Productivity and Structure in U.S. Agriculture

By Clark Edwards*

Abstract

Changes in productivity are usually associated with technology At the firm level, this is a natural way to think about productivity. However, in aggregate analysis, measures of productivity can change even when technology does not The measures change when the proportions of farms in stable technological situations change For example, more high yielding wheat on irrigated land in Arizona increases the national average wheat yield even though technology does not change either in Arizona or Kansas Changes in the proportions of farms that are larger, incorporated, specialized, and operated by full-time farmers affect farm-sector productivity The productivity of the farm sector is partly a function of structure

Keywords

Technology, productivity, structure, aggregation, farm

Introduction

Productivity is a general term, frequently associated with ratios of output to input and sometimes with ratios among inputs (labor/capital) or outputs (crops/livestock). We usually think of changes in these productivity ratios as indicators of technical change But, when the ratios use aggregate statistics (national summaries, for example), they can be affected by shifts within the aggregates, such as a shift in corn acreage from Iowa to Georgia Hence, aggregate measures of productivity can change even when there is no change, from the farm manager's viewpoint, in technology

For example suppose a farmowner acquires control over a 40-acre field which had been in pasture and puts it in corn The size of the farm is increased by 40 acres, and it may be in a higher sales class If the added acreage is rented, the tenure class is changed If the farm is incorporated in connection with the acquisition, the type of farm organization is changed An accompanying change in management could result in a change in the age and chief occupation of the operator The change in cropping results in a reclassification of the commodity specialization of the farm If the decision is implemented outside the Corn Belt, say in the Southeast, then the aggregate statistics show a regional shift in the location of corn production If the decision is implemented in the Southwest, the chances are that the additional 40 acres will be irrigated This action will not be seen as a change in technology to the Southwestern farmer who irrigates as a matter of course, but it will appear as technical change in the aggregate statistics as more irrigated corn is produced relative to dryland corn If the yield per acre on the additional land is above the national average, the national average yield increases and aggregate productivity will be said to increase These changes resulting from a farm management decision are all seen in aggregate descriptions of agriculture as structural shifts They are not seen by the farm manager as technological change, yet they are important in explaining changes in aggregate measures of productivity

The aggregate statistics reflect changes in both technology and structure The accompanying changes in the ratios of, say, machinery to land as more land is used with the same machinery, or of labor to machinery as more labor is used, are interpreted in the aggregate statistics as indicators of

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technological change, although the farmer may not have considered them so In addition, some changes considered by the farmer to be technological might be a part of the decision to gain control over the additional land New and larger planting and harvesting equipment might be acquired, fertilizing and cultivating practices might be changed, or a higher yielding crop variety might be adopted

This single decision, considered as a whole by the farmer, is separated in economic analysis into three parts changes in structure, changes in technology, and changes in productivity Associating the change in productivity with a change in technology, assuming constant structure, can miss the most important aspect of change This is not to say that structural change causes technical change or that technical change causes structural change Which of the two is causal is not at issue here What is at issue is that we have to learn to talk simultaneously about both as parts of a whole process rather than try to analyze them as separable processes

The example suggests that we must consider technology and structure together as we try to explain productivity Analytical models used in agricultural economics frequently assume that output is a function of technology by specifying yield equations in conjunction with acreage-harvested equations The yield equations are fit to time-series data and frequently include time as an explanatory variable on the assumption that technology is adopted in such a way as to increase yields over time The yield equations may also include price ratios on the assumption that a cost/price squeeze limits the use of inputs such as fertilizer and reduces the incentive to adopt output-increasing practices The yield equations sometimes include acreage planted, on the assumption of diminishing returns to land Such models explicitly (or, at least, through explicit interpretation of the trend coefficient) incorporate technological advance as a means of increasing farm output, but the structural changes that were part of the farm management decisions leading to the increase in productivity are omitted The yield equations do not explicitly recognize the relation of structure to productivity A specification which recognizes and incorporates structural change may improve the ability of economic models to explain and predict agricultural behavior

Let us narrow the idea of productivity to include only crop yield per acre Under this narrower definition, this study illustrates, using the national (and, occasionally, State) summary tables from the *1982 Census of Agriculture*, that productivity varies with structure Little is said here about technology, although some indications of technology are available from these data, such as machinery investment per acre and fertilizer applied per acre The hypothesis under consideration is that aggregate measures of productivity are affected by structural change If yields are not significantly affected by structural changes, then the implication is to continue business as usual—that is, to assume that productivity change can be adequately explained by technological change without reference to structural change However, the data suggest that there is a relationship between structure and productivity and that agricultural economists need to develop ways to use this relationship in their descriptions and analyses

The tests of the hypothesis that follow are limited by the available data A number of summary tables are published by the Census Each gives a one-way tabulation of yield and other farm characteristics by a structural measure such as farm size or sales class The source does not permit a two- or more-way cross-classification such as yield by farm size by sales class Therefore, the results are based on a series of one-factor experiments where a single multifactor experiment would be more fitting Consequently, the results are suggestive, not conclusive Conclusive tests require more detailed tabulations of the cross-sectional data and of longitudinal data

Corn Yield by Acres Harvested per Farm

The relation of aggregate corn production to corn acreage harvested per farm is shown in table 1

Yield in bushels per acre is highly correlated with the acres harvested for corn per farm; higher yields per acre are consistently obtained from larger acreages (fig 1) This relationship suggests that, as farmers continue to increase farm size and reduce the number of farms, the output of U S agriculture is likely to increase

Table 1—Corn yield, by acres harvested per farm

Farm size	Farms	Harvested cropland per farm	Yield per acre	Share of output
	Number	*Acres*	*Bushels*	*Percent*
Total, all farms	715,171	97 68	107 49	100 00
1 to 14 acres	169,322	6 84	78 59	1 21
15 to 24 acres	75,385	18 80	86 64	1 63
25 to 49 acres	118,291	34 95	93 47	5 15
50 to 99 acres	131,659	69 44	99 38	12 10
100 to 249 acres	152,232	153 22	106 27	33 01
250 to 499 acres	50,896	332 73	113 12	25 51
500 to 999 acres	14,470	643 66	116 21	14 41
1,000 acres or more	2,916	1,519 68	118 04	6 97

Source *1982 Census of Agriculture*, United States Summary, Table 41, Specified Crops by Acres Harvested

However, conclusions about cause and effect cannot be drawn from the data in the Census tables because of the limitations of one-way tabulations and because the tables do not report additional explanatory factors Two omitted factors deserve consideration Because the operators of large farms may have more education and better management skills, they might have obtained higher yields from smaller farms if they chose to operate them And, the operators of larger farms may control the best land, leaving the poorer land for use by smaller farmers

The evidence from the corn enterprise suggests a positive correlation between farm size and yield However, inasmuch as 80 percent of the grain is harvested from farms of 100 or more acres which

Figure 1

Corn Yield by Acres Harvested per Farm

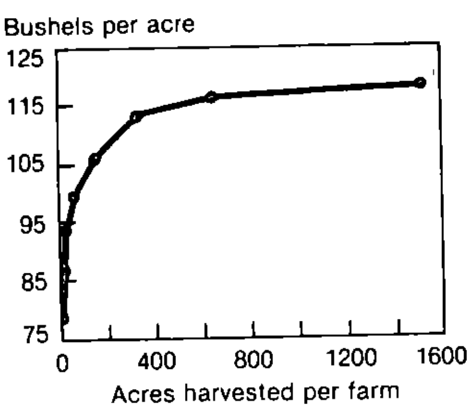


Figure 2

Wheat Yield by Acres Harvested Per Farm

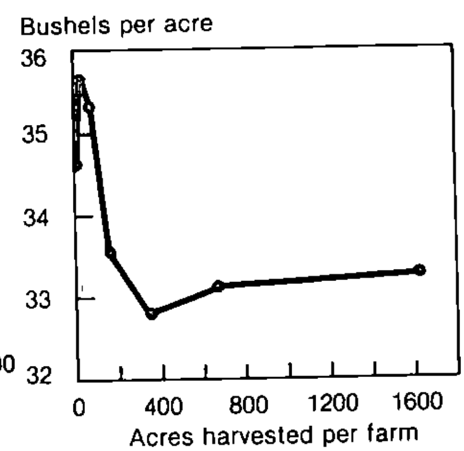


Figure 3

Soybean Yield by Acres Harvested per Farm

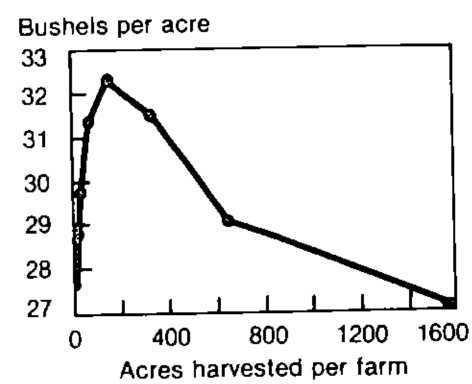


Figure 4

Wheat Yield by Value of Products Sold

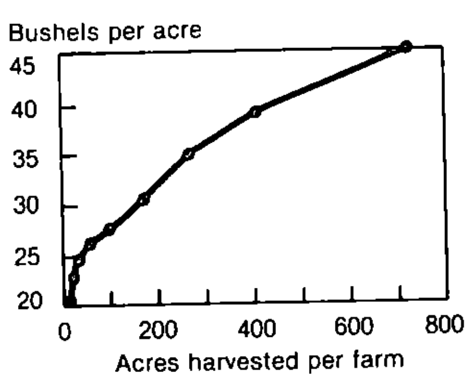
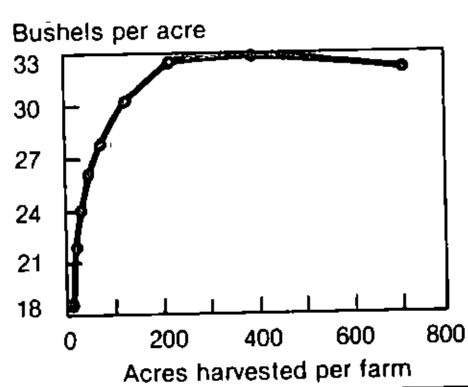


Figure 5

Soybean Yield by Value of Products Sold



have yields of about average or above, the potential effect of farm size on corn production, as indicated in the table, does not appear to be dramatic That is, the hypothesis that productivity is associated with structure may be true, but may not be empirically important.

A similar, monotonically increasing pattern of yields with respect to number of acres harvested per farm appears for several other crops, including sunflower seed, cotton, rice, and alfalfa However, a look at some other enterprises suggests that, while it is true that structure and productivity are functionally related, the relation may not be monotonically increasing

Wheat Yield by Acres Harvested per Farm

The relation of aggregate wheat production to wheat acreage harvested per farm in shown in table 2

Wheat yield in bushels per acre is bimodal, with the higher yields on the larger as well as the smaller farms, and with lower yields on farms harvesting from 250 to 499 acres (fig 2), 67 percent of the wheat is grown on fields of 250 or more acres. Throughout the range of these larger farms there is little apparent trend of yield with respect to size, and the average yield on the larger farms is below the average on the smaller farms These data appear to conflict with the hypothesis, the larger fields, which produce most of the wheat, have lower

Table 2—Wheat yield, by acres harvested per farm

Farm size	Farms	Harvested cropland per farm	Yield per acre	Share of output
	Number	*Acres*	*Bushels*	*Percent*
Total, all farms	446,075	158 96	33 47	100 00
1 to 14 acres	73,594	8 38	34 63	90
15 to 24 acres	54,452	18 81	35 67	1 54
25 to 49 acres	77,877	34 65	35 67	4 06
50 to 99 acres	74,189	68 49	35 33	7 57
100 to 249 acres	85,276	155 35	33 54	18 72
250 to 499 acres	45,977	345 45	32 81	21 95
500 to 999 acres	25,076	667 43	33 12	23 36
1,000 acres or more	9,634	1,621 62	33 27	21 90

Source *1982 Census of Agriculture*, United States Summary, Table 41, Specified Crops by Acres Harvested

yields than the smaller fields A U-shaped curve also appears for sugar beets and tobacco

The U-shaped distribution for wheat is partly explained by regional location, which implies not only climate but type of wheat grown and type of technical practices which are appropriate Wheat yields by State are highest in Arizona, California, Idaho, and Nevada, where most of the wheat is irrigated They are lowest in Colorado, New Mexico, South Dakota, Texas, and Wyoming Within Kansas, the State with the largest acreage seeded in wheat, wheat yields increased monotonically with acreage harvested—from 26 bushels on the smaller farms to 33 bushels on the larger ones, with a State average of 32 bushels In Arizona, the State with the highest yield, all the wheat is irrigated, even the smaller farms have yields well above the national average As in Kansas, Arizona yields increase monotonically with farm size

Adjusting the aggregate summary for regional location, which controls for land quality, type of wheat, and farming practices appropriate to the region, lends support to the hypothesis that productivity increases with size of farm

Soybean Yield by Acres Harvested per Farm

The relation of aggregate soybean production to soybean acreage harvested per farm is shown in table 3

Soybean yields in bushels per acre are lower on the larger as well as the smaller farms and are higher on the farms harvesting 100 to 249 acres (fig 3) Farms with 100 acres or more planted in soybeans account for 81 percent of the crop. As fields increase above 100 acres, yields appear to decrease As inverted U-shaped curve also appears for barley, oats, and sorghum

The inverted U-shaped distribution for soybeans is partly explained by regional location. Soybean yields are highest in Illinois, Iowa, Minnesota, Nebraska, and Ohio They are lowest in North Dakota, Oklahoma, and South Carolina Within each State, yields tend to increase with farm size For example, within Illinois, the State with the largest acreage planted in soybeans, yields increased as the number of acres harvested per farm increased from under 14 acres to 999 acres. Yields went from 32 bushels on the smaller farms to 38 bushels on the larger ones, with a State average of 37 bushels For the farms of 1,000 acres and over, which account for only a small percentage of total production and tend to be located in a different part of the State, yields dropped to 35 bushels. For Oklahoma, the State with the lowest soybean yields, the yields are higher for the larger farms, yet still well below the U S average yield

Again, the aggregate data appear to conflict with the hypothesis But, after the aggregate summaries are adjusted for regional location, there again is support for the hypothesis that productivity increases with size of farm.

Yield by Size of Farm

The number of acres harvested per farm is correlated with the size of the farm, the acreage harvested per farm tends to be larger on the larger farms However, the two series are not perfectly correlated because there are small corn fields on some larger farms, and some smaller farms plant corn fence to fence Table 48, Summary by Size of Farm, in the *1982 Census of Agriculture*, provides yield data by size of farm Had table 48 been used instead of table 41 as the basis for the above discussion, the details of the discussion would have been different, but the general conclusion would have been the same

Table 3—Soybean yield, by acres harvested per farm

Farm size	Farms	Harvested cropland per farm	Yield per acre	Share of output
	Number	*Acres*	*Bushels*	*Percent*
Total, all farms	511,229	126 82	30.69	100 00
1 to 14 acres	56,552	8.64	27 64	68
15 to 24 acres	51,790	18 95	28 78	1 42
25 to 49 acres	97,209	35.24	29 75	5 12
50 to 99 acres	110,872	69 46	31.34	12 13
100 to 249 acres	129,171	153 23	32.34	32 16
250 to 499 acres	45,711	333 87	31 48	24 15
500 to 999 acres	15,345	648 08	29 05	14 52
1,000 acres or more	4,579	1,580 51	27 03	9 83

Source *1982 Census of Agriculture*, United States Summary, Table 41, Specified Crops by Acres Harvested

For example, corn and cotton have the same monotonically increasing relationship whether tabulated by acres harvested per farm or by size of farm And, soybeans retain the U-shaped relation in both tabulations. But, wheat and barley become monotonically decreasing, and alfalfa shifts from monotonically increasing to an inverted U-shape

However, once again, adjustments for region generally support the hypothesis that larger farms are more productive than smaller ones This finding—coupled with additional information discussed in subsequent sections of this article—suggests that the U-shaped and inverted U-shaped yield relationships become monotonically increasing when additional subsorts are made with respect to various structural attributes.

The most straightforward test of the hypothesis using the national summary of yield by size of farm is mixed. However, after inquiry behind the national summary data available in the tables, the story becomes less mixed and more supportive of the hypothesis, but not spectacular Other national summary tables are published which sort by various structural variables—one at a time—such as sales class, tenure, and type of farm organization These tabulations allow one to examine both yield and size of farm as various structural measures change These data provide additional and stronger evidence that productivity is associated with structure. Furthermore, the size of farm is also correlated with each structural variable, and yield is consistently found to be a monotonically increasing function of the acres harvested per farm for most of the major crops.

Yield by Value of Products Sold

The relation of aggregate corn production to the value of products sold per farm is shown in table 4

The number of acres harvested per farm is highly correlated with the value of products sold per farm, so the results of examining productivity by sales class appear to be about the same as examining productivity by size of farm. At least this finding is so for corn (the production of which is dominated by the homogeneous Corn Belt region) and for the

Table 4—Corn yield and acres of corn harvested per farm, by value of products sold per farm

Sales class	Farms	Harvested cropland per farm	Yield per acre	Share of output
	Number	*Acres*	*Bushels*	*Percent*
All farms	715,171	97 68	107 49	100 00
Total, $10,000 or more	546,581	123 68	108 59	97 77
$500,000 or more	9,946	622 50	122 48	10 10
$250,000 to $499,999	30,152	355 50	118 93	16 98
100,000 to $249,000	125,438	189 97	112 10	35 58
$40,000 to $99,999	182,194	98 44	101 75	24 30
$20,000 to $39,999	110,907	54 99	93 12	7 56
$10,000 to $19,999	87,944	32 17	86 27	3 25
Total, less than $10,000	168,118	12 89	73 27	2 11
$5,000 to $9,999	67,056	18 86	79 05	1 33
$2,500 to $4,999	45,419	11 83	70 54	50
Less than $2,500	55,643	6 57	57 25	28
Abnormal farms	472	186 05	98 25	11

Source *1982 Census of Agriculture*, United States Summary, Table 49, Summary by Value of Agricultural Products Sold

other crops for which the national summaries indicated a monotonically increasing relation of yield to acres harvested per farm.

In addition, the subsort by value of products sold lends further support to the hypothesis that productivity is a function of structure. It does so by changing the U-shaped and inverted U-shaped yield curves into monotonically increasing functions of acres harvested per farm. It places, for example, larger farms with relatively low yields and, therefore, low total sales in the same class as small farms with relatively low sales The relation of productivity to value of sales per farm is monotonically increasing for all the major crops, such as corn, wheat, cotton, and soybeans When farms are sorted by sales class, the relation of productivity to number of acres harvested is also monotonically increasing for all the major crops

The relation of aggregate wheat production to value of agricultural products sold per farm is shown in table 5 The comparable table for soybeans is omitted, but note in figures 4 and 5 that, when farms are sorted by value of sales per farm, the relation between farm size and yield is monotonically increasing for both wheat and soybeans

Farms with lower yields on larger acreages, leading to inverted U-shaped relations, apparently have lower total sales, just as the farms with higher yields on smaller acreages, leading to U-shaped relations, have higher total sales. Classifying farms by sales instead of acres appears to adjust for this (partly regional) variation in intensity of land use. The cross-classification of farms by size and by sales class which should make this point clear is not published by the Census These data support the hypothesis that productivity is associated with structure

Yield by Tenure

The relation of aggregate corn production to tenure is shown in table 6

Yield of corn in bushels per acre is higher for tenant farmers and part owners than for full owners (fig. 6). The tendency for full owners to have lower yields than tenants and part owners held for most major crops including sorghum, soybeans, wheat, and tobacco An exception was for cotton, where the national summary showed that tenants had lower yields than full or part owners. Tenancy is more prevalent on cotton farms in Texas than in Georgia, the tenant farms are larger, and the cotton yields are lower However, full owners in Texas operated smaller farms and obtained higher cotton yields than the other tenancy classes. According to the national summaries for most crops, most production is on farms operated by part owners who tend to have not only higher yields but also larger farms These data suggest that, as farmers change from full owners to part owners and tenants, productivity increases Farm size also increases, so productivity again appears to be an increasing function of farm size.

Table 5—Wheat yield acres of wheat harvested per farm, by value of products sold per farm

Sales class	Farms	Harvested cropland per farm	Yield per acre	Share of output
	Number	*Acres*	*Bushels*	*Percent*
All farms	446,075	158 96	33 47	100 00
Total, $10,000 or more	367,277	186 45	33 80	97 52
$500,000 or more	8,825	725 42	45 18	12 19
$250,000 to $499,999	21,929	410 17	39 01	14 79
100,000 to $249,000	77,748	266 25	34 98	30 51
$40,000 to $99,999	116,667	173 11	30 60	26 04
$20,000 to $39,999	79,814	104 30	27 70	9 72
$10,000 to $19,999	62,294	61 98	26 32	4 28
Total, less than $10,000	78,466	30 41	23 86	2 40
$5,000 to $9,999	40,687	38 79	24 71	1 64
$2,500 to $4,999	21,273	25 80	22 98	53
Less than $2,500	16,506	15 68	20 57	22
Abnormal farms	332	137 12	42 37	08

Source *1982 Census of Agriculture*, United States Summary Table 49, Summary by Value of Agricultural Products Sold

The summary by tenure of operator includes data for farms in two sales classes above and below $10,000 per year Farms in the lower sales class consistently had smaller farms and lower yields

Yield by Type of Organization

The relation of productivity to type of farm organization is shown in table 7

Yield in bushels per acre is a function of the type of organization, the largest farms with the highest yield are large, nonfamily corporations, and the smallest farms with low yield are individual or family farms (fig. 7) There are very few farms in the

Table 6—Corn yield and acres of corn harvested per farm, by tenure

Tenure class	Farms	Harvested cropland per farm	Yield per acre	Share of output
	Number	*Acres*	*Bushels*	*Percent*
All farms				
Total	714,699	97 62	107 50	100 00
Full owner	309,599	55 22	102 29	23 31
Part owner	298,769	139 64	108 84	60 55
Tenant	106,331	103 02	110 51	16 14
Farms with sales of $10,000 or more				
Total	546,581	123 68	108 59	97 88
Full owner	190,768	82 29	104 73	21'92
Part owner	265,291	155 50	109 31	60 13
Tenant	90,522	117 68	111 51	15 84
Farms with sales of less than $10,000				
Total	168,118	12 89	73 27	2 12
Full owner	118,831	11 76	74 83	1 39
Part owner	33,478	14 00	67 40	42
Tenant	15,809	19 07	75 16	30

Source *1982 Census of Agriculture*, United States Summary, Table 44, Summary by Tenure of Operator

highest yielding group, large, nonfamily corporations produce only 0 14 percent of total corn production Individual or family farms produce about 74 percent of the total

These data suggest that farmers who incorporate tend to have higher productivity For example, 90 percent of corporate farms are small family-held organizations These farms have corn yields 11.6 percent above the yields of family and individual farms If the family and individual farms were, through structural change, to acquire the characteristics of, and to have the same yields as, the smaller corporate family farms, total corn production from all farms would increase 8 6 percent

Larger corporate farms have higher yields than other types of organizations for wheat and cotton as well as for corn. For rice and tobacco, the smaller family-held corporations have higher yields than other types. However, for all major crops, corporate farms tend to show consistently higher yields than do individual or family farms, partnership farms, and institutional farms The type of farm organiza-

Figure 6

Corn Yield by Tenure

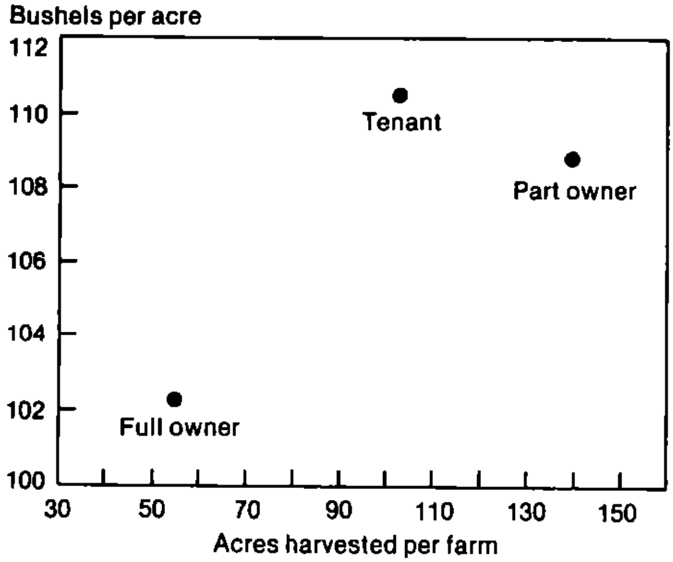


Figure 7

Corn Yield by Type of Organization

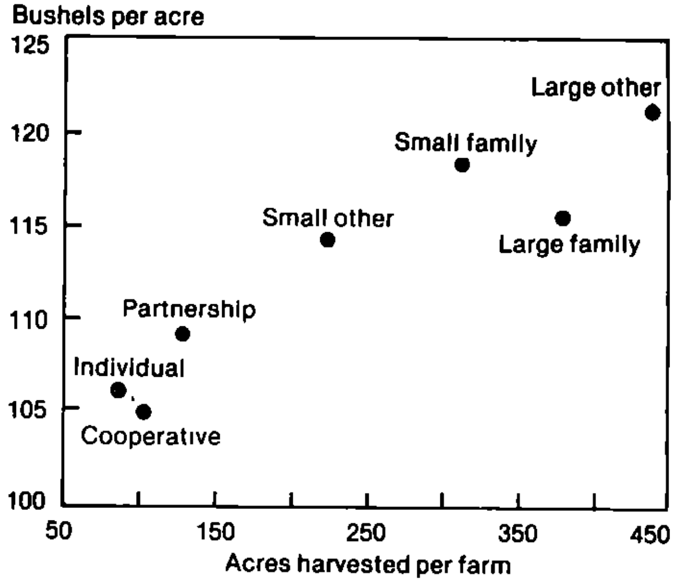
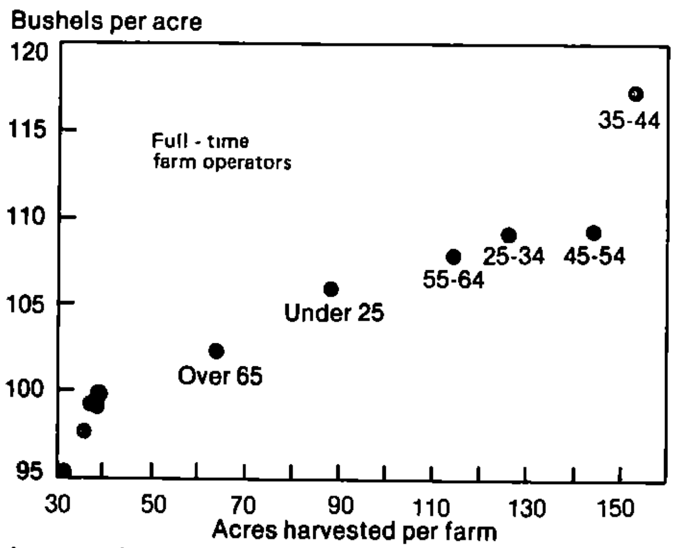


Figure 8

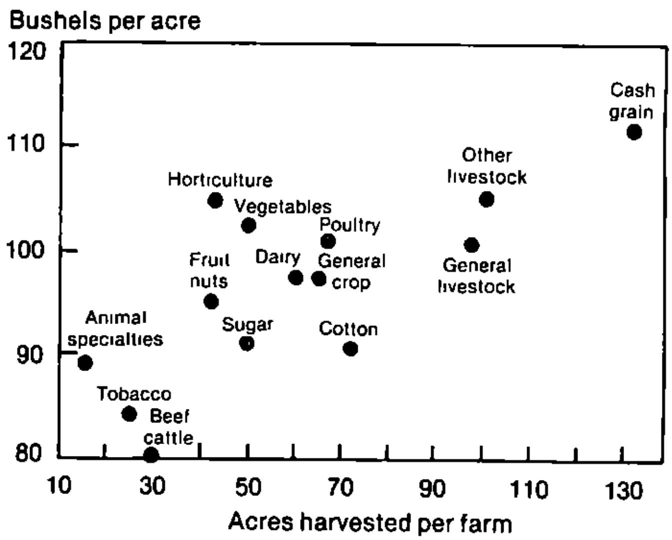
Corn Yield by Age and Occupation



Age groups for other occupations not labeled

Figure 9

Corn Yield by Industrial Classification



tion that has the higher yields also tends to have the larger farms, so when farms are sorted by type of organization, productivity again appears, for all the major crops, as a monotonically increasing function of acres harvested per farm.

Yield by Age and Principal Occupation

The relation of productivity to the age and the principal occupation of farm operators is shown in table 8 Yield in bushels per acre is highest for full-time operators of 35 to 44 years of age, lower for those slightly older or younger, and lowest for the oldest and the youngest operators Hence, a graph of yield by age has an inverted U-shaped. However, operators aged 35 to 44 years operate larger farms with higher yields; the oldest and the youngest farmers operate smaller farms with lower yields. So the yields are a monotonically increasing function of farm size (fig. 8). Most major crops display an in-

Table 7—Corn yield and acres of corn harvested per farm, by type of organization

Type of organization	Farms	Harvested cropland per farm	Yield per acre	Share of output
	Number	*Acres*	*Bushels*	*Percent*
Total, all farms	714,699	97 62	107 50	100 00
Individual or family	604,727	86 56	106 00	73 98
Partnership	88,761	128 53	109 09	16 59
Total corporation	18,659	308 37	118 11	9 06
Family held, total	17,241	313 00	118 25	8 51
More than 10 holders	480	376 83	115 53	28
10 or fewer holders	16,761	311 18	118 34	8 23
Not family, total	1,418	251 99	116 03	55
More than 10 holders	197	435 93	121 25	14
10 or fewer holders	1,221	222 31	114 38	41
Cooperative, estate or trust, institutional, and so forth	2,552	103 42	104 89	37

Source *1982 Census of Agriculture*, United States Summary, Table 45, Summary by Type of Organization

Table 8—Corn yield and acres of corn harvested per farm, by operator's age and principal occupation

Age and occupation of operator	Farms	Harvested cropland per farm	Yield per acre	Share of output
	Number	*Acres*	*Bushels*	*Percent*
Total, all farms	714,699	97 62	107.50	100 00
Farming	519,798	120.36	108 51	90 52
Under 25 years	20,373	88 15	105 98	2.54
25 to 34 years	79,975	125 94	109 21	14 67
35 to 44 years	90,816	152 56	117.39	20 35
45 to 54 years	112,325	143.94	109 40	23 58
55 to 64 years	135,918	114 38	107 99	22 38
65 years and over	80,391	63 79	102 38	7 00
Other occupations	194,901	36 97	98 66	9 48
Under 25 years	5,485	37 22	99.23	27
25 to 34 years	29,756	38 81	99 86	1 54
35 to 44 years	49,373	37 48	99.28	2.45
45 to 54 years	49,788	38 78	99 13	2 55
55 to 64 years	39,787	35 93	97.71	1 86
65 years and over	20,712	30.67	95.24	81

Source *1982 Census of Agriculture*, United States Summary, Table 46, Summary of Age and Principal Occupation

verted U-shaped pattern of yields with respect to age and a monotonic yield-size relation Exceptions are that older operators maintain relatively high yields for cotton and rice

These data suggest that as full-time farmers in their midthirties to midforties acquire control of farms operated by older or younger persons, farm size and yield per acre both increase.

Operators who report that farming is not their principal occupation tend to report lower yields than full time farmers (table 8)

Yield by Standard Industrial Classification of Farm

The relation of productivity to the industrial classification of the farm is shown in table 9.

Yield in bushels per acre is related to the industrial classification of farms The largest farms with the highest yields are those specializing in cash grains (fig 9). These farms produce two-thirds of the total corn output Another fifth of corn output is produced on farms which specialize in livestock enterprises such as cattle or hog feedlots; the acreage harvested per farm and the yields per acre for these livestock farms are only slightly smaller than for cash grain farms These data suggest that specialization is related to increasing productivity and larger farms

Conclusions

Two general conclusions follow from this examination of the national summary tables for the *1982 Census of Agriculture* The first is that measures of aggregate productivity are not affected by technology alone but also by structural change Three concepts distinguished by analysts—productivity, structure, and technology—are perhaps different aspects of a single process and can no more be separated from one another than the forest from the clearing, or the hill from the valley.

The second conclusion is that the summary tables published by the Census are suggestive, but do not

Table 9—Corn yield and acres of corn harvested per farm, by industrial classification of farm

Industrial classification of farm	Farms	Harvested cropland per farm	Yield per acre	Share of output
	Number	*Acres*	*Bushels*	*Percent*
Total, all farms	714,699	97 62	107 50	100 00
Cash grains	336,877	131 85	111 76	66 19
Cotton	1,272	71 97	90 61	11
Tobacco	36,061	25 03	84 24	1 01
Sugar, potatoes, and other	14,957	49 68	91 07	90
Vegetables and melons	4,764	49 98	102 55	33
Fruits and tree nuts	1,598	42 06	95 14	09
Horticultural specialties	549	42 70	104 91	03
General farms, primarily crop	21,490	65 12	97 53	1 82
Beef cattle, except feedlots	53,121	29 45	80 09	1 67
Other livestock	129,556	100 76	105 34	18 34
Dairy	94,907	60 11	97 48	7 41
Poultry and eggs	6,296	66 89	101 10	57
Animal specialties	1,826	15 24	89 06	03
General, primarily livestock	11,425	97 51	100 82	1 50

Source *1982 Census of Agriculture*, United States Summary, Table 50, Summary by Standard Industrial Classification of Farm

in themselves provide a sufficient data base with which to definitively test the hypothesis that the measures of aggregate productivity are related to structure.

The summary tables are one-way tabulations, they sort farms by size and again by sales class, but do not cross-classify by size by class. What is required is two-way or even three- or more-way cross tabulations These can be obtained from available data for national surveys, but the number of farms in these samples do not permit very much cross tabulation The sheer size of the data base already collected by the Census permits much greater cross tabulation. Special runs are needed that use Census data which provide analytically useful cross tabuluations, longitudinal tabulations, and multiple regressions without violating disclosure rules for maintaining the privacy of respondents. The straightforward way of doing this—publication of all the data in a three- or four-way cross tabulation—is not efficient because it involves too many numbers and too many disclosure problems. But, there are other ways. Let me mention three· user tapes containing a 1-percent sample of individual farm records, a research-friendly data base which can be accessed with standard statistical software packages such as SPSS or SAS at moderate marginal cost per query, or a covariance matrix suitable for correlation, regression, and factor analyses

When farmers make managerial decisions affecting output per unit of input, a change in technology is usually involved. The technological change may involve a new variety of crop, new cropping practices such as minimum tillage, different machinery, and others And, the change may also involve what is called structure. The size of farm may increase, and the farm may be reclassified into a higher sales class, a different tenure ownership status, and a different specialization. If the decision involves a change in ownership, then the characteristics of the operator, such as age and principal occupation, may change.

The data available from the summary tables of the *1982 Census of Agriculture* support the hypothesis that the productivity of the farm sector is related to structure Some of the tables suggest that the relationship exists, but is empirically small, others suggest the relationship may be substantial

Larger farms consistently tend to have higher yields The persistence of this conclusion surprised me more than any other finding as I examined the Census tables The finding supports the maxim that "bigger is better" and counters the maxim that "small is beautiful." Consequently, it can affect how we feel about the displacement of families living on small farms.

Comparison with similar data in other countries is interesting. A positive relation between yield and farm size has been noted in Ireland, but the yield-size relation was found to be spurious and was explained by education of the operator. In West Germany, where the education of the operator of smaller farms is probably as high as those of larger farms and where the average size of farm is smaller than in the United States, the data do not reveal a clear yield-size trend Detailed analyses of agricultural Census data cannot reveal whether the yield-size relation noted for the United States is spuriously related to education or land quality, because such information is not collected by the Census.

It is usual in agricultural economics research to seek to explain yields as a function of technological change, but structure is seldom included as an explanatory variable. The findings here suggest that yield per acre should be specified as a function not only of technical change but also of structural change, such as acres per farm, sales class, tenure, type of organization, kind of specialization, and regional location If this specification were made, it might be shown that yield equations for agriculture are relatively stable and that equations for agriculture productivity can be forecasted, explained, and modeled more accurately.

In Earlier Issues

Two dynamic forces active in 1941-50 are likely to have a lasting effect on the relationship of aggregate food expenditure to income: the shift of population from rural to urban areas and the change in manner of living reflected in increased processing of food outside the home, either in public eating places or in processing plants. These forces appear to have increased the dynamic income elasticity of demand for food by raising the general level of food expenditures Lacking sufficient basis as yet for ascertaining the contribution of these enduring forces to the lower static income elasticity of demand that is evident in the 1947 urban data, compared with 1941, we cannot estimate their possible offsetting effect upon future dynamic income elasticity of demand for food

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July 1951, Vol. 3, No. 3