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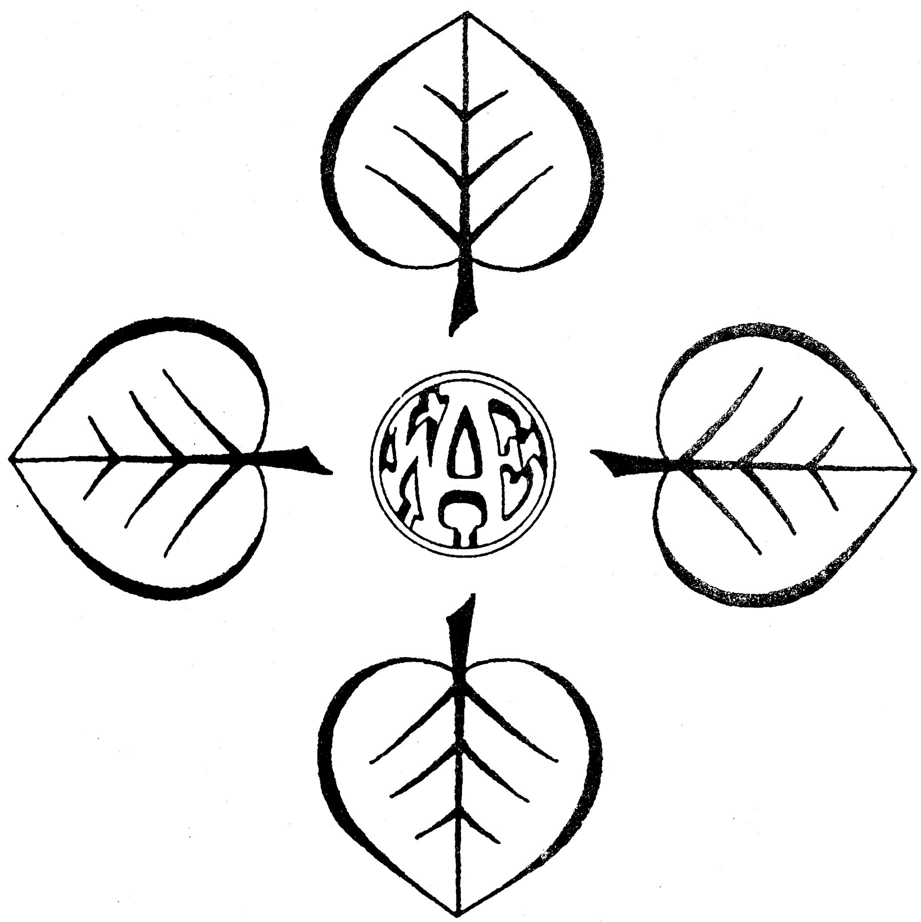

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AN EVALUATION OF SCS STREAMFLOW OUTLOOK BASED ON ADAPTIVE CROP COMBINATIONS

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ABSTRACT

The value of SCS water supply outlook information is examined in the context of adjusting crop combinations and irrigation rates for a 1000-acre Wyoming farm facing variable water supplies. Compared to using average water expectations, SCS outlook yielded added returns ranging from $5.43/ac to $10.20/ac and lower income variability.

With limited precipitation in western agriculture, realizing adequate supplies of irrigation water can become a major constraint and source of uncertainty for crop production. Water supply outlook as provided by the Soil Conservation Service (SCS) can be valuable for reducing such uncertainty. Water supply outlook reports are issued periodically each spring by the SCS to predict streamflow volume over the ensuing six-month peak flow period (April to September). Such information could be beneficial for adjusting production practices, e.g., in years when below average water is expected producers may elect to grow low water using crops and vice versa. The purpose of this paper is to examine the economic value of SCS water supply outlook information in terms of added income and reduced risk--within an experimental firm-level setting where crop enterprise combinations and irrigation rates can be adjusted in response to expected water supplies.

APPROACH

As described below, a linear programming model is developed for a 1000-acre farm unit in the Riverton area of northwest Wyoming. The Riverton area is an important irrigated crop production area in Wyoming, growing a combination of barley, corn, alfalfa and dry beans (Agee). Important components of the LP model will include monthly constraints for expected and actual water supplies, as well as monthly water requirements needed to achieve lower or higher yields for the above-mentioned crops. With the LP model, annual crop acreage is optimized with respect to expected water supplies; and resulting returns are then determined by water supplies actually incurred over the same 20-year period (1969-88).

Actual and Expected Water Supplies

Table 1 shows actual and expected monthly (May-September) water supplies developed for the 1000-acre model farm over a 20-year (1969-88) period. Actual monthly water supplies for the 1000-acre farm were derived by downsizing aggregate water withdrawals for the project area to a micro (1000 acre) farm-level, and using an overall project delivery and field efficiency factor of .3238 to account for the net amount of streamflow that is delivered and used by the farm (Wenberg, p. 92). It is noted from Table 1 that most (≈80%) of the actual five month flow is withdrawn over a three month period, June through August.

Expected summer streamflow for the Wind River watershed is based on March 1 SCS outlook for the same 20-year period (1969-88). Projected summer streamflow for each of these years was distributed among the five months (May-September) in proportion to the average historical distribution of actual streamflow (i.e., May = 15%; June = 35%; July = 30%; August = 14%; and September = 6%). Resulting forecasts of expected monthly water supplies for the 1000-acre farm are shown in Table 1.

Table 2 summarizes the performance of monthly derived forecasts in terms of: (1) annual error between actual versus predicted (20-year average flow); (2) annual error between actual versus predicted (SCS outlook); and (3) correlation between actual and monthly derived SCS forecasts. Water supply forecasts are shown to have reasonable predictive potential for peak mid-summer flows (June-August) which constitute about 80 percent of May-September volume. However, forecasts do not appear to be advantageous for early season (May) or late season (September) flows which comprise an average of only 20% of May-September volume.

Crop Yields, Irrigation Rates and Gross Margins

Low and high crop yields associated with two levels of irrigation were derived with PLANTGRO, a crop yield-water response simulator developed by Hanks (1982). PLANTGRO estimates crop yield response to water by considering the relationship between actual and potential transpiration, such that when a plant is stressed, actual transpiration is less than potential transpiration.

Table 3 shows monthly irrigation requirements for high and low yield levels for each of the irrigated crops. Barley/Alf is a special barley enterprise needed to establish a stand of alfalfa; and the water coefficients for August (1.6 ac.in.) and September (2.8 ac.in.) are for irrigating newly established alfalfa planted in barley stubble and do not affect barley yields per se. Irrigation requirements for high yields were derived in PLANTGRO by applying water in sufficient quantities so as to not stress the crop. High yield levels correspond to those reported by Agee (1982) as being representative of producers using above average management techniques with adequate water supplies. After the high irrigation-yield combinations were identified, the amount of irrigation water was reduced by 40 percent. Low yields, as a result of 40% less water, were estimated to be the following percentage of high yield goals by crop: barley (80.8%); corn (82.5%); alfalfa (83.8%); and beans (87.1%). Cutbacks in irrigation water were made toward the end of the season (as opposed to being evenly distributed among all months) to better represent observed practices of Wyoming producers facing low water supplies. From Table 3, alfalfa and corn are shown to be relatively high users of water relative to barley and dry beans.

Using yield information derived above, gross margins (gross returns over variable costs) are estimated for each of the irrigated crops (Table 4). Gross returns are derived as the product of designated yield levels times corresponding crop prices. Crop prices are developed as a five year average (1983-87) of area prices reported by the Bureau of Reclamation, which are adjusted to a 1987 real dollar basis using the implicit GNP deflator. Variable costs are obtained from Agee and are likewise considered in 1987 dollars.

Linear Programming Models

Two distinct but similar LP models are used in the analysis. The first is an optimizing model used to derive a crop acreage mix based on expected water supplies; and the second is a calculating model for deriving income that is subsequently realized from the crop mix planted on the basis of expected water supplies, given monthly water actually incurred.

The optimizing tableau shown in Table 5 consists of low and high yield activities for each crop (e.g., BY:LO and BY:HI for barley). Water supplies are based on expected monthly flows for a particular year (e.g., SCS forecasts featured in Table 1), which become components of the RHS in Table 5. Irrigation requirements (introduced in Table 3) are included as coefficients in the monthly water constraints. An upper limit of 500 acres is imposed on barley, corn and dry beans and a lower limit of 200 acres is required for barley. A fixed rotation is established for barley/alfalfa (50 acres) and alfalfa (200 acres).

Optimum crop combinations and irrigation rates are developed with the optimizing model for each year over the 20 year period (1969-88) given four alternative planning situations: (1) a non-adaptive fixed acreage mix (200 ac. barley; 500 ac. corn; 50 ac. barley-alfalfa; 200 ac. alfalfa; and 50 ac. dry beans), which represents the optimal plan based on a previous "long-term average water" supply expectation (1942-1968); (2) an adaptive strategy where the crop mix is revised annually with reference to SCS forecasts (from Table 1); (3) a more conservative adaptive strategy, whereby the crop mix is revised each year with reference to 80% (vs. 100%) of SCS forecasts given in Table 1; and (4) an artificial adaptive benchmark scenario, allowing crop acreages to be adjusted each year on basis of "perfect" information of variable water supplies (using actual water supplies, Table 1, as the source of expectations).

Table 6 shows the calculating tableau used to derive actual income for the 1000 acre farm with reference to the crop mix developed with the optimizing model. Actual (vs. expected) water supplies are used in the RHS of monthly water constraints. The crop acreage mix in the calculating tableau is predetermined by incorporating the crop combinations derived from the initial optimizing model. For those years when actual water supplies are short of expectations, abandon acreage activities (NO) are available in the calculating model with negative objective function values for barley (-$89), corn ($-110), and dry beans (-$83)--to reflect the loss of selected unrecovered costs (fertilizer, chemicals, seed, fuel and repairs) as derived from Agee (1982). In this setting, an overly optimistic water supply expectation can result in large losses of unrecovered costs if expected water supplies failed to materialize. Conversely, overly pessimistic expectations can result in foregone opportunities if more water is received than expected. Another option to abandoning acreage in the model is irrigating at lower (LO) versus higher (HI) rates to the extent adequate water is available.

RESULTS

Crop acreages (based on expected water supplies), irrigation rates and resulting returns (based on actual water supplies) are shown for the 20 year period in Table 7 (average water outlook); Table 8 (100% SCS outlook); Table 9 (80% SCS outlook); and Table 10 (perfect knowledge of actual supplies). In all cases, some general acreage patterns emerge given either years of low water or years of abundant water. In years of low water the model favors barley and dry beans. Corn (a high water user) is planted in years when abundant water is expected. Also, when sufficient water was expected but failed to materialize, the model abandoned acreage to various degrees (Barley:

NO, Corn: NO, and/or Dry Beans: NO). Abandoned acreage was most evident with the average water outlook case (Table 7), and nonexistent in the perfect knowledge case (Table 10). In addition, using conservative (80%) SCS outlook (Table 9) tended to minimize the need for abandoning crops compared to 100% SCS expectations (Table 8).

Table 11 summarizes annual income from Tables 7-10, as well as associated 20-year average income, and related variability and risk measures given alternative cases of expected water supplies. Using the fixed crop mix case (based on average water outlook) as a reference point, the value of 100% SCS information is \$5341 (\$97,519 - \$92,178), while the value of using more conservative (80%) SCS outlook in even higher at \$10,201 (\$102,379 - \$92,178). The \$10,201 value is nearly 60% of the possible upper limit (i.e., value of perfect information) of \$17,259 (\$109,437 - \$92,178). Finally, adapting the crop acreage mix to SCS water supply outlook not only generated higher income, but less income variability (sd = \$32,803 for 100% SCS; and \$26,254 for 80% SCS) than the average water outlook case (sd = \$40,911). In all three cases, annual income fell below the designated (\$100,000) income target in nine of 20 years. However, the total amount that annual income missed the \$100,000 target over the 20-year period was substantially less for the 100% SCS case (\$293,144) and 80% SCS case (\$186,731) than the average water scenario (\$403,199). Finally, risk-preference properties of the income distributions associated with the four settings in Table 11 were examined with first and second degree stochsatic dominance (FSD and SSD). As expected, the perfect information setting dominated the other three by FSD. In addition, both of the SCS outlook strategies dominated the average water outlook case with SSD, confirming their preference by all classes of risk-averse decision-makers.

CONCLUSION

Usage of SCS water supply outlook appears to have potential for yielding income and risk benefits in terms of adjusting production practices in response to expected water supplies. To the extent that optimistic errors of expecting more water than realized can be more severe (in terms of unrecovered production costs from abandoned acreage) than errors of underestimation--additional payoff from conservative usage of outlook information seems reasonable. It is important to note that extra income from using SCS outlook was achieved in conjunction with both reduced income variability as well as lower risk of falling below a designated income target. This contrasts with many other management strategies in which reduced income variability is often associated with lower (vs. higher) income over time. Thus the value of using SCS outlook for adaptive decisions, may be especially pronounced for producers sensitive to both income and risk.

Table 1. Actual and Expected (SCS Outlook) Water Supplies for a 1000 acre Farm Unit, 1969-88.

Year	May		June		July		August		Sept.	
	-----	-----	-----	-acre inches/1,000 acre unit-	-----	-----	-----	-----	-----	-----
	Act.	Exp.	Act.	Exp.	Act.	Exp.	Act.	Exp.	Act.	Exp.
1969	5579	3497	8431	8489	6588	7141	3176	3515	959	1585
1970	3126	2895	8157	7027	4944	5911	2416	2910	1096	1312
1971	3138	4138	14159	10045	7596	8449	3910	4159	1743	1875
1972	3001	4135	12416	10037	6301	8442	3275	4156	1195	1874
1973	3151	2984	6949	7244	5791	6093	2889	2999	386	1352
1974	3275	3338	10747	8102	6376	6815	2503	3355	1245	1513
1975	1233	3120	6301	7572	11930	6369	2677	3135	922	1414
1976	3960	3272	6824	7942	6862	6681	2976	3289	1308	1483
1977	1332	2120	4533	5146	3200	4328	2341	2131	1420	961
1978	2765	3520	9415	8545	7758	7187	3026	3538	996	1595
1979	3661	3297	5828	8004	4159	6732	3063	3314	1171	1494
1980	4633	3200	9340	7767	7360	6534	1930	3216	511	1450
1981	3362	2657	8966	6449	4608	5425	2279	2670	984	1204
1982	1905	3363	7522	8163	9938	6867	4433	3380	2217	1524
1983	2105	3008	11158	7302	9228	6142	5043	3023	1756	1363
1984	3686	3191	6613	7745	7621	6515	3524	3207	1743	1446
1985	3860	2801	5454	6799	4222	5719	1245	2815	411	1269
1986	3250	4575	14346	11104	7721	9340	3723	4598	884	2073
1987	5330	3394	5180	8239	5230	6931	2167	3412	1196	1538
1988	3300	2745	5218	6664	2354	5606	1332	2759	411	1244
Avg.	3283	3263	8378	7919	6489	6661	2896	3279	1128	1478
sd.	1126	556	2936	1349	2318	1134	949	558	492	252

Table 2. Statistical Comparison of Observed and Expected Monthly Streamflow (1969-1988).

Item	May	June	July	August	Sept.
	-----	-----	acre inches/1,000 acre unit	-----	-----
$Error_1$, (actual flow - 20-year Avg.)[a]	1126	2936	2318	949	492
$Error_2$, (actual flow - SCS Outlook)[b]	1141	2162	2126	933	628
Correlation (actual and SCS Outlook)	.2202	.7557	.4129	.4690	.1678

a/ $E_1 = \sum [((A_i - \bar{X})^2)/19]^{1/2}$

b/ $E_2 = \sum [((A_i - SCS)^2)/19]^{1/2}$

Table 3. Monthly Irrigation Requirements and Corresponding Yields for Barley, Corn, Barley-Alfalfa, Alfalfa, and Dry Beans.

Month	Barley		Corn		Barley/Alf		Alfalfa		Dry Beans	
	-40% water	Max. water	-40% water	Max. water	-40% water	Max. water	-40% water	Max. water	-40% water	Max. water
					acre-inches					
May	2.8	2.8	1.2	1.2	2.8	2.8	4.4	4.4	0.0	0.0
June	4.0	4.0	5.3	5.3	4.0	4.0	7.6	7.6	1.0	1.0
July	2.6	8.8	7.2	9.5	2.6	8.8	3.6	8.0	7.6	7.6
Aug	0.0	0.0	0.0	5.2	1.6	1.6	0.0	6.0	0.4	4.4
Sept	0.0	0.0	0.0	1.6	2.8	2.8	0.0	0.0	0.0	2.0
Total	9.4	15.6	13.7	22.8	13.8	20.0	15.6	26.0	9.0	15.0
					yield/acre					
	72.7 (bu/ac)	90.0 (bu/ac)	90.8 (bu/ac)	110.0 (bu/ac)	72.7 (bu/ac)	90.0 (bu/ac)	3.77 (ton/ac)	4.2 (ton/ac)	17.4 (cwt/ac)	20.0 (cwt/ac)

Table 4. Derivation of Gross Margins for Selected Crops, 1987.

	Barley	Corn	Barley/Alf	Alfalfa	Dry Beans
		Gross Margins:	High Yields		
Yield	90 bu/ac	110 bu/ac	90 bu/ac	4.5 ton/ac	20 cwt/ac
X Price ($)	3.04/bu	2.97/bu	3.04/bu	65.67/ton	16.76/cwt
= Gross Return ($/ac)	274	327	274	296	335
- Var. Costs ($/ac)	168	182	218	112	209
= Gross Margin ($/ac)	106	145	56	184	126
		Gross Margins:	Low Yields		
Yield	72.7 bu/ac	90.8 bu/ac	72.7 bu/ac	3.77 ton/ac	17.4 cwt/ac
X Price ($)	3.04/bu	2.97/bu	3.04/bu	65.67/ton	16.76/cwt
= Gross Return ($/ac)	221	270	221	248	292
- Var. Costs ($/ac)	165	179	215	109	206
= Gross Margin ($/ac)	56	91	6	139	86

Table 5. LP Tableau for Optimizing Crop Combinations, Given Expected Water Supplies.

Rows	Barley (1) BY:LO	Barley (2) BY:HI	Corn (3) CO:LO	Corn (4) CO:HI	Barley/Alf (5) BA:LO	Barley/Alf (6) BA:HI	Alfalfa (7) AL:LO	Alfalfa (8) AL:HI	Dry Beans (9) BE:LO	Dry Beans (10) BE:HI	RHS
	ac	ac	ac	ac	ac	ac	ac	ac	ac	ac	
Max. Return	56	106	91	145	6	56	139	184	86	126	
S.T. water (ac-in)											
1) May-Water	2.8	2.8	1.2	1.2	2.8	2.8	4.4	4.4			<= *
2) Jun-Water	4.0	4.0	5.3	5.3	4.0	4.0	7.6	7.6	1.0	1.0	<= *
3) Jul-Water	2.6	8.8	7.2	9.5	2.6	8.8	3.6	8.0	7.6	7.6	<= *
4) Aug-Water				5.2	1.6	1.6		6.0	0.4	4.4	<= *
5) Sep-Water				1.6	2.8	2.8				2.0	<= *
Acreage (ac)											
6) Min-Barley	1.0	1.0									>= 200
7) Max-Barley	1.0	1.0									<= 500
8) Max-Corn			1.0	1.0							<= 500
9) Fix-Barley/Alf					1.0	1.0					= 50
10) Fix-Alfalfa							1.0	1.0			= 200
11) Max-Beans									1.0	1.0	<= 500
12) Land	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	<=1000

*Expected monthly streamflow

Table 6. LP Tableau for Computing Returns from Planted Crop Combinations, Given Actual Water Supplies.

Rows	Barley (1) BY:NO	Barley (2) BY:LO	Barley (3) BY:HI	Corn (4) CO:NO	Corn (5) CO:LO	Corn (6) CO:HI	Barley/Alf (7) BA:LO	Barley/Alf (8) BA:HI	Alfalfa (9) AL:LO	Alfalfa (10) AL:HI	Dry Beans (11) BE:NO	Dry Beans (12) BE:LO	Dry Beans (13) BE:HI	RHS
	ac	ac	ac	ac	ac	ac	ac	ac	ac	ac	ac	ac	ac	
Max. Return($)	-89	56	106	-110	91	145	6	56	139	184	-83	86	126	
S.T.														
Water (ac-in)														
1) May-Water		2.8	2.8		1.2	1.2	2.8	2.8	4.4	4.4				<= *
2) Jun-Water		4.0	4.0		5.3	5.3	4.0	4.0	7.6	7.6		1.1	1.0	<= *
3) Jul-Water		2.6	8.8		7.2	9.5	2.6	8.8	3.6	8.0		7.6	7.6	<= *
4) Aug-Water						5.2	1.6	1.6		6.0		0.4	4.4	<= *
5) Sep-Water						1.6	2.8	2.8					2.0	<= *
Fix Acreage (ac)														
6) Barley	1.0	1.0	1.0											= **
7) Corn				1.0	1.0	1.0								= **
8) Barley/Alf							1.0	1.0						= **
9) Alfalfa									1.0	1.0				= **
10) Dry Beans											1.0	1.0	1.0	= **

* Actual Monthly Streamflow

** Forced Crop Acreage Based on Expected Water Supplies

Table 7. Annual Crop Acreages (Based on Average Water Expectations); Irrigation Rates and Resulting Returns (Based on Actual Water Supplies), 1969-1988.

Year	Barley NO	Barley LO	Barley HI	Corn NO	Corn LO	Corn HI	Barley/Alf LO	Barley/Alf HI	Alfalfa LO	Alfalfa HI	Dry Beans NO	Dry Beans LO	Dry Beans HI	Realized Net Inc.
							ac.							$
1969	--	200	--	--	51	449	50	--	154	46	--	--	50	117,457
1970	--	200	--	4	496	--	50	--	200	--	50	--	--	79,924
1971	--	143	57	--	--	500	50	--	32	168	--	--	50	128,541
1972	--	200	--	--	87	413	50	--	200	--	--	--	50	113,427
1973	--	200	--	--	409	91	50	--	148	52	--	--	50	98,391
1974	--	192	8	--	77	423	50	--	200	--	--	--	50	114,393
1975	200	--	--	322	--	177	--	50	--	200	--	--	50	18,362
1976	--	151	49	--	--	500	50	--	187	13	--	--	50	121,140
1977	175	25	--	300	--	200	50	--	200	--	--	--	50	16,400
1978	--	23	177	--	--	500	50	--	165	35	--	22	28	127,706
1979	--	200	--	112	388	--	50	--	200	--	50	--	--	58,009
1980	--	36	164	--	269	231	50	--	96	104	--	50	--	114,521
1981	--	200	--	50	450	--	50	--	200	--	50	--	--	70,544
1982	98	--	102	--	--	500	--	50	--	200	--	--	50	120,449
1983	27	--	173	--	--	500	--	50	--	200	--	--	50	134,378
1984	--	93	107	--	--	500	50	--	96	104	--	--	50	128,131
1985	--	200	--	104	396	--	50	--	200	--	50	--	--	59,768
1986	--	133	67	--	35	465	50	--	--	200	--	50	--	126,609
1987	--	200	--	5	495	--	50	--	200	--	11	--	39	87,783
1988	--	200	--	363	137	--	50	--	200	--	50	--	--	7,620

Table 8. Annual Crop Acreages (Based on 100% SCS Water Supply Outlook); Irrigation Rates and Resulting Returns (Based on Actual Water Supplies), 1969-1988.

Year	Barley NO	Barley LO	Barley HI	Corn NO	Corn LO	Corn HI	Barley/Alf LO	Barley/Alf HI	Alfalfa LO	Alfalfa HI	Dry Beans NO	Dry Beans LO	Dry Beans HI	Realized Net Inc.
							ac.							$
1969	--	200	--	--	51	449	50	--	154	46	--	--	50	117,457
1970	--	200	--	--	50	--	50	--	200	--	77	--	423	90,735
1971	--	143	57	--	--	500	50	--	32	168	--	--	50	128,451
1972	--	200	--	--	87	413	50	--	200	--	--	--	50	113,427
1973	--	200	--	--	135	--	50	--	133	67	--	292	123	95,212
1974	--	189	11	--	74	411	50	--	200	--	--	--	64	114,418
1975	200	--	--	92	--	177	--	50	106	94	--	32	249	66,840
1976	--	134	66	--	--	421	50	--	177	23	--	--	129	120,950
1977	281	111	--	--	--	--	50	--	200	--	51	--	271	39,129
1978	--	23	177	--	--	500	50	--	165	35	--	22	28	127,706
1979	--	200	--	57	387	--	50	--	200	--	105	--	--	59,494
1980	--	39	161	--	118	231	50	--	107	93	--	201	--	113,183
1981	--	232	--	--	18	--	50	--	200	--	101	--	398	84,423
1982	98	--	101	--	--	500	--	50	--	200	--	--	50	120,449
1983	--	--	200	--	--	159	--	50	--	200	--	--	391	133,123
1984	--	60	140	--	--	340	50	--	75	125	--	--	210	127,746
1985	--	200	--	--	50	--	50	--	200	--	172	192	135	63,184
1986	--	133	67	--	35	465	50	--	--	200	--	50	--	126,609
1987	--	200	--	5	495	--	50	--	200	--	10	--	39	87,783
1988	--	205	--	--	44	--	50	--	200	--	414	--	85	20,059

Table 9. Annual Crop Acreages (Based on 80% SCS Water Supply Outlook); Irrigation Rates and Resulting Returns (Based on Actual Water Supplies), 1969-1988.

Year	Barley NO	Barley LO	Barley HI	Corn NO	Corn LO	Corn HI	Barley/Alf LO	Barley/Alf HI	Alfalfa LO	Alfalfa HI	Dry Beans NO	Dry Beans LO	Dry Beans HI	Realized Net Inc.
							ac.							$
1969	--	185	15	--	--	50	50	--	7	193	--	131	369	113,771
1970	--	364	--	--	--	--	50	--	152	48	--	--	386	99,308
1971	--	135	65	--	--	459	50	--	27	173	--	--	91	128,442
1972	--	200	--	--	51	405	50	--	200	--	--	--	94	114,554
1973	--	330	5	--	--	--	50	--	--	200	--	292	123	96,760
1974	--	92	136	--	--	22	50	--	182	18	--	--	500	114,684
1975	214	--	76	--	--	--	--	50	59	141	--	68	391	81,020
1976	--	77	166	--	--	7	50	--	91	109	--	--	500	118,978
1977	129	111	--	--	--	--	50	--	183	17	--	--	261	56,478
1978	--	--	200	--	--	50	20	30	45	155	--	112	388	123,593
1979	--	238	--	--	12	--	50	--	200	--	157	--	342	72,624
1980	--	29	236	--	--	--	50	--	48	152	--	300	185	110,739
1981	--	395	--	--	--	--	50	--	139	61	--	--	324	93,791
1982	--	--	222	--	--	28	--	50	--	200	--	--	500	130,194
1983	--	--	327	--	--	--	--	50	--	200	--	--	423	127,563
1984	--	22	246	--	--	--	50	--	--	200	--	--	482	125,189
1985	--	395	--	--	--	--	50	--	200	--	46	173	135	78,320
1986	--	133	67	--	35	465	50	--	--	200	--	50	--	126,609
1987	--	214	--	--	36	--	50	--	200	--	31	--	469	99,881
1988	--	413	--	--	--	--	50	--	200	--	280	--	56	35,087

Table 10. Annual Crop Acreages (Based on Perfect Information); Irrigation Rates and Resulting Returns (Based on Actual Water Supplies), 1969-1988.

Year	Barley NO	Barley LO	Barley HI	Corn NO	Corn LO	Corn HI	Barley/Alf LO	Barley/Alf HI	Alfalfa LO	Alfalfa HI	Dry Beans NO	Dry Beans LO	Dry Beans HI	Realized Net Inc.
							ac.							$
1969	--	240	--	--	--	500	50	--	134	66	--	--	9	118,236
1970	--	321	--	--	--	--	50	--	200	--	--	--	428	100,116
1971	--	143	57	--	--	500	50	--	32	168	--	--	50	128,541
1972	--	200	--	--	--	139	50	--	90	110	--	--	410	116,220
1973	--	403	97	--	97	153	50	--	--	200	--	--	--	101,051
1974	--	82	125	--	--	42	50	--	200	--	--	--	500	115,209
1975	--	--	--	--	--	177	--	50	121	79	--	251	249	112,882
1976	--	151	49	--	--	500	50	--	188	12	--	--	50	121,140
1977	--	111	--	--	--	--	50	--	200	--	--	--	271	68,497
1978	--	28	194	--	--	500	50	--	163	37	--	5	23	127,947
1979	--	478	--	--	--	--	50	--	200	--	--	--	271	89,126
1980	--	113	387	--	19	231	50	--	93	107	--	--	--	115,596
1981	--	388	--	--	--	--	50	--	200	--	--	--	361	95,412
1982	--	--	200	--	--	270	--	50	--	200	--	--	279	135,247
1983	--	--	200	--	--	437	--	50	--	200	--	--	112	138,414
1984	--	93	107	--	--	500	50	--	96	104	--	--	50	128,131
1985	--	500	--	--	64	169	50	--	200	--	--	--	--	86,510
1986	--	151	134	--	--	465	50	--	--	200	--	--	--	127,200
1987	--	266	9	--	--	--	50	--	200	--	--	--	474	103,773
1988	--	500	--	--	--	--	50	--	200	--	--	--	26	59,482

Table 11. Annual and 20-year Average Income, and Measures of Variability and Risk, Given Alternative Water Supply Expectations.

Year	Average Water Outlook	100% SCS Outlook	80% SCS Outlook	Perfect Information Outlook
	---Net Income per 1000 ac. unit ($)---			
1969	117,457	117,457	113,771	118,236
1970	79,924	90,735	99,308	100,116
1971	128,541	128,451	128,442	128,541
1972	113,427	113,427	114,554	116,220
1973	98,391	95,212	96,760	101,051
1974	114,393	114,418	114,684	115,209
1975	18,362	66,840	81,020	112,882
1976	121,140	120,950	118,978	121,140
1977	16,400	39,129	56,478	68,497
1978	127,706	127,706	123,593	127,947
1979	58,009	59,494	72,624	89,126
1980	114,521	113,183	110,739	115,596
1981	70,544	84,423	93,791	95,412
1982	120,449	120,449	130,194	135,247
1983	134,378	133,123	127,563	138,414
1984	128,131	127,746	125,189	128,131
1985	59,768	63,184	78,320	86,510
1986	126,609	126,609	126,609	127,200
1987	87,783	87,783	99,881	103,773
1988	7,620	20,059	35,087	59,482
20-yr Avg. ($)	92,178	97,519	102,379	109,437
Std. Dev. ($)	40,911	32,803	26,254	21,420
Coef. of Var.	.444	.336	.256	.196
Freq. (yrs. in 20) Annual Inc. is Below $100,000 Target:	9/20	9/20	9/20	5/20
Total Amt. (1969-88) Annual Inc. is Below $100,000 Target ($):	403,199	293,144	186,731	100,973

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