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IMPACTS OF DIFFERING FARM SIZES ON FARM AND NONFARM SECTORS OF THE NORTH CENTRAL REGION*

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One of the most persistent features of American agriculture over the last three decades has been the rapid expansion of the individual farming unit. In 1939, the national average farm size was 174 acres but by 1969 the average farm unit had grown to 390 acres, an increase of 124 percent [4]. Although not quite as pronounced as for the rest of the nation, a rapid growth in average farm size also occurred in the North Central region of the nation, from 185 acres per farm in 1939 to 311 acres in 1969 [4]. An interrelated set of economic and social forces has combined to encourage this rapid expansion in the size of individual farming operations. Included in this set are relatively high prices for farm labor combined with relatively lower prices for capital inputs, increasing managerial abilities of the farm operator, expansion of available farm credit, introduction of labor-saving technologies, and the desire of the farm family for higher incomes. An additional factor for much of the period was government programs that restricted the land input but allowed the farmer to increase his capital inputs and to increase the total land area under his control.

At the same time that the farming industry was experiencing an increase in farm size, and a resulting decrease in farm numbers, many rural communities were experiencing sharp decreases in population and economic activity. As fewer and fewer farm workers remained to be served and as those remaining became able to travel farther distances to receive their services, the small rural village, which had been started to serve the farm industry, began to lose its economic reason for existence. As the farm labor force was reduced, the farm population plummeted from over 30 million people in 1940 to less than 10 million in 1970 [4]. And as the farm population fell, the percentage of the nation's population living in rural areas declined from 36 percent in 1950 to 26.5 percent in 1970 [4]. Recently, national attention has been focused on the plight of those rural communities who were possibly suffering the major costs of the structural changes occurring in farming. This national concern led to enactment of the Rural Development Act of 1972 as an attempt

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to redress some of the inequities falling on the nonfarm component of the rural community.

Under Title V of that Act, an explicit relationship is hypothesized between rapid growth in farm size and decline of the rural community. The study discussed in this paper is an attempt to investigate that hypothesis and to quantify some of the welfare trade-offs implied by structural changes in the farming industry. These trade-offs are examined as they exist between the farming industry, the rural community, and consumers of farm products. Specifically, the analysis centers on the question: What are the effects of alternative farming systems on the various economic groups affected by the agricultural industry? Although all of the relationships between the structure of agriculture and farm-related groups are not quantified in the study, initial estimates for variables concerning major economic groups are made. These estimates, combined with the relative importance society attaches to those variables, can then be used as input to the policy making process. In addition to quantifying trade-offs, a further goal of the analysis is to propose the concept that farm size itself may be a policy variable.

Although national implications also are discussed, outcomes specifically for the North Central region of the nation are detailed for some variables. For this presentation the North Central region is defined as including the following 12 states: North Dakota, South Dakota, Nebraska, Kansas, Missouri, Iowa, Minnesota, Wisconsin, Illinois, Indiana, Michigan, and Ohio. These 12 states were chosen for explicit analysis because they form a major agricultural production area of the nation and because rural communities remain a relatively large component of this region.

Assumptions and Programming Model for the Study

To measure trade-offs among various groups, quantities for certain economic variables are estimated and compared in this analysis. These variables include average farm size, receipts to the farm sector, number of farms required, net receipts per farming operation, farm labor required, farm supply prices, and secondary income generation. (The secondary income generation variable relates value of farm production to the off-farm income generated by that production). Outcomes for these particular variables are presented because they serve as indicators of well-being for major groups affected by the agricultural industry.

Outcomes for the above mentioned variables are estimated under four different assumptions as to the future structure of American agriculture. For three of these assumptions, farms are constrained to a discrete size, and outcomes are estimated as if the farming industry were entirely composed of farms of that size. These alternative situations are identified as: the Small-Farm Alternative, the Medium-Farm Alternative, and the Large-Farm Alternative. A fourth situation, called the Typical-Farm Alternative, represents commercial agriculture where a mix, based on present trends in the structure of farming, of the three farm sizes coexist.

Production coefficients of the Small-Farm Alternative represent the technology of commercial farms with gross farm sales of no more than $10,000.

This category corresponds to farms in economic classes IV and V of the United States Bureau of the Census. Nationally, commercial farms in this category had an average size of 232 acres in 1969 [5]. Farms in this group generally would be considered too small to provide an adequate family income if the family was dependent on farming as its sole income source. In evidence of the low-farm income potential in this category, 41 percent of its farm operators were employed in off-farm work for more than 100 days in 1969 [5].

Production coefficients for the Medium-Farm Alternative are representative of commercial farms in economic classes II and III of the Census Bureau. Farms in this category have gross sales of more than $10,000 but no more than $39,999. The average farm in this grouping was 520 acres in size and had $20,597 in gross farm sales in 1969 [5].

Production data for the Large-Farm Alternative characterize farms in economic class I, gross sales of more than $40,000, of the Census Bureau. For the nation, these farms averaged 1,603 acres and $113,552 in gross sales in 1969 [5]. Farm operators in this group are highly commercial and could depend entirely on their farming operation for their family income.

Because American agriculture is not expected to be composed entirely of small, medium, or large farms in 1980, the Typical-Farm Alternative is also defined. This alternative provides a base situation to compare with the situations incorporating coefficients of the three distinct farm size categories. This category represents the cost structure and productive technology of farming if recent farm size trends were to continue to 1980. Average farm size for this structure would be similar to the average under the Medium-Farm Alternative. However, productive coefficients of each of the three farm size situations (small, medium, and large) are incorporated within the Typical-Farm Alternative.[1]

A national interregional programming model is the basic quantitative tool of the analysis. This model incorporates an interregional comparative advantage production analysis, a transportation submodel, and a regional demand sector. It internally describes the wheat, feed grains, soybeans and cotton production sectors of American agriculture while the forage and livestock sectors are included as fixed bounds to the system. The model, which contains 275 equations and 2,060 real activities, minimizes the cost of producing its crop commodities in 150 producing areas and of transporting them among 31 market regions. For each region in the model, different productive coefficients have been developed to reflect each farm size assumption for the four model crops. All parameters and coefficients for this programming model are estimated for the year 1980.

The model estimates commodity supplies endogenously in each of the 150 rural (or agricultural producing) areas shown in Figure 1. Land in each area

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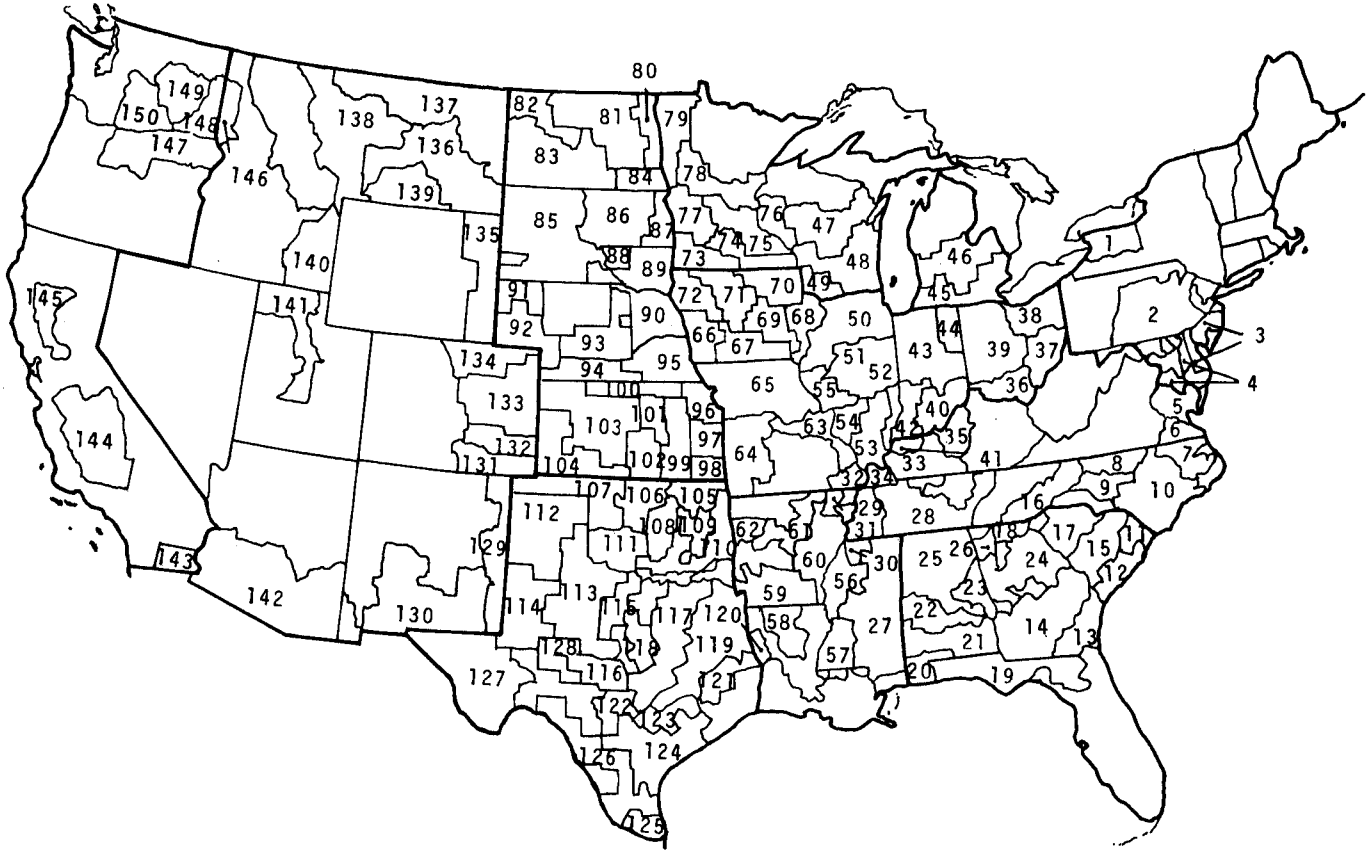
[1]For this alternative, farm numbers would be distributed among the three farm size categories with 32 percent of the farms in the large-farm category, 24 percent in the medium-farm category, and 44 percent in the small-farm group.

FIGURE 1: Rural Areas Defined for Study



serves as an internal restraint on the supply of crop commodities. In the absence of any further restraints, the programming model would assume complete resource mobility among regions and commodities. This assumption was considered untenable for a 1980 time frame. Therefore for each alternative situation, each of the 150 rural areas is required to have at least 80 percent as many acres of wheat, feed grain, and soybeans and 67 percent as many acres of cotton in production as it had in 1969.[2] Because of space limitations, further details of the programming model are not presented here. This model is an extension of the family of programming models developed at Iowa State University [2] and a complete description of this model can be found in [1, 3].

Economic Impacts

Although many numerical estimates are available from the programming model, only a few will be presented here. The relationships included here were chosen because they represent some of the major trade-offs dictated by the different farm size situations.

Average Farm Size. Because of the different types of farming in the North Central region, the size of the average farming operation varies widely among its three farm production regions. Traditionally, farm units in the Corn Belt and Lake States regions have been very much smaller than those of the Northern Plains region. In 1971 for example, the average farming operation contained 720 acres in the wheat and cow/calf ranching areas of the Northern Plains. This acreage is more than three times larger than the average farming unit in the other two farm production regions [4].

Estimates of the average size of farming operation for each of the farm size situations are presented in Table 1. For the Typical-Farm Alternative, the national average farm size is estimated at 613 acres, 224 acres larger than in 1971. This rapid growth in per farm acreage assumes that the expansion in farm size that occurred from 1959 to 1969 will continue to 1980. Nationally, average farm size under the Medium-Farm Alternative, 502 acres, is 18 percent less than estimated for the situation where all three farm structures exist but is 113 acres larger than the 1971 farm size. For this analysis, the most extreme farm size values are estimated for the Small- and Large-Farm Alternatives. When the agricultural industry is assumed to be entirely composed of small farms, average farm size is estimated at 239 acres, 374 acres less than estimated for the Typical-Farm Alternative and only 61 percent of the 1971 average farm size. In contrast, average farm size is estimated at 1,132 acres if all farms were large, almost three times the 1971 average.

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[2]The levels of 80 and 67 percent were arbitrarily chosen to force the model results to be influenced by past production patterns. The upper limit on any area's production is the land base historically available to the model crops in that area.

TABLE 1: Estimated Average-Farm Size for the United States, the North Central Region, and the Three Farm Production Regions Within the North Central Region for 1971 and for each of the Farm-Size Alternatives

Region	Farm Size 1971[a]	1980 Estimates			
		Typical-Farm Alternative	Small-Farm Alternative	Medium-Farm Alternative	Large-Farm Alternative
United States	389	613	239	502	1,132
North Central	318	450	183	392	700
Corn Belt	215	312	125	289	556
Lake States	206	294	157	260	492
Northern Plains	720	912	300	691	1,049

[a]Source: [4]

For the North Central region, average farm size is projected to be smaller than the national average but follows the same pattern between the model alternatives as exhibited at the national level. Within the region, the Corn Belt and Lake States regions would have smaller farms for all of the model situations than would the Northern Plains region. Average farm size for all three farm production regions under the Typical-Farm Alternative would be larger than in 1971 but would not have grown as rapidly as the national estimate.

Generally the average farm size estimates for each of the three farm production regions follow the same pattern as the national estimates. Small farms in the Lake States region, however, would be 47 percent smaller than for the Typical-Farm Alternative even though the national farm size decreases by 61 percent between these two estimates. This indicates that the Lake States region has relatively larger farms (in acres) in the small-farm category than does the rest of the nation. Also, average farm size in the Northern Plains region is estimated to be 1,049 acres for the Large-Farm Alternative. Although this is the largest acreage estimated in the North Central region, it is only 115 percent of the typical-farm acreage in this region. In contrast, average farm size increases by 78 and 68 percent in the Corn Belt and Lake States, respectively, between the Typical- and Large-Farm Alternatives. The smaller increase noted for the Northern Plains region indicates that a relatively large proportion of the farms in the Typical-Farm Alternative would be from the large-farm category in this region.

Supply Prices. For each of the farm size alternatives, the programming model estimates the price necessary to induce farmers to produce the quantity of output demanded. To determine these prices, the programming model chooses the rural area with the lowest production costs to enter the solution first. (Here land costs are not a part of the cost of production, but landowners are assumed to receive any residual return from production.) It then selects additional rural areas with increasingly higher production costs until the specified demands are exactly satisfied. Because the model operates as if agriculture were a perfectly competitive industry, the cost of production in the highest-cost rural area selected is the price applicable throughout the rest of the industry (abstracting for the moment from price differentials due to transportation costs). In those rural areas with lower costs than the last rural area, the difference between their cost of production and the national price is considered to be a residual return to land. Table 2 presents these supply prices for the nation and the North Central region for each of the model alternatives. These are farm level prices and therefore do not include charges for transportation between consuming regions. For the three commodities presented in Table 2, supply prices are highest under the Small-Farm Alternative, both at the national and regional levels. Between this and the Typical-Farm Alternative, national price increases are estimated at 18 percent for wheat, 15 percent for feed grains, and 21 percent for soybeans. These increases result because of the higher production costs associated with a farming industry consisting of all small farms.

In contrast, only slight differences in price are estimated between the Typical- and Medium-Farm Alternatives. Per unit the largest difference between

TABLE 2: Estimated Supply Prices for the Nation and the North Central Region[a]

	Typical Farm Alternative	Small Farm Alternative	Medium Farm Alternative	Large-Farm Alternative
		Wheat		
National	1.80	2.12	1.75	1.56
North Central	1.57	1.84	1.54	1.33
		Feed Grains		
National	1.26	1.45	1.24	1.07
North Central	1.14	1.32	1.13	0.97
		Soybeans		
National	2.44	2.95	2.41	1.98
North Central	2.36	2.87	2.34	1.90

[a]All prices for 1980 are measured in 1972 dollars and do not take into account inflation to 1980.

these two situations is the 5 cent differential for wheat. The similar supply price estimates of these two alternatives imply that these three commodities could be produced as cheaply by a farming industry composed of all medium-sized farms as by one where a mix of farming structures exists.

Supply price estimates under the Large-Farm Alternative are the lowest of the four farm size situations described here. Because of the economies of large scale operations, price reductions of from 13 percent for wheat to 19 percent for soybeans are estimated between the Typical- and Large-Farm Alternative.

Supply prices generated for the North Central region are consistently lower than the national estimates for the three commodities. This reflects the region's ability to produce wheat, feed grains, and soybeans at a lower cost than the national average.

Although differences in consumer food costs are not directly estimated between the four model alternatives, the effect of each situation on the supply prices of the model commodities does reflect an implied impact on consumer food costs. For example, the higher supply prices of the Small-Farm Alternative must eventually be translated into higher feed costs for livestock producers and higher consumer prices for livestock products. The reverse, of course, is true for the lower prices of the Large-Farm Alternative. In addition, if the scale economies estimated for the crop commodities are also present in livestock production, supply price differentials for livestock production between the farm size situations would vary in the same fashion as estimated for wheat, feed grains and soybeans.

Receipts from Farming. When combined with production estimates for the North Central region, the supply prices just discussed can be used to estimate cash receipts for the model commodities. After deducting production expenses, net receipts to the farming sector (for the model commodities) also can be estimated. These estimates, as well as farm numbers and net receipts per farm, are presented in Table 3 for the North Central region.

Because production levels are held essentially constant among the four model alternatives, the net receipt estimates of Table 3 reflect the price effect of the different situations. Therefore, net receipts for the Small-Farm Alternative, $3.2 billion, are 35 percent greater than for the Typical-Farm Alternative. But the number of farms required if all farms were small, 2.2 million, is 246 percent greater than in the latter situation. This increase in farm numbers is consistent with the decrease in average farm size (from 450 acres to 183 acres) discussed previously. Because farm numbers increase much more rapidly between the Typical- and Small-Farm Alternatives than do net receipts, per farm net receipts must decline substantially. Net receipts per farm are estimated at $1,454 in the latter situation, only 55 percent of the per farm receipts estimated for the Typical-Farm Alternative.

Total net receipts are nearly equivalent for the Typical- and Medium-Farm Alternatives. However, the number of farm units required for the latter situation, 1,026,700, is 132,600 greater than for the former. This greater

TABLE 3: Estimates for the North Central Region of the Total Number of Farms Required, Net Receipts and Net Receipts per Farm for the Model Crop Commodities

	Typical Farm Alternative	Small Farm Alternative	Medium Farm Alternative	Large Farm Alternative
Net receipts (million dollars)	2,379.8	3,201.7	2,442.5	1,710.0
Number of farms (thousand)	894.1	2,202.3	1,026.7	574.6
Net receipts per farm (dollars)	2,662	1,454	2,379	2,976

number of farms translates to an 11 percent decrease in per farm net receipts for the Medium-Farm Alternative.

The differential in farm size between the Typical- and the Large-Farm Alternatives is not as great in the North Central region as for the entire nation. For the nation, average farm size would increase by 519 acres between these two situations but for the North Central region the increase is only 250 acres. This differential results because traditionally large farms (on the basis of sales) in this region were not as large (on the basis of acres) as was true for the rest of the nation. With the lower prices of the Large-Farm Alternative, total net receipts for the region would be only 72 percent of their level for the Typical-Farm Alternative. But at the same time the number of farms required decreases by 36 percent, resulting in a 12 percent per farm increase in net receipts between the Large- and Typical-Farm Alternative. Although in the North Central region this increase in receipts is only $314 per farm, a larger increase would be expected for the entire nation as relatively fewer large farms would be needed in the other regions of the nation [1].

Labor Requirements. Each of the farm size structures analyzed implies a different labor input/output relationship. Estimates of the man-hours of labor required to produce the model commodities are presented in Table 4 for the North Central region and for the three farm production regions it contains. The size of the agricultural labor force, of course, is extremely important to those rural communities serving agriculture. Although those rural citizens who supply productive inputs or process farm output may not be directly affected by changes in the size of the farm work force, those rural townspeople who supply services consumed directly by the farm worker would be affected. This latter group includes suppliers of services such as the barber, clergyman, and educator as well as those who supply retail goods to the farming community.

The estimates presented in Table 4 indicate the significant impact changes the farming structure can have on the size of the farm labor force needed in the North Central region. The 983.7 million man-hours required to produce the four model crop commodities under the Small-Farm Alternative are 26 percent more than required for the Typical-Farm Alternative. In sharp contrast, when all farms are assumed to be large only 89 percent as many man-hours of labor are required as when all three farm sizes are assumed to exist. Man-hour requirements for the Typical- and Medium-Farm Alternatives are nearly equal, with only a slight reduction noted for the latter.

Man-hour estimates for the three farm production regions generally follow the same pattern as noted for the entire North Central region. The most notable fluctuation occurs between the Medium- and Typical-Farm Alternatives. For the entire region, man-hour requirements vary only slightly between the two situations. But in the Corn Belt region the labor requirement for the Medium-Farm Alternative is 5 percent less than for the Typical-Farm Alternative. This decrease is substantially offset, however, by a 5 percent increase between the two situations in the Northern Plains

TABLE 4: Estimated Hours of Labor Required to Produce the Model Commodities for Each Farm-Size Situation

	Typical Farm Alternative	Small Farm Alternative	Medium Farm Alternative	Large Farm Alternative
	(Thousand Hours)			
North Central Region	781,548	983,718	776,077	695,744
Corn Belt	454,331	573,149	435,184	400,337
Lake States	139,160	163,943	141,131	130,368
Northern Plains	188,057	246,626	199,762	165,039

region. These estimates indicate differing labor intensities between the Medium- and Typical-Farm Alternatives in these two regions. This situation illustrates that an outcome which has neutral impacts at a higher level of regional aggregation could have significant positive or negative effects at a lower level of aggregation.

Secondary Income Generation. In addition to those rural citizens who directly support farm workers, other rural people supply productive inputs and process the outputs of the farming industry. Although estimation of farm-labor requirements provides information of effects on the first group, effects on the entire group are also of interest. To indicate this effect, variables were developed which relate the value of production of the model commodities to their total income generating capability. In Table 5, we present indices which indicate this total effect where outcomes for the Typical-Farm Alternative are normalized to equal 100 and outcomes for the other circumstances are presented as the change from that base situation. A complete description of the derivation of these indices can be found in [3].

As the price of farm output and the amount of labor used increase, more economic activity would be generated in those industries and rural communities serving agriculture. Therefore, the secondary income index for the North Central region is estimated to be 19 percent higher for the Small-Farm Alternative than for the Typical-Farm Alternative.

In sharp contrast, the lower prices and reduced labor requirements of the Large-Farm Alternative lead to a sharply lower index of secondary income than for the Typical-Farm Alternative. This index value of 84 is the lowest estimate of the four farm size situations (Table 5).

Index values for the three farm production regions contained in the North Central region follow very closely the estimates noted for the entire region. These estimates indicate similar impacts on secondary income at the farm production region level as for the North Central region as a whole.

Summary

The study discussed in this paper has attempted to quantify some of the conflicts dictated by different assumptions as to the size of the individual farming operations. Because economic groups, in addition to farmers themselves, are affected by changes in the agricultural industry, impacts on consumers and on the economic vitality of agriculturally related industries are considered as well as effects on strictly agricultural variables. To trace these impacts, variables for which estimates are made in this study include average farm size, receipts to the farm sector, number of farms required, net receipts per farming operation, farm labor requirements, farm supply prices, and secondary income generation.

Outcomes for each of these variables are estimated under four farm-size assumptions. For three of these situations, the farming industry would be

TABLE 5: Indices of Secondary Income Generation

	Typical Farm Alternative	Small Farm Alternative	Medium Farm Alternative	Large Farm Alternative
North Central Region	100	119	99	84
Corn Belt	100	117	98	83
Lake States	100	121	101	85
Northern Plains	100	121	101	85

composed entirely of farms of one size. These circumstances are identified as: the Small-Farm Alternative, the Medium-Farm Alternative, and the Large-Farm Alternative. A fourth situation, the Typical-Farm Alternative, represents commercial agriculture where small, medium, and large farming operations would coexist.

The estimated results of the analysis indicate some of the potential conflicts of differing farming structures for major economic groups. Using the Typical-Farm Alternative as a base, an agriculture composed of all small farms implies an average farming operation of 183 acres in this region, only 41 percent as large as for that base case and requiring more than twice as many farming operations. Production inefficiencies of smaller scale operations require increases in the supply price of farm commodities, implying increases in the price consumers would pay for food commodities. Although the supply price of farm commodities is higher when all farms are small, the tremendous expansion in farm numbers reduces net receipts per farm to a level only 55 percent as great as estimated for the Typical-Farm Alternative. And the labor-intensive agriculture assumed in the small farm hypothesis results in a 25 percent increase in farm labor requirements. As the farm labor force expands and the price of farm products rises, economic activity in agriculturally related industries and in rural communities also must increase. Therefore, the secondary income generation variable is 20 percent higher in the circumstance where all small farms exist.

The trade-offs implied when all farms would be large are the opposite of those for all small farms. Average farm size, again using the Typical-Farm Alternative as the base, increases by 56 percent and farm numbers decrease by 36 percent. Because of production efficiencies for larger farms, the supply price of farm commodities and consumer food costs fall. The estimated decrease in price is offset by a reduction in farm numbers allowing net receipts per farm in the region to increase by 12 percent. And the more capital-intensive structure of the Large-Farm Alternative leads to an 11 percent reduction in the man-hours of farm labor needed. This labor force reduction, coupled with lower output prices, results in a negative impact on secondary income generation. The scenario of rising per farm income and decreased economic activity in rural communities described by this farm size situation characterizes the economic forces that have been at work in the nation's rural areas throughout much of this century.

For all of the variables considered, results estimated when agriculture is assumed to consist of all medium-sized farming units are nearly equivalent to those resulting when a mix of farm sizes would exist. This lack of change implies that the model's crop commodities could be supplied equally well in either of these situations.

The analysis discussed in this paper certainly does not quantify all effects of alternative farm size situations. Such factors as potential environmental gains implied by a more grass- and livestock-intensive agriculture of smaller farms or a greater reliance on petroleum products by larger farms are also of relevance. In addition, even though decreasing returns to scale exist for the farm sizes of this study, a continued reduction

in per unit production costs may not occur for farm sizes substantially larger than those considered here. This may be especially true if less efficient management forms are combined with a greatly expanded scale of operation. But, even though this analysis does not provide estimates for all variables, it does highlight some of the major potential gains and losses as farm size expansion proceeds in the agricultural industry.

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