Changes in Production During World War II By Size of Farm

By Jackson V. McElveen[1]

American agriculture is again being asked to expand output to meet national emergency needs. BAE, in cooperation with the Land-Grant Colleges and other agencies, is undertaking a survey of the potentialities for increasing farm output in 1952 and later years. This paper compares the performance of different sizes of farms during World War II in the spectacular increase of output then achieved, and points the moral in relation to our present production program.

PRESENT NEEDS for increasing agricultural production direct attention to the production capacities of farm families as an integral part of the national economy. Increases in agricultural production must be attained as efficiently as possible and must be accomplished with a minimum drain on scarce items. A decision as to where and how such production can best be achieved depends partly upon what farms can increase their production the most with their currently available labor and materials. Equally important is the problem of channelling the right type of assistance to the right kind of farms. In this setting the relative contribution of different sizes of farms is a question of considerable significance.

The purpose of this article is to investigate changes made during World War II when farm production was expanding rapidly. The findings should be helpful when the future possibilities among sizes of farms are evaluated. It may cast some light on the question, "Where can production be increased most readily?"

In the last war agriculture responded to the emergency by a tremendous increase in production. The total volume was increased by approximately one-fifth. It was done in the face of war-imposed scarcities of labor and of many types of farm equipment and supplies.

In the immediate future there seems to be little prospect of increasing materially the present 1,140 million acres of land now in farms. As much of this land is not at present adaptable to a more intensive land use, the cropland harvested is not expected to increase much above the 1945 figure of 353 million acres. Nor is there so much opportunity as formerly of shifting acres from production of horse-and-mule feed to production for human consumption, now that horses and mules have declined to about 6 million compared with 13 million in 1940. The bulk of any production increase must come from increased efficiency and the application of improved technology to existing land resources.

Our agriculture is characterized by family-operated farms. Management, capital, and most of the labor is provided by the farm family. As farms increase in size the production becomes more mechanized. Further increases in size are characterized by the greater relative importance of hired labor. The predominance of family-farms is indicated by the fact that of the 10 million agricultural workers employed in 1950, more than 75 percent were classified as operators and members of operator families.

This study tries to measure the changes in production per unit of land resources that took place on family farms, compared with large farms, during the war period 1939 to 1944. No one measure of size makes this separation adequately. The problem of separation is further intensified when the type of farm and the geographic location are considered. Therefore the terms "large" and "family size," as used in this study, indicate a relative rather than absolute division of commercial farms.

Procedure

Data used in this study were taken from the United States Census of Agriculture Special Reports on Farm Characteristics by Value of Products, 1940 and 1945, and Economic Classes of Farms, 1945. These reports are based on a sample of farms included in the Census of Agriculture.

[1] Kenneth L. Bachman assisted in the development of the principles used in this study. Discussions with Richard O. Been and Glenn L. Burroughs were helpful in the development of the statistical method.

The sampling rate varied from a 2-percent sample in 1940 to approximately a 7-percent sample in 1945.

Estimates of production per acre and of production per acre equivalent of land were derived for each of the value-of-product groups of commercial farms.[2] Production per acre equivalent was used as a primary measure because it reflects the effect of the addition of less productive land during the period 1939-44. Production per acre equivalent and production per acre were plotted by value of products adjusted for price levels by deflating for prices received by farmers.[3] A correction factor was used to adjust for shifts in the farms in each value group arising because of changes in output per acre.[4]

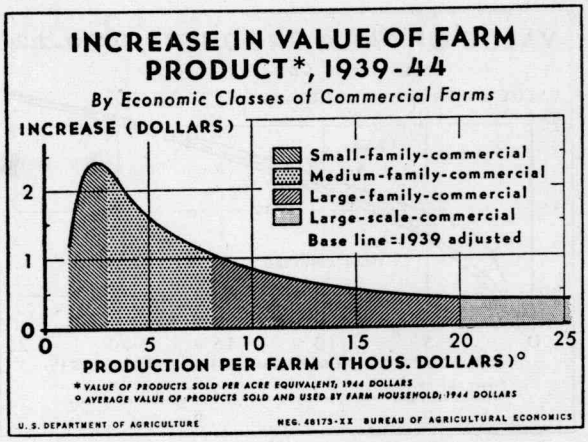

FIGURE 1

There were also shifts of farms between value groups caused by the trend toward larger farms. Combinations of farms that took place, particularly among the smaller sizes, meant that a considerable number of farms moved into higher value-of-product groups. The effect of this on the over-all measure of production per acre equivalent would be problematical. It would depend on what kinds of farms combined and what associated changes occurred in the farm organization.

In the final analysis, farms with a value of products of under $1,200 were excluded. Many farms that had a value of products of less than $1,200 were part-time and nominal units; their changes were not considered to be significant. Excluded were approximately one-half million part-time, 1 million nominal, and 1 million small-scale farms.

Changes in Production Intensity

Measured by production per acre equivalent of land in farms, the increase in production from 1939 to 1944 was greatest on small-to-medium commercial family farms (fig. 1). The increase in production per acre equivalent between 1939 and 1944 reached a maximum for farms with about $1,500 to $4,000 gross value of products and gradually declined among larger and smaller farms. Farms included in the study were divided into four

[2] In order to obtain comparability among groups of farms between 1939 and 1944, acres in each group were converted to acre equivalents. Had these adjustments not been made the 1944 value groups would have been subjected to a downward bias in comparisons of production per acre because of the 8-percent increase in land in farms. Most of this land came in the mountain region. Because of the lower production per acre and the predominance of larger farms there, this bias would have been particularly evidenced among the larger sizes of farms. An acre equivalent is the amount of land that equals in value the average value of land per acre in 1940. With the application of this the new land brought into agricultural use during 1939-44 was weighted equivalent to its relative value.

[3] A possible cause of bias would occur if size groups of farms produced in different proportions, products whose prices rose (or fell) more than the average of all prices received. However, no substantial difference was observed in the price behavior of outputs on different sizes of commercial farms except in the case of large-scale farms. Prices received for products sold from these farms in 1944 increased slightly more than the U. S. average.

[4] For purposes of comparison farms are grouped for size by value-of-product intervals. The amount of production increase or decrease that any individual farm may show and still remain within the value-of-product interval depends upon the width of the interval and the farms' position within the interval in respect to the upper and lower limits. Farms that are just below the upper limit of the value-of-product interval will move into the value group above, with any increase in production. Therefore, any increase in production for a value group is accompanied by a loss of farms to the value group above and a gain in farms from the value group below. As large farms have a higher production per acre equivalent than smaller farms, the effect of such a movement would be to minimize the production increase that could be indicated for any value group. The relative extent of this minimization was determined by the relationship in 1939 of the production per acre equivalent and number of farms per unit of value interval at the upper limit of each value interval compared with the production per acre equivalent and number of farms per unit of value interval at the lower limit of each value interval. The correction factor used was the relationship between an assumed percentage increase and the resultant indicated increase, or X : Y when:

$$Y = \frac{\Sigma (P+PX) N + \Sigma (P_1+P_1X) N_1 - \Sigma (P_2+P_2X) N_2}{N + N_1 - N_2}$$

X = Percentage increase in product per acre equivalent

P and N = Product per acre equivalent and number, respectively, of farms in the value group in 1939

P_1 and N_1 = Product per acre equivalent and number, respectively, of farms that could be expected to move into the value group from the value group below as a result of X percent increase in product per acre equivalent

P_2 and N_2 = Product per acre equivalent and number, respectively, of farms that could be expected to move into the value group above as a result of X percent increase in product per acre equivalent.

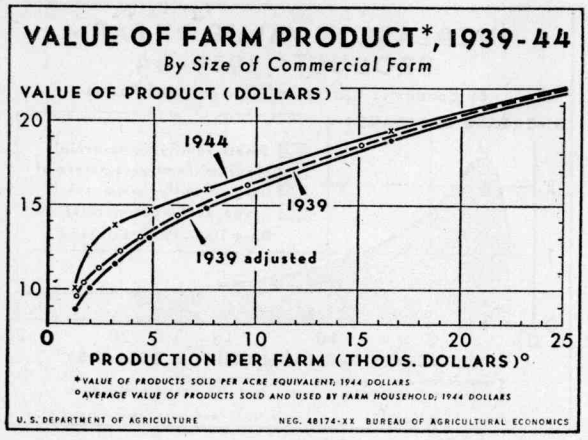

FIGURE 2

groups for purposes of comparison with the existing economic classification. In 1945 there were approximately 1½ million farms classified as small commercial-family farms, 1 million medium commercial-family farms, ½ million large commercial-family farms, and 100,000 large-scale farms.[5]

The product per acre equivalent on large farms was greater than on smaller farms in both 1939 and 1944 (fig. 2). However, farms from $1,500 to $4,000 tended to increase production at a greater rate from 1939 to 1944. This increase brought the levels of production per acre equivalent closer together.

Measured by production per acre, the farms above the $5,000 value-of-product group showed a decrease in production in 1945 whereas commercial farms below the $5,000 value group increased production per acre. The actual decrease on larger farms is due largely to the increase in acres of land in farms during the war. The use of acre equivalents of land as a measure is an attempt to correct for this bias.

In an effort to test these relationships in a specific area, a study was made of Illinois farm-account farms in farming-type areas 2, 3, 4, and 5. The farms were grouped for size by acres of land in farms and compared over the period 1940-43 (table 1.). (Comparable data for these areas were not available for 1939-44.) The same general relationship between size groups is apparent. Average gross earnings per farm and average gross earnings per acre increased more on the smaller farms. This increase in product per acre was 9 percent in the group of less than 120 acres and declined to only 1 percent on farms of more than 280 acres. These data are restricted to a certain kind of farm in a certain kind of area in one State. The range in size approximates that of medium and large commercial farms in 1945, but the data fit into the pattern for the United States and to some extent substantiate the trend shown in figure 1.

The increase in production from 1939 to 1944 was largely due to increases in production per acre equivalent of land. Most of this increase came from medium and small commercial-family farms. An explanation involves an analysis of the situation during the period 1939-44 with respect to labor, mechanization, and levels of technology employed on different sizes of commercial farms. Another factor to be considered is the long-time trend toward larger and fewer commercial farms.

Larger farms were much more dependent upon hired labor. Possibly in many cases labor shortage could be met only by a more extensive land use. This was the most profitable alternative of farms that had already taken fullest advantage of mechanization and other labor-saving innovations.

Family farms, dependent primarily upon family labor, tended to have a more plentiful labor supply. Participation of the old and young and of women, when work was heaviest, lent a degree of flexibility in the number of hours worked. Family farms were also much less mechanized. With this greater latitude, they responded with a tremendous substitution of machinery for hand labor; tractors for workstock. This transfer of acres from the production of feed for workstock to the production for human consumption played an influential part in the increased volume of agricultural products for sale in 1944. Medium and small commercial family farms that reported tractors increased by more than 50 percent, an increase of 400,000 farms. Large-scale and large commercial family farms reporting tractors increased by 100,000 farms during the period. This does not take into account the numbers of tractors. It is probable that on many farms that had one tractor in 1940, another was added during this period. Sizes of tractors or the workstock displacement per tractor, or both, may have been greater on large farms. Nevertheless, it is apparent that the number of acres released for production for human consumption was much larger on medium and

[5] See BACHMAN, K. L., and JONES, R. W. SIZES OF FARMS IN THE UNITED STATES. U. S. Dept. Agr. Tech Bul. 1019. July 1950.

TABLE 1.—*Size of farm related to farm earnings and other factors for farm accounting farms in farming type areas 2 3, 4, and 5, Illinois, 1940-1943, Illinois Farm Economics*

(Deflated 1943 = 100)

Item	Under 120 acres		121–200 acres		201–280 acres		Over 280 acres	
	1940	1943	1940	1943	1940	1943	1940	1943
Number of farms	212	144	662	503	456	386	560	342
Acres per farm	103	106	167	167	242	241	403	410
Average gross earnings per farm[1]	$4,829	$5,408	$7,535	$7,907	$10,320	$10,611	$16,073	$16,104
Percent increase	xxx	12	xxx	5	xxx	3	xxx	0.2
Average gross earnings per acre[1]	$47.11	$51.30	$45.03	$47.34	$42.56	$44.04	$40.12	$40.65
Percent increase	xxx	9	xxx	5	xxx	3	xxx	1

[1] Includes the value of farm products used in the household; also includes any increase or decrease in inventory from the preceding year.

small commercial family farms during the war.

It is also reasonable to assume that family farms lagged somewhat behind large farms in the extent to which they had adopted such technological advancements as improved varieties of seed, improved insecticides, and proper use of fertilizer. The increase in the volume of agricultural production was not due merely to additional inputs. Rising farm prices hastened technological change. The production response to price changes that took place on the efficient farm, operating at or near its highest profit combination, was likely to have been very small when reckoned as a percentage change in total product. Farms operating at lower levels of efficiency tended to change the quality of inputs and not so much the quantity. Use of better cultural methods and the more efficient allocation of inputs contributed most in raising the levels of production.

Another factor is the trend in size and number of farms during the war. The number of farms over 500 acres increased more during the war years than in any 5-year period except 1925-30. Contributing to this increase was the stimulant of rising costs of labor in relation to costs of land. To the extent that additional inputs of land were more profitable than additional inputs of labor, a more extensive land use was a combination of higher profit.

An enormous shift took place from small to larger family farms. Apparently this was accomplished with little loss in intensity. The shift was to a size of operation that would more adequately utilize the advantages of mechanization and provide fuller employment for the farm family.

Regional estimates raise difficult problems of deflation for changes in prices, sampling reliability, and variations in crop yields from region to region. Tentative evidence indicates a general similarity of trends in most regions. In the middle Atlantic region and in the Pacific region, however, trends were somewhat different. This may be partly due to variability in type of farming and variations in prices received for different agricultural commodities in 1944 relative to 1939.

Application to the Future

Our large farms are producing nearer to total capacity than our family farms. Production per acre equivalent is nearly double that of small and medium commercial family farms. Investment and production per man equivalent of available labor resources on small and medium commercial family farms are only one-fourth that on large-scale farms. Surplus capital, the ability to borrow when necessary, and informed management, have made possible the general introduction of many production innovations on large farms.[6] Profitable investments have been made in improved strains of breeding stock to upgrade their herds and flocks and in the use of preventives of diseases and pests. Increased applications of fertilizer and use of improved varieties of seed have been common among larger farms. A large proportion of available cropland has been shifted to high-producing grains and high-yielding legumes. Much of the labor is hired and it is used nearer to maximum efficiency.

To sum up, production practices on large farms are kept up to date. Limitations of capital and lack of information on available alternative production techniques are at a minimum. Increases in

[6] In this connection see WILCOX, WALTER W. EFFECTS OF FARM PRICE CHANGES ON EFFICIENCY IN FARMING. Jour. Farm Econ. 33:58. February 1950.

production may be geared to innovations now on the horizon. These farms are more nearly in balance, hence have fewer opportunities to increase output profitably.

The great technological advances of the last two decades have opened up stimulating and amazing possibilities for increased production on family farms. Increased output since the beginning of World War II is indication that many have taken advantage of new methods. Despite intensive educational and other programs, others have not, either because they did not know about them or because they did not believe they could afford it.

Increases in production by small and medium family commercial farms during the war, though striking, leave much room for improvement. Present levels of production are lower than on larger farms. To some extent, to increase this production is a function of management and capital rather than size. It is doubtful that notable efficiencies in size continue beyond a point at which the farm can adequately employ the advantages of mechanization. Needed reorganization frequently involves a change to a larger size of unit, but substantial gains can usually be made on existing acreage. For example, a study of small and medium cotton and livestock farms in the Short Leaf Pine Area of Mississippi disclosed that the opportunities for increasing crop yields are good. The yield of cotton could be increased by 46 percent, corn by almost 100 percent, egg production per hen could be doubled, and milk production per cow could be raised 90 percent.[7]

Studies made on small and medium commercial-family farms in the Southern Piedmont of North Carolina disclosed that use of improved varieties of seed, treatments for disease and insects, increased use of commercial fertilizers, better tillage, and crop rotations, could increase yields of corn by 100 percent, yields of small grains by 50 to 75 percent, and yields of hay and seed crops by 15 to 50 percent.[8] Production of milk and eggs could be increased by 50 to 80 percent over present rates through the adoption of more efficient practices. Furthermore, the increased yields of grain and hay enable a farmer to increase his numbers of productive livestock.

Increased production on large-scale farms may require the use of additional labor that is obtainable only in the labor market. Hired labor constitutes approximately 80 percent of their available labor resources.[9] Recruitment of scarce manpower in increasing production is less of a critical problem on family farms. Hired labor comprises less than one-third of the available labor resources. Family farms have an element of flexibility in the number of hours worked. Man-power in an emergency can be stretched considerably by increased participation of the old and the young and of women in certain farm operations.

If technical assistance can be made more effective and if provision can be made for adequate financing, family farms are in a position to increase substantially their contribution to the defense effort. Such assistance will also be influential in achieving the kinds of production needed in the defense period.

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[7] ELBRIDGE, A. TUCKER, WELCH, FRANK J., and DOWNING, JAMES C. FARM ORGANIZATION AND ADJUSTMENT PROBLEMS IN THE SHORT LEAF PINE AREA OF MISSISSIPPI. Miss. Agr. Expt. Sta. Bul. 405. June 1944.

[8] MCPHERSON, W. W., PIERCE, W. H., and GREENE, R. E. L. OPPORTUNITIES FOR ADJUSTMENTS IN FARMING SYSTEMS. N. C. Agr. Expt. Sta., Tech. Bul. 87. Sept. 1949.

[9] See footnote 4, p. 99.