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AGRICULTURAL PROCESSING POSSIBILITIES IN SOUTH DAKOTA: THE ALCOHOL FUELS CASE*

by

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Fuel alcohol production experience and prospects are addressed in this paper as a case example of agricultural processing development in South Dakota. The remarks here are based largely on interdisciplinary research at South Dakota State University (SDSU) in which I have participated over the past four years. This research, coupled with development experiences in fuel alcohol over the past few years, provides insights to prospects and limitations for furthering agricultural processing in South Dakota.

Before commenting on the economics of fuel alcohol production, however, I would like to provide some perspective on manufacturing and processing in general in South Dakota. I will briefly describe trends in the South Dakota manufacturing and processing sector since the 1960's and will then mention some of our research findings in the Economics Department at SDSU on factors behind these trends. Attention will then be focused on the economics of fuel alcohol production and how that has affected development of this particular ag related industry in the U.S. and in South Dakota. Finally, I will comment briefly on some of the public policy issues facing proponents of fuel alcohol and other agricultural processing development.

Manufacturing and Processing Growth in South Dakota

The manufacturing and processing (M/P) sector has grown dramatically in South Dakota since the mid-1960's. Employment in the M/P sector doubled between 1965 and 1979, going from 13,500 to 27,500 employees (Figure 1). Although M/P employment was still only 10.9% of non-agricultural wage and salary employment in South Dakota by 1982--up from 8.7% in 1965--it did contribute to an overall expansion of the employment base in South Dakota during the 1960's and 1970's (Figure 2). The M/P employment growth helped offset the continued declines in agricultural (farm and ranch) employment over that period. Within the M/P sector, durable goods was the principal source of expansion (Figure 1). Between 1965 and 1982, durable goods employment in South Dakota increased from 2.5% to 5.3% of total non-ag wage and salary employment, while non-durable goods slipped from 6.2% to 5.6% (Table 1). Both categories of employment increased in absolute terms.

In spite of this impressive performance of the M/P sector as a whole, employment growth in agricultural processing components of the sector has been disappointing. The category called "Food and Kindred Products" (FKP) captures many types of agricultural processing. While Figure 3 shows that many of the new M/P firms established in South Dakota were in the FKP category, overall employment between 1965 and 1982 only went from 7,700 to 8,000. In fact, FKP employment in South Dakota stood at 8,200 in 1960. Evidently, there has been high turnover in this segment of the M/P sector, with either firms changing hands often or a great deal of exit and entry. Also, perhaps many new firms were capital- rather than labor-intensive. Although there has been little growth in FKP employment, the aggregate employment provided has been relatively stable. Recessions such as that in 1981 and 1982 generally hit durable goods much harder than they do FKP and other non-durable goods (Figure 1).

In general, what has contributed to the growth in M/P employment in South Dakota in recent years? Probably lower wages and lower workman's compensation in South Dakota than in some other States and South Dakota's improved access to external markets via the interstate transportation system have been important factors. Other factors are of greater importance, however, in explaining why some South Dakota communities have experienced more rapid M/P growth than others. Our research has shown that communities with such characteristics as large numbers of women available to enter the work force, relatively low levels of poverty, and good community services tended to be somewhat more successful than others during the 1970's (Table 2). In addition to having these characteristics, it can be advantageous for communities to assist new firms in identifying and gaining access to industrial sites and buildings. (Construction of "Spec Buildings" is often not a cost-effective strategy.) We need to keep in mind, however, that the employment growth explained by these factors was largely in durable, rather than non-durable, goods.

Experience and Feasibility of the Fuel Alcohol Industry

Interest in fuel alcohol production intensified in this country after events in Iran and other parts of the Middle East sent oil prices soaring in the late 1970's. This was the second oil price "shock", the first having occurred with the Arab oil embargo of the early 1970's. Attention turned to all kinds of synthetic fuels, including ones using agricultural products as a feedstock. This coincided with long-standing interest in the Midwestern U.S. in developing alternative markets for grain, to strengthen agricultural prices and increase local value-added. The years 1979 and 1980 were ones in South Dakota of especially intense interest in producing fuel from corn.

In early 1980, the U.S. was producing ethanol (fuel alcohol) at a rate of approximately 80 million gallons per year. The Federal Government at about that time established national ethanol production targets of 500 million gallons per year for 1981 and 2 billion gallons for the mid-1980's (Table 3). The 2 billion gallon figure would have been equivalent to 2% of U.S. gasoline consumption and would have required as feedstock the equivalent of 11% of the nation's corn crop.

Technical and economic factors have caused growth in alcohol fuels production to fall short of these targets thus far. By early 1982, U.S. ethanol production capacity was approximately 255 million gallons, compared to the 1981 production target of 500 million gallons (Table 3). Projections as of 1982 indicated that ethanol plants under construction or definitely planned would likely lead to production capacity of 500 million gallons by early 1983 and 1,500 million gallons by 1984.

After a slow start, sales of gasohol (a mixture of 10% ethanol and 90% gasoline) picked up in 1982 and 1983. The increased production capacity, coupled with the State and Federal excise tax waivers, caused ethanol to be more price competitive with unleaded gasoline at the pump than it had been earlier. The marketing image was also altered, by switches to names like "super unleaded gasoline".

Most of this expanded ethanol capacity and production has come from relatively large-scale ethanol plants. Smaller-scale plants (producing a

million or less gallons of ethanol per year) have encountered many difficulties. Several that started in South Dakota in the past three to four years have either never gone into regular production or have ceased operations after producing for a time. Technical difficulties which delayed startups for a year or more, at a time of high interest rates, were fatal to some plants. In addition, however, there are substantial economies of size not available to the smaller-scale plants.

Let's look, for a moment, at the economics of small-scale plants. Our research at SDSU, with a "small" or "community-scale" plant located on the campus, indicates baseline costs of $1.78 per gallon of 185-proof ethanol (Table 4). Production costs of course vary with corn prices (Table 5) and interest rates (Table 6). Regardless of such factors, costs in small-scale plants tend to be higher than in large-scale operations (Table 7). Although small-scale plants can offer certain advantages, such as being located close to users of the feed byproduct, we have not found sufficient cost savings in these advantages at this point in time to offset various economies of production and marketing offered by the larger plants. A major advantage thus far of the larger plants is greater economy in going the final processing step to 200-proof (anhydrous) alcohol. The "wet" (hydrous) alcohol sometimes produced by small plants often has great difficulty moving into renumerative markets.

We have estimated returns on sale of "wet" alcohol various ways. However, one simple calculation is shown by Table 8. This shows that 185 proof alcohol would be worth $1.07/gallon when the gasoline it substitutes for costs $1.15/gallon and the current $0.37½/gallon Federal income tax credit for use of such alcohol is in effect. This compares to our estimated costs ranging from $1.59 to $2.30/gallon for producing "wet" alcohol in small scale plants. With certain plant improvements our researchers have worked with, one might get costs for small-scale plants down to $1.20-$1.30/gallon in some instances. Only with a combination of assumptions about costs and returns that are <u>at present</u> on the optimistic side do small-scale plants producing ethanol from corn appear to be economically feasible.

Some of the large-scale plants have presumably been profitable. With the various State and Federal excise tax examptions in effect, 200-proof ethanol has sold for $1.60 to $1.80/gallon over the past few years. Judging from various cost estimates for producing 200-proof alcohol in large-scale plants, these prices appear to have been sufficiently renumerative to return a profit in at least the efficient operations.

We have done some very preliminary analyses on the potential feasiblity of fuel alcohol production with feedstocks other than corn. It appears that some feedstocks, such as sweet sorghum and fodder beets, could be competitive with corn as a feedstock (Table 9). However, it will take more agronomic, microbiological, engineering, and economic research to determine whether costs might be significantly lower with such other energy crops as these than with corn.

Public Policy Toward Agricultural Processing Development

I noted in my opening remarks that agricultural processing in South Dakota--at least as measured by employment numbers--has shown little or no growth over the last couple of decades. Of course, there have been many individual cases of processing development, such as the potato processing plant at Clark. In aggregate, however, the progress has not been that desired. The most recent major disappointment has been in fuel alcohol production. Technical and economic factors have thus far worked against this particular kind of agricultural processing in South Dakota, in spite of various State and Federal attempts to encourage growth of the industry. I would like now to comment briefly on some public policy issues regarding promotion of agricultural processing, drawing in part on recent experiences with the fuel alcohol case.

One major issue concerns the role of tax and financing inducements to encourage growth of a new industry or new plants at particular locations. Grants, loans, and loan guarantees for fuel alcohol plants were available, until recently, in many forms from Federal agencies such as the Farmers Home Administration, the Small Business Administration, and the U.S. Department of Energy. Energy related investment tax credits have also been available. The most significant inducements, however, have been the waivers of portions of the State and Federal excise taxes on road fuel containing at least 10 percent ethanol. Exemptions on gasohol are presently $0.05/gallon of the Federal excise tax (out of the $0.09 applicable to gasoline) and $0.04/gallon of the South Dakota excise tax (out of the $0.13 applicable to gasoline). The total exemption is $0.09/gallon of gasohol--or $0.90/gallon of ethanol (Table 10), since only one gallon of ethanol is needed to satisfy the 10 percent requirement for 10 gallons of gasohol. Because of separation problems, ethanol must be essentially anhydrous to be mixed with gasoline for gasohol. Therefore, in lieu of the Federal excise tax exemption on gasohol, Federal income tax credits are available for use of straight alcohol. The credit varies with proof level of the alcohol (Table 10). It is currenly $0.37½/gallon for 185 proof alcohol, the type considered in our economic analyses, and $0.50/gallon for alcohol of at least 190 proof. No analogous subsidy exists at the State level in South Dakota for "wet" alcohol.

I noted earlier in my remarks that the income tax credit on "wet" alcohol is generally not sufficient to make small-scale alcohol plants economically feasible at the present time. In contrast, the Federal and State excise tax waivers, which total $0.90/gallon of alcohol in South Dakota and similar levels in a number of other States, have been critical to the development of large-scale plants. There is an obvious economic tradeoff, however. Sales of gasohol within South Dakota from July 1982 to May 1983 totaled 16.5 million gallons, or roughly 18 million gallons on a 12-month basis. This level of gasohol sales, at $0.04/gallon of State excise tax waived, entails foregone highway taxes of $720,000. This is about 1 percent of the South Dakota excise taxes collected annually on gasoline and gasohol.

The ethanol constituting gasohol sold in South Dakota is coming entirely or almost entirely from outside the State, since no plants of any significant size are currently operating here. Thus, though the revenue foregone is relatively modest, it is not currently helping to directly support South Dakota alcohol production. Since corn is bought and sold nationally, ethanol production

elsewhere at least indirectly strengthens the demand for South Dakota grown corn. The gasohol currently sold annually in South Dakota requires about 690,000 thousand bushels of corn as feedstock, or the equivalent of 4/10 of 1 percent of South Dakota's average corn crop over the past four years. The highway revenues foregone in South Dakota come to $1.04/bushel of corn used as feedstock for the gasohol sold or the equivalent of $0.04/bushel of corn grown in the State. At $3/bushel corn, this equals 1.3 percent of the corn value. South Dakota policy makers will need to decide whether this subsidy to ethanol production has prospects of sufficiently increasing corn prices and/or enhancing in-State ethanol production to justify continuation of the exemption.

Another policy issue concerns whether to encourage ag processing plants of large- or small-scale. Growth in durable and some types of non-durable goods manufacturing in South Dakota has been quite decentralized in recent years, with many labor-intensive plants of modest size located in small and medium population towns. In contrast, many types of agricultural processing exhibit substantial economies of size and are quite capital-intensive. This seems to be the case at present for alcohol fuels. While numerous small plants are preferable from a rural development standpoint, economic factors may make this difficult to accomplish for some types of agricultural processing. Research is continuing on the feasibility of small-scale plants. However, we may ultimately have to focus on developing one or a few relatively large plants in the State in some cases, as has been done in sunflower processing.

Finally, in planning for agricultural processing development, we must realize in advance that not all "possibilities" will eventually materialize. We need to look ten to twenty years down the road at ag processsing "targets of opportunity". Having identified "targets", research and development strategies must be put in place to work toward achievement of those targets. Even with the best planning, research, and development efforts, some of the ag processing targets will not be achieved, because of unforeseen technological and economic factors. A failure to look ahead and attempt to identify and exploit "targets of opportunity", however, is likely to lead to great costs. These costs are in the form not only of missed opportunities, but also of misdirected capital investments.

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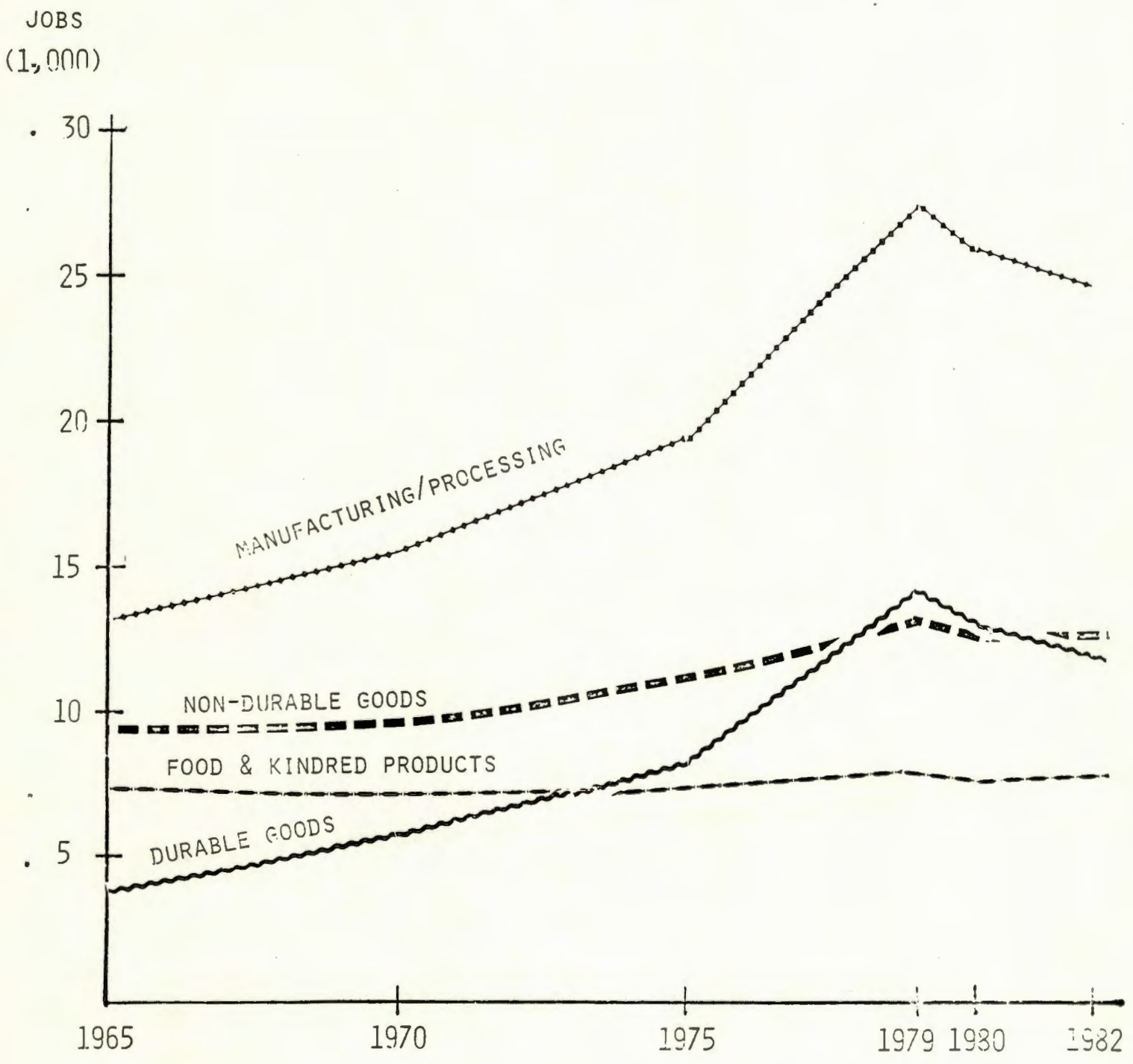
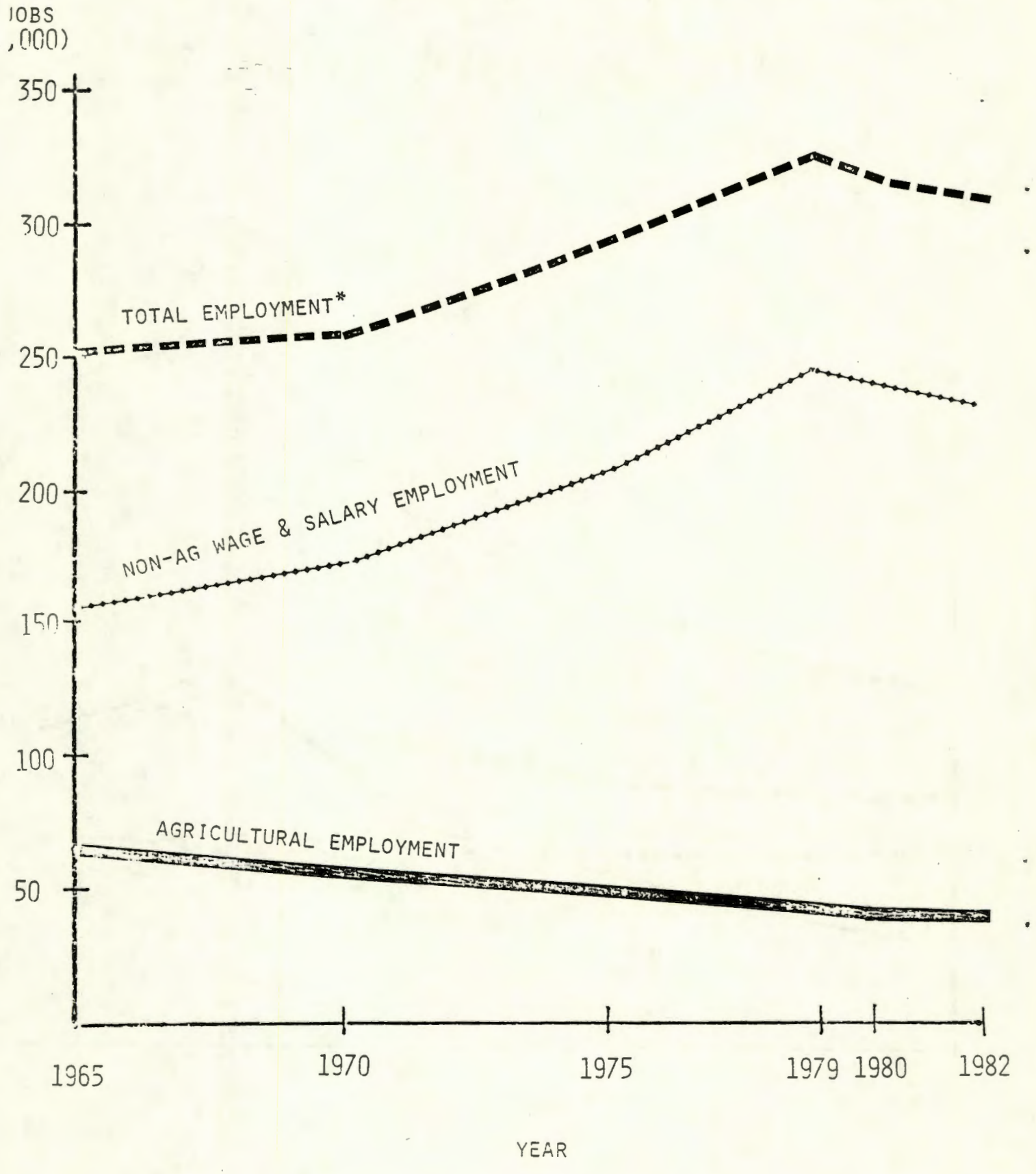
FIGURE 1

S.D. Manufacturing/Processing Employment Trends



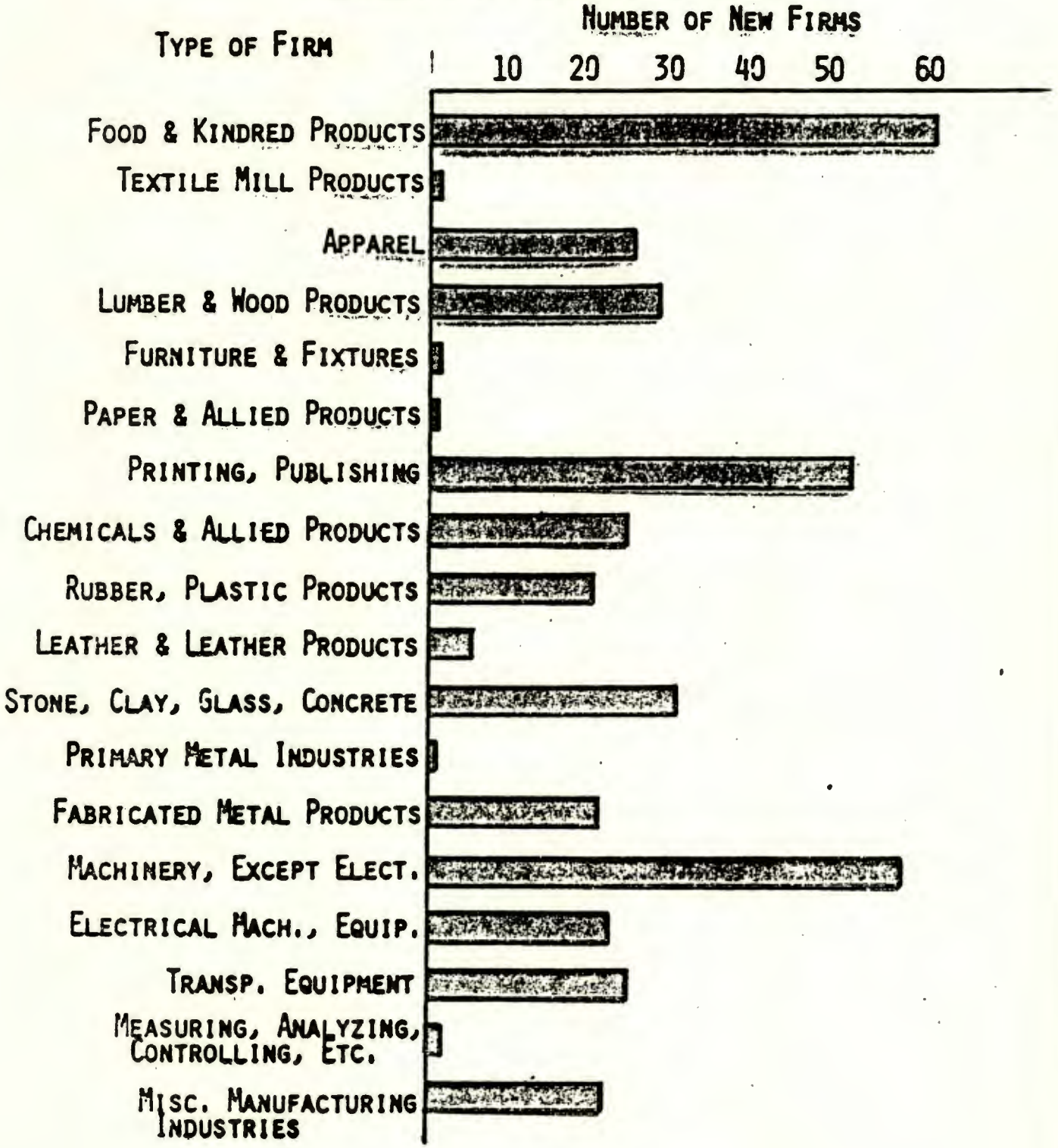
S.D. Employment Trends



*NOTE: "TOTAL" INCLUDES "AGRICULTURAL", "NON-AGRICULTURAL WAGE AND SALARY", AND "OTHER" EMPLOYMENT; IT ELIMINATES DOUBLE COUNTING DUE TO DUAL JOB HOLDERS.

FIGURE 5

New Manufacturing Firms in South Dakota, Established Between 1970 and 1979 (Excluding S. Falls and R. City)



NON-AGRICULTURE WAGE AND SALARY EMPLOYMENT IN SOUTH DAKOTA

INDUSTRIAL CATEGORY OF EMPLOYMENT	YEAR 1965 EMPLOYMENT AS % OF TOTAL	YEAR 1982 EMPLOYMENT AS % OF TOTAL
MANUFACTURING	8.7	10.9
DURABLE GOODS	2.5	5.3
NON-DURABLE GOODS	6.2	5.6
NON-MANUFACTURING	91.3	89.1
MINING	1.6	1.0
CONTRACT CONSTRUCTION	5.6	3.4
TRANSPORTATION AND PUBLIC UTILITIES	6.5	5.4
WHOLESALE AND RETAIL TRADE	26.7	26.9
FINANCE, INSURANCE, AND REAL ESTATE	4.5	5.1
SERVICES	16.3	22.7
GOVERNMENT	30.2	24.6
TOTAL NON-AG WAGE AND SALARY EMPLOYMENT	100%	100%

FACTORS INFLUENCING LOCAL INDUSTRIAL DEVELOPMENT

FACTORS OF MOST IMPORTANCE

--AVAILABILITY OF FEMALE WORK FORCE

--AVAILABILITY OF WORKERS CURRENTLY EMPLOYED ONLY PART-TIME

--ABSENCE OF POVERTY

--LACK OF PRIOR INDUSTRIALIZATION

--LARGER POPULATION (BY SOUTH DAKOTA STANDARDS)

--PRESENCE OF COLLEGES AND POST-SECONDARY VO-ED FACILITIES

*--INDUSTRIAL SITE AVAILABILITY AND QUALITY

*--COMMUNITY SERVICES

FACTORS OF LESS IMPORTANCE

--ACCESS TO INTERSTATE HIGHWAY SYSTEM

*--LOCAL TAX LEVELS

*--LOCAL DEVELOPMENT CORPORATION ACTIVITIES OTHER THAN ASSISTANCE WITH INDUSTRIAL SITES

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*FACTORS LOCAL COMMUNITIES THEMSELVES CAN DO SOMETHING ABOUT.

U.S. FUEL ALCOHOL PRODUCTION, CAPACITY, AND TARGETS

YEAR	MILLION GALLONS/YEAR PRODUCTION	CAPACITY	TARGET
EARLY 1980	80		
1981	80		500
1982	210	255	
1983	400**	500*	
1984		1,500*	
MID-1980's			2,000

*PROJECTED, AS OF 1982

**ESTIMATE, AS OF MID-1983

Cost Summary for 175,074-gallon Plant
(1981 Costs)

Cost Type	Costs/Gallon of Alcohol (185 Proof)
Fixed	$0.33
Variable	1.75
Subtotal =	$2.08
Credit for feed by-product	.30
Net cost =	1.78

EFFECT OF CORN PRICE ON COST/GALLON
(175,074 GAL./YR. PLANT)

PER BUSHEL PRICE OF CORN	COSTS/GALLON OF ALCOHOL (185 PROOF)
$2.00	$1.59
2.50 (BASELINE CASE)	1.78
3.00	1.97

TABLE 6

EFFECT OF INTEREST RATES ON COST/GALLON
(175,074 GAL./YR. PLANT)

INTEREST CHARGE (ANNUAL %)	COSTS/GALLON OF ALCOHOL (185 PROOF)
10%	$1.72
15% (BASELINE CASE)	1.78
20%	1.85
30%	1.98

TABLE 7

FUEL ALCOHOL PRODUCTION COSTS AT ALTERNATIVE LEVELS OF ANNUAL OUTPUT

Cost estimate source	Assumed Annual Output (185 proof Equivalent)	Costs per gallon (1981 dollars; 185 proof Equivalent)
1. S. Dakota State Univ.	9,300	3.87
2. Univ. of Nebraska	13,000	3.28
3. Univ. of Nebraska	43,200	2.44
4. S.D. State Univ.	48,863	2.69
5. U.S. Dept. of Agriculture	61,600	1.45
6. S.D. State Univ.	175,074	1.78
7. U.S. Dept. of Agriculture	369,700	1.22
8. Solar Energy Research Inst.	410,800	1.27
9. U.S. Dept. of Agriculture	1,081,000	1.25
10. E.S.C.S., U.S.D.A.	10,810,800	1.54
11. E.S.C.S., U.S.D.A.	43,243,300	1.27

ECONOMIC VALUE OF 185 PROOF FUEL ALCOHOL

IF GASOLINE SELLS FOR $1.15/GAL.,

AND IF FUEL ALCOHOL HAS 60% OF ENERGY VALUE OF GASOLINE,

THEN ECONOMIC VALUE OF FUEL ALCOHOL IS:
$1.15 x .60 = $0.69/GAL

IF THE 37½¢/GAL FEDERAL INCOME TAX CREDIT IS ADDED, THE VALUE BECOMES $0.69 + 0.38 = $1.07/GAL

ALTERNATIVE ALCOHOL FUEL CROPS

CROP	ESTIMATED ALCOHOL YIELD/ACRE IN SD (GAL'S/ACRE)	ESTIMATED ALCOHOL COST ($/GAL)
CORN	180	$1.78
SWEET SORGHUM*	210	1.68
FODDER BEETS*	315	1.74
JERUSALEM ARTICHOKES**	135-265	2.06

*PRELIMINARY ESTIMATES

**EXTREMELY TENTATIVE FIGURES

TAX FEATURES OF GASOHOL AND ETHANOL

GASOHOL (90% GASOLINE AND 10% ANHYDROUS ETHANOL)

TAX WAIVER	AMOUNT/ UNIT GASOHOL	AMOUNT/ UNIT ETHANOL
FEDERAL EXCISE TAX ON ROAD FUEL	5¢/GAL	50¢/GAL
PORTION OF STATE EXCISE TAX ON ROAD FUEL	4¢/GAL	40¢/GAL
TOTAL	9¢/GAL	90¢/GAL

NON-ANHYDROUS (LESS THAN 200-PROOF) ALCOHOL

FEDERAL INCOME TAX CREDITS	AMOUNT/ UNIT ETHANOL
ALCOHOL OF AT LEAST 190 BUT LESS THAN 200 PROOF	50¢/GAL
ALCOHOL OF AT LEAST 150 BUT LESS THAN 190 PROOF	37½¢/GAL