The Role of Energy in the Structure of Agriculture

Special Report 639
September 1981

Oregon State University Extension Service

The Role of Energy in the Structure of Agriculture

J. B. Wyckoff*

Components of Structure

To usefully discuss energy and the structure of agriculture, we need to clarify what is meant by the "structure of agriculture." Structure is concerned with 1) the organization of resources going into the farming units; 2) the size, management, and operation of those units; 3) the form of the business enterprise, i.e., sole proprietorship, partnership or corporation; 4) the freedom that the operator has to make business decisions -- and to bear the associated risks; 5) the ease of entering and leaving the operation; 6) the freedom to transfer assets to succeeding generations and to other operators; 7) and the "right" to change the present use of the land.

The real questions are the shifts in the control of the key decisions within agriculture.

- Is the farmer still free to make the decision relative to what he produces and when he produces it?
- Is the farmer still free to buy the inputs and to sell the outputs at the place and time and in the form that he desires?
- Is industrialization of agriculture shifting control away from the farm operator through such devices as vertical integration?
- Who makes the decisions in situations such as the broiler industry where vertical coordination comes into play?
- Does the farmer really have a choice in contracting commodities such as potatoes, onions, processing vegetables, and, in many cases, even feeder cattle?

In virtually all of these cases control, defined as the ability to make the key decisions, has been shifting away from the producer to other levels of the industry.

* Professor and Extension Economist, Department of Agricultural and Resource Economics, Oregon State University.

Future Structure

Why is society concerned about the structure of agriculture; why would society prefer one structure over another? Quite frankly, society is not interested in structure, *per se*. What it does care about is the performance of alternative structural forms for agriculture and the welfare of the participants. Society in the United States may also feel that family farms are important as a measure of the maintenance of a democratic society. Thus, when the number of farms declined over 50 percent from 1950 to 1978, the structure of agriculture became an issue.

American agriculture, by any set of reasonable standards, can be judged to have performed well throughout history to the benefit of all citizens. Many changes have occurred and evolution will continue, caused by many of the forces that have shaped it in the recent past. It is often said that the past is the best predictor of the future. If this is the case, then we can anticipate that:

- Farm size will continue to grow, while the number of farms continues to decrease;
- there will be more full owners, more part-time owners, and less tenants;
- most of the land resources freed by those going out of agriculture will be absorbed by their neighbors who are presently involved in farming, allowing their operations to grow larger;
- a structure may develop with many small farms, few medium size farms and some large farms because of the willingness of small farmers who work off the farm and economies of size on large farms providing the ability to pay higher prices for available farmland;
- land prices will continue to increase, further concentrating the wealth of agriculture and leading to greater separation of land ownership and operation of farms;
- entry will become even more of a problem because of the large capital requirements; and,
- more complex organizations will develop in commercial agriculture to cope with risk, tax provisions and other institutional relationships, including arrangements for obtaining inputs and accessing markets for output.

Impact of Energy on Structure[1/]

What impact will energy prices rising faster than the general price level have directly upon this changing structure? The United States, with five percent of the world's population, accounts for about 32 percent of the world's fossil fuel energy consumption. The proportion of U.S. fossil fuel energy consumed in the food and fiber sector is relatively small, requiring only about 13 percent of the total energy consumed in the United States. Fossil fuel energy used in the food and fiber sector increased about three times between 1940 and 1970, while farm output doubled. Energy use increased another 11 percent from 1970 to 1980, Table 1.

Table 1. BTU's Used in U.S. Food and Fiber Sector by Major Types of Industries*

	1980		
Item	Trillion BTU's	Percent	Change from 1970 Percent
Farm production	1,095.3	21.1	+ 4.2
Farm family living	499.2	9.6	- 10.0
Food processing	1,548.3	39.8	+ 19.8
Marketing and distribution	988.9	19.0	+ 18.8
Input manufacturing	1,063.8	20.5	+ 15.0
TOTAL	5,195.5	100.0	+ 11.3

* Adapted from Duncan, Marvin and Kerry Webb, Energy and American Agriculture, Federal Reserve Bank of Kansas City, February 1980.

1/ The next three sections draw heavily upon Duncan, Marvin and Kerry Webb, Energy and American Agriculture, Federal Reserve Bank of Kansas City, February 1980, pp. 41.

Over time, the productivity of U.S. agriculture increased as a result of replacing labor with machinery, fertilizer and other chemicals. This released a large number of people for employment in the other sectors of the economy. The productivity gains that came with the development of energy intensive agriculture permitted food prices to be substantially lower than they would have been without mechanization. Farmers in the U.S. have not only produced adequate food for our domestic consumers but have facilitated the movement of the products from about one-third of our harvested acreage into the export market. These exports have provided foreign exchange to help offset the cost of this country's energy imports in recent years.

Energy Efficiency of U.S. Agriculture

U.S. agriculture has often been accused of being energy inefficient, as compared with the agricultural production of other countries. Indeed, it has frequently been suggested that energy scarcities and resultant higher energy costs will ultimately cause U.S. agriculture to adopt the more labor intensive practices of the third world countries. However, when data on energy efficiency are examined, the popular notion -- that subsistence farming uses less energy per unit of production than American agriculture -- is not supported.

While developed countries such as Japan and the United States use substantially greater amounts of mechanical horsepower, fertilizer, and irrigation energy; when non-commercial energy sources -- wood, crop residues, animal manure and human labor -- are taken into account, there is a surprisingly small difference in the total energy input among countries. Japan and the U.S. have substituted machine power with superior productivity for labor and animal power.

Table 2. Energy Use Per Hectare in Rice Production in Various Countries*/

Country	Installed Horsepower Per Hectare Farm Machines and Draft Animals Only	Energy for**/ Farm Operations Million BTU's/ Hectare	Energy for Irrigation & Nitrogen Fertilizers Manufacture Million BTU's Per Hectare	Total Energy Input/ Hectare Million BTU's	Rice Yield Kilograms Per Hectare	Energy Intensity Million BTU's Per Ton of Rice
India	0.7	20	6.5	26.5	1,400	19
China	0.7	20	12	32	3,000	10.7
Taiwan	0.5	10	22	32	4,000	8
Japan	1.6	10	25	35	5,600	6.2
U.S.A.	1.5	7	25	32	5,100	6.3

* Duncan, Marvin and Kerry Webb, Energy and American Agriculture, Federal Reserve Bank of Kansas City, February 1980.

** Includes non-commercial energy sources.

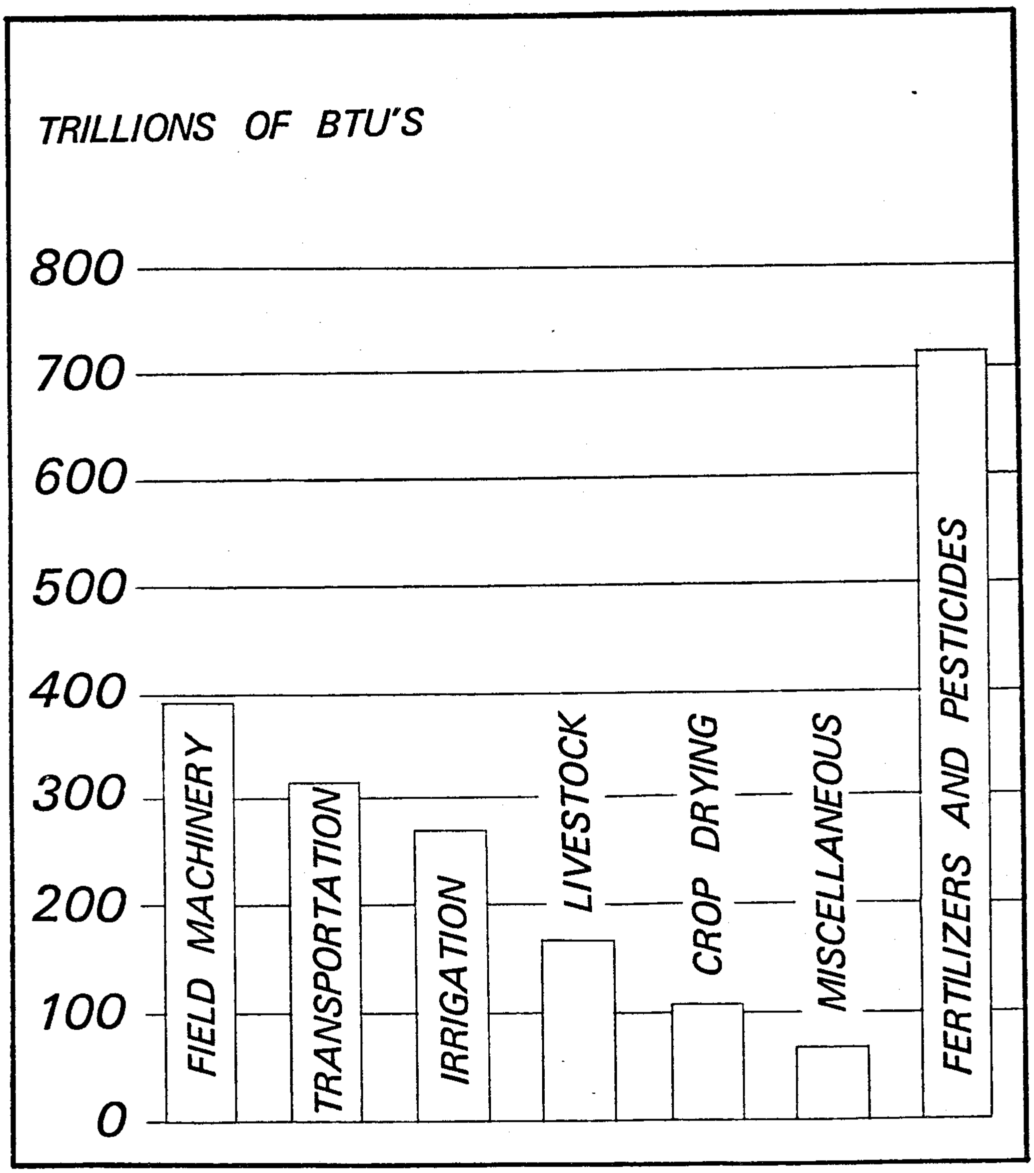
The belief that energy use in agriculture and underdeveloped countries is far less than in developed countries is based on the comparative use of fossil fuels, nuclear energy, and hydroelectric power. The energy sources common to peasant agriculture -- wood, crop residues, animal manure, and human and animal labor -- are not usually taken into account. The principal difference in energy use between developed and underdeveloped countries is not that substantially less energy is used in the latter countries, but rather how little productive work is obtained from energy used there as compared to developed countries.

Since 1910, the amount of land harvested in the U.S. has remained relatively constant. However, the average index of crop production nearly doubled between the 1911-1920 period and the decade 1967-1976. While the average index of farm labor use fell 74 percent, the average indices for machinery and agricultural chemicals rose 382 and 2,312 percent, respectively, between the two periods. Research suggests that about half of the increase in energy inputs has gone to improved productivity (with such inputs as fertilizers and chemicals), while half has been used to replace labor (with such inputs as larger machinery). Of the energy used in agricultural production, crop producing activities used 89 percent, while livestock production used only 11 percent. The purposes to which the energy used in agricultural production was put are shown in Figure 1.

Energy Use and Economics

The impact of energy on structure will be determined primarily by economic factors. In a market economy, relative prices guide resource

ENERGY USE IN AGRICULTURAL PRODUCTION



SOURCE: ENERGY AND U.S. AGRICULTURE: 1974 DATA BASE

Figure 1

use, with those inputs generating the greatest output relative to their respective costs, being the ones used in production. If all prices are known to producers, then profit maximizing behavior by producers will result in the most efficient use of all resources -- including energy resources. If the price of energy resources rises faster than substitute inputs in the production process, then less energy will be utilized relative to the other inputs.

Studies examining the elasticities of substitution between various inputs indicate a very high elasticity of substitution between mechanical energy and hired labor, chemical energy and mechanical energy, and land and mechanical energy.[2/] The elasticities of substitution for other variables are much lower, with the lowest being that between chemical energy and hired labor. (The elasticities of input substitution are pure numbers which measure the degree of relative ease with which substitution between two inputs may take place, when the prices and quantities of all other inputs remain constant. The higher the number, the easier the substitution.)

Table 3. Elasticities of Substitution[*/]

Elasticities of substitution between	Pacific Region
Land and Hired Labor	1.03
Land and Mechanical Energy	1.35
Land and Chemical Energy	.72
Hired Labor and Mechanical Energy	1.98
Hired Labor and Chemical Energy	.18
Mechanical Energy and Chemical Energy	1.42

*/ Duncan, Marvin and Kerry Webb, Energy and American Agriculture, Federal Reserve Bank of Kansas City, February 1980.

2/ These include E.R. Berndt and D.V. Wood, "Technology, Prices and Derived Demand for Energy." The Review of Economics and Statistics, August 1975 pp. 259-268; D.B. Humphrey & J.R. Moroney, "Substitution Among Capital Labor and Natural Resource Products in American Manufacturing," Journal of Political Economy, Vol. 83, No. 1, 1975, pp. 57-82; and M. Duncan and K. Webb, op. cit.

Duncan and Webb's study results indicate that mechanical energy (machinery) is the most flexible input included in the analytical model. It readily substitutes for hired labor, chemical energy and land.

The degree of substitutability between mechanical energy and chemical energy is quite important. There are those who have suggested that agriculture should return to less energy intensive production to conserve energy, i.e., by using more land and labor, energy could be saved. Duncan and Webb's research would indicate that, if conserving mechanical energy is important, substitution of hired labor would be the most efficient, followed by chemical energy and land.

On the other hand, if chemical energy conservation is the priority, mechanical energy is always a more realistic substitute than the two non-fossil fuel energy inputs, land and hired labor. Thus, the substitution of one form of energy for another may be more practical than using non fossil fuel energy consuming substitutes, making widespread shifts to human labor inputs impractical.

Farmers have flexibility to substitute inputs while maintaining output levels. It is not surprising that the farmers' substitutions are based primarily on the relative prices of the inputs and their input-output relationships as determined by the production function. Adjustments can be made within a production season between mechanical and chemical energy. However, some of the other possible substitutions are of a longer term nature and will occur more slowly.

Other Energy Impacts

The data analyzed here indicates that energy price rises have solidified the position of large farms in American agriculture. This is because the energy cost per unit of output is lower on large farms. With energy prices expected to rise relatively faster than other input prices, farmers are likely to substitute capital and land for energy. These changes imply that the existence of economies of size of operation will continue to provide pressure for farm size expansion. Fewer and larger farms will develop in those areas most suitable for efficient mechanization.

There will be some other impacts. It has been shown that it takes 62,000 BTU per bushel of corn produced in North Dakota and 169,000 BTU to produce corn in Kansas. The main difference is higher fertilizer use and supplemental irrigation required in the plains states. With water tables falling and the energy costs of pumping increasing, this difference is likely to intensify. As such, we may see some shifts from irrigated to non-irrigated agriculture in the plains states, thus, away from corn production.

Even among crops, corn requires more than three times as much energy per acre to produce as soybeans, and almost three times as much as wheat. Thus, we may see some shifts between crops. Crops that are nitrogen dependent require more energy than those that are not. Livestock and crop products that require extra processing or transportation are energy consumptive relative to others, thus their production costs will rise faster than the average. Some shifts may occur among crops and livestock and among cropping regions as the competitive relationships change.

Another factor which affects the producers in western states is the impact of public land policies upon the livestock industry. Energy requirements for extensive range type operations are generally less than those for intensive feedlot production of livestock. Thus, if access to the public lands becomes more difficult, the competitive position of range livestock operations will decline, relative to the rest of production agriculture.

Economies of Size and Energy Costs in Oregon Agriculture

The major inputs in the agricultural production process that reflect energy costs are fuels; fertilizer and chemicals; and machinery and equipment. These items were analyzed specifically for Oregon's farms and ranches using Census data. A measure of sales per dollar of energy related costs was derived for comparisons among types of farms. Economies of size were determined using the value of farm sales as the size criterion.

Energy related costs by value of sales for Oregon's agricultural output are presented in Table 4. Using acres of harvested cropland as the denominator, fuel costs decline as sales increase, fertilizer and chemical costs increase and machinery and equipment values decline. In total, fuel and chemical costs per harvested acre for Oregon's farms with sales of $100,000 or more are 136 percent of those with $2,500 to $4,999 sales, while machinery and equipment costs are only 26 percent as large. This relationship, together with the fact that sales per harvested acre are 2 2/3 times as high for the largest farmers, gives a ratio of 8.99 of sales per dollar of fuel and chemical related costs for these farmers versus 4.55 for those in the lowest sales category. Sales per dollar of machinery and equipment investment are 10 times as large for the largest farms as the smallest farms.

Table 4. Energy Related Costs and Machinery Investment per Harvested Acre of Cropland by Level of Farm Sales, Oregon, 1974 */

Value of farm sales	Cost per harvested acre		Value of machinery and equipment per harvested acre	Sales per harvested acre	Sales/ fuels, fertilizer & chemical cost	Sales/ value of machinery and equipment
	Fuel	Fertilizer and chemicals				
($)	($)	($)	($)	($)	($)	($)
100,000+	10.22	35.06	123.36	407.04	8.99	3.30
40-99,999	9.94	21.78	159.82	246.79	7.78	1.54
20-39,999	11.57	17.40	185.48	221.06	7.63	1.19
10-19,999	13.68	16.90	257.26	208.77	6.83	0.81
5-9,999	14.38	16.42	321.91	188.76	6.13	0.59
2.5-4,999	17.13	16.40	465.77	152.66	4.55	0.33
Average	10.82	27.89	161.93	324.15	8.37	2.94

*/ Calculated from Census of Agriculture Data

Livestock

Energy related costs were examined for each of the major types of farms, again by volume of sales. For livestock farms, all of the costs examined generally declined as the volume of sales increased, Table 5. The ratio of sales to fuel and chemical costs per harvested acre was 27.96 for the largest farms, declining to 4.38 for the smallest group. For this type of farming, fuel costs generally averaged higher than fertilizer and chemical costs. The ratio of sales and machinery and equipment investment was 5.98 for the largest farms and 0.31 for the smallest.

Table 5. Energy Related Costs and Machinery Investment per Harvested Acre of Cropland by Level of Farm Sales, Oregon, 1974, Livestock Farms, Except Dairy, Poultry and Animal Specialty */

Value of farm sales	Cost per harvested acre: Fuel	Cost per harvested acre: Fertilizer and chemicals	Value of machinery and equipment per harvested acre	Sales per harvested acre	Sales/ fuels, fertilizer & chemical cost	Sales/ value of machinery and equipment
($)	($)	($)	($)	($)	($)	($)
100,000+	10.47	10.79	99.40	594.39	27.96	5.98
40-99,999	10.45	7.01	134.30	193.21	11.07	1.44
20-39,999	11.88	8.32	176.92	185.56	9.19	1.05
10-19,999	14.69	10.82	250.84	182.33	7.15	0.73
5-9,999	16.96	14.41	358.89	198.03	6.31	0.55
2.5-4,999	20.05	16.70	522.09	161.00	4.38	0.31
Average	12.19	10.08	180.97	327.87	14.72	1.81

*/ Calculated from 1974 Census of Agriculture Data

Cash Grain

Cash grain farms showed economies of size in fuel costs and for machinery and equipment investment. The per acre cost of fertilizer and chemicals was relatively constant for all levels of sales. The ratio of sales to fuel and chemical costs was 7.54 for the largest farms and 4.50 for those with the least sales. Sales to machinery and equipment ratios were 2.39 and 0.35, respectively. Total energy related costs were lowest for this type of farming, Table 6.

Table 6. Energy Related Costs and Machinery Investment per Harvested Acre of Cropland by Level of Farm Sales, Oregon, 1974, Cash Grain Farms */

Value of farm sales	Cost per harvested acre		Value of machinery and equipment per harvested acre	Sales per harvested acre	Sales/ fuels, fertilizer & chemical cost	Sales/ value of machinery and equipment
	Fuel	Fertilizer and chemicals				
($)	($)	($)	($)	($)	($)	($)
100,000+	5.52	16.47	69.48	165.73	7.54	2.39
40-99,999	6.23	14.92	96.76	136.56	6.64	1.44
20-39,999	7.68	14.57	120.93	132.44	5.95	1.10
10-19,999	9.69	18.05	195.49	143.77	5.18	0.74
5-9,999	9.63	16.39	227.63	129.33	4.97	0.57
2.5-4,999	11.96	15.73	352.89	124.70	4.50	0.35
Average	6.09	15.70	89.98	149.34	6.86	1.66

*/ Calculated from 1974 Census of Agriculture Data

Field Crops

The cost pattern for field crop farms showed increasing costs per harvested acre for fertilizer and chemicals. Fuel costs decreased from the smallest sales group to those selling from $10-19,999, then increased. Machinery and equipment values per acre were relatively constant. The ratio of sales per dollar of fuel and chemical energy costs was relatively constant. However, the ratio of sales to machinery investment was 2.78 for the largest group declining to 0.42 for the smallest group, Table 7.

Table 7. Energy Related Costs and Machinery Investment per Harvested Acre of Cropland by Level of Farm Sales, Oregon, 1974, Field Crop Farms */

Value of farm sales	Cost per harvested acre		Value of machinery and equipment per harvested acre	Sales per harvested acre	Sales/ fuels, fertilizer & chemical cost	Sales/ value of machinery and equipment
	Fuel	Fertilizer and chemicals				
($)	($)	($)	($)	($)	($)	($)
100,000+	9.81	59.72	136.64	380.47	5.47	2.78
40-99,999	8.47	32.70	162.41	206.90	5.03	1.27
20-39,999	7.92	16.63	126.29	130.38	5.31	1.03
10-19,999	6.40	9.58	124.40	88.57	5.54	0.71
5-9,999	6.71	7.70	146.43	75.83	5.26	0.52
2.5-4,999	6.81	6.97	146.00	61.20	4.44	0.42
Average	8.90	42.93	140.25	279.32	5.39	1.99

*/ Calculated from 1974 Census of Agriculture Data

Vegetables and Melons

Vegetable and melon farms' per acre fuel costs for the largest group were only about half as much as for the smallest sales group. Those with sales between \$5,000 and \$100,000 had about equal fuel costs. Fertilizer and chemical costs were mixed. Machinery and equipment values were 5½ times as much per acre for the smallest versus the largest farms. The ratio of sales to fuel and chemical costs showed no trend. However the ratio of sales to machinery investment was 2.61 for the largest sales group compared to 0.42 for the smallest, Table 8.

Table 8. Energy Related Costs and Machinery Investment per Harvested Acre of Cropland by Level of Farm Sales, Oregon, 1974, Vegetable and Melon Farms */

Value of farm sales	Cost per harvested acre		Value of machinery and equipment per harvested acre	Sales per harvested acre	Sales/ fuels, fertilizer & chemical cost	Sales/ value of machinery and equipment
	Fuel	Fertilizer and chemicals				
($)	($)	($)	($)	($)	($)	($)
100,000+	15.59	69.03	198.77	518.89	6.13	2.61
40-99,999	20.94	70.02	385.07	627.34	6.90	1.37
20-39,999	21.56	53.10	405.54	522.43	7.00	1.29
10-19,999	20.58	68.84	488.96	463.90	5.19	0.95
5-9,999	22.18	55.44	721.77	468.75	6.04	0.65
2.5-4,999	30.12	39.16	1,114.46	463.85	6.70	0.42
Average	16.29	68.36	243.55	532.33	6.29	2.19

*/ Calculated from 1974 Census of Agriculture Data

Fruit and Tree Nuts

Fuel, fertilizer and chemical costs per acre increased with size for fruit and tree nut farms, but the ratio of sales to these costs was 8.68 for the largest farms declining to 4.88 for the smallest farms. Machinery and equipment values generally declined. The ratio of sales to machinery investment was 3.40 for the largest farms declining to 0.36 for the smallest, Table 9.

Table 9. Energy Related Costs and Machinery Investment per Harvested Acre of Cropland by Level of Farm Sales, Oregon, 1974, Fruit and Tree Nut Farms */

Value of farm sales	Cost per harvested acre		Value of machinery and equipment per harvested acre	Sales per harvested acre	Sales/ fuels, fertilizer & chemical cost	Sales/ value of machinery and equipment
	Fuel	Fertilizer and chemicals				
($)	($)	($)	($)	($)	($)	($)
100,000+	28.51	97.62	322.50	1,095.04	8.68	3.40
40-99,999	23.15	80.48	413.88	846.21	8.17	2.04
20-39,999	22.35	53.80	412.54	596.77	7.84	1.45
10-19,999	21.88	43.47	500.48	520.82	7.97	1.04
5-9,999	18.92	38.44	534.86	376.50	6.57	0.70
2.5-4,999	15.43	23.35	531.20	189.16	4.88	0.36
Average	23.63	68.92	413.95	752.73	8.13	1.82

*/ Calculated from 1974 Census of Agriculture Data

Dairy

Dairy farms showed a mixed bag considering fuel costs. Yet, farms with the largest sales had costs about 30 percent lower than those with the least sales. Per acre fertilizer and chemical costs increased with sales volume. Machinery and equipment values were over 30 percent lower for the largest sales group and about 30 percent higher for the smallest farms as compared to all of the others. Sales to fuel and chemical cost ratios ranged from 24.33 for those farms with sales of $100,000 or more to 7.17 for the smallest farm category, Table 10. Sales to machinery investment ratios were 3.95 and 0.41 for the largest and smallest farms, respectively.

Table 10. Energy Related Costs and Machinery Investment per Harvested Acre of Cropland by Level of Farm Sales, Oregon, 1974, Dairy Farms */

Value of farm sales	Cost per harvested acre		Value of machinery and equipment per harvested acre	Sales per harvested acre	Sales/ fuels, fertilizer & chemical cost	Sales/ value of machinery and equipment
	Fuel	Fertilizer and chemicals				
($)	($)	($)	($)	($)	($)	($)
100,000+	22.06	31.19	327.93	1,295.55	24.33	3.95
40-99,999	28.42	28.75	534.51	1,165.12	20.38	2.18
20-39,999	24.63	21.27	516.03	721.55	15.72	1.40
10-19,999	23.87	19.73	503.80	544.21	12.48	1.08
5-9,999	24.97	10.24	540.33	362.36	10.29	0.67
2.5-4,999	30.52	10.77	718.13	296.23	7.17	0.41
Average	24.37	28.02	426.25	1,118.56	21.35	2.62

*/ Calculated from 1974 Census of Agriculture Data

Examining average energy related costs among types of farming shows the lowest fuel costs and machinery and equipment investment associated with cash grain farms. Lowest fertilizer and chemical costs were incurred by livestock farms, Table 11.

Table 11. Energy Related Costs and Machinery Investment per Harvested Acre of Cropland by Type of Farm, Oregon, 1974 */

Type of farm	Cost per harvested acre		Value of machinery and equipment per harvested acre	Sales per harvested acre	Sales/ fuels, fertilizer & chemical cost	Sales/ value of machinery and equipment
	Fuel	Fertilizer and chemicals				
	($)	($)	($)	($)	($)	($)
Livestock	12.19	10.08	180.97	327.87	14.72	1.81
Cash grain	6.09	15.70	89.98	149.34	6.86	1.66
Field crops	8.90	42.93	140.25	279.32	5.39	1.99
Vegetable crops	16.29	68.36	243.55	532.33	6.29	2.19
Fruit & tree nuts	23.63	68.92	413.95	752.73	8.13	1.82
Dairy	24.37	28.02	426.25	1,118.56	21.35	2.62
All farm average	10.82	27.89	161.93	324.15	8.37	2.94

*/ Farms with sales of $2,500 or more, Census Data

However, the highest ratio of sales per acre to fuel and chemical related costs, as well as machinery investment, was obtained for dairy farms. The lowest fuel and chemical ratio was obtained for field crops and machinery investment for cash grain farms. The ratios of sales to fuel and chemical costs indicate large economies of size in these energy cost components for livestock and dairy operations. Modest economies appear to be present for cash grain and fruit and tree nut farms. Field crop and vegetable farms are largely size neutral for these inputs at present price levels.

Preliminary figures from the 1978 Census of Agriculture indicate that the average fuel cost per acre of harvested cropland in Oregon has increased 45 percent; fertilizer and chemicals, 19 percent; and machinery and equipment value, a whopping 72 percent. With a 23 percent increase in average value of sales per acre, the sales to fuel and chemical cost ratio fell to 8.16 (as compared to 1974's 8.37). The ratio of sales to machinery value declined to 1.43 in 1978 compared to 2.94 in 1974.

Summary

Economies of size, measured by the ratio of value of sales per acre of harvested cropland to machinery investment per acre of harvested cropland, exist for all types of farms in Oregon. Economies of size were also present on livestock, dairy, cash grain, and fruit and tree nut farms for fuel and chemical costs. Vegetable and field crop farms showed little change in ratios as farm size changed.

Sales per harvested acre were higher in every type of farming for the largest farms versus the smallest farms. They averaged 6.2 times as much for field crop farms, 5.8 for fruit and tree nut farms, 4.4 for dairies and 3.7 for livestock farms. The difference was much less for cash grain and vegetable farms averaging 1.3 and 1.1, respectively.

The value of machinery and equipment per harvested acre was less than 20 percent as much for the largest as compared to the smallest farms for livestock, cash grain and vegetable farms. It was 46 percent for dairy farms and just over 60 percent for fruit and tree nut farms. Vegetable farms showed little variance in per acre value of machinery and equipment related to the volume of farm sales.

Conclusions

Rising fuel, fertilizer and chemical prices will affect Oregon's livestock and dairy farms the least, relatively, as indicated by the very high sales to cost ratios. Field crops will be affected the most. The largest farms producing field crops, fruit and tree nuts and the larger dairies will suffer relatively more impact than their smaller counterparts, as the absolute level of their expenditures for these inputs are 4.1, 3.1 and 1.6 times greater for the largest versus the smallest farms. The absolute impact could be much greater, however, for the small farmers because of their low sales per harvested acre.

The incentive to increase the size of operation, as measured by increased sales, appears to be greatest for livestock and dairy operations when considering only fuel, fertilizer and chemical costs. These same costs provide little per unit incentive for expansion in other types of farming. The ratio of sales to machinery investment per acre provides incentive for expansion for all categories of farms. A more important incentive for livestock, field crop, fruit and tree nut, and dairy farmers to expand might be the increase in sales per harvested acre associated with farms with larger total sales.

Caveat

It must be remembered that this analysis considers only the cost of selected energy related inputs in the production process; thus, at best, is a partial analysis. All other production costs would need to be considered in a complete analysis of economies of size in crop and livestock production. If there are marketing advantages to be gained as quantities sold increase, these are incorporated in this analysis since total value of sales was used as the measure of size. The largest census classification of farm size, as measured by sales, is $100,000+. This is not a very large farm in many types of production. Thus, the relevant areas for an analysis such as this may be among those farm sizes aggregated in the $100,000+ sales class.

Further, income, gift and inheritance tax policies, cost characteristics of irrigation water delivery systems, federal price and income policies and inflation may all have size related impacts that are more significant than energy costs. These should be kept in mind to give proper perspective to this analysis.