1976 PUMP IRRIGATION ENERGY SURVEY

Texas High Plains and Trans-Pecos Areas

TEXAS DEPARTMENT OF AGRICULTURE

John C. White
Commissioner

1976
PUMP IRRIGATION ENERGY SURVEY
Texas High Plains and Trans-Pecos Areas

Compiled by

TEXAS CROP AND LIVESTOCK REPORTING SERVICE
Wilbert H. Walther, Agricultural Statistician In Charge
Paul M. Williamson, Assistant Statistician In Charge
M. David Humphrey, Jr., Mathematical Statistician

CONSULTANTS
Edmund L. Nichols, Assistant Commissioner of Agriculture
John S. Kelly, Energy Advisor

PROJECT COORDINATORS
Charles W. Wallis
Robert S. McCauley
Garry D. Kepley

TEXAS
DEPARTMENT OF AGRICULTURE

John C. White, Commissioner
Ben H. Baisdon, Director
Marketing Division

Funding assistance provided by
Governor's Energy Advisory Council
State of Texas

ACKNOWLEDGEMENTS

The Texas Department of Agriculture wishes to thank the following organizations and individuals who provided funds, time and experience as a contribution to this survey and publication:

Governor's Energy Advisory Council
High Plains Underground Water Conservation
District No. 1
Frank Rayner, Manager
Texas Water Development Board
James M. Rose, Director
Herbert Grubb, Director of Planning
C. R. Baskin, Principal Engineer

To the People of Texas:

The Texas Department of Agriculture is proud to have initiated and participated in this important survey which provides information to help address the problems of our irrigation farmers.

This 1976 Pump Irrigation Energy Survey should serve to focus attention on the severe conditions the ever-increasing costs of energy are bringing to irrigation farmers of West Texas. In addition, we are hopeful the information here will provide useful guidance to the research groups who are working diligently to find solutions to the irrigation pump and energy problem.

The survey was conducted on behalf of the Texas Department of Agriculture by the Texas Crop and Livestock Reporting Service during August 1976. Information was provided by 900 High Plains and Trans-Pecos farmers and ranchers for irrigation pump motors, energy used, water pumped, fuel cost and related items. Texas Water Development Board files were used to develop tables for pumping lift and pump size.

We wish to thank all those West Texas irrigation farmers and ranchers who provided the much-needed information.

Sincerely,

John C. White

John C. White, Commissioner
Texas Department of Agriculture

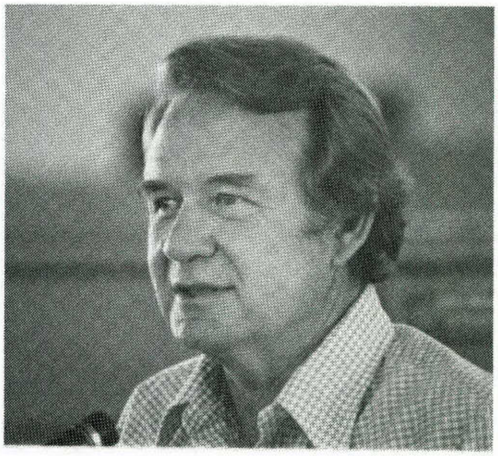
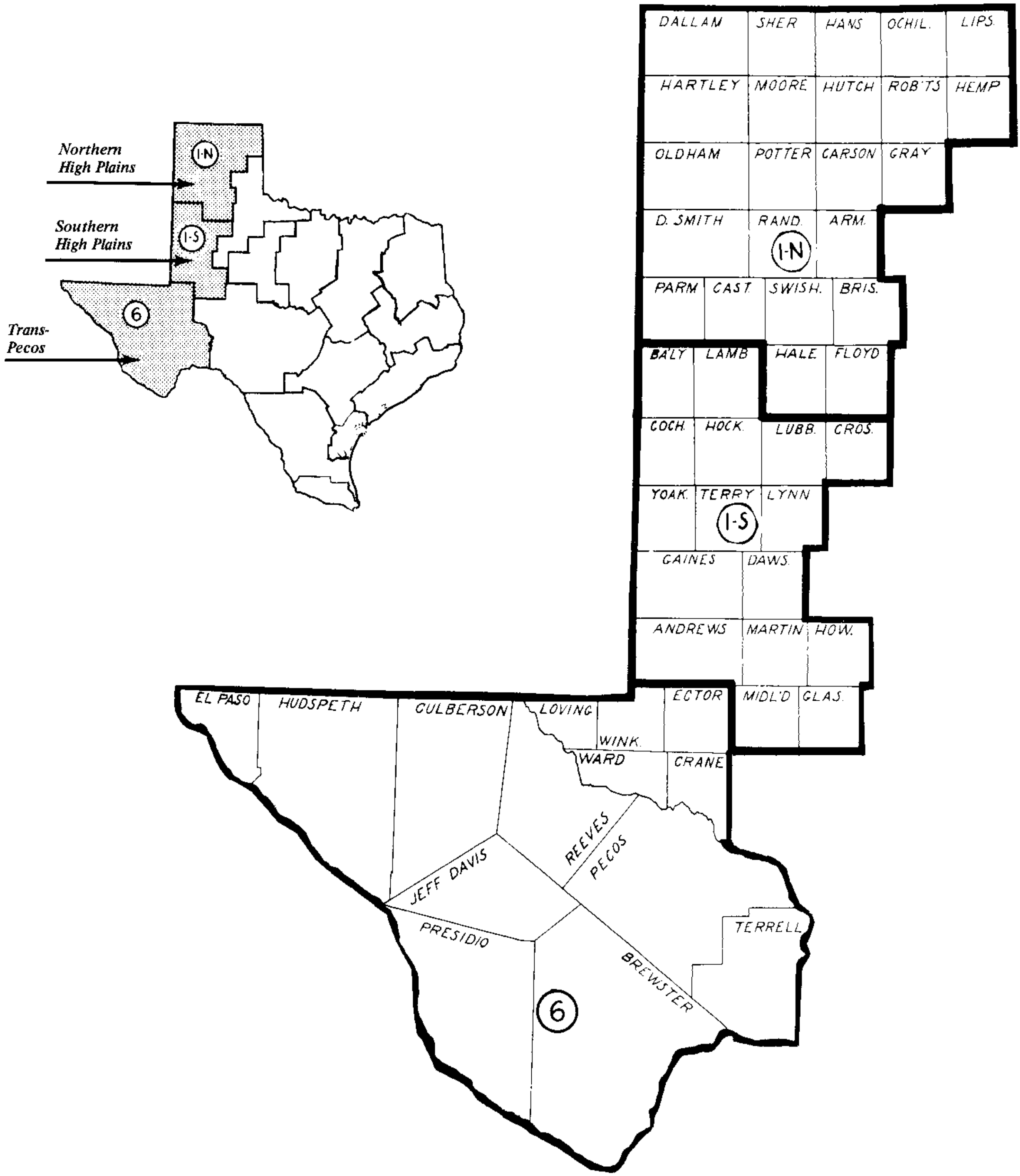


TABLE OF CONTENTS

1976 FARM IRRIGATION ENERGY SURVEY AREA



ENERGY USED IN PUMP IRRIGATION ON FARMS IN THE TEXAS HIGH PLAINS AND TRANS-PECOS AREAS

FARMS AND LAND IRRIGATED

The area covered by this survey includes the Texas High Plains and Trans-Pecos crop reporting districts. This area, with 23,300 total farming operations and 41,250,000 acres of land, represents 11 percent of the Texas farms and 29 percent of the Texas land in farms. However, with 12,000 irrigation farming operations, the area has 52 percent of the Texas irrigation farming operations and 71 percent of the irrigated land.

Nearly all the irrigation water on the High Plains is pumped from wells, but some water does come from playa lakes. In the Trans-Pecos, one-third of the 250,000 irrigated acres in 1976 was watered from surface (mostly Rio Grande canal) sources and the other two-thirds from ground water. Land irrigated from wells in the Trans-Pecos has declined sharply since 1974, primarily due to the rapidly rising natural gas prices.

PUMP MOTORS AND REPAIRS

The number of well pumps in the three-district area is estimated at 78,500 and tailwater pit and lake pumps at 6,500. This total of 85,000 excludes any booster pumps or pumps associated with irrigation from river basins. The motors installed in the Sixties and early Seventies to pump water from deep wells were mostly fueled by natural gas and rated well over 100 horsepower. Most of the earlier drilled wells in the Southern High Plains were shallower and used electric motors around the 50 horsepower rating. Very few pumps are now powered by LP gas, diesel or gasoline. The repair and maintenance cost for the pump motors fueled by natural gas, at over $1,000 per well, is double that for electric motors because of the large size, lift of water, and usage. The irrigation pump motors in this survey are confined to well pumps and tailwater pit and playa lake pumps.

PUMPING LIFT AND WATER TABLE

The most common pumping lift is around 275 feet in the Northern High Plains and around 125 feet in the Southern High Plains. In the Trans-Pecos, the lift varies by aquifer. The decline in the water table averages about two feet per year but varies from about three-fourths to four feet.

CHANGE IN OPERATIONS

Irrigation farmers were asked to state their opinion of likely changes in their farming operations if fuel costs continue to rise. The change deemed most likely to happen was a reduction in crop acreage (39 percent), followed by the prospect of moving to crops requiring less water (24 percent) and to dryland farming (17 percent). Many producers also expressed interest in moving to more efficient systems. Three-fourths agreed they would consider an alternate energy source, such as solar energy, subject to cost factors.

ENERGY USED, WATER PUMPED, AND COST

The primary source of energy used to drive the irrigation pumps in 1976 was natural gas. This fuel accounted for nearly 97 percent of the BTU (British thermal unit) total energy used in irrigation, electricity over 2 percent and LP gas less than 1 percent. The acre-feet of water pumped per MCF (thousand cubic feet) of natural gas in the Southern High Plains was much lower than in the Northern High Plains since a much larger acreage is watered by sprinklers than by surface method. Also, the newer systems in the northern area are probably more efficient in lifting the water. However, the acre-feet of water pumped per acre irrigated was much higher in the northern area. Cost of fuel per MCF for wells pumped with natural gas was much lower in the Northern High Plains than in the Southern because of more long-term gas contracts.

The three-district average cost of energy per acre-foot of water pumped by natural gas was nearly $9 compared with $11 by electricity. The most common cost for natural gas was $1.00-$1.25 per MCF in the Northern High

Plains and $1.25-$1.50 per MCF in the Southern High Plains. For electricity the most common cost was 2.0 cents - 2.4 cents per Kwh in the Northern High Plains compared with 3.0 cents - 3.4 cents in the Southern High Plains.

Producers were asked to estimate the cost per acre at which irrigation would no longer be economical, assuming present crop prices. Their estimates averaged $30 for wheat, $34 for cotton, $38 for grain sorghum, $56 for corn. Prices received by Texas producers for these commodities at survey time in mid-August were wheat, $3.05 per bushel; Upland cotton, 61 cents per pound; grain sorghum, $4.02 per cwt.; and corn, $2.74 per bushel.

Interest in irrigation, its cost and energy demands has grown dramatically in recent years. A national survey underway by *Irrigation Age*[1] magazine demonstrates the concern of the industry itself. Substantial irrigation energy information was developed in a Texas farm fuel and fertilizer survey conducted in 1974.[2] Results of this current survey complement those 1974 findings. The current results also complement and to some extent update the comprehensive irrigation and energy study conducted by Texas Tech University in 1968.[3]

RESPONDENTS' STATEMENTS

Space was left on the survey questionnaires so that each respondent could express his views on the irrigation energy situation. Although not all respondents took advantage of this opportunity for self-expression a very significant number did. Clearly there was a lot of redundancy in these comments; for example, one comment occurred more than 30 times with almost identical phraseology.

The following table lists repeated comments:

Frequency	Comment
31	Gas price (and product cost) are too high for farmers.
24	Farmers must have higher commodity prices to offset rising fuel (and other) costs.
12	Farmers have (or are going to) quit irrigation.
12	Present water table is too low.
10	Labor is expensive and scarce (Too many are on food stamps).
8	Gas companies overcharge.
7	Alternative energy source should be electricity.
7	Alternative water source (importation) should be considered.
6	In-state users of fuel should pay the same prices as out-of-state users.
6	Alternative energy source must be feasible.
6	Government loans are needed to improve irrigation system (e.g., center pivot system).
5	Pumped water is not good (salty).
4	Electricity is too high.
4	Gas/Oil companies are making excessive profits.
3	Government interferes too much.
2	No gas is available.
2	Farmers must have priority for gas.
2	Alternative energy source should be wind or solar energy.
2	Survey is useless.

The most frequently stated comment was, of course, that irrigation energy costs are too high for farmers. A close second in frequency of occurrence was the comment that farmers must have higher prices for their products to offset the rising energy costs. It is noted that farmers have neither a method of passing on their increased costs nor any protection from exhorbitant energy cost increases from intrastate suppliers.

Another comment made by a significant number of respondents is that many farmers either already have or will soon have to quit farming or at least quit irrigating if energy costs continue to rise. To illustrate the reality of this comment, in some places in the Trans-Pecos area as many as 90 percent of the farmers have already quit farming. This action can be a serious blow to food production since in Texas the one-third of the tilled land which is irrigated produces two-thirds of the food in the state.[4]

The subject of irrigation and food production is covered in a report written by Dr. Ronald Lacewell.[5] This report indicates that at 1976 crop prices in the Trans-Pecos area irrigation is not profitable at energy costs in excess of about $1.80 per million BTU's. This cost is the reason that farmers are going out of business or quitting irrigation. Calculations indicate that similar reactions are likely to occur in the High Plains area if energy costs reach the $2.00 per million BTU's. These calculations coincide with answers received in this survey.

Other comments include suggestions that some energy supply companies may be overcharging, that alternate energy sources, preferably electricity, need to be developed and government loans or other assistance will be essential to improvement of irrigation equipment.

Another frequent observation made in some of the comments is that the shortage of water will soon become as acute as the shortage of energy.

One point made in the comments is that the government interferes too much. There appears to be a particularly strong resentment over the large difference in interstate and intrastate gas prices that very often puts the Texas farmer in an unfair economic competitive position.

Other respondents commented on the declining water quality and on the hope for advancement of alternate energy sources such as solar.

CONCLUSIONS

This survey clearly shows the close interaction between irrigation fuel costs and the profit or loss of irrigation farming in the highly productive area of West Texas. It shows that the irrigation farmers are caught in the squeeze between those forces that are driving energy costs up and those that are holding food prices down. This squeeze is already forcing many farmers out of business. If no intervening action is taken, it appears that this trend may continue and even spread to other states. Such an occurrence would result in acute food shortages, and lead to dramatic increases in food costs. In the past it has always taken a substantial economic incentive to reactivate abandoned farm land.

The only effective intervening actions for the near future are administrative measures that can be implemented quickly. These include price supports for food crops, price regulation, preferably by a state agency, of farm energy costs and similar alternatives.

Longer term relief measures might be expected from technological advances. These include but are not limited to development of less costly energy sources, improvements in irrigation equipment and advances in irrigation procedures.

LIST OF REFERENCES

1. *Irrigation Age.* Special Survey by the Editors, July-August 1976.
2. *1974 Texas Farm, Fuel and Fertilizer Survey.* Austin, Texas. Texas Department of Agriculture and U.S. Department of Agriculture Texas Crop and Livestock Reporting Service. 1974.
3. "Power Requirements and Efficiency Studies of Irrigation Pumps and Power Units." Lubbock, Texas. Agricultural Engineering Department, Texas Tech University, September 1968.
4. *Texas Almanac, 1976-1977.* Dallas, Texas. A. H. Belo Corporation. 1975.
5. Lacewell, Ronald D. "Impact of Energy Cost on Food and Fiber Production." College Station, Texas. Department of Agricultural Economics, Texas A&M University. March 1976.

Table 1: Number of farms, land in farms and irrigation pumps by fuel type, 1976

Farms, land and irrigation pumps 1976	Northern High Plains 1-N	Southern High Plains 1-S	Trans-Pecos 6	Three-district total
1. Number of farms	10,900	10,500	1,900	23,300
a. All land in farms	14,350,000	9,200,000	17,700,000	41,250,000
2. Number of farms with irrigation	6,000	5,600	400	12,000
a. Land irrigated during the year (acres)	3,900,000	2,250,000	250,000	6,400,000
3. Number of irrigation pump motors	43,000	40,300	1,700	85,000
a. Number of well pumps	38,000	39,000	1,500	78,500
b. Number of tailwater pit and lake pumps	5,000	1,300	200	6,500
4. Number of irrigation pump motors fueled by:				
a. Natural gas	31,450	17,490	1,060	50,000
b. Electricity	10,240	21,790	470	32,500
c. L P Gas (Butane/Propane)	1,240	1,000	160	2,400
d. Diesel and other	70	20	10	100

Table 2: Irrigation pump motors: Percentage by horsepower rating by fuel type - Three districts 1/

Horsepower rating (size group)	Pump motors fueled by			
	Natural gas	Electricity	L P gas and diesel	All energy types
	Percent	*Percent*	*Percent*	*Percent*
150 and over	22	2	24	14
100 - 149	68	3	62	40
50 - 99	9	14	14	11
10 - 49	1	55	--	24
9 and under		26	--	11
All sizes	100	100	100	100

1/ *Source: This table was developed from the water well record files of the Texas Water Development Board.*

Table 3: Energy used, water pumped and cost of fuel by fuel type, 1976 season

Energy used, water pumped and cost of fuel	1-N	1-S	6	Three districts
1. Natural Gas:				
a. Energy used - MCF (000 cu. ft.).......	78,625,000	22,737,000	3,286,000	104,648,000
b. Acre feet of water pumped	13,492,000	2,309,000	286,000	16,087,000
c. Acre feet per MCF (b ÷ a)	.171	.102	.087	.154
d. Cost of fuel per MCF .... Dollars	1.25	1.55	1.65	1.35
e. Cost per acre foot (d ÷ c) .... Dollars	7.31	15.20	18.97	8.77
2. Electricity:				
a. Energy used - Kwh	378,880,000	403,115,000	10,810,000	702,805,000
b. Acre feet of water pumped	788,000	1,264,000	24,000	2,076,000
c. Acre feet per Kwh (b ÷ a)	.00208	.00314	.00222	.00262
d. Cost of fuel per Kwh .... Cents	2.6	3.1	2.6	2.9
e. Cost per acre foot (d ÷ c) .... Dollars	12.50	9.87	11.71	11.07
3. LP Gas - Butane/Propane:				
a. Energy used - Gallons	6,076,000	3,500,000	544,000	10,120,000
b. Acre feet of water pumped	186,000	46,000	7,000	239,000
c. Acre feet per gallon of fuel (b ÷ a) ..	.0306	.0131	.0128	.0236
d. Cost of fuel per gallon .... Cents	30	30	30	30
e. Cost per acre foot (d ÷ c) .... Dollars	9.80	22.90	23.40	12.70
4. Diesel:				
a. Energy used	574,000	60,000	33,000	667,000
b. Acre feet of water pumped	21,000	2,000	1,000	24,000
c. Acre feet per gallon of fuel (b ÷ a) ..	.0365	.0333	.0303	.0360
d. Cost of fuel per gallon .... Cents	35	35	35	35
e. Cost per acre foot (d ÷ c) .... Dollars	9.59	10.51	11.55	9.72

Chart 1: Price paid for energy used in pump irrigation by price ranges - Percent of producers by fuel type

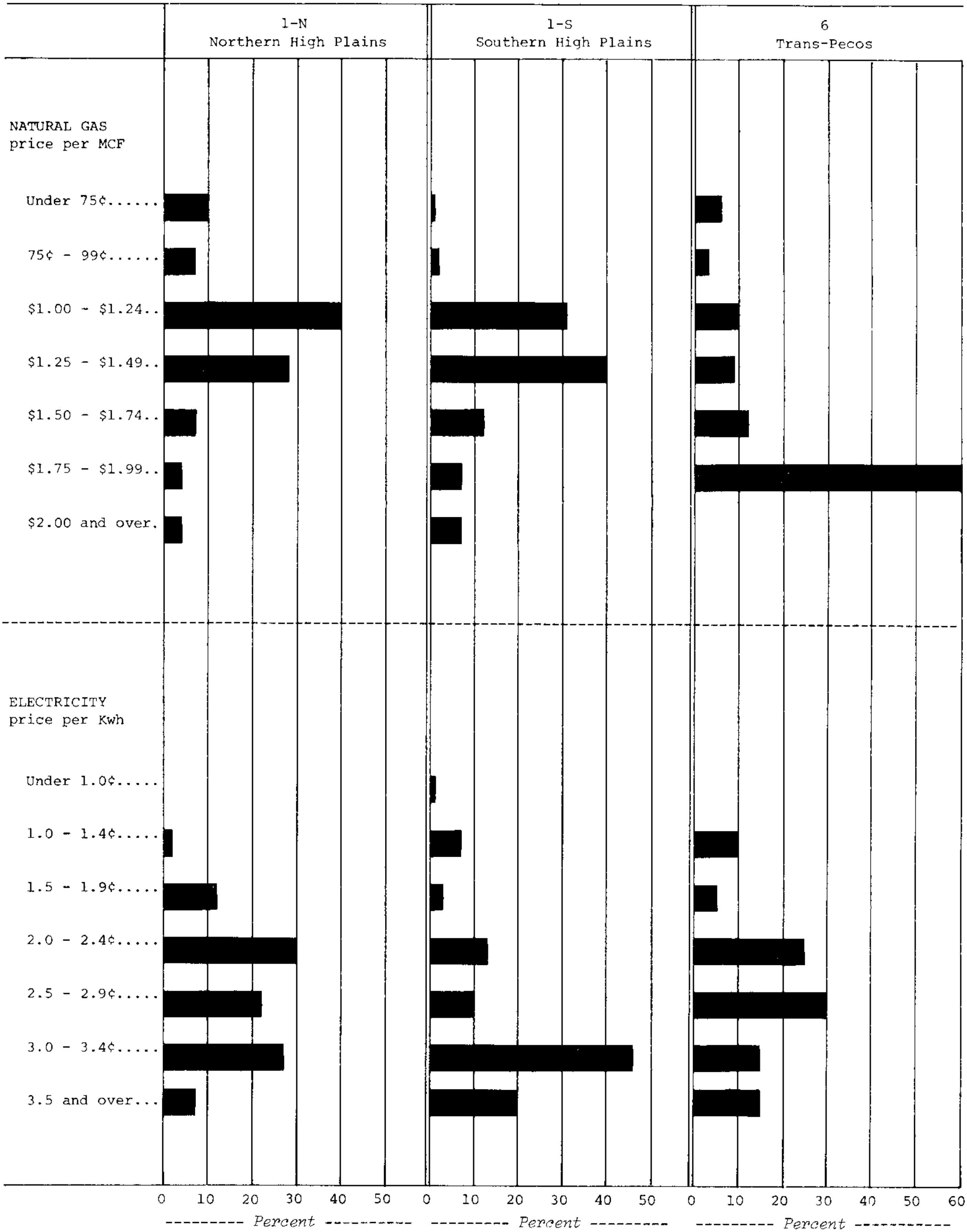


Table 4: Relative importance of energy types used in pump irrigation in the High Plains and Trans-Pecos areas

District	Energy type and unit	Energy used in pump irrigating 1976 season	BTU 1/ per unit	BTU total	% of total
1-N	Natural gas - cu. ft.	78,625,000,000	1,062	$83{,}500 \times 10^9$	97.8
	Electricity - Kwh	378,880,000	3,412	$1{,}293 \times 10^9$	1.5
	L P gas - gallons	6,076,000	96,000	583×10^9	.7
	Diesel - gallons	574,000	140,000	80×10^9	--
	All types	xxxx	xxxx	$85{,}456 \times 10^9$	100.0
1-S	Natural gas - cu. ft.	22,737,000,000	1,062	$24{,}100 \times 10^9$	93.3
	Electricity - Kwh	403,115,000	3,412	$1{,}380 \times 10^9$	5.4
	L P gas - gallons	3,500,000	96,000	336×10^9	1.3
	Diesel - gallons	60,000	140,000	8×10^9	--
	All types	xxxx	xxxx	$25{,}824 \times 10^9$	100.0
6	Natural gas - cu. ft.	3,286,000,000	1,062	$3{,}490 \times 10^9$	97.5
	Electricity - Kwh	10,810,000	3,412	37×10^9	1.0
	L.P gas - gallons	544,000	96,000	52×10^9	1.5
	Diesel - gallons	33,000	140,000	5×10^9	--
	All types	xxxx	xxxx	$3{,}584 \times 10^9$	100.0
Three districts	Natural gas - cu. ft.	104,648,000,000	1,062	$111{,}100 \times 10^9$	96.7
	Electricity - Kwh	792,805,000	3,412	$2{,}705 \times 10^9$	2.4
	L P gas - gallons	10,120,000	96,000	972×10^9	.9
	Diesel - gallons	667,000	140,000	90×10^9	--
	All types	xxxx	xxxx	$114{,}867 \times 10^9$	100.0

1/ Source: *"Handbook of Chemistry and Physics," Chemical Rubber Company, 43rd edition, 1961-62; "Mechanical Engineering Handbook," Lionel S. Marks, 6th edition, 1958; and "Agricultural Engineering Handbook," C.B. Richery, editor, 1961.*

Table 5: Annual repair and maintenance cost per well by pump motor energy type - 1976 season

Pump motor energy type	Repair and maintenance cost 1/			
	1-N	1-S	6	Three districts
	Dollars per well	*Dollars per well*	*Dollars per well*	*Dollars per well*
Natural gas	1,400	475	2,000	1,085
Electricity	600	280	620	440
L P gas	500	210	400	400
Diesel	2,000	--	--	2,000

1/ Does not include fuel cost or any overhead items such as depreciation, interest, taxes.

Table 6: Water cost survey question--"At what total irrigation water cost per acre do you feel that irrigation is no longer economical in your area for the crops listed (assuming present crop prices)?"

Crop	Average reported cost per acre (dollars)			
	1-N	1-S	6	Three districts
1. Grain sorghum	43	33	39	38
2. Cotton	25	38	67	34
3. Corn	56	55	60	56
4. Wheat	31	25	38	30
5. Soybeans	38	30	--	36
6. Sugarbeets	65	--	--	65
7. Sunflowers	19	25	--	21
8. Alfalfa	59	28	25	44
9. Vegetables	56	79	64	62

Table 7: Fuel cost survey question - "If fuel price continues to rise, what is likely to be the change in your farming operation and irrigation system?" (1 - most likely occurrence; 2 - second most likely; 3 - third most likely)

Change in operation with increased fuel price		Percentage reporting by order of likelihood											
		1-N			1-S			6			Three districts		
		Likelihood			Likelihood			Likelihood			Likelihood		
From	To	1	2	3	1	2	3	1	2	3	1	2	3
		Percent			*Percent*			*Percent*			*Percent*		
Present acreage........	reduced acreage.........	43	17	14	36	19	12	24	38	--	39	18	13
Present crops..........	crops requiring less water..................	29	41	8	19	37	12	8	39	--	24	40	10
Irrigation............	dryland...............	11	4	8	24	14	15	8	--	7	17	8	11
Irrigating............	quit farming..........	3	2	8	5	3	8	27	--	15	4	2	8
Present tillage........	minimum tillage........	3	22	43	2	14	19	16	13	--	3	18	33
Open ditch............	gated pipe............	2	2	4	2	1	7	1	--	--	2	1	5
Open ditch............	center pivot sprinkler.	2	2	5	3	1	11	16	--	71	3	2	8
Gated pipe............	center pivot sprinkler.	5	8	8	3	5	11	--	--	--	4	6	9
Present watering.......	less watering..........	2		1	2	3	1	--	--	--	2	2	1
Miscellaneous..............................		--	2	1	4	3	4	--	--	7	2	3	2
All changes............................		100	100	100	100	100	100	100	100	100	100	100	100

Table 8: Most common pumping lift and annual decline in water table for that level. 1/
Selected counties

District	County selected	Aquifer	Pumping lift most common (feet)	Annual decline in water table at current (Column c) level (feet)
	(a)	*(b)*	*(c)*	*(d)*
1-N	Carson	Ogallala	400	3
	Ochiltree	Ogallala	300	2
	Dallam	Ogallala	275	2 1/2
	Sherman	Ogallala	275	3
	Hutchinson	Ogallala	275	2
	Hartley and Moore	Ogallala	250	2
	Potter	Ogallala	225	2
	Deaf Smith and Randall	Ogallala	200	2
	Swisher	Ogallala	175	2
1-S	Crosby	Ogallala	225	2
	Glasscock	Ogallala	175	2
	Lubbock	Ogallala	150	1 1/2
	Terry	Ogallala	125	3/4
	Gaines	Ogallala	125	2
	Dawson and Andrews	Ogallala	125	1
	Martin	Ogallala	125	1 1/2
6	Pecos	Pecos	225	4
	Reeves	Alluvium	200	3
	Reeves	Cretaceous	300	1 1/2

1/ Source: This table was developed from the water well record files of the Texas Water Development Board.

Table 9: Alternate energy survey question - "Would you use an alternate energy source such as solar energy if it were available at a cost comparable to the energy source you now use?"

Use an alternate energy source	Percentage by response			
	1-N	1-S	6	Three districts
	Percent	*Percent*	*Percent*	*Percent*
Yes	76	80	47	78
No	7	9	3	8
Not answered or don't know	17	11	50	14
Total	100	100	100	100

SURVEY METHODOLOGY

OBJECTIVE OF SURVEY

The survey was designed to generate estimates of energy used for pump irrigation in both the High Plains and Trans-Pecos districts of Texas. Multiple Frame Probability Sampling was used to make both magnitude and proportion estimates.

SAMPLE DESIGN

Two sampling frames were used: an area frame of land segments and a list frame of farm operations with 50 acres or more plus known livestock producers regardless of acreage operated.

The survey was an application of Multiple Frame Probability Sampling and the data was collected by mail and personal interview from a random number of farm operators as follows:

1. **List frame**

   The list sample includes 899 respondents who were sampled in June 1976 for a crop acreage survey. For the June Acreage Survey, the list frame was stratified, based on size of operation using cropland acreage as the stratification variable. Each sampling unit was selected with a known probability and at varying sampling rates. The sample was allocated on an optimum basis with the larger farms being sampled at a heavier rate than the smaller farms. Systematic sampling with a random start was used within stratum and within Crop Reporting Districts.

   Of the 899 respondents selected in the sample, ten or about one percent of the total sample refused to report data.

2. **Area frame**

   The Texas area frame includes 156,764 sampling units (areas of land called segments) stratified geographically and by land use. The sample of 26 non-overlap tracts selected from this frame provides coverage of farm operators not on the list frame.

Sample sizes by stratum within districts are shown in the following table:

SAMPLE SIZE: Number of farms in Pump Irrigation Energy Survey, by Districts, Texas, August, 1976

Stratum	High Plains		District 6 Trans-Pecos	Total three-districts
Cropland acres	District 1-N (Northern)	District 1-S (Southern)		
1-149	29	50	8	87
150-599	141	146	21	308
600-1999	193	179	8	380
2000 and over	62	39	1	102
White corn	15	6	1	22
List Total	440	420	39	899
Non-overlap	--	--	--	26