	22000	450	400	19800	10000
70	:	0	20000	350	350	19500	8600
71	:	400	20000	200	100	11200	4000
72	:	0	10000	900	40	17000	4200
731	:	510	8000	200	0	9300	3200
74	:	350	(35000)	(1400)	350	20000	5000
	:						
	:						

Source: USDA Statistical Reporting Service and New Mexico State Crop and Livestock Reporting Service. New Mexico Agricultural Statistics 1959-1974.

6. The fitted trend equations were used to arrive at projection-year acreage values for 1980, 2000 and 2020 for each crop-county combination. (See Table 2).

7. In each county the aggregate of harvested crops' irrigated acreage called for in Steps 1-5 above was compared to projected irrigated acreage availability. The latter unpublished projections were supplied by the New Mexico state water agency (State Engineer Office, or "SEO"). The SEO's irrigated crop acreage projections were based on SEO projections of water availability and consumptive use for all purposes, agricultural irrigation being assumed to be the least valuable use, and the residual use, of water.

The SEO assumed, based on past history, that all higher valued uses of water can and do purchase agricultural water rights as those uses expand, over time.

8. In counties where the acreage to be supplied with irrigation water was projected to be less than the aggregate of crop acreages projected, all irrigated crop acreage projections for individual crop types were reduced proportionally to meet the projected available irrigated acreage (for the county in question).

9. In counties where the amount of water projected by the New Mexico State Engineer Office to be available to agriculture was in excess of the acreage projected by Steps 1-7, the excess of water was assumed to be used for grazed land. Irrigated grazed acreage was thus assumed to be a residual quantity which reconciled the State Engineer Office projections of available-and-utilized irrigated acreage with the irrigated harvested-crop acreage projections resulting from Steps 1-7.

TABLE 2. INDIVIDUAL PROJECTED CROP-ACREAGE TREND VALUES,
AWR BASIN COUNTIES, NEW MEXICO; 1980, 2000, AND 2020

(Values shown are acres, rounded to nearest 10 units.) Part 1 of 2 parts

Crops	Colfax		Curry ^{1/}		Harding	
	1980	2000	1980 ^{2/}	2000	1980	2000
<u>Irrigated</u>						
Cotton				0		
Corn, grain	0	0	520	14,530	10	10
Corn, silage	310	0	4,910	7,450	70	60
Sorghum, grain	0	0	76,110	100,090	750	920
Sorghum, silage	0	0	2,570	2,570	40	0
Wheat	1,200	1,200	73,760	92,450	1,750	2,920
Alfalfa	9,400	9,400	2,440	2,440	670	670
Other hay	2,380	1,430	4,010	5,370	2,710	2,410
<u>Non-irrigated</u>						
Sorghum, grain	0	0	33,300	33,300	740	740
Sorghum, silage	0	0	12,430	9,210	380	380
Wheat	3,000	3,000	98,780	98,780	10,780	10,780

1/ Curry County crop acreages were later reduced to portion in AWR Basin.

2/ In later projection stages the 1980 irrigated crop acreages in Curry County were reduced by 23.1% and non-irrigated acreages were increased by 6.0%, to reflect the New Mexico State Engineer Office (SEO) projections of declining irrigated acreage, due to declining level and increased pumping cost of mined groundwater in Curry County.

3/ In later projection stages Curry County projected irrigated crop acreage was treated as nonexistent in 2000 and 2020, due to New Mexico SEO projections of groundwater availability for crop irrigation.

Crops	Mora			Quay#1			Union		
	1980	2000	2020	1980	2000	2020	1980	2000	2020
<u>Irrigated</u>									
Cotton									
Corn, grain	0	0	0	1,050	210	0			
Corn, silage	120	90	80	1,440	1,440	210	7,230	12,910	16,910
Sorghum, grain	0	0	0	7,570	6,860	1,440	3,840	6,650	8,540
Sorghum, silage	0	0	0	1,470	1,330	6,460	4,820	7,940	11,060
Wheat	0	0	0	12,440	18,920	1,240	90	0	0
Alfalfa	3,160	3,010	2,930	8,340	8,340	23,350	7,300	12,500	16,000
Other hay	4,270	0	0	5,380	8,740	8,340	3,630	4,780	5,570
						11,030	7,450	8,650	9,440
<u>Non-irrigated</u>									
Sorghum, grain	0	0	0	10,790	10,790	10,790	12,860	12,860	12,860
Sorghum, silage	90	70	60	21,100	29,660	35,490	1,810	0	0
Wheat	500	450	420	85,410	99,360	108,790	3,640	5,520	7,400

4/ Quay County crop acreages are later reduced to the portion occurring in AWR Basin.

Equation types used for Table 2 acreage projections, by county and crop type

	Colfax	Curry	Harding	Mora	Quay	Union
<u>Irrigated</u>						
Cotton		L			L	
Corn, grain	L	L	C	L	J	S
Corn, silage	L	S	L	C	J	S
Sorghum, grain	L	S	L	L	C	L
Sorghum, silage	L	J	L	L	C	L
Wheat	J	S	S	L	S	S
Alfalfa	J	J	J	C	J	S
Other hay	C	S	C	L	S	S
<u>Non-irrigated</u>						
Sorghum, grain	L	J	J	L	J	J
Sorghum, silage	L	C	J	C	S	L
Wheat	J	J	J	C	S	L

S = Spillman function; C = Cobb-Douglas; L = Linear; J = No definite trend to extrapolate

The projected crop acreage values in Table 3 are the result of summing the crop acreage trends for individual counties and county portions. Because some counties' acreage trends were rising for a given crop and others were falling, the summed counties' trends for a crop could easily exhibit discontinuity. Irrigated corn silage, sorghum grain and "other hay" are examples of the discontinuity effect resulting from the process of summing rising and falling trend values.

Projected crop production, without plan

Projecting future production of crops is essentially a process of multiplying projected crop acreage by a set of projected future crop yields, as follows:

1. Estimates of future yields of major Study-Area crops were made by utilizing a time series of past mean annual crop yields (1959-1974) reported in New Mexico Agricultural Statistics by county. Each crop's past series of mean annual yields was fitted with a Spillman function equation (of the form mentioned above).
2. Future values derived from the fitted Spillman-function trends were obtained for Years 1980, 2000, and 2020.
3. Agronomic specialists of SCS reviewed the mathematically derived yield projections and altered some of these to make them more consistent with their ideas of productivity trends and prospects in the Study Area. (See Table 4). This alteration was made in accordance with a prior agreement between SCS and ESCS.

The resulting yield projections differ somewhat from OBERS yield

TABLE 3. PROJECTED CROP ACREAGES, WITHOUT CHANGE
IN ONGOING PROGRAM, AWR BASIN, NEW MEXICO

Crops	1980	2000	2020
<u>Irrigated Crops</u>			
Cotton	1,050	0	0
Corn, grain	7,390	12,910	16,910
Corn, silage	8,380	7,070	8,940
Sorghum, grain	18,240	14,420	17,380
Sorghum, silage	6,110	1,330	1,240
Wheat	18,950	19,650	23,920
Alfalfa hay	24,720	25,730	26,440
Other hay	18,730	15,550	16,670
Other harvested crops ^{1/}	5,570	6,200	6,400
Irrigated grazed lands ^{2/}	53,580	58,680	58,620
Total irrigated crops ^{3/}	162,720	161,540	176,520
<u>Dryland Crops</u>			
Sorghum, grain	28,320	28,320	28,320
Sorghum, silage	14,050	8,000	6,790
Wheat	123,900	128,520	131,960
Other dry crops ^{1/}	730	2,200	1,130
Total dry crops	167,000	167,040	168,200
Cropland unharvested ^{4/}	360,790	360,750	359,590
Total dry cropland ^{5/}	527,790	527,790	527,790

^{1/} Utilizes U.S. Water Resources Council OBERS Projections, Series E' unpublished backup materials, 1974.

^{2/} Irrigated grazed acreage figures are residual amounts equal to the difference between total projected irrigated land acreage planted in harvest crops and projections based on New Mexico State Engineer estimates of water depletion by irrigation.

^{3/} Based on New Mexico State Engineer estimates of depletion, unpublished.

^{4/} Includes fallow, idle, and crop-failure acreage, plus land in cover crops, legumes and soil-improvement grasses.

^{5/} Assumed to remain at 1974 level through Year 2020.

- Sources:
1. USDA, Statistical Reporting Service and New Mexico Dept. of Agriculture New Mexico Agricultural Statistics, Series 1959-1974.
 2. Unpublished information from USDA field specialists stationed in the Arkansas-White-Red River Basin Study area, New Mexico.
 3. New Mexico River Basins Staff, USDA; unpublished projections of future crop yields.
 4. New Mexico State Engineer Office; unpublished projections of irrigation water availability.

TABLE 4a. PROJECTED CROP YIELDS WITHOUT PLAN, AWR BASIN

Crops	1980		2000		2020	
	Initial Trend	Revised Yield	Initial Trend	Revised Yield	Initial Trend	Revised Yield
<u>Irrigated crops</u>	:	:	:	:	:	:
Cotton ^{1/} (bales)	:	.69	:	.92	:	1.15
Corn, grain (bu.)	123	114	189	143	233	163
Corn, silage ^{1/} (tons)	:	16	:	20	:	25
Sorghum, grain (bu.)	78	78	92	99	103	117
Sorghum, silage ^{1/} (tons)	:	17	:	21	:	25
Wheat (bu.)	51	41	68	55	79	75
Alfalfa (tons)	3.6	4.5	4.5	5	5.1	5.4
Other hay (tons)	1.4	1.5	1.7	1.7	1.9	1.8
<u>Non-irrigated crops</u>	:	:	:	:	:	:
Sorghum, grain (bu.)	26	19	32	31	35	39
Sorghum, silage ^{1/} (tons)	:	7.3	:	9.2	:	11.2
Wheat (bu.)	13.6	15	13.6	19	13.6	22

^{1/} Yield estimates for this crop were made directly by SCS agronomists

TABLE 4b. PROJECTED CROP YIELDS WITHOUT PLAN,
BY LAND MANAGEMENT-AND-TREATMENT LEVELS, 2000 AND 2020

Crop Type	2000			2020		
	Treatment levels			Treatment levels		
	High	Medium	Low	High	Medium	Low
<u>Irrigated</u>	:	:	:	:	:	:
Cotton (bales)	1.0	.9	.8	1.3	1.2	1.1
Corn, grain (bu.)	167.4	149.2	133.6	199.5	173.9	153.8
Corn, silage (tons)	23.8	21.1	19.0	30.8	26.8	23.7
Sorghum, grain (bu.)	108.0	96.2	86.2	142.5	124.2	109.8
Sorghum, silage (tons)	23.9	21.2	19.2	30.1	25.8	22.6
Wheat (bu.)	63.4	57.0	51.4	88.0	77.8	69.4
Alfalfa (tons)	5.4	4.8	4.3	6.2	5.4	4.7
Other hay (tons)	1.9	1.7	1.5	2.2	1.9	1.6
<u>Non-irrigated</u>	:	:	:	:	:	:
Sorghum, grain (bu.)	37.1	33.0	29.5	48.7	42.2	37.2
Sorghum, silage (tons)	10.6	9.5	8.6	13.2	11.6	10.4
Wheat (bu.)	21.8	19.4	17.3	27.8	24.1	21.3

Source: Projections are based on procedures outlined in the text.

projections^{4/} and published yield projections made for a neighboring State's Cooperative Basin Study^{5/}. The OBERS combined irrigated and non-irrigated yield projections tend to be much higher for crops that are grown chiefly as irrigated crops in the AWR Basin (e.g., cotton and hay). For other crops (sorghum grain and wheat) that have considerable irrigated and nonirrigated production the OBERS combined yield projections values are of a size that does not clearly conflict with the yield projections produced for the AWR Study.

The Santa Cruz-San Pedro Basin Study's projected cotton yields are about 45% higher than those of the AWR Study, and projected alfalfa yields are about 40% higher. On the other hand, for crops which have considerable irrigated and non-irrigated acreage, the Santa Cruz-San Pedro yield projections are of a size that does not clearly conflict with those of the AWR Study.

4. SCS personnel provided without-plan estimates of future crop-yield relative percentage differences among three different levels of intensity of combined management and land treatment practices. These estimates were based on the experience of SCS field specialists. They were used to derive estimates of projected crop yields by crop type and land treatment level. (Table 4b)

5. SCS personnel provided a timetable of estimated future movement of cropland acreage (by percent of total) among the three levels mentioned in Step 4, without-plan. (See Table 5).

^{4/} U.S. Water Resources Council, unpublished back-up materials on which OBERS Series E' projections are based.

^{5/} Arizona Water Commission and U.S. Department of Agriculture, Santa Cruz-San Pedro River Basin, Arizona, 1977.

TABLE 5. PROJECTED CROPLAND ACREAGE PROPORTIONS
IN THREE DIFFERENT REGIMES OF LAND
TREATMENT/MANAGEMENT, WITHOUT PLAN;
AWR BASIN

Land treatment level	:	1980	2000	2020
	:	-----Percent-----		
High	:	15	20	25
Medium	:	60	65	65
Low	:	25	15	10
	:			

Source: Unpublished estimates by SCS agronomic specialists
stationed in New Mexico.

6. The timetable of Step 5 and the yield-projections table resulting from Step 4 were used inconjunction with the crop acreages projected for the without-plan condition to obtain projected crop production for the Study Area, without-plan. The projected individual crops' acreages were assumed to be equally affected by the proportions of acreages in the different levels of land treatment, as shown for

each projection year. (See Table 6).

Beef-cattle projections

Beef cattle production was projected for the AWR Basin Study, but other types of livestock production were assumed to conform to the OBERs projections of market shares (Series E', appearing in unpublished, supportive, detailed projections). The OBERs projections emphasize National demand and price relationships. The future production of livestock products other than beef and veal depends relatively less on the supply of local natural resources and relatively more on National market forces, especially those forces that determine National commodity price changes and price changes for purchased farm supplies. However, range land cattle production is pressing against a limit of available developed range resources in the AWR Basin.

SCS local range specialists estimated that beef production on range land is currently at its practical upper limit because the presently developed grazing capacity of AWR range land is utilized fully. This was the basis for making an assumption that an equilibrium degree of beef production has been reached, in which an increase in grazing (management and conservation effort remaining constant) will cause a deterioration of range quality such that beef production will be forced to a lower level for a time period that compensates in lost production for the temporary production increase.

Feed-lot production is assumed to remain constant for the projection period, as there is insufficient basis for projecting a positive or negative trend.

TABLE 6. PROJECTED PRODUCTION AMOUNTS OF MAJOR CROP TYPES,
WITHOUT PLAN; AWR BASIN, NEW MEXICO

Crops		1980	2000	2020
<u>Irrigated Crops</u>		(Specified Units)		
Cotton	(bales)	720	0	0
Corn, grain	(bu.)	842,580	1,849,110	2,758,190
Corn, silage	(tons)	134,000	141,400	223,500
Sorghum, grain	(bu.)	1,413,970	1,271,840	2,024,770
Sorghum, silage	(tons)	103,870	27,930	31,000
Wheat	(bu.)	777,750	1,089,450	1,783,470
Alfalfa hay	(tons)	100,980	118,880	133,520
Other hay	(tons)	26,410	24,720	28,420
<u>Non-irrigated Crops</u>				
Sorghum, grain	(bu.)	539,600	890,240	1,107,880
Sorghum, silage	(tons)	102,780	73,560	75,790
Wheat	(bu.)	1,805,220	2,375,050	2,953,920

Source: Projections are based on procedures outlined in the text.

An increase in beef production is projected to occur during part of the projection period as a result of some irrigated harvested cropland's projected conversion to irrigated pasture.^{6/}

Because of the relative importance of beef cattle production in the Study Area, projections of it warranted considerable time and care. However, the available beef-cattle data offer only a fragmentary view of beef cattle production by individual county from year to year.

The steps of the beef production projections are as follows:

1. The New Mexico Agricultural Statistics¹ reported beef cattle population for each of the Study Area's counties for the years 1969 and 1974 were used to calculate a coefficient of change in annual beef and veal production that relates 1974 production to 1969 production (pounds, live weight).

2. The Study Area's combined beef and veal production for 1969 reported in the U.S. Census of Agriculture (139,260,000 lb.) was multiplied by the coefficient obtained in Step 1 to arrive at an estimate of 1974 combined beef and veal production. This represents the basic projected annual beef and veal production over the projection period, (i.e., no projected change in basic production, 1974-2020). (See Table 7).

3. The projected changes in amounts of irrigated lands used for grazing obtained in the crop-projections process were converted into

^{6/} It is assumed here that irrigated harvested cropland's conversion to irrigated pasture simply results in increased beef cattle production and that the harvested crops thus eliminated are not of a type (e.g., hay and silage) that is significantly cheaper to produce and use locally to feed cattle, thus contributing to the current scale¹ of feed-cattle production. Local SCS personnel mentioned an observed tendency for retired cropland to become irrigated pasture.

TABLE 7. PROJECTED BASIC LEVEL OF BEEF AND VEAL PRODUCTION
AND PROJECTED INCREASES DUE TO INCREASES IN AREA
OF IRRIGATED PASTURE

	:	1980	2000	2020
	:			
Basic annual production ^{1/} (lb.)	:	201,927,000	201,927,000	201,927,000
Projected irrigated pasture (acres)	:	53,580	58,680	58,620
Difference in projected area and 1974 area ^{2/} (acres)	:	12,630	17,730	17,670
Increase above basic production ^{3/} (lb.)	:	4,862,550	6,826,050	6,802,950

^{1/} Beef and veal production in the Study Area was 201,927,000 lb. in 1974.

^{2/} Irrigated pasture area was estimated at 40,946 acres in 1974.

^{3/} Increase was obtained by use of coefficient of 385 lb. live weight per additional acre of irrigated pasture.

Sources: (1) U.S. Census Bureau, U.S. Census of Agriculture, 1974.

(2) U.S. Department of Agriculture, Agricultural Statistics, 1974.

terms of annual beef and veal production by use of a standard New Mexico number of annual animal-unit-months (AUM's) per acre of irrigated pasture and a standard conversion factor from AUM's to pounds, live weight. (Both coefficients were supplied by SCS range production specialists).

4. The changes in beef and veal production due to projected changes in the amount of irrigated grazing area estimated in Step #3 for the projection years were added to the basic beef production estimate from Step #2. The result was the projected annual beef and veal production. (See Table 8).

Projections for livestock other than beef cattle

These projections were based upon the OBERS Series E' projections. The method followed involved expanding the OBERS projections from the WRSA #1108 four-whole-county area^{7/} to all counties and county portion of the Study Area. The procedure used for doing this was as follows:

1. 1969 livestock production (usually numbers of animals) for each class of livestock was recorded for each of the seven Study Area counties. (Source: U.S. Census of Agriculture).

2. The county production number of animals in each livestock class was converted into pounds, using New Mexico 1969 average live-weight data from the USDA annual statistical abstract.^{8/}

3. Amounts of livestock poundage produced in counties partially outside of the Study Area were reduced in proportion to the counties'

^{7/} The four whole counties of Water Resource Subarea #1108 are Colfax, Harding, Mora, and Quay. WRSA #1108 is designated by the U.S. Water Resources Council in 1972 OBERS Projections, Vol. 3, Page 2 (1974).

^{8/} U.S. Dept. of Agriculture, Agricultural Statistics, 1970.

TABLE 8. PROJECTED ANNUAL BEEF AND VEAL PRODUCTION, COMBINED,
WITHOUT PLAN, AWR BASIN, NEW MEXICO

(In thousands of pounds)

1980	206,790
1990 ^{1/}	207,770
2000	208,750
2020	208,730

^{1/} Obtained by interpolation between 1980 and 2000
projected values.

Source: Projections are based on procedures outlined in the text.

land area falling outside of the Study Area. In other words, livestock production sites were assumed to be located in a manner that causes a county's production portion that occurs within the Study Area to be proportional to the county's land area that lies within the Study Area.

4. The 1969 production of the various livestock types in the Study Area's counties and county portions, from Step 3, was summed by category.

5. The totals from Step 4 were used in conjunction with the livestock totals from four whole counties representing the OBERS subregion (#1108) to form "ratios of Study Area production to OBERS subarea production" for each livestock class.

6. The ratios from Step 5 were applied to the Series E' OBERS non-beef livestock products projections, found in unpublished "back-up" projections for Subregion #1108 in order to obtain AWR Basin projections consistent with OBERS projections. (See Table 9).

Projected crop production changes, with a plan for accelerated land treatment

The analysis of effects and impacts of contemplated USDA programs is the most important aspect of applied economics in a cooperative river basin study. The program measures are not stated as precise, detailed plans affecting a certain precisely designated land area, as in a project implementation study. Nevertheless, a decision concerning a large-scale program may involve greater costs and more momentous effects than one that concerns a single project. Therefore, it is quite important that estimates and/or projections of program effects be a valid tool for decisionmakers.

TABLE 9. PROJECTIONS OF ANNUAL PRODUCTION OF LIVESTOCK PRODUCTS,
OTHER THAN BEEF AND VEAL; AWR BASIN^{1/}

Product	:	1980	1990 ^{2/}	2000	2020
Pork, lb.	:	4,073.5	4,089.4	4,105.3	3,723.4
Lamb and mutton, lb.	:	393.2	326.0	258.9	287.7
Chickens, lb.	:	142.9	164.6	186.3	219.1
Turkeys, lb.	:	11,546.0	5,773.0	.0	.0
Eggs, doz.	:	1,091.1	1,251.3	1,411.5	1,662.6
Milk, lb.	:	14,269.2	15,220.0	16,171.8	19,025.6

^{1/} Projections based upon unpublished supplementary materials relating to the Series E' OBERS projections.

^{2/} Interpolation estimate.

To project the changes that would occur in farm acreage and production due to a contemplated acceleration of the existing USDA cropland treatment program SCS estimates of the acreage to be benefited were used in conjunction with SCS estimates of yield changes and cost changes due to an accelerated program of land treatment. This required definition of "accelerated program," was expressed in terms of: steps for implementation, extent of acreage affected, changes in farm operator's activities, increases in production amounts, changes in costs to farm firms and USDA agencies, and implementation date.

Soil Conservation Service personnel provided the criteria and data for defining and describing "accelerated land-treatment program." The author recommended defining it in such a way that it would be realistically possible to implement, given the SCS specialists' conclusion that large numbers of farm operators and/or landowners may not participate in such a program and the fact that program participation is voluntary.

SCS personnel defined the "accelerated program" partly by the rate at which they estimated some farmland acreage would move from one level (of three general, broad levels) of management and land treatment to another level. They also defined it partly in the crop and livestock yields and treatment costs that they estimated for the three levels of management/treatment. They further defined it by estimating the portions of land treatment costs that would be paid by farm firms and/or landowners, through cost sharing with the U.S. Government and by estimating the number of additional USDA personnel required to implement it, on both the administrative level and the detailed planning level. It

was assumed that (a) if the designated numbers and types of USDA personnel were assigned to assisting farm owners to implement more intensive land treatment and (b) if the USDA made available the funds necessary to meet the designated Federal share of costs, then the land treatment program would be accelerated according to the estimated timetable and would result in the projected yield increases.

The SCS personnel responsible for defining the accelerated land treatment program concluded that unused cropland will not become cultivated as a result of the program. Accordingly, their timetable for the adoption or upgrading of land treatment includes no additional cropland cultivation that is expected to result from the program.

Range land acreage is expected to be used more intensively by cattle due to the program, mainly because of a planned increase in stock watering facilities and fencing. However, the implementation of the program was defined in such a way that no increase is projected in the total area of AWR range lands within which cattle would graze.

Environmental benefits are expected as a result of the contemplated accelerated program. The unfavorable environmental effects of the program are almost non-existent, as land treatment tends generally to improve environmental quality as it increases agricultural production. The program thus does not appear to warrant an intensive analysis of environmental-economic tradeoffs.^{9/}

The procedural steps for projecting crop production increases under an accelerated land-treatment program were as follows:

^{9/} The following possible adverse effects were suggested but not studied:
(1) Fencing of range land would interfere with some wildlife mobility,
(2) Improved irrigation efficiency would eliminate some aesthetically appealing phreatophytes that presently provide an unmeasured amount of wildlife habitat.

1. The yield projections resulting from Steps 1-4 of the crop-production projection without-plan procedure described earlier were recorded. SCS personnel provided a timetable of estimated future movement of crop acreage (by percent of total) from given levels of land treatment to other levels. (See Table 10). Timing was based on the assumption that an acceleration of the existing land-treatment program would be implemented in Year 1980.

2. The timetable and yield-projections table were used in conjunction with the crop acreages projected previously for the without-plan condition to obtain projected crop production with an accelerated program of land treatment. Accelerated land treatment was assumed not to result in changes in crop types produced on any given cropland parcel. The projected individual crops' acreages were assumed to be equally affected by the proportions of acreages subject to different levels of management and land treatment that are shown for each projection year in the timetable mentioned above. (See Table 11).

3. The projected production without plan, previously shown in Table 6, was subtracted from the projected production with plan, from Step 2 above, to obtain the effect on production of accelerating the AWR land-treatment program. For the 1990 production increase due to the accelerated program, straight-line interpolation between the 1980 value (zero) and the Year 2000 value was employed.

Projected cost of accelerated program

The projected cost of accelerating the land treatment program on AWR cropland was obtained essentially by subdividing crop acreage into six soil groupings, (three applying to irrigated land and three applying

TABLE 10. PROJECTED CROPLAND ACREAGE PROPORTIONS IN THREE DIFFERENT REGIMES OF **MANAGEMENT AND LAND TREATMENT**, WITH ACCELERATED LAND TREATMENT PROGRAM; AWR BASIN

Land treatment level	1980	2000	2020
	-----Percent-----		
High	15	30	40
Medium	60	60	55
Low	25	10	5

Source: Unpublished estimates by SCS agronomic specialists stationed in New Mexico.

TABLE 11. PROJECTED CROP PRODUCTION OF
MAJOR HARVESTED CROPS WITH ACCELERATED LAND TREATMENT PROGRAM AND
NET PRODUCTION INCREASES; AWR BASIN, NEW MEXICO

Crop Type	1980	1990 ^{1/}	2000	2020
<u>Irrigated Crops</u>				
Cotton (bales)	720	360	0	0
Corn, grain (bu.)	842,580	1,409,550	1,976,520	3,096,980
Corn, silage (tons)	134,000	143,120	152,240	252,360
Sorghum, grain (bu.)	1,413,970	1,419,320	1,424,670	2,323,010
Sorghum, silage (tons)	103,870	66,970	30,070	35,000
Wheat (bu.)	777,750	962,400	1,147,050	1,948,550
Alfalfa hay (tons)	100,980	114,010	127,030	149,900
Other hay (tons)	26,410	26,740	27,070	33,160

<u>Dryland Crops</u>				
Sorghum, grain (bu.)	539,600	749,540	959,480	1,261,660
Sorghum, silage (tons)	102,780	90,340	77,890	82,840
Wheat (bu.)	1,805,220	2,182,020	2,558,830	3,357,060

Net increases in crop production due to program acceleration

Crop Type	1990 ^{1/}	2000	2020
<u>Irrigated Crops</u>			
Corn, grain (bu.)	63,700	127,410	338,790
Corn, silage (tons)	5,420	10,840	28,860
Sorghum, grain (bu.)	76,420	152,830	298,240
Sorghum, silage (tons)	1,070	2,140	4,000
Wheat (bu.)	28,800	57,600	165,080
Alfalfa hay (tons)	4,080	8,150	16,380
Other hay (tons)	1,180	2,350	4,740
<u>Dryland Crops</u>			
Sorghum, grain (bu.)	34,620	69,240	153,780
Sorghum, silage (tons)	2,160	4,330	7,050
Wheat (bu.)	91,890	183,780	403,140

^{1/} Interpolation estimates.

Source: Projections are based on procedures outlined in the text.

to dry cropland). Each of the six groupings have characteristics which are estimated to make for unique and different land-treatment cost increases under an accelerated land-treatment program. They were not explicitly considered in the projections of crop production without plan. The six groups and their proportion of land area are described as follows:

Irrigated

- I. (25%) Soils with fine sandy loam and coarser textures.
- II. (60%) Nearly level (0-1% slope) soils with loam, silt loam, and clay loam or silty clay loam.
- III. (15%) Gently sloping (2-5% slope) soils, same types as in II.
100% of irrigated.

Non-Irrigated

- IV. (12%) Deep soils, fine sand, or fine sandy loam.
- V. (60%) Nearly level (0-1% slope) soils with fine sandy loam or finer textures.
- VI. (28%) Gently sloping (2-5% slope) soils, as in V.
100% of non-irrigated.

The proportions of irrigated crop acreage and dry land acreage that fall into these six groupings were determined by SCS field personnel, as was the expected increase in annual land treatment cost for each, with plan. The types of treatment activities associated with the accelerated program are as follows: (1) using crops adapted to the soil and water supply; (2) using a cropping system capable of maintaining good soil physical conditions; (3) managing crop residue in a way that effectively controls erosion; (4) maintaining optimum fertility level by applying fertilizer or by growing soil improving crops; (5) conserving moisture; (6) controlling

insects, diseases, and weeds; (7) keeping tillage to a minimum and tilling only when the moisture content is such that compaction is minimized; (8) planting improved varieties; (9) practicing timely planting, tilling, and harvesting, and (10) using terraces, stripcropping, contour farming, and other erosion control practices where needed.

For irrigated soils treatment includes the above measures in addition to: (1) having an adequate supply of irrigation water; (2) using properly designed irrigation systems; (3) applying water according to the needs of crops and soils, and (4) coordinating crops with water delivery and irrigation systems.

The procedural steps are as follows:

1. Total projected irrigated and dry land acreage was multiplied by the percentage determined to be in the irrigated and dry "soil-use" groupings to arrive at projected amounts of cropped land area in each grouping. (See Table 12).

2. The total estimated change in annual land treatment cost per acre for each group (supplied by SCS personnel) was differentiated into three different cost levels corresponding to three different levels of management and treatment.

3. The acreages in Step 1 were multiplied by appropriate per-acre costs in Step 2 to obtain 18 products for each projection year, each product representing what the total annual land treatment cost would be if each of the three different management levels took up 100% of the absolute land area amount found (in Step 2) for each of the six "soil-use" groupings.

4. The products in Step 3 were multiplied by appropriate percentage

TABLE 12 - PROJECTED SOIL-USE GROUPS' CULTIVATED ACREAGE AND ANNUAL LAND-TREATMENT COST,
BY LAND TREATMENT LEVELS, YEARS 2000 and 2020, ONGOING PROGRAM

Soil-Use Group	Land Treatment Level	Projected 2000 Cropped Area of Soil-Use Group (Acres)	Annual Land Treatment Cost, 2000 (1976 dollars)	Projected 2020 Cropped Area of Soil-Use Group (Acres)	Annual Treatment Cost, 2020 (1976 dollars)
<u>Irrigated</u>					
I	High (H) Med. (M)	25,719	52,827 103,043	29,475	75,753 118,021
II	Low (L)	61,733	7,973	70,740	6,042 212,075
III	H M L H M L	15,431	148,036 288,972 22,039 43,484 84,771 6,481	17,685	331,112 16,980 62,254 97,138 4,987
Total Irrigated		102,833	757,626	117,900	924,382
<u>Non-Irrigated</u>					
IV	H M L	20,046	3,247 6,385 481	20,184	4,060 6,385 321
V	H M L	100,239	50,721 99,487	100,920	62,900 99,035
VI	L H M L	46,777	7,318 42,567 82,328 6,549	47,096	5,173 53,092 82,094 4,257
Total Non-Irrigated		167,062	299,083	168,200	317,257

amounts appearing in the SCS "timetable of percentage areas of land treatment by classes" for the without-plan condition (See Table 5). The result was 18 cost figures for each projection year, representing the total land-treatment cost for the acreage at each land treatment level in each "soil-use" group. The 9 irrigated-area and 9 dry-area figures were then summed, for each projection year (2000 and 2020).

5. The products in Step 3 were multiplied by percentage amounts (of total land area) appearing in the SCS timetable for the "with plan" condition. (See Table 10). The 18 resulting products were analogous to those in Step 3, but represented land treatment cost with plan. (See Table 13).

6. The land treatment costs for each projection year in Step 4 were then subtracted from the appropriate years' costs in Step 5 to arrive at the total land treatment cost change (by projection years) due to accelerating the ongoing program.

7. The 1990 land-treatment cost change due to plan was obtained by straight-line interpolation between the 1980 value (zero) and the value for 2000.

Procedure for projecting change in beef cattle production, with plan

The procedure for estimating future changes in cattle production due to plan is somewhat analogous to that used for estimating crop-production changes. However, it is very different from the procedure used for projecting annual cattle production without plan. It is an approach that is less well adapted to producing an absolute-level projection of cattle production without plan than it is to estimating

TABLE 13 - PROJECTED SOIL-USE GROUPS' CROP ACREAGE AND ANNUAL LAND-TREATMENT COST,
BY LAND-TREATMENT LEVELS, YEARS 2000 AND 2020, WITH ACCELERATED PROGRAM

Soil-Use Group	Land Treatment Level	Projected 2000 Cropped Area of Soil-Use Group (Acres)	Annual Land Treatment Cost, 2000 (1976 dollars)	Projected 2020 Cropped Area of Soil-Use Group Irrigated Acres	Annual Treatment Cost, 2020 (1976 dollars)
<u>Irrigated</u>					
I	High (H)	25,719	79,317	29,475	121,204
	Med. (M)		100,459		99,864
	Low (L)		5,272		3,021
II	H	61,733	222,053	70,740	339,226
	M		266,687		280,171
	L		14,816		8,490
III	H	15,431	65,181	17,685	99,605
	M		78,235		52,824
	L		4,352		2,494
Total Irrigated		<u>102,833</u>	<u>836,372</u>	<u>117,900</u>	<u>1,006,899</u>
<u>Non-Irrigated</u>					
IV	H	20,046	4,871	Non-Irrigated	6,494
	M		5,894	<u>20,184</u>	5,402
	L		321		160
V	H	100,239	75,580	100,920	100,640
	M		91,217		83,799
	L		5,213		2,556
VI	H	46,777	63,617	47,096	84,947
	M		75,779		69,463
	L		4,210		2,128
Total Non-Irrigated		<u>167,062</u>	<u>326,702</u>	<u>168,200</u>	<u>355,589</u>

CHANGE IN COST DUE TO ACCELERATED LAND TREATMENT

	1990 ^{1/}	2000	2020
	---	1976 dollars ---	
Irrigated			
Non-Irrigated	39,373	78,746	82,517
Total Change	13,809	27,619	38,332
	53,182	106,365	120,849

^{1/} Interpolation estimate

Source: Projections are based on procedures outlined in the text.

the change occurring on range land due to implementing the plan. Therefore, the absolute levels of cattle production that were obtained incidental to projecting the change due to plan are not expected to represent more than the cattle production attributable to range-grazing activity. As such, they exclude cattle production that results from feed-lot and irrigated pasture and forage-crop operations, neither of which are well-documented in statistics reported by individual county.

The steps of the procedure for projected changes with plan are as follows:

1. All Study Area land was subdivided by SCS range specialists into nine "ecosystems," having unique production, vegetation, soil, and/or climate characteristics. The acreage of each ecosystem was estimated. Acreage known to be devoted to harvested crops was not excluded from the estimates because the extent of harvested crop acreage by ecosystem is unknown and a major amount of crop acreage is grazed, --- although it is not range land. (However, range acreage exists on the order of ten million acres, whereas crop acreage that is regularly planted is on the order of 220,000 acres, projected to rise to about 280,000 acres by 1980; i.e. about 2.2% rising to 2.8% of the total treated as range land).
2. For three broad, general levels of range land management and treatment SCS range specialists provided a consensus estimate of per-acre productivity, without plan, expressed in terms of 1976 dollars of revenue per acre. These revenue levels were different for all 9 ecosystems.

3. A "timetable" showing percentages of all range land area expected to fall into the three different levels of range management and treatment for the projection years, without plan and with plan, was developed by SCS personnel who had defined the accelerated range land treatment program. (Table 14).

4. For each projection year (2000 and 2020) each ecosystem's total acreage was used in conjunction with the percentages of acreages expected to be in the three broad levels of management (both for with-plan and without-plan) and appropriate ecosystem revenue-per-acre estimates for each level of management, to obtain 27 total revenue amounts for each projection year (and for with-plan and without-plan condition). Each of the 27 amounts represents revenue from grazing the acreage of one of three subdivisions (management levels) of one of the nine ecosystems' acreage. (See Table 15).

5. For with-plan and without-plan conditions, and by projection years, the 27 individual revenue amounts were summed.

6. The without-plan revenue totals were subtracted from the with-plan revenue totals to obtain, for Years 2000 and 2020, the projected change in beef cattle revenue due to accelerating the range land treatment program. (See Table 16). A 1990 projection was calculated by straight line interpolation between 1980 (zero) and Year 2000 value.

7. The change in beef cattle production cost due to the accelerated program was calculated in a manner exactly analogous to the calculation of the change in beef cattle revenue. The activities proposed for the accelerated range land treatment program are described as follows:

TABLE 14. PROJECTED RANGE MANAGEMENT LEVEL WITH ONGOING AND ACCELERATED
USDA PROGRAM, BY PERCENT OF TOTAL RANGE ACREAGE

Management Level	:	:	2000		:	2020	
	:	1980	Ongoing	Accelerated	:	Ongoing	Accelerated
	:	%	%	%	:	%	%
Low		60	55	45		50	30
Medium		30	30	30		30	30
High		10	15	25		20	40

Source: Unpublished estimates by SCS State Office Range Conservationist and
other SCS field specialists.

TABLE 15. PROJECTED ANNUAL REVENUE UNDER THREE REGIMES OF RANGE LAND TREATMENT
IN ECOSYSTEMS I AND IX, AWR BASIN, WITH AND WITHOUT PLAN

(Grand totals represent all nine ecosystems)

Ecosystem	Acres	L.T. cost per acre	On-Going Program Revenue						Accelerated Program Revenue						
			% Participation			1980	Total Revenue		% Participation			1980	Total Revenue		
			1980	2000	2020		2000	2020	1980	2000	2020		2000	2020	
I	204,700														
Level of Mgmt.															
1		3.56	60	55	50	\$437,000	\$401,000	\$364,000	60	45	30	\$437,000	\$330,000	\$219,000	
2		5.04	30	30	30	310,000	310,000	310,000	30	30	30	310,000	310,000	310,000	
3		6.26	10	15	20	<u>128,000</u>	<u>192,000</u>	<u>256,000</u>	10	25	40	<u>128,000</u>	<u>320,000</u>	<u>513,000</u>	
						\$875,000	\$903,000	\$930,000				\$875,000	\$960,000	\$1,041,000	
(Parts II through VII are intentionally not included here.)															
IX															
Level of Mgmt.															
1	367,300	1.53	60	55	50	\$337,000	\$309,000	\$281,000	60	45	30	\$337,000	\$253,000	\$169,000	
2		3.15	30	30	30	347,000	347,000	347,000	30	30	30	347,000	347,000	347,000	
3		4.40	10	15	20	<u>162,000</u>	<u>242,000</u>	<u>951,000</u>	10	25	40	<u>162,000</u>	<u>404,000</u>	<u>646,000</u>	
						\$946,000	\$899,000	\$951,000				\$846,000	\$1,004,000	\$1,162,000	
<u>Grand Total, I through IX</u>						\$24,603,000	\$25,626,000	\$26,648,000				\$24,603,000	\$27,673,000	\$30,740,000	

(Grand totals represent all nine ecosystems)

Ecosystem	Acres	L.T. cost per acre	On-Going Program Revenue						Accelerated Program Revenue						
			% Participation			Total Revenue			% Participation			Total Revenue			
			1980	2000	2020	1980	2000	2020	1980	2000	2020	1980	2000	2020	
I	204,700														
Level of															
Mgmt. 1		3.56	60	55	50	\$437,240	\$400,800	\$364,370	60	45	30	\$437,240	\$329,930	\$218,620	
2		5.04	30	30	30	309,510	309,510	309,510	30	30	30	309,510	309,510	309,510	
3		6.26	10	15	20	<u>128,140</u>	<u>192,210</u>	<u>256,280</u>	10	25	40	<u>128,140</u>	<u>320,360</u>	<u>512,570</u>	
						\$874,890	\$902,520	\$930,160				\$874,890	\$959,800	\$1,040,700	
						(Parts II through VII are intentionally not included here.)									
IX															
Level of															
Mgmt. 1	367,300	1.53	60	55	50	\$337,180	\$309,080	\$280,980	60	45	30	\$337,180	\$252,890	\$168,590	
2		3.15	30	30	30	347,100	347,100	347,100	30	30	30	347,100	347,100	347,100	
3		4.40	10	15	20	<u>161,610</u>	<u>242,420</u>	<u>951,300</u>	10	25	40	<u>161,610</u>	<u>404,030</u>	<u>646,450</u>	
						\$845,890	\$898,600	\$951,300				\$845,890	\$1,004,020	\$1,162,140	
												\$24,602,810	\$77,673,290	\$30,739,760	
						<u>Grand Total, I through IX</u>	\$24,602,810	\$25,625,640	\$26,648,470						

TABLE 16. PROJECTED CHANGE IN GRAZING REVENUE DUE TO ACCELERATION
OF LAND TREATMENT PROGRAM, AWR BASIN (1976 DOLLARS)

	:	1980	:	1990 ^{1/}	:	2000	:	2020
Annual revenue with	:		:		:		:	
accelerated program	:	\$24,603,000	:	\$26,138,000	:	\$27,673,000	:	\$30,740,000
Annual revenue with	:		:		:		:	
ongoing program	:	24,603,000	:	25,114,000	:	25,626,000	:	26,648,000
Projected change	:	0	:	1,024,000	:	2,047,000	:	4,092,000

^{1/} Interpolation estimates

Source: River Basin Party staff calculations.

(Grand totals represent all nine ecosystems)

(Parts II through VIII are intentionally not included here.)

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TABLE 18 - PROJECTED CHANGE IN COST DUE TO AN
ACCELERATED PROGRAM OF RANGE LAND TREATMENT AND
MANAGEMENT AWR BASIN (1976 DOLLARS)

	:	1980	:	1990 ^{1/}	:	2000	:	2020
	:		:		:		:	
Annual costs with	:		:		:		:	
accelerated program	:	\$19,622,000	:	\$20,701,000	:	\$21,780,000	:	\$23,939,000
	:		:		:		:	
Annual costs with	:		:		:		:	
ongoing program	:	19,622,000	:	19,982,000	:	20,341,000	:	21,061,000
	:		:		:		:	
Projected change	:	0	:	719,000	:	1,439,000	:	2,878,000
	:		:		:		:	

1/ Interpolation estimates

2/ Cost shares based on unpublished estimates by U.S. Soil Conservation Service personnel, New Mexico

Source: River Basin Party staff calculations.

The alternative plan definitions would call for (a) changes in the estimated implementation timetable for land treatment, and/or (b) changes in the per-acre cost of land treatment.

Analysis of program effects would then proceed as under the procedures described previously for projecting change on cropland and range land.

Cost sharing

The estimated Federal and private cost share for the alternative USDA programs considered was based on the assumption that there would be no change in the estimated current, overall USDA cost share (50%). An increase in the proportion paid by USDA was not included in the SCS definition of the alternative accelerated programs, and therefore it was not considered as an additional, incentive means of implementation. Implementation means call for more Federal funds to be made available for the land-treatment program in the Study Area. Even at this higher level of USDA funding, SCS personnel estimate that the average overall share paid by USDA will still be 50% of the total cost.

The net increases in annual crop production projected to result from the accelerated program (See Table 11) were multiplied by 1976 WRC normalized prices to obtain the projected values of crop production increases due to the accelerated land treatment program. Those values are: \$1,136,000 in 1990; \$2,819,000 in 2000; and 5,286,200 in 2020.

The projected grazing revenue increases (from Table 16) were added to the crop revenue increases to arrive at the projected revenue increase for crops and livestock. These totals were: \$2,159,000 in

1990; \$4,865,600 in 2000; and \$9,377,500 in 2020.

The projected change in installation cost of accelerating the cropland treatment program (from Table 13) were added to the projected changes in cost for the range land treatment program (from Table 18). The projected total annual installation cost of accelerating the land treatment program on both crop and range land is: \$772,200 in 1990; \$1,545,400 in 2000; and \$2,998,800 in 2020.

Profitability of land treatment

The projected increases in annual production and the increased annual costs associated with acceleration of land treatment were compared, to form an idea of the economic feasibility of such a program.

Based on SCS estimates and the analysis as outlined above, annual land treatment direct benefits estimated for the accelerated program proposals compared with costs to society at a ratio ranging from 2.4:1 in 1990 to 3:1 in 2020. These program benefits compared with costs to private firms and individuals at a ratio ranging from 4.8:1 in 1990 to 6:1 in 2020, with a private-cost share of 50%. (As all direct pecuniary benefits to society are expected to be received by crop and livestock farm firms, the benefit-cost ratio for private firms in the aggregate is double the benefit-cost ratio for society if the Federal cost share in one half.)

Aggregate annual future streams of benefits and costs were not discounted to the present to obtain a present-value benefit-cost ratio. This is because such a comparison was not required, and because the program's initial-cost component of land treatment was expected to

be borne, on an aggregative scale, over a long period of time (1980 to 2020) as farm owners gradually decide to increase their level of investment in land treatment above the level that would be achieved by means of the existing program.

With land treatment costs and productivity effects estimated by SCS personnel, some additional information could have been obtained if they had been asked to provide further estimates of cost and revenue changes, for "typical" ranches and crop farms so that the "typical" firms' benefits and costs of investing in increased land treatment activity might be expressed as present values.

Ordinarily what might have been gained by comparing the individual farm firm's present-value costs and benefits of increased land-treatment is some insight into the extent of the firm owner's time-horizon and time-preference, as evidenced by his declining to increase land treatment activity even though the present-value benefit-cost ratio may be relatively high.

Variability of weather and farm revenues

Farm revenues vary greatly from year to year in the Study Area mainly due to weather's effect on crop yields. Yields are affected by: degree of cloudiness, timing of frosts, growing season temperatures, extent and distribution of precipitation over the year, insects and blights, and presence and severity of hail.

Even knowledge of the realtionships between these weather factors and yield levels would be of little use in predicting crop yields long before the beginning of any given crop planting season. Therefore, no attempt was made to measure such relationships, or to establish their

probabilities.

The main object here in projecting the effect of weather variability on yields is to get an idea of how variable the yields themselves are likely to be in the future. Accordingly, yield variability of dryland crops and crops irrigated with surface water supplies was traced through a study of past records.

Because individual farm firms usually produce a conglomerate of crops over the long term, the analysis dealt with a conglomerate of crops. Yields were expressed in current dollars per acre rather than in physical units. For drylands of the Basin, a conglomerate of wheat yield and sorghum yield was found to vary over the years as follows: The conglomerate yield, in dollars per acre, fell below 90 percent of its average level in about 28 percent of all years, 1957-1976. It fell below 80 percent of its average level about 17 percent of the time, and below 41 percent of the average level 17 percent of the time.

Representing past yields on cropland irrigated from surface water supplies is the record of yields for the U.S. Bureau of Reclamation's Tucumcari Project, in Quay County. The yield, in dollars of revenue, of a conglomerate of crops grown there was studied and the frequency of years with yield declines was determined. (The conglomerate of crops is as follows: Sorghum, alfalfa, silage, and cotton).

Because there was a trend in conglomerate yield for the Tucumcari Project, yield variations were measured as variations from a straight-line trend. The conglomerate yield fell below 90 percent of the trend value in about 32 percent of all years from 1954 through 1975. It

fell below 80 percent of the trend value about 9 percent of the time, and below 70 percent of the trend value about 5 percent of the time. The yield declines are all believed to be associated with some unfavorable aspect of weather that was not necessarily a lack of rainfall or irrigation water storage in reservoirs.

The accelerated programs described above are not expected by SCS staff members to have a significant, predictable effect on yield variations caused by weather changes from year to year. However, to whatever extent an accelerated program of land treatment may stave off an era of "Dust Bowl" wind erosion conditions during years of future droughts, it is expected to limit long-term downward variations in yields to some unpredictable extent.

In conclusion, the program is not expected to eliminate the year-to-year variations in farm revenues that are caused by year-to-year weather variations. Through its protection against gradual loss of soil productivity it is expected to maintain average farm revenues at a substantially higher level than the without-plan levels of land treatment.

Projections of employment and income in the service industries, without plan

The OBERS Series E projections of service-industry activity were based partly on OBERS projections of production in agriculture, a basic industry of the Study Area. Because the without-plan projections of the value of agricultural production were considerably lower than those of OBERS Series E, the service-industry projections by OBERS were assumed to be too high. They were altered by the method described in the following

narrative. Also, the effects (on service industries) of implementing an accelerated program of land treatment were estimated by essentially the same method.

1. The projected value (in 1967 dollars) of agricultural production, without plan, was subtracted from the projected value of OBERS production (Series E) keeping aggregate values of crop and livestock production separate. The result was projected differential values between OBERS and without-plan projections (and with-plan projections).

2. Previously published^{9/} interindustry-multiplier production coefficients (empirically derived) relating crop production and livestock production to production in five broad service-industry categories (and the food-processing sector of "manufacturing") were employed in conjunction with the differentials obtained for crop and livestock production in Step 1 to obtain estimated differentials in output for each of the five broad service-industry categories and the food-processing sector of manufacturing. (See Table 19). (The interindustry multiplier coefficients reflect both direct and indirect effects of changes on the various industries.)

The interindustry coefficients were originally developed for industries in a neighboring, overlapping region of a size similar to that of the Study Area. The chief difference in the input-output study's region and the AWR Study Area was a large government sector (mainly in Santa Fe, New Mexico). This was judged to be no drawback; because the present study assumed that government earnings and employment will

^{9/} U.S. Dept. of Agriculture; Forest Service and Economic Research Service, Evaluation of Economic Impact of Forest Service Programs in Northern New Mexico, 1973.

TABLE 19. EXTENT TO WHICH OBERS PROJECTED
AWR SERVICE-INDUSTRY AND MANUFACTURING
OUTPUTS EXCEED WITHOUT-PLAN PROJECTIONS
(In 1976 Dollars)

		Crops		
Industry	Direct-indirect multipliers	1980	2000	2020
Manufacturing	.0657475	975,262	1,389,546	864,066
Contract construction	.0023972	35,558	50,664	31,504
Transportation, communication & utilities	.0030723	45,574	64,932	40,376
Wholesale & retail trade	.0082135	121,835	173,590	107,943
Finance, insurance & real estate	.0014324	21,247	30,273	18,825
Services	.0056094	83,206	118,552	73,720
		Livestock		
Manufacturing	.4378051	236	13,384	18,253
Contract construction	.0013174	0	40	54
Transportation, communication & utilities	.0019994	2	62	84
Wholesale & retail trade	.0044895	2	136	187
Finance, insurance & real estate	.0007290	0	22	31
Services	.0029485	2	91	124

Sources: (1) U.S. Department of Agriculture; Forest Service and Economic Research Service, Evaluation of Economic Impact of Forest Service Programs in Northern New Mexico, March 1973.

(2) Projections are based on procedures outlined in the text.

remain as projected by OBERS (or will vary proportionally as the as the Study Area's population varies from the level assumed in OBERS). In other words, the method used to obtain government employment and earnings made no use of interindustry relationships.

3. 1973-4 annual value-of-output data and annual earnings data^{10/} were recorded as State aggregate amounts for each of New Mexico's five broad service-industry categories and for manufacturing. From these, ratios of earnings to value of output were calculated for each of the six industry categories. These ratios were assumed to prevail in the AWR Basin.

4. The differentials in value of output obtained in Step 2 were multiplied by the ratios in Step 3 to obtain the differentials in earnings for the six industries. For the without-plan projections, these differentials showed how much earnings (expressed in 1967 dollars) are projected to fall short of OBERS projected earnings. (See Table 20.)

For the analysis of the accelerated program, the difference between Step 4's earnings projections and a similar type of projections based on the accelerated program's agricultural output indicates the effect of the program on earnings in the five service-industry categories and in manufacturing. (See Table 21).

5. To estimate employment numbers, New Mexico State totals of numbers employed, by industry, were related to State totals of earnings by industry, and ratios of earnings to employment were thus obtained. They were assumed to hold true for the Study Area.

^{10/} Employment Security Commission of New Mexico, New Mexico Labor Market Trends, 1975.

TABLE 20. EXTENT TO WHICH OBER'S PROJECTED INDUSTRY EARNINGS
EXCEED PROJECTED EARNINGS, UNDER WITHOUT-PLAN
CONDITION, AWR BASIN (IN THOUSANDS OF 1976 DOLLARS)

Industry	: Earnings- :output coeff. :	Projected earnings difference		
		1980	2000	2020
	:	(Difference in absolute values)		
	:			
Manufacturing	: .447	293	1,260	1,363
	:			
Contract construction:	: .298	8	31	33
	:			
Transport., comm. and: publ. utilities	: .406	13	53	59
	:			
Wholesale and retail trade	: .154	13	54	59
	:			
Finance, insurance and real estate	: .663	9	40	44
	:			
Services	: .487	27	116	128
	:			
Agriculture	: .388	<u>3,875</u>	<u>16,637</u>	<u>18,007</u>
	:			
Total	:	4,238	18,191	19,693
	:			
	:	(Percent difference)		
	:			
Manufacturing	:	2.6	4.9	2.6
	:			
Contract Construction:	:	.3	.6	.4
	:			
Transport,, comm. and: pub. utilities	: .1	.1	.4	.3
	:			
Wholesale and retail trade	: .1	.1	.2	.2
	:			
Finance, insurance and real estate	: .1	.1	.0	.1
	:			
Services	: .1	.1	.4	.3
	:			
Agriculture	:	8.2	42.0	34.7
	:			
Total	:	2.6	7.6	5.0
	:			

Source: Projections are based on procedures described in the text.

TABLE 21. PROJECTED INCREASES IN EARNINGS FOR
THE MAJOR BASIN INDUSTRY GROUPS RESULTING FROM DIRECT AND
INDIRECT EFFECTS OF THE USDA ACCELERATED PROGRAM

(1976 DOLLARS)^{1/}

Industry Group	Earnings-output Coefficient	1990 ^{2/}	2000	2020
		(Change in absolute values)		
Transportation, Utilities, and Communications	.406	1,440	2,880	6,420
Wholesale and Retail Trade	.154	1,290	2,580	5,960
Finance, Insurance, and Real Estate	.663	950	1,900	4,400
Services	.487	2,820	5,640	12,910
Contract Construction	.298	1,970	3,940	6,750
Manufacturing	.447	309,220	340,130	1,028,140
Agriculture	.388	443,710	784,500	2,544,890
Total		761,400	1,141,570	3,609,470
(Percent difference) ^{3/}				
Transportation, Utilities, and Communications		.01	.02	.03
Wholesale and Retail Trade		.01	.01	.02
Finance, Insurance, and Real Estate		.01	.01	.01
Services		.01	.02	.03
Contract Construction		.05	.08	.09
Manufacturing		1.61	1.27	1.91
Agriculture		.83	1.40	3.64

^{1/} Excludes projected wages from land treatment installation.

^{2/} Interpolation estimates.

^{3/} Values are shown to the nearest hundredth of a percent because rounding to tenths would conceal most values' magnitudes.

6. From the OBERS Series E projections of total earnings and total number of workers, by projection years, ratios of aggregate earnings to aggregate employment for industry as a whole were obtained for each projection year.

7. The rate of increase in the OBERS-derived ratios of Step 6, from one projection year to the next, was calculated and applied to the individual industry category's ratio of earnings to employment to arrive at a ratio of earnings to employment in all projection years for each industry category.

8. The projected ratios of earnings to employment were used in conjunction with the appropriate earnings projections for each industry category to obtain estimates of numbers employed for each category in each projection year. (See Table 22). Here it was assumed that the ratios of earnings to employment in each industry will maintain the same level relative to those of the other industries, as the ratios for all industries rise, through Year 2020. For employment increases projected to occur due to increased agricultural production with plan, see Table 23.

Implications and Conclusions

OBERS Projections

The OBERS projections of crop and livestock were, in general, higher than either the with-plan or without-plan projections made for the AWR Study. Production of certain crop types was an exception to this generalization. The projected differences between OBERS and AWR projections are shown in Tables 24 through 26. The projected differences in livestock production are shown in Table 27.

TABLE 22. EXTENT TO WHICH OBERS PROJECTIONS OF EMPLOYMENT EXCEED
PROJECTED EMPLOYMENT WITHOUT PLAN, AWR BASIN

Industry	Differential in employment		
	1980	2000	2020
Agriculture	251 (12.3%)	217 (20.9%)	82 (9.9%)
Manufacturing	32 (3.9%)	27 (2.5%)	10 (.8%)
Contract construction	1 (.4%)	1 (.4%)	0 (.4%)
Transp., comm., & utilities	1 (.1%)	1 (.2%)	1 (.2%)
Wholesale & retail trade	2 (.1%)	2 (.1%)	1 (.1%)
Finance, insur., & real estate	1 (.1%)	1 (.1%)	1 (.1%)
Services	3 (.1%)	2 (.1%)	2 (.1%)

Workers per \$100,000 earnings (1967 dollars)

	1970	1980	1990	2000	2020
Agriculture	5.2	4.3	3.4	2.6	1.6
Manufacturing	8.7	7.3	5.6	4.2	2.4
Contract construction	9.9	8.4	6.5	5.1	3.1
Transp., comm., & utilities	8.0	6.8	5.3	4.1	2.5
Wholesale & retail trade	13.6	11.5	9.0	7.0	4.2
Finance, insur., & real estate	10.8	9.1	7.2	5.6	3.4
Services	20.5	17.3	13.5	10.6	6.4
OBERS projections index	1.000	.842	.658	.515	.311

Source: Projections of employment and worker-earnings ratios are based on procedures described in the text.

TABLE 23. PROJECTED INCREASE IN NUMBERS EMPLOYED IN MANUFACTURING AND BROAD SERVICE-INDUSTRY CATEGORIES DUE TO IMPLEMENTING AN ACCELERATED LAND-TREATMENT PROGRAM: 1990, 2000 & 2020

Industry	1990	2000	2020
(In absolute numbers)			
Agriculture ^{1/}	0	0	0
Manufacturing (food)	31	26	45
Contract construction	0	0	0
Transport., communic., and public utilities	0	0	0
Wholesale and retail trade	0	0	0
Finance, insurance, and real estate	0	0	0
Services	1	1	1
(Percent change)			
Agriculture	0	0	0
Manufacturing (food, processing)	3.26	2.40	3.54
Contract construction	0	0	0
Transport., communic., and public utilities	0	0	0
Wholesale and retail trade	0	0	0
Finance, insurance, and real estate	0	0	0
Services	.03	.03	.03

^{1/} The number of workers employed in agriculture is assumed not to increase due to accelerated land treatment.

TABLE 24. DIFFERENCE BETWEEN OBERS AND
WITHOUT-PLAN PROJECTIONS OF ACREAGE AND PRODUCTION, 1980

Crop	Acreage Difference	Production Difference
(Minus amounts show OBERS smaller than without-plan)		
Cotton	934	1,720 bales
Corn, grain	360	-222,620 bu.
Silage	-12,875	-122,900 tons
Sorghum, grain	8,300	3,422,670 bu.
Wheat	-68,812	297,110 bu.
Hay	-14,500	2,870 tons
Irrigated pasture	41,640	

TABLE 25. DIFFERENCE BETWEEN OBERS AND
WITHOUT-PLAN PROJECTIONS OF ACREAGE AND PRODUCTION, 2000

Crop	Acreage Difference	Production Difference
(Minus amounts show OBERS smaller than without-plan)		
Cotton	1,740	2,190 bales
Corn, grain	-8,480	-1,369,370 bu.
Silage	-4,610	53,470 tons
Sorghum, grain	23,310	5,235,300 bu.
Wheat	-48,010	802,280 bu.
Hay	-200	43,740 tons
Irrigated pasture	-35,760	

Source: Projections are based on procedures outlined in the text.

TABLE 26. DIFFERENCE BETWEEN OBERS AND
WITHOUT-PLAN PROJECTIONS OF ACREAGE AND PRODUCTION, 2020

Crop	Acreage Difference	Production Difference
(Minus amounts show OBERS smaller than without-plan)		
Cotton	1,710	2,190 bales
Corn, grain	-15,110	-2,526,930 bu.
Silage	-8,350	-110,510 tons
Sorghum, grain	4,420	4,386,010 bu.
Wheat	-52,850	-8,380 bu.
Hay	-6,580	69,310 tons
Irrigated pasture	-31,870	

TABLE 27. DIFFERENCE BETWEEN OBERS AND
WITHOUT-PLAN PROJECTIONS OF BEEF AND VEAL PRODUCTION

Year	Amount that OBERS exceeds without-plan projection
	(1,000 lb.)
1980	1,196.4
2000	68,561.5
2020	93,090.0

The most striking feature of the OBERS Series E' projections is that sorghum grain production was projected to rise above its current level by 1980 and to continue increasing through Year 2020. The average annual production in the four counties of WRSA #1108 in 1973-75 was 388,700 bushels of sorghum grain, with 476,200 bushels being produced in 1975.^{11/} However, the OBERS Series E' projection places sorghum grain production for 1980 at 1,213,100 bushels in WRSA #1108. The OBERS projections methods thus would appear to call for too much sorghum grain production in 1980 and perhaps later years. The OBERS procedures' assignment of resources to massive production of sorghum grain may possibly have resulted in compensatingly lower OBERS projections for other crops than the OBERS procedures would have called for if less sorghum production had been projected. The latter statement is based on the OBERS practice of projecting each major region's share of aggregate national agricultural production and further disaggregating the regional share into finer subregions. Inherent in this process is the loss of projection validity that tends to ensue from projecting more specific crop types and geographic areas, rather than more general crop classes and larger geographic areas. An example would occur in the assigning of future feed grain production of a region among its subregions. If more of one feed grain is assigned to one of the subregions, less of other feed grains thereby tend to be assigned to it in projections.

The OBERS projected amounts of crops are overall somewhat larger for the AWR Basin than the amounts in the without-plan projections.

^{11/} U.S. Dept. of Agriculture, Statistical Reporting Service and New Mexico State Crop and Livestock Reporting Service, New Mexico Agricultural Statistics, Years 1974-76.

Exceptions are corn for grain and silage. The differences in these crop amounts are essentially due to the differences in the OBERS procedures and the trend-extension method used for without-plan projections, but they are partly a result of OBERS projections' being basically an estimate of future market demand, whose size is based ultimately on projected U.S. population size, per capita food consumption levels, and export levels for food and fiber. Thus, it is essentially an expression of National market demand, which is subdivided among regions and subregions according to their traditional market shares and recently changing production capacities. Instead of projecting the scale of production it merely implies that, if a given region produces x amount of a commodity, there is (or is not) sufficient market demand for that amount.

The presumption is that, if a region produces more than its OBERS share, the extra production either will not be bought or will displace farm production elsewhere in the Nation.

Summary of effects of the contemplated acceleration of the land treatment program

As was previously mentioned, the cost of moderately accelerating the ongoing USDA land treatment program for cropland and range land in the Study Area would range from \$772,200 annually in 1990 to \$2,998,800 in 2020. The increased output value would range from \$2,159,000 annually in 1990 to \$9,377,500 in 2020.

The contemplated increase in land treatment measures would provide protection of soils' productivity from progressive deterioration in the form of erosion and sedimentation caused by farming activity and weather

over a period of years. This would have the general effect of making average annual yields (and revenues) measurably higher than they would be with the existing USDA program regime.

In the event of unusually long and extreme drought, the land treatment measures in question would have some positive protective effect (mainly against wind-erosion damage) the extent of which has not been estimated for the AWR Basin Study.

The effects of USDA land-treatment programs tend to be favorable both in regard to farm production and in regard to concerns of the environment. There are possible environmental ill effects, however, whose severity tends to depend to some extent on subjective opinions of a variety of persons affected. An example would be the decline in phreatophyte water supply that would result from improved irrigation water efficiency (one part of the accelerated program). A decline in phreatophytes would mean a loss of aesthetic value to some persons and a loss of wildlife cover also considered serious by some persons. As was implied earlier, no estimate was made of the marginal value to affected persons of a unit of wildlife cover or a unit of vegetative beauty existing alongside irrigated crop operations. ESCS employees are working toward developing methodology for such estimates. That methodology, once fully developed, would become useful in future assessments of environmental effects of public programs.

The projected increases in earnings and employment in the service industries expected to result from accelerated land treatment are large and important to the local economy, which suffers from a relatively low level of per-capita income. It is not certain, however, that Study Area citizens who have been chronically underemployed in the past will become

better employed as a result of projected increases in service-industry employment. New arrivals who may migrate into the Study Area may be the persons who absorb the projected increases in service-industry earnings.

No compensating net decline is projected for service-industry and agricultural earnings and employment outside of the Study Area as a result of increased AWR agricultural production resulting from an acceleration of the land treatment program. This is because the available projections (OBERS Series E') of the Study Area's share of the Nation's food and fiber market demand indicated a degree of food and fiber demand for products of the Area that exceeds, in general, the Area's projected production, even with the accelerated land treatment program.

The question of sufficiency of methods, and advisable changes

The extrapolation of past crop acreage trends into the future is justified if we accept that long-enduring institutional forces, mainly of a type not affected by frequently legislated changes, have affected those past trends and will continue to affect them similarly in the future. A limited number of institutional changes are noted that appear to account for discontinuities in the past crop-acreage trends. These are, for the most part, legislated and/or localized institutional changes, such as a local change in extent and nature of official acreage allotments.

However, if discontinuities in observed past acreage trends were explained mainly in terms of seeming changes in the long-enduring, large-scale institutional forces, the whole basis for the method used would become internally inconsistent.

Other projections methods for crop acreages and production are subject to the same type of principle, of course, as they are ultimately all based on assumed continuity of institutional forces.

Projections based to a large extent on the trend in National population growth (and therefore growth in aggregate demand for food and fiber) were thought to need changing after the U.S. 1970 population census results were released. One may still question whether the population growth-rate decrease indicated by that census is a result of a temporary, limited institutional change or of a pronounced change in institutional forces that once were accepted to be of a long-enduring nature. If it is the latter pronounced change, then the extrapolating of 1959-1974 crop acreage trends into the future may be a process that has an inherent upward bias. This is because crop acreage trends from the 1950's to 1975 still reflect a rather fast-growing U.S. population's demand for food, even though the growth rate slowed. The upward bias mentioned above could be compensated for, somewhat, by deriving a correction coefficient for crop-acreage extrapolated values based on the assumption that the future rate of National population growth and/or the future birth and death rates will continue to change at their new rates of change. No such correction coefficient was produced for the AWR Study projections.

One decisive test of projections methods, of course, is whether the projections turn out to be right if the projections' stated conditions "come true." Because there are hardly any conditions surrounding the simple extrapolation-projection of crop acreage trends, they have more the character of predictions than projections; and thus invalidity in

their methodology can easily be detected.

In case of projections that are surrounded by such numerous conditions that it is unlikely that all conditions could "come true," it is difficult to make empirical comment on the validity of the method used even after the projections have been found not to match actual conditions at the projection dates. In either case, the validity of projections "without-plan" is somewhat less critical than the validity of projections concerning net effects of USDA program actions.

In this study the projections of program effects departed from the method of extrapolating past trends, except for crop-yield trends. The central factor in program-effects projections was the subjective opinions of the SCS State Agronomist and Range Conservationist (and field specialists whom they regularly consult) concerning the rate at which farmers and ranchers could be persuaded to upgrade their acreage through more intense efforts at land treatment, given a certain degree of additional assistance from USDA. In effect, the scale of the program effects depends on the response of private firms; and that response had to be predicted, albeit rather subjectively.

Superficially, it would seem that the effects of certain other types of USDA program features such as dams require no predictions of the response of private firms to the better farming conditions caused by the dams, but to some extent they do. Often the extent of benefits of a P.L. 566 dam is concluded to be partly dependent upon the land-treatment efforts of neighboring farm firms. (Land treatment tends to slow siltation of impoundments' water-storage space).

The use of a representative-sample interviewing process might have led to more penetrating analyses of institutional forces that affect both farm firms' motivation regarding (A) program participation and (B) their major "without-program" decisions (e.g., choice of crop types and rotations, or the placing of land in or out of production for long periods or permanently) that affect the overall regional cropping pattern. These sample surveys' results could complement or replace the process of asking local field specialists their opinions about what institutions have influenced farm firm managers in making the types of decisions that they make regarding (1) response to public programs, (2) product choice, and (3) retirement of land. Such sample survey procedures would tend to eliminate some of the subjectivity that is associated with USDA field specialists' efforts to account for the institutional and other influences that motivate farm firm managers to convert land from one productive use to another use or to increase or decrease their amounts of producing acreage. The same survey procedures would help to account more exactly for the timing of large changes in a given crop acreages' past trend, thereby aiding the trend extrapolation process by indicating the appropriateness of truncating past acreage data series.

Potential extensions of the analyses

The crop-acreage-trend projection method employed in this study could be appropriately used for similar studies in which the cropping pattern and soils pattern are not sufficiently complex or extensive to warrant more than a simple projections procedure.

Memorandum

The District Conservationists for Counties of Colfax,
Curry, Harding, Mora, Quay, San Miguel, and Union DATE: Dec. 12, 1975

Clif Dickason, ERS

County Crop Acreage Projections

For the AWR New Mexico Type IV Study, projections are being made of individual crops' acreages in each county of the Basin. They are not to be based entirely on soil-climate considerations affecting costs and yields. They are to be based partly on the following considerations:

A. Farmers' actions do not always correspond to what seems, on the basis of climate and soil type, to be their most profitable route. They may have rational reasons for choosing a crop other than the one that their soil, climate, and terrain would indicate to be most profitable; and they may mention those reasons sometimes. Reasons shared by many crop producers who produce the same crop or rotation are of more interest to us than reasons that apply to one or two producers, of course.

B. Crop producers of a locale respond to "producers' environment" changes, such as: government programs' commencing, being "de-emphasized", or ending; projects being constructed or deteriorating; processors and market or storage places moving in or moving away, etc.. When these types of things occur in and near an area, the trend of certain crop acreages in the county is likely to change. What happens to the trend after that change is a better clue to future crop acreages than what happened before it.

Points A and B are parts of the same overall question, and they are intertwined some. In connection with them, I am asking for your observations on Points A and B such as you can collect by consulting your memory for about 20--30 minutes. I will contact you by phone in the future so that you can transmit them to me without writing them, if you prefer. Also, estimates of acres affected and especially dates of occurrence will be useful. You may term the estimates "definite," "rough", or "vague", if you feel that you are aware of any such numerical or time information.

To put this request into other words, I want your ideas on why the acreages of particular crops are trending upward, of downward, based on what you have heard about the reasons of crop producers in your District. Also, when these changes started or stopped, in the last 20 years, and if public projects or programs were somehow a contributing cause.

I need your response by Dec. 30, 1975. I will also be calling county agents and ASCS personnel in each county, on the same subject. Thank you. Yours truly, *Clif Dickason* ERS Member of the AWR Study Staff
Buy U.S. Savings Bonds Regularly on the Payroll Savings Plan

Appendix A

Information From Telephone Interviews of USDA Field Personnel Stationed in the Study Area

Crop acreage information, by counties

Colfax - Mr. C. N. Sundt, SCS
 Mr. L. H. Jump, SCS
 Mr. L. E. Whitaker, SCS

There is serious silting of reservoirs supplying irrigation water. This, plus shallow depth and much evaporation, especially in 1969 drought, explains the decline in hay acreage.

Much irrigated wheat acreage was converted to pasture acreage in about 1967.

The declines noticed in various crop acreages are due mainly to decline of irrigation reservoir capacity.

When harvested crops cease to be grown on irrigated land, that land tends to be used for intermittently irrigated pasture thereafter, when water supplies permit it.

Curry - Mr. R. R. Ramsey, SCS

The recent corn acreage rise was due to a marked price rise for corn.

The amount of land in Soil Bank ("Set-Aside") began a significant drop in 1971. This accounts for much of the wheat acreage increase 1970.

On dryland acreage, farmers have little choice: wheat or sorghum grain. They tend to grow both in rotation and shift more to one or the other in response to perceived long-term price shifts.

Mora - Mr. H. J. Dineen, SCS
Mr. G. I. Storch, SCS
Mr. Levi Garcia, SCS

Local welfare programs tend to explain declining cultivation of cropland. Fractionation of landholdings tends to inhibit cost-reducing technological change. Thus, horse-drawn equipment has fallen into disuse; but not much has been replaced by mechanized farming.

There is a tendency for irrigated crop area to be converted to irrigated pasture that is grazed more heavily in abundant-water years.

No significant water storage exists; merely a maintained, ancient diversion dam.

The Office of Economic Opportunity sponsored and subsidized a program to encourage hay production; but when the program ended, about 1968 and 1969, hay acreage declined markedly following the program's end.

Quay - Mr. H. C. Shanks, SCS
Mr. T. Peabody, County Agent
Mrs. P. Welch, ASCS

When broomcorn acreage declined in the mid 1960s, due to increasing harvest costs, that land began a shift to dryland wheat.

Irrigated cotton acreage is expected to decrease as time goes by, following the past trend.

What stability has occurred in dryland small grain acreages has been mainly due to the USDA price-support programs.

Land in the "Set-Aside" program has just recently begun to come into production starting about 1972 or 1973. "Set-Aside" area was fairly constant until then.

Quay is irrigated mainly with surface water, which is being used to its limit.

Union - Mr. L. L. Schultze, SCS

Of late, irrigated corn is replacing irrigated grain sorghum acreage. This is due to a change in their relative prices, which has made corn more profitable.

Wheat acreage jumped when the price started upward in 1973.

Alfalfa prices (and acreage) jumped in 1970.

Irrigated acreage is ever-increasing due to groundwater sources being newly tapped. This utilizes mainly sprinkler irrigation.

There was a temporary boom in silage production, 1968-1971, due to changing relative prices of silage and other cattle feed crops.

Harding - Mr. Armstrong, SCS

Not much land has been taken out of the Soil Bank or Conservation Reserve because the equipment formerly used on it has rusted or otherwise deteriorated.

Also there may be future river basin studies that must include projections of irrigated crop acreages of a region in which water rights are somewhat "tied" to certain land parcels (to the extent that irrigators experiencing a higher marginal productivity of water on their soils cannot easily purchase water from those of lower MP's). The projections method used here would be appropriate.

