To: Bob Campbell, SDCWA

From: David Sunding

Subject: Observations on Land Allocation and Water Use in Imperial Irrigation District Relevant to the Design of a Fallowing Program with Minimal Third-Party Impacts

Date: May 21, 2002

Overview:

As requested, I have conducted a preliminary investigation of the economic impacts of a fallowing program that would transfer 300,000 acre-feet of water annually from Imperial Irrigation District ("IID") to the San Diego County Water Authority ("San Diego") and the Coachella Valley Water District ("CVWD"). I have also explored the related question of how to design the transfer program to minimize direct and indirect (or "third-party") impacts. I am convinced that it is possible to design the water transfer program in a way that would have minimal impacts on the Imperial County economy, almost certainly lower than the amount of money that San Diego has proposed to pay IID.

In reaching these conclusions, I have reviewed various economic analyses of the transfer program, including those prepared by CH2MHill and the Bureau of Reclamation. I have reviewed public information on cropping patterns within IID, market prices for these crops, and costs of production; I have also conducted a series of telephone interviews with experts on these subjects. In preparing this memo, I have also reviewed the testimony of Dr. Rodney Smith, IID's economic consultant, on the economic impacts of a fallowing program on the Imperial County economy. Dr. Smith's testimony overstates the impacts of the fallowing program for a number of reasons, the most basic of which is his confusing of the *average* value of water used in IID with its *marginal* value. I return to this point below.

My own conclusion about the transfer program is more optimistic than Dr. Smith's: the proposed transfer between IID and San Diego can be implemented by fallowing in a way that would cause very modest third-party impacts in Imperial County. This assessment of third-party impacts is consistent with the performance of other water transfer programs based on interruptible or rotational fallowing (including the MWD-Palo Verde transfer), and is consistent with past, natural fluctuations in the intensity of agricultural production in Imperial County that are unrelated to water transfers.

Data and Methods:

I have constructed a data set covering 18 major crops grown in IID. These include field, seed and vegetable crops and reflect the overall range of crops grown in the District. Acreage figures are for 2000, yield and price figures are "typical" as determined by UC

Cooperative Extension personnel. Taken together, this sample of 18 crops accounts for over $600 million in annual sales and nearly 500,000 acres of irrigated land within IID. Table 1 summarizes the crops comprising the sample – they are listed according to total revenue.

I also gathered data on water use per acre, which is generally available from published UC Extension reports. For some crops, I supplemented published information with telephone interviews with UC Extension and County Agricultural Commissioner's office staff.

Crop revenue is one good measure of the total contribution of agriculture to the regional economy. Sales includes both farmers' profit (which is their income) as well as the costs of production (which is income to the segment of the community earning their income by selling inputs – including labor – to agriculture). It is worth asking whether water applied to some crops generates more economic benefit to Imperial County than applying water to other crops. If so, then these less-productive uses of water should be targeted by a fallowing program.

Table 2 ranks the crops in the sample according to the amount of revenue generated per acre-foot of water applied. As is typical of agriculture in the western United States, there is a large variation in terms of value-added per acre-foot of water applied. At the low end, three field crops – sudangrass hay, alfalfa hay and wheat – generate less that $200 in sales per acre-foot of water applied. Together, these three crops account for 67% of the water used by the crops in the sample, but generate only 23% of total farm revenues.

At the high end, a small number of vegetable crops – broccoli, onions, watermelon, cauliflower, carrots and lettuce – use just 10% of the water, but produce 40% of farm sales. Clearly, a large fraction of the water used in IID produces only a small share of total value. If the fallowing program were to target the least productive water, which is, I believe, an attainable goal, then 300,000 acre-feet of water could be freed up with a reduction in farm sales of just over $26 million annually.

Because a farmer's cost of production is income to those businesses and individuals supplying farm inputs, it is of interest to measure how a fallowing program might impact costs. Table 3 ranks crops according to farmers' investment per acre-foot of water used. Interestingly, this ranking is nearly identical to the ranking based on revenues per acre-foot. Again, sudangrass hay is at the bottom, followed by alfalfa hay and wheat. Together, these crops use 67% of all the water in the sample, but generate only 30% of income to input suppliers.

There is another reason to consider cost of production. Some have argued that a crop like alfalfa or sudangrass hay is grown not just for its own sake, but also because it improves the productivity of other crops. This is a common argument, and there is a kernel of truth to it. In fact, many of the lowest-value crops in the sample actually lose money in a typical year, suggesting that farmers receive benefits from them that are not reflected in sales figures. However, the returns from producing a crop should be in proportion to their cost of production – that is, in an economic equilibrium, there is an expected rate of return over the cost of production that is equal for all crops. But the ranking of crops based on cost of production per unit of water use is almost exactly the same as the ranking based on revenues. Thus, sudangrass hay, alfalfa hay and wheat are still the least productive crops in the sample, even considering their potential benefit to other crops grown in the rotation.

Figures 1 and 2 display some of the information contained in Tables 2 and 3. Figure 2 plots the cumulative revenue generated with water applied in IID against the 45-degree line. The purpose of showing these two lines together is to illustrate the size of the error from assuming, as does Dr. Smith, that all water generates the same amount of economic benefit per acre-foot. If that were the case, then cumulative revenues should just be equal to the 45 degree line – x% of water used should generate x% of sales. What this analysis shows is the large disparity between the average and the marginal value of water in IID. The goal of the fallowing program should be to target the marginal water, or the water producing the least value to the Imperial County region.

I should also note that adding crops to this analysis only strengthens its conclusions. A large number of crops are grown in IID, literally dozens. The crops not included in my analysis (e.g., dates, lemons, honey, etc.) tend to be higher value than many of the crops I have considered. Adding more crops to the calculation of water use vs. revenue, for example, will only reduce the proportional contribution of field crops. In this way, the distinction between the average and marginal value of water in IID is even greater than shown here.

Another valid measure of community impacts of fallowing is the number of lost jobs. To investigate this question, I examined data on Imperial County employment and the number of acres n production in IID from 1984 to 2000. Figure 3 plots the progression in acreage and employment during this period. While both trend upward, there is no apparent relationship between acres and employment, and a more formal analysis shows that there is no statistically significant relationship between them.

Perhaps more illuminating is Figure 4, which shows the percent change in acreage and employment from 1984 to 2000. Again, there is no apparent or statistical relationship between these series.

The explanation for this finding lies in the low-intensity nature of field crop production and in the nature of the local labor market. The most marginal crops are those that have the lowest costs of production – a fact that is verified by comparing the rankings of crops based on sales and costs per acre-foot of water applied. The most marginal crops use the least amount of labor, and if they are the ones targeted for fallowing, then there should be only a small number of jobs lost as a result. This fact is confirmed by the experience of the MWD-Palo Verde fallowing program, where fewer than 30 jobs were lost. Further, if a farmworker loses his job as a result of fallowing, it is still possible for him to obtain employment elsewhere in the local economy – although perhaps at a lower wage.

Implications for the Fallowing Program:

While preliminary, these results suggest that a fallowing program can be designed in a way that there would be only minimal impacts on the local economy. In fact, the amount of money San Diego has proposed to pay to IID seems more than adequate to cover the direct and third-party impacts of fallowing. The key to designing a successful program is to target the least productive water for transfer to San Diego and CVWD.

How can this be accomplished? I believe that the answer lies in Tables 2 and 3. In particular, because the rankings of crops based on sales and costs are so close, the ranking of crops in terms of profit per acre-foot of water applied should be very similar. This result is important because profit is the measure of value used by farmers themselves, who are, after all, business owners. If the fallowing program is market-based, that is, if it is designed in such a way that farmers bid for the right to sell water, then they will curtail growing the crops generating the least amount of profit per acre-foot of water applied. These are precisely the crops that contribute the least to the local economy. In this way, a market-based fallowing program is consistent with minimizing third-party impacts.

For an auction concept to meet San Diego and CVWD's needs, it would have to be designed in such a way as to ensure that IID would, in fact, transfer 300,000 acre-feet. There are several ways in which this could be accomplished. One possibility is to auction long-term contracts in which a farmer would bid for the right to transfer x% of his water in exchange for $y per acre-foot each time the option is exercised. The frequency which San Diego and CVWD could make a call on the water (say, one year out of five) could be determined explicitly and up front.

An auction of this type would also need to be designed in such a way that growers are not able to "game" the system. This problem frequently arises with auctions and can be dealt with by careful design. For example, a simultaneous second-price auction provides powerful incentives for truthful bidding. Auctions of this type are common in markets for bandwidth and electricity generation, and have a proven track record even in situations involving billions of dollars and highly sophisticated bidders. Clearly more work needs to be done with respect to auction design, but I believe that there is every reason to expect that an auction can be applied successfully in this case.

It may also be desirable to augment an auction with a point system that gave preference to growers operating on the periphery of the District or in certain areas where farming has minimal third-party benefits. A grower's decision to fallow can impact his neighbors if, for example, it increases conveyance costs within the District. These factors can be taken into account when deciding which bids to accept.

There are other, even more innovative ways that markets could be harnessed to minimize third-party impacts from the proposed water transfer between IID, San Diego and CVWD. Another possibility would be for IID to agree to reduce its aggregate deliveries by 300,000 acre-feet annually, and this water would be transferred to San Diego. The remaining water would then be allocated to District members on a per-acre basis, which they could then trade freely within the District boundaries. This solution would provide assurance to San Diego and CVWD that they would receive their agreed-upon amount of water, and would also encourage the more efficient use of water within IID.

Creating a water market within IID would, in a sense, combine the on-farm conservation and fallowing approaches to the transfer program, with the distinction that farmers would decide *for themselves* how best to conserve water. Given the opportunity to sell to other IID farmers, some may indeed choose to fallow. Others may decide to improve on-farm water use efficiency and sell some of their entitlement.

A main advantage of this approach is that it would, in all probability, remove third-party impacts as a serious issue. In fact, I would argue that crop output in IID would probably increase as a result of the water market, and that the transfer program would produce third-party *benefits*. This solution would also eliminate the need for monitoring of fallowing, and would avoid the question of how much water was actually conserved by fallowing (i.e., would the ground have been fallowed anyway, as some fraction of IID is in any given year).

Of course, return flows to the Salton Sea would have to be monitored under this approach, which they will have to be in any case. Note, however, that creating a local water market gives resource managers an additional option – if return flows are insufficient, perhaps they could enter the IID water market and purchase the required water from willing sellers for release into the Salton Sea. This is essentially the approach taken by state and federal agencies in their creation and operation of the CVPIA Restoration Fund and the Environmental Water Account underway in the San Joaquin Valley.

Clearly, more work remains to be done to design a fallowing program that works for San Diego, CVWD, IID and residents of Imperial County. But I am quite optimistic that such a program exists, and am sure that the best transfer program relies on market concepts. The marginal cost analysis described in this memo shows that if farmers themselves identify when, where and how much to fallow, that they will curtail the activities with the smallest benefit to the regional economy. Like any market, such a transfer program would need to be carefully monitored to ensure that it is not abused, and that it is meeting the goals of all participants. But there is ample evidence that a market-based fallowing program can work.

TABLE 1

Major Crops Produced in IID

CROP	ACRES	YIELD	UNITS	PRICE/UNIT	REVENUE/ACRE	WATER USE/ACRE	REVENUE/AF	TOTAL REVENUE
ALFALFA HAY	172,771	8.04	tons	$85.45	$687	6.5	$106	$118,693,677
CARROTS	16,995	834	50 lb. sacks	$5.45	$4,544	3.75	$1,212	$77,225,280
SUGAR BEETS	33,386	40.7	tons	$43.59	$1,774	5	$355	$59,226,764
BERMUDAGRASS H	55,179	10	tons	$90.00	$900	2.5	$360	$49,661,100
LEAF LETTUCE	10,498	833	25 lb. carton*	$5.52	$4,599	3	$1,533	$48,280,302
HEAD LETTUCE	9,072	604	carton	$8.31	$5,021	3	$1,674	$45,550,512
BROCOLLI	13,603	428	26 lb. carton	$6.13	$2,625	3.5	$750	$35,707,875
CANTALOUPES	14,664	380	38 lb. carton	$6.09	$2,315	3.75	$617	$33,947,160
SUDANGRASS HAY	65,786	4.87	tons	$81.72	$398	5	$80	$26,182,828
ONIONS	6,042	825	50 lb. sacks	$5.25	$4,333	4.5	$963	$26,179,986
ASPARAGUS	5,006	141	30 lb. cart. equiv.	$28.30	$3,991	8	$499	$19,978,946
CAULIFLOWER	4,353	559	23 lb. carton	$7.85	$4,386	4	$1,097	$19,092,258
WHEAT	44,303	3.06	tons	$117.97	$361	2.5	$144	$15,993,383
SWEET CORN	6,790	289	48 ear-cartons	$7.85	$2,270	4	$568	$15,413,300
ALFALFA SEED	24,362	411	lbs	$1.26	$517	2	$1,034	$12,595,154
COTTON	10,028	2.88	500 lb. bales	$332.99	$959	4.5	$213	$9,616,852
WATERMELONS	2,315	20.7	tons	$149.00	$3,084	3	$1,028	$7,140,155
POTATOES	3,159	246	hundredweight	$8.64	$2,125	4	$531	$6,714,265
								$627,199,796

TABLE 2

Ranking of Crops by Revenue per Acre Foot

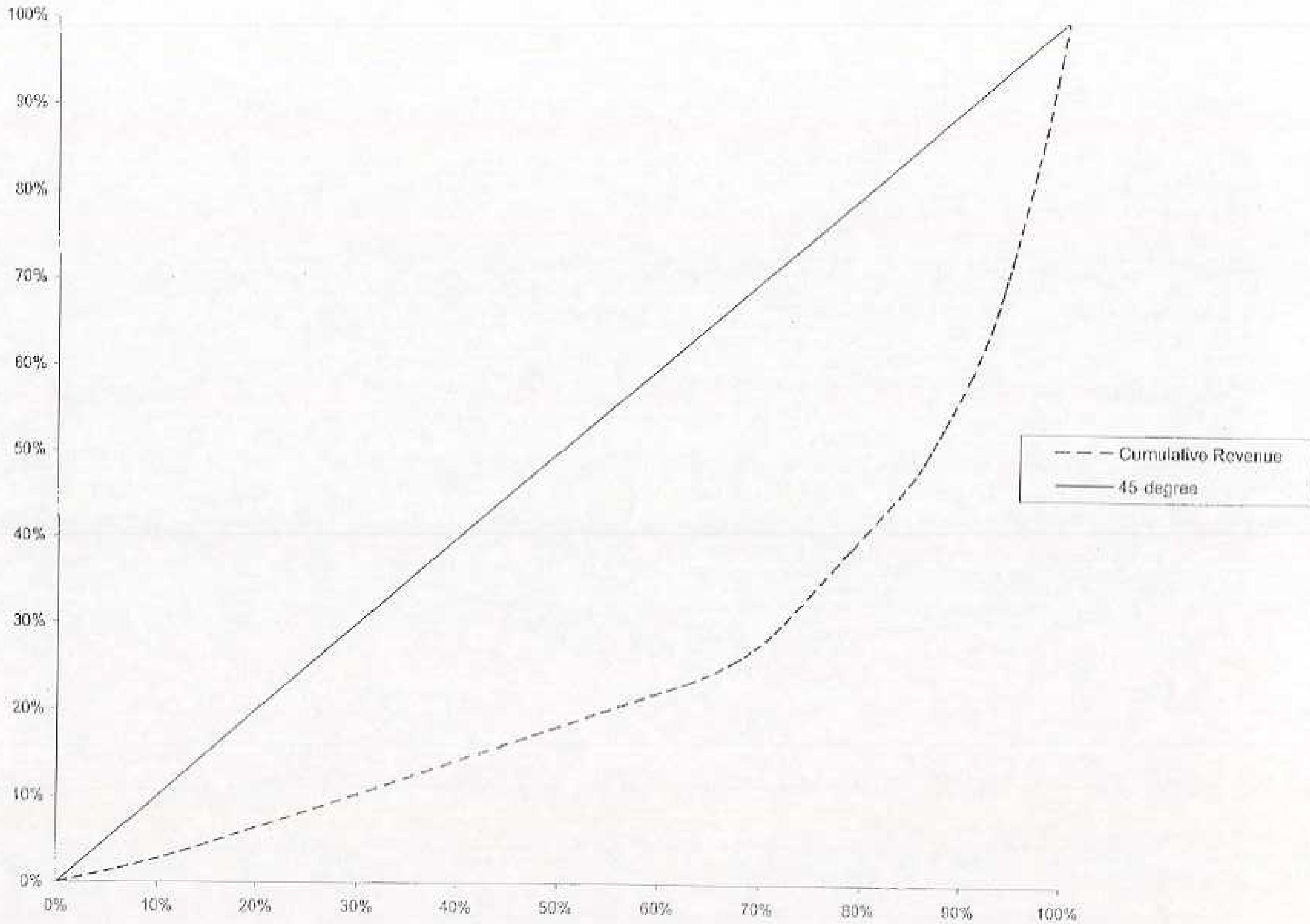
CROP	ACRES	REVENUE/ACR	WATER USE/ACR	REVENUE/AF	CUM. WATER U	CUM. REVEN	CUM. % WATE	CUM. % REVEN	45 Degree
SUDANGRASS HAY	65,786	$398	5	$80	328,930	$26,182,828	0%	0%	0%
ALFALFA HAY	172,771	$687	6.5	$106	1,451,942	$144,676,505	14%	4%	14%
WHEAT	44,303	$361	2.5	$144	1,562,699	$160,869,888	63%	23%	63%
COTTON	10,028	$959	4.5	$213	1,607,825	$170,486,740	67%	26%	67%
ALFALFA SEED	24,362	$517	2	$259	1,656,549	$183,081,694	69%	27%	69%
SUGAR BEETS	33,386	$1,774	5	$355	1,823,479	$242,308,658	71%	29%	71%
BERMUDAGRASS I	55,179	$900	2.5	$360	1,961,427	$291,969,758	79%	39%	79%
ASPARAGUS	5,006	$3,991	8	$499	2,001,475	$311,948,704	85%	47%	85%
POTATOES	3,159	$2,125	4	$531	2,014,111	$318,662,969	86%	50%	86%
SWEET CORN	6,790	$2,270	4	$568	2,041,271	$334,076,269	87%	51%	87%
CANTALOUPES	14,664	$2,315	3.75	$617	2,096,261	$368,023,429	88%	53%	88%
BROCOLLI	13,603	$2,625	3.5	$750	2,143,871	$403,731,304	90%	59%	90%
ONIONS	6,042	$4,333	4.5	$963	2,171,060	$429,911,290	92%	64%	92%
WATERMELONS	2,315	$3,084	3	$1,028	2,178,005	$437,051,444	94%	69%	94%
CAULIFLOWER	4,353	$4,386	4	$1,097	2,195,417	$456,143,702	94%	70%	94%
CARROTS	16,995	$4,544	3.75	$1,212	2,259,148	$533,368,982	95%	73%	95%
LEAF LETTUCE	10,498	$4,599	3	$1,533	2,290,642	$581,649,284	97%	85%	97%
HEAD LETTUCE	9,072	$5,021	3	$1,674	2,317,858	$627,199,796	99%	93%	99%
							100%	100%	100%

TABLE 3

Ranking of Crops by Investment per Acre Foot

CROPS	ACRES	NVESTMENT/ACRI	/ATER USE/ACR	NVESTMENT/AI	CUM. WATER L	CUM. INVESTMI	CUM. % WATE	CUM. % INVESTMI	45 Degree
							0%	0%	0%
SUDANGRASS HAY	65,786	$551	5	$110	328,930	$36,248,086	14%	5%	14%
ALFALFA HAY	172,771	$919	6.5	$141	1,451,942	$195,024,635	63%	27%	63%
WHEAT	44,303	$465	2.5	$194	1,562,699	$216,511,590	67%	30%	67%
ALFALFA SEED	24,362	$412	2	$206	1,611,423	$226,548,734	70%	32%	70%
COTTON	10,028	$1,238	4.5	$275	1,656,549	$238,963,398	71%	33%	71%
SUGAR BEETS	33,386	$1,377	5	$275	1,823,479	$284,936,920	79%	40%	79%
BERMUDAGRASS I	55,179	$805	2.5	$322	1,961,427	$329,355,015	85%	46%	85%
POTATOES	3,159	$1,794	4	$449	1,974,063	$335,022,261	85%	47%	85%
ASPARAGUS	5,006	$5,112	8	$639	2,014,111	$360,612,933	87%	50%	87%
SWEET CORN	6,790	$2,900	4	$725	2,041,271	$380,303,933	88%	53%	88%
CANTALOUPES	14,664	$3,361	3.75	$896	2,096,261	$429,589,637	90%	60%	90%
CAULIFLOWER	4,353	$3,929	4	$982	2,113,673	$446,692,574	91%	62%	91%
ONIONS	6,042	$4,622	4.5	$1,027	2,140,862	$474,618,698	92%	66%	92%
BROCOLLI	13,603	$3,794	3.5	$1,084	2,186,472	$526,228,480	94%	74%	94%
CARROTS	16,995	$4,688	3.75	$1,250	2,252,203	$605,901,040	97%	85%	97%
HEAD LETTUCE	9,072	$4,557	3	$1,519	2,279,419	$647,242,144	98%	91%	98%
LEAF LETTUCE	10,498	$5,188	3	$1,729	2,310,913	$701,705,768	100%	98%	100%
WATERMELONS	2,315	$5,775	3	$1,925	2,317,858	$715,074,893	100%	100%	100%

FIGURE 1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Cumulative Revenue
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FIGURE 2

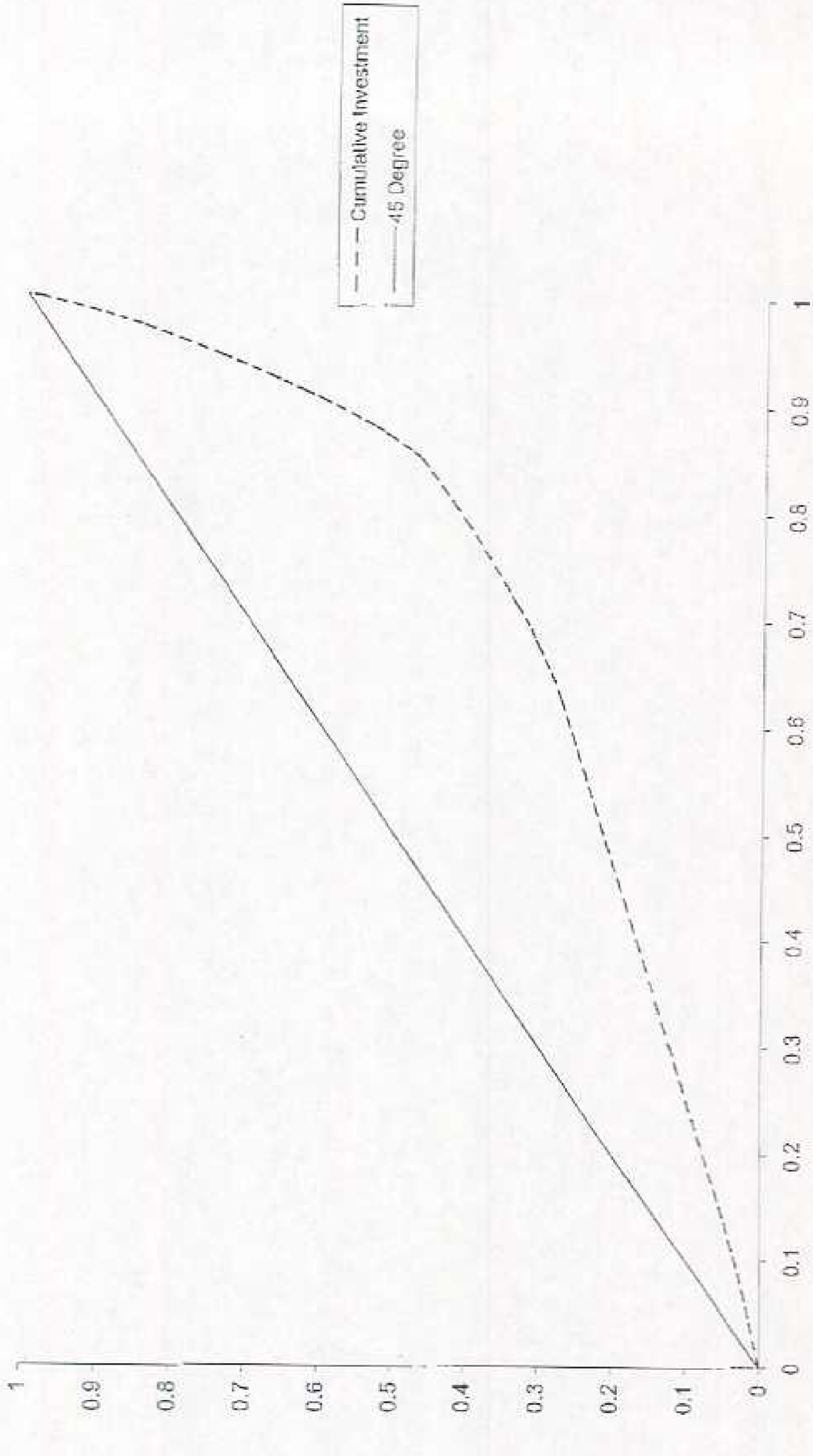

FIGURE 3

Acres Irrigated vs. County Employment

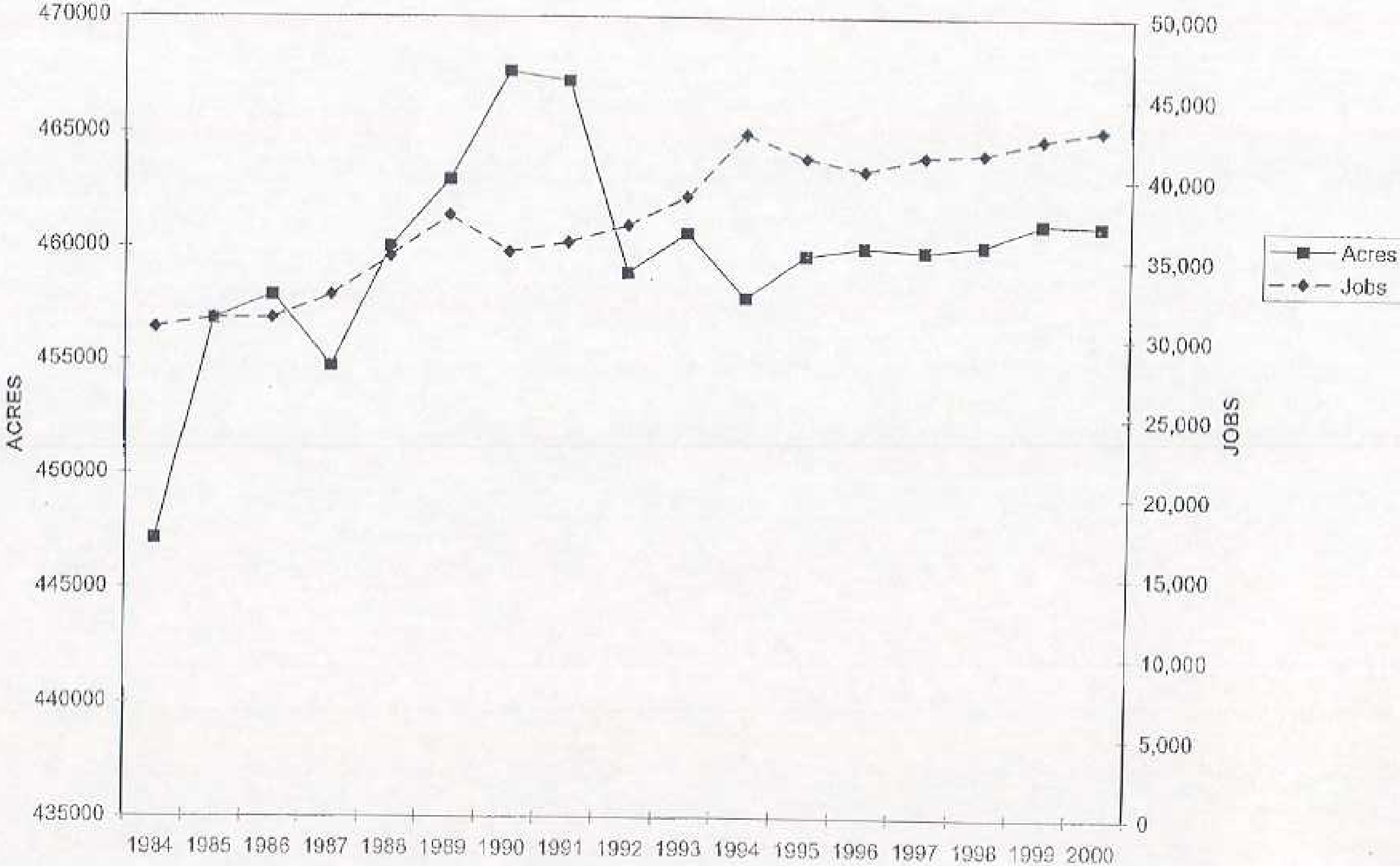

FIGURE 4

% Change Acres Irrigated vs. % Change County Employment