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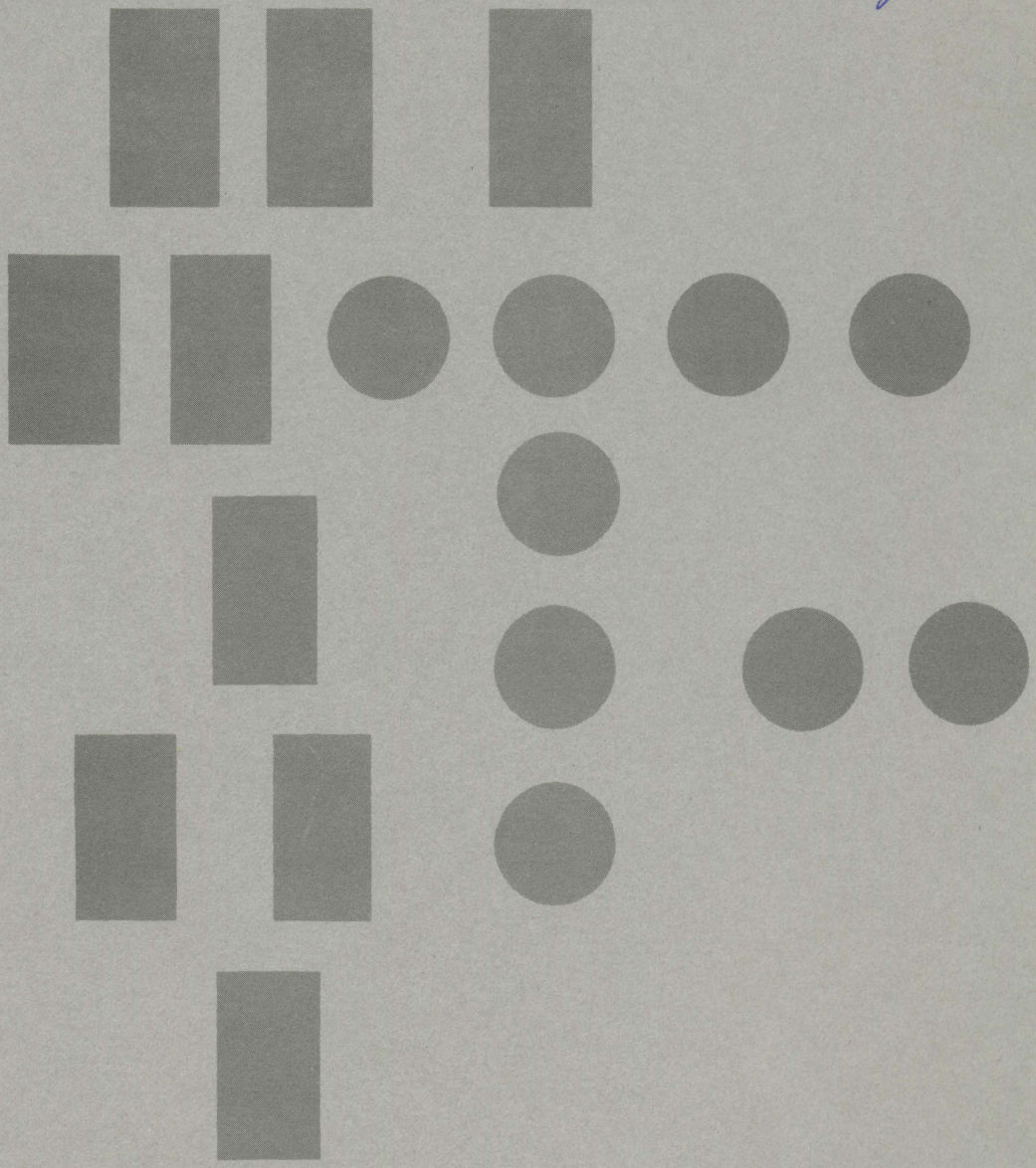
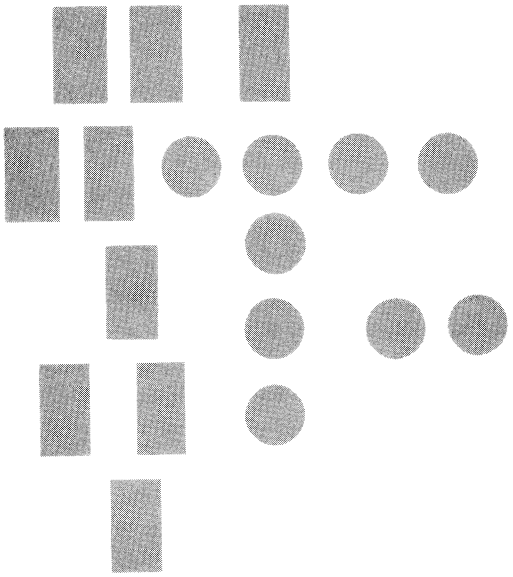


U.S. AGRICULTURE IN 1980

CAED Report 27

CENTER FOR AGRICULTURAL AND ECONOMIC DEVELOPMENT
IOWA STATE UNIVERSITY of Science and Technology
Ames, Iowa, 1966



U.S. AGRICULTURE IN 1980

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CAED

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Two major problems have troubled American commercial agriculture over the last decade or longer. These problems are related, but not identical.

1. The Overproduction Problem. The first problem is the tendency for U.S. farmers to produce too much -- and for farm incomes to be depressed. It is the well known and most obvious problem. It is largely "what our farm policies are about." This problem has arisen because farmers have rapidly adopted new farming methods based more and more on capital inputs such as tractors, hybrid seed, weedicides and feed additives. Using such methods farmers are able to produce an abundant food supply with less and less land and labor. These new capital forms are substitutes for land and labor -- but land and labor have not moved out of agricultural production as rapidly as the capital inflow has made it possible for them to do. Thus, except where farm programs have taken them out of farm production, more land and labor have remained in agriculture than needed. Accordingly food surpluses have accumulated.

True, our growing population and increasing per capita incomes have considerably boosted domestic demand. Demand also has gained somewhat through a rise in per capita income. Moreover a very substantial increase has taken place in exports. However, so much capital has flowed into agriculture and land and labor have moved out of farming so slowly

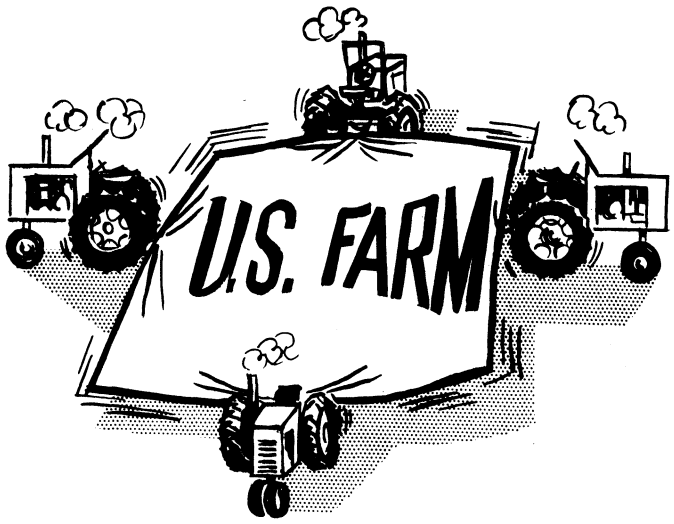
that we still have great capacity to overproduce food and fiber.

An important question thus is posed: Will new capital flow into agriculture as fast in the future, so that despite the expected growth in domestic and foreign demand we will maintain our surplus capacity to produce food?

2. The Input Makeup of Farming. But there is a second problem that will be with us whether the excess capacity problem remains or evaporates. This second problem relates to the relative mix of labor and capital items used in farming, and hence, to the size and number of farms and to the farm and rural community population. This problem results from national economic growth and industrialization which causes capital items to be relatively cheaper than human labor and to substitute for labor. Significantly, more favorable prices of the new capital inputs cause capital to be substituted for labor even where such items do not necessarily increase output.

In highly mature economics, with highly-skilled labor forces and rapid scientific and technological advances, the prices of capital items typically are low relative to the wages of labor. Hence, pressure continuously exists to replace labor with capital, a process has long been under way but now has been given the more sophisticated label of automation. As the farm work force declines, the productivity of manpower rises rapidly, farms become larger, capital requirements per farm increase

rapidly and the managerial function changes greatly.



We have witnessed some widespread effects of this process in the last 25 years. During this period the number of farms in the nation has been almost halved, farm size has more than doubled, and the farm labor force has declined by a similar amount.

This process will continue under further economic growth of the nation and changes in the relative price and productivity of capital and labor. While the process has been gradual in the past, it has added up to considerable change in the last 20 years. For several reasons, we can expect these changes to be even more rapid in the future:

1. Numerous national programs are aimed at reducing economic disadvantages, and at improving educational opportunities.

2. Communication and mobility among regional and economic sectors of the nation are becoming more intense and effective.

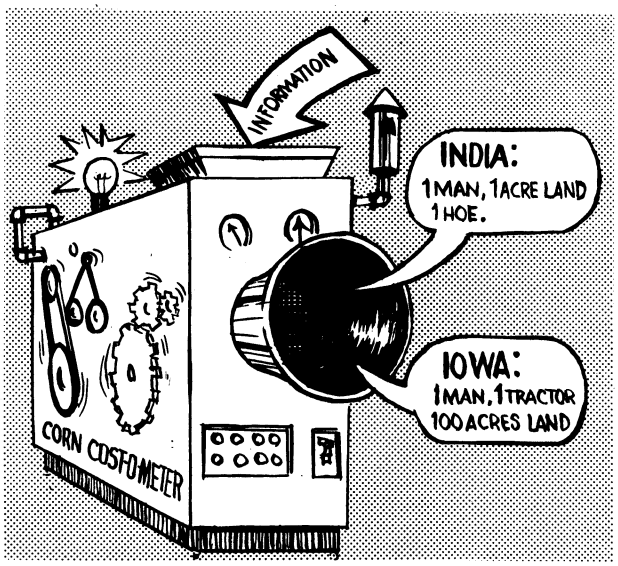
3. We are becoming more knowledgeable about and acclimated to the process of economic growth.

4. Competition within the farm industry is gathering momentum as capital, land and other agricultural resources move into the hands of stronger managers.

This process is one which is to be expected in a wealthy society, a society which has attained a high level of economic development and looks to even greater growth in the future. At low stages of national economic development,

as in India, Ethiopia, or even Portugal, the cost of farm labor is low but the price of capital and capital items is high. Optimally, under these conditions, farms employ mainly labor and only a little capital. Today, for example, in countries of Asia, Africa and South America, the main farm input is labor and very little capital is used. Farmers in those areas of the world use mostly labor in producing crops because the cost to the farm family is very low. Capital, both as borrowed funds and in the form of material items, is very costly and little of it is used. Under labor technology, which is optimum in the agriculture of less developed nations, there is little efficiency to be gained in large-scale operations, simply because so little capital is used. Consequently, there ordinarily is a large number of small farms in such countries.

THE CHEAPEST WAY TO RAISE CORN...
...Depends on Where You Are!



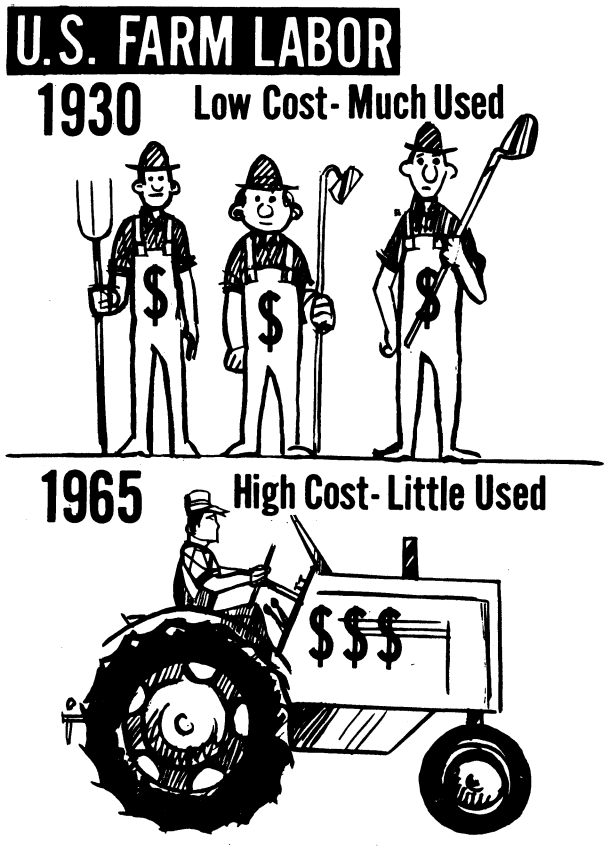
You have to consider the relative cost and productivity of land, labor and capital inputs to find which production scheme is best. In India, where farm machinery is relatively expensive and labor is not, it may still be most economic to combine 1 man, 1 acre and 1 hoe. In Iowa it may be more economic to combine 1 man, 1 tractor and 100 acres of land.

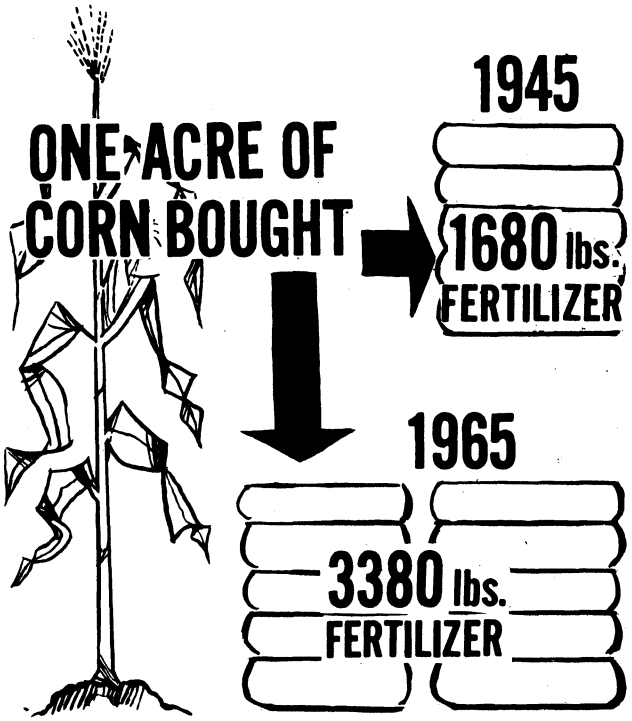
In some nations, as much as 90% of all resource inputs come from labor and less than 10% come from capital. Even as late as 1910 in the United States, labor and land represented 85% of all inputs used by agriculture. Of the 15% represented by capital, more than half came directly from the farm in the form of work stock, farm produced seed and fertilizer, breeding stock, etc. In Ethiopia, where I was recently, I would guess that less than 5% of the inputs used in crop production come from capital. Moreover, of this capital nearly the "whole lot" comes from the farm where it is used. Back in the 19th century in the United

States, when very few farm inputs came from industry, the amount of capital items manufactured by industry and retailed to farmers was small. Consequently, the private sector invested little in research to create new knowledge about inputs or production, and in communicating this knowledge to agriculture.

However, as economic development has progressed in the United States the price of labor has risen and the relative price of capital, both in terms of interest rates and of materials of production such as machines and fertilizer, has declined. Consequently, it has become profitable to substitute capital in every form for labor. This process has occurred rapidly in the United States over the last 30 years. Thus capital now represents more than 75% of all inputs and labor less than 25% of all inputs. It is likely that in 20 years or less, capital will represent 90% of all inputs used in U.S. farming and labor no more than 10%.

The effect of economic growth and full employment on the relative prices of inputs can be noted by comparing trends in prices over recent decades. In general, more of those resources will be used which have a declining relative price; fewer of those will be used which have an increasing relative price. We can cite some examples why so much capital has shifted into agriculture, thus reducing the amount of labor and land needed or increasing our potential to supply food in the future. Since 1950, compared with the price of labor, the cost



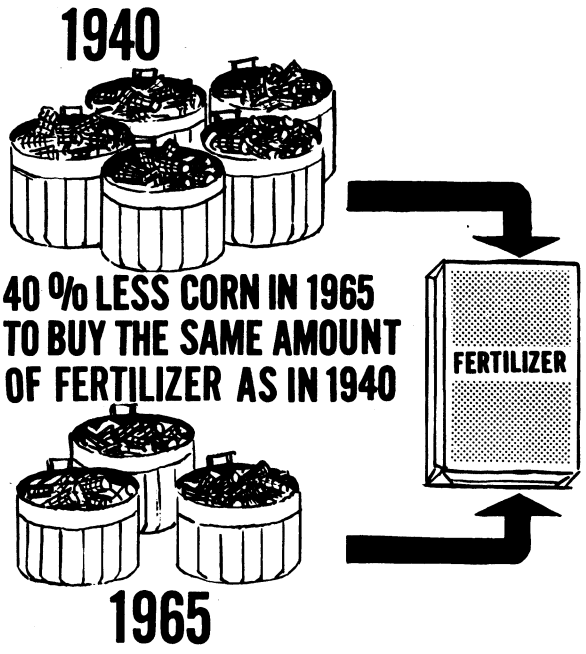


of fertilizer has dropped by 70%, farm machinery by 50% and all capital input items by 59%. Even the price of capital in the form of credit is now 40% lower, relative to the price of labor, than in 1940. Obviously these price differentials encourage a shift favoring the use of more capital and less labor and land.

Not just knowledge of new technology has caused farmers to use more of it. New capital technology has been used because it has been profitable with the prices of capital and labor which have emerged under economic development of the nation. Even with prevailing prices which farmers receive for crops and livestock, the new capital technology has been highly profitable. As compared to crop prices, the cost of fertilizer declined by about 40% from 1940 to 1965. Thus 60 bushels of corn would buy the same quantity of fertilizer in 1965 that 100 bushels of corn would buy in 1940. In other words it took 40% less corn in 1965 to buy the same amount of fertilizer. Compared to the price of all farm products, the price of all production items was about 5% lower in 1965 than in 1940.

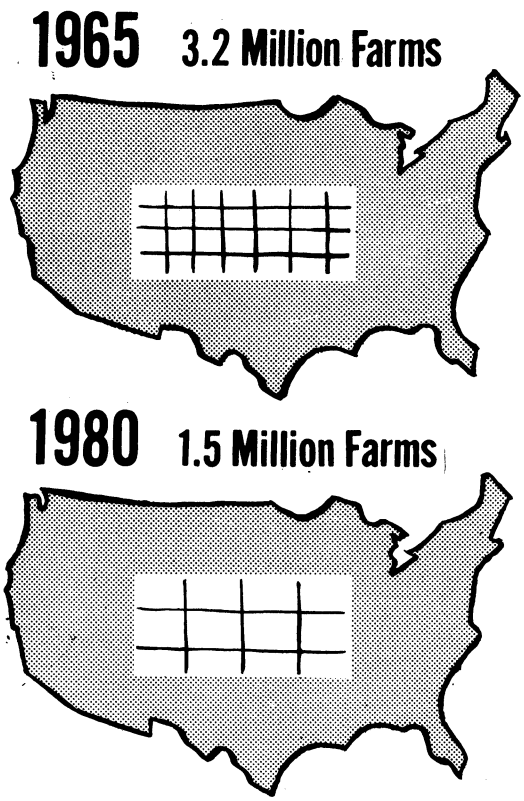
With continued economic growth of the nation, agriculture will depend even more heavily on capital. Even if capital prices increased somewhat as compared to farm product prices, capital prices would still continue to decline relative to labor and land prices under present programs. The trend toward using a more capital intensive technology can be expected to continue during the next two decades as capital prices decline in relation to other input prices.

Implications for Tomorrow's Agriculture



These changes have important implications foragriculture. They especially affect managerial and capital requirements, kinds and sources of knowledge which farmers use, the number and sizes of farms, and the agricultural labor force and the rural population. As we move towards a capital intensive agriculture, more of the capital items come in the "lumps" such as machines. These machines have high fixed costs and can be operated economically only as they are spread over more acres and animals. Consequently, as a result of economic development and changing input prices which favor capital, farms are larger and many fewer farms are needed. The tempo of this change will be faster in the future than during the past two decades. If recent rates of change prevailed in the future, we could expect the number of farms in the United States to decline from the present 3.2 million to approximately 1.5 million by 1980. About half of these would be commercial farms and the other half part-time or subsistence farming units. Accompanying this decline in farm numbers, farm employment could be expected to decline from the present 6 million persons to 3.5 million. But these are conservative estimates; the farm labor force could actually drop as low as 2.5 million, or to less than half the present number. The 750,000 commercial farms and a 2.5 million farm laborers we are projecting for 1980 could

still easily produce surpluses. For example, currently less than a quarter of all of the farms in the United States produce, in aggregate, over three-quarters of our farm output.



The shift from labor to a capital-oriented production process which occurs under economic growth not only affects the size and numbers of farms but also has an indirect but large impact on the communication of knowledge by the private sector. This shift helps speed up innovation and the rate of change. At low levels of economic development, when the main farm inputs are land and labor, private firms have little opportunity to produce and merchandise these resources. However, as farming comes to rest mainly on capital, industry not only has a broad commercial opportunity to produce and distribute the materials so represented, but it also has a great stake in developing and extending knowledge so that these inputs can be retailed. The results are evident, for example, in farm machinery, fertilizer, feeds, insecticides, seeds and other materials where a significant investment is now made by industry in research and communication of knowledge. Increasingly, firms want to conduct their own research and carry the knowledge to farmers, because they can thus better sell the capital items which they process and which have come to dominate the input makeup of agriculture. The private sector thus becomes an increasingly important force in generating new farming knowledge, in getting this knowledge

into action and in speeding changes in agriculture.

Efficient farm production more and more requires the use of a complex bundle of capital items. But these capital items are most profitable if programmed in economically efficient combinations rather than applied as distinct individual items. Thus business concerns are furnishing more managerial services to highly commercial farmers; they are serving more as "overall consultants" than as retailers of distinct practices. This prospect is emphasized by the predictions of two experts from one of the nation's largest chemical companies:[1]

"The forceful and directed application or development of scientific inputs into useful products and processes for the farmer is already being felt at the farm level... As U.S. agriculture continues to commercialize, these new inputs from agribusiness are in fact being demanded by the farmer. The fertilizer dealer now not only sells fertilizer but must advise on government programs, pest control, cultural practices, financing, etc. The systems approach to business farming is rapidly coming about. It is via this concept of a system that industrial research and development will have its greatest impact on the farm firm...Segments of the (systems) concept have been used in some components of agriculture and agribusiness for many years, i.e., poultry production and pesticide sales. The technical inputs have been supplied by the supplier to the user -- the farmer. It seems logical that more and more of

the technical decisions made by farmers will be left to the experts -- the suppliers who serve them...The farmer today is already looking for profit-making crop or animal production systems of matched products, practices and services that will minimize risk and assure him of greater, more consistent profits than he ever had before. It will be the role of industrial research in the life sciences, physical sciences, economics, and marketing to insure that improved profit systems are always on the drawing boards...When technically sound, profitable production systems and inputs are available, economic and scientific data will be accumulated by the salesman and transmitted to a control data processing center. The computer print-out will go back to the salesman, who will then take the results directly to his farmer-customer. It is even conceivable that, as electronic communications are improved, data will be transmitted directly to and from the farmer... In the future, from a central data processing headquarters, planting recommendations, pesticide recommendations, land-use maps, etc. could flow routinely from supplier to user. Marketing information would be supplied as needed and danger signals identified whenever they arise. Modern farm service centers of tomorrow are not likely to be solely shopping centers with all items needed for farming such as seed, petroleum products, pesticides and fertilizers. They almost certainly will have the added input of technology as the basis of crop and animal production systems... Essentially what we have predicted is technical selling and technical support with management guidance for maximum profit systems."

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[1]Army, T. J. and Smith, M. E., "Research and Development in Farm Related Firms - Its Impact on Agriculture in Structural Changes in Commercial Agriculture, CAED Report 24, Iowa State University, Ames, 1965, pp. 131-139.

Following this general line, firms which provide finished inputs for farmers are certainly likely to provide knowledge and managerial aids which will speed the adoption of more and more advanced farming practices. Inputs are likely to be retailed along with services which increase the perfection and efficiency of their use. This will occur largely because inputs will be identified more with the management service than as differences in brand names.

Specialization and Capacity

Economic changes which favor the further substitution of capital for labor and land also will encourage greater specialization in farming. We will have more farms which specialize in just a single activity such as hogs, cattle fattening, dairying or cash crops. Greater capital use and higher fixed costs per farm also will emphasize specialization. The greater the reliance on labor and the smaller the fixed costs in farming, the smaller the penalty for having several small or diversified enterprises. However, with a lot of money tied up in machines and other capital items, fixed costs can be spread over sufficient volume to give lower per unit costs and sufficient profit margins only if there are larger but fewer enterprises. Specialization, both by regions and by farms,not only will affect the total amount of land required to meet national and export demands for food but will change the number of farms and their capital makeup. However, the trend toward specialization may be restrained or encouraged by government programs.

The decline in the price of capital items relative to the price of land under economic development of the nation also causes the substitution of capital for land. Thus a smaller amount of land is required to produce a given agricultural or food supply. This point is well illustrated in the United States; we now require about 50 million fewer acres to produce a larger national food product than 40 years

ago. And we can expect these trends to continue in American agriculture, with capital technology increasingly serving as a substitute for land. Moreover, if market forces are allowed to exert themselves or if government programs permit, agricultural regions also will become more specialized. The level areas of the Corn Belt will move more to specialized and continuous cropping. The Southern and Great Plains fringe areas will move from grain production to grazing and forestry, etc.

An important question at this point in time is: How will our producing potential mesh with the potential demand in the years ahead? We have made some projections over the 10 year period ahead. In making one set of estimates, we assumed, conservatively, that improvement in technology would simply follow the trend of the past two decades. We assumed that exports of grain would double, with crop production patterns allowed to shift among regions with production being concentrated in areas having the greatest comparative advantage. We assumed that the expected growth in foreign and domestic demand could be met without using 42 million acres of our basic cropland acreage (our current surplus cropland average being about 50 million acres). If the rest of the country followed this trend in technology but the Southeast simply "caught up," this greater demand could be attained without using 49 million acres of our basic cropland acreage. We would then have about the same surplus capacity we now have. Without the expected increase in foreign demand, our potential surplus acreage would grow to 75 million by 1980. Hence, foreign demand, associated with population growth and economic development in other countries must much more than double before our nation finds itself in any real pinch in meeting demands for U.S. food .

This is especially true if we consider the trend in improved technology over the past 20 years to be conservative, which I do. Not only is there a trend toward a very capital intensive agriculture and few farms, but production is moving into the hands of the most capable managers. These shifts aren't revolutionary in a single year but they sum up to a lot of change in 10 to 20 years. While we may expect a steady growth in exports, our ability to produce will undoubtedly increase, too. It is possible, under new programs of the future, that exports will more than double. Under these prospects, the outlook for farming is favorable: farming profits could increase some even with a relative decline in basic commodity prices -- but only if production capacity were not unleashed so fast that it more than offset the growth in demand for food.

We estimate that by 1980 farm output could be 47% greater than in 1960 without any strain on American agriculture. The output could be accomplished with only a 10% increase in total input, the entire boost in inputs coming from capital. Such an increase in output would allow input productivity to increase by another 35%.

Management

With further economic growth and commercialization of farming, management will become an increasingly important input. It will be an important complement to capital and a key determinant in successful farming, since competition will continue, with profit margins tending to the low side. Successful farm operation will call for efficient farm managers operating on a large scale. Competition in farming will remain extreme, even under supply control programs or the absence of surplus capacity. Management becomes extremely important as farming rests less on labor and the form of capital changes each few years.

The current average age of U.S. farm operators is nearly 55 years, and one-third are over 55 years. Thus a large proportion of existing farm operators can be expected to retire within the next 10 years, and two-thirds of the present operators will have reached their 65th year within 15 years. Because of the "openings" created from this source, and because land available to other operators will be increased accordingly, changes at the end of the next decade will be mammoth as compared to those at the end of the last decade. The entering managers who take over the land and assets of those who retire or die, as well as existing managers who remain, generally will be of a different managerial class than those they replace. They are unlikely to select agriculture as an occupation unless the financial rewards for their labor and management are much greater than those of the operators they replace. Their level of education and ability to seek out new knowledge will differ greatly from the farmers they replace. Ten years from now the high school graduate will be nearly as advanced as the person with several years of college was only 20 years back. The managerial aids they will require and the technical knowledge they will routinely seek will be greatly different and much more potent than those of the past.

Capital Requirements

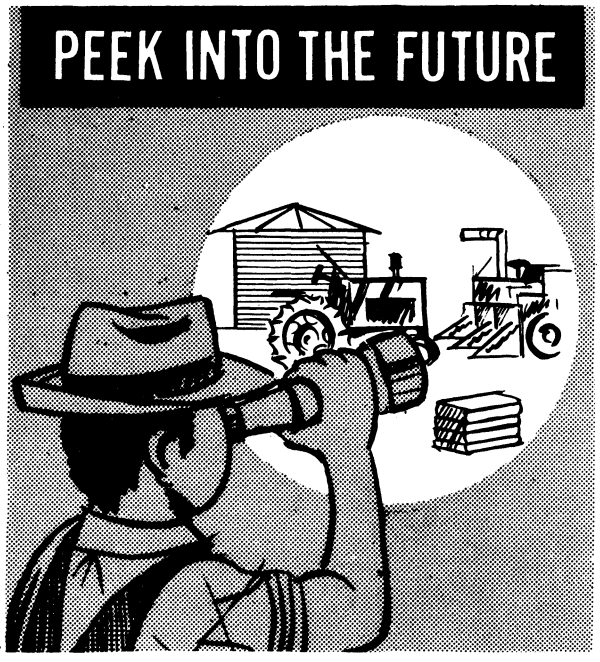
The continued substitution of capital for land and labor and the growth in the size of farm enterprises will have a great impact on the capital investment and credit needs of farming in the future. Not only will farmers use more capital, but a greater percentage of their inputs will be purchased. In the last 20 years, the amount of

capital investment required to generate $1 of farm income has increased from $4.73 to more than $15 and the proportion of unpaid inputs has declined from approximately 60% to 25%. Cash expenditures as a percentage of cash farm income have increased from 50% to more than 80%. The "profit margin" will continue low and, accordingly, farming will be highly competitive.

Inputs and capital investments on individual farms are increasing more rapidly than for the agricultural industry as a whole. Similarly the problem of financing differs. Between 1940 and 1965, the total value (current dollars) of physical assets in U.S. agriculture increased only 300%, as compared to nearly 700% for the average American farm. Even then, the over-all average per farm obscures the mammoth growth in capital usage and requirements by the large number of farms that are shifting to the highly commercialized basis. An investment of $200,000 per farm may well define the "lower bounds" for a successful commercial farm by 1980.

Projections to 1980

The use of two capital items in farming, real estate and machinery is expected to increase less than in the past as projected levels of output are attained by 1980. Real estate use is expected to gain only 4%, and machinery for farming by 22%. These increases would be considerably below the past rate of growth of these inputs but also below the projected future output level. (See Table 1). However, the investment per farm in these two items is expected to more than double. This is because farms are becoming larger and because rapid changes are taking place in technology involving new feed and



livestock handling equipment. A large amount of new field machinery will continue to be purchased, not only to replace worn-out machines but also to substitute for machines which are inadequate for large farming units. Because of the declining number of farms such substitutions will offer sizable opportunities for machinery to replace labor, despite the rather small increase in farm machinery in agriculture as a whole.

Table 1. Projected U.S. annual inputs in 1980; Productive operating and labor inputs, durable services, output-input ratios and total output (million 1947-49) dollars.[a]

	Actual		Projected	
	1940	1960	1980	Percent Change 1960-1980
Labor (based on man-hour requirements)	13,631	6,866	3,600	-48
Real estate (services)	3,485	3,750	3,900	4
Fertilizer and lime	393	1,561	2,763	77
Power and machinery	2,305	5,558	6,800	22
Livestock and feed[b]	1,151	1,526	1,930	26
Aggregate nonfarm[c]	1,296	3,112	4,900	57
Taxes and interest on operating inputs	1,088	1,611	2,400	49
Miscellaneous inputs[d]	831	1,307	1,600	22
Total inputs	24,181	25,292	27,292	10
Output-input ratio	.94	1.40	1.9	35
Total output	22,825	25,454	52,000	47

[a]Data based on Heady, Earl O., Tweeten, Luther W., Resource Demand and Structure in the Agricultural Industry. Iowa State University Press, Ames, 1963, Ch. 17. Loomis, R.A. and Barton, G.T. Productivity of agriculture, United States, 1870-1958. USDA Tech. Bul. 1238. 1961, and U.S. Stat. Bul. 233. Revised 1961.

[b]Interest and other costs for holding livestock and feed inventories.

[c]Includes purchased feed, seed and livestock, but excluding interfarm sales

[d]Miscellaneous inputs include dairy supplies, blacksmith repairs, hardware items, etc.

Operating Capital

A large share of the rising productivity of agriculture over the next two decades will come from operating capital inputs because their productivity is much higher than that of the labor and land resources they replace. Operating inputs include fertilizer, lime, feed, seed, high protein concentrates, herbicides, insecticides, hybrid seeds and such.

By 1980 the use of operating inputs for the farm industry are projected to increase to 70% above the present. Purchases of fertilizer and lime in 1980 are conservatively projected to grow about 80%. Operating inputs used per farm are expected to be nearly three times that of the present.

Size Distribution of Farms

A projected doubling of the size of farms by 1980 indicates considerable potential for reducing per unit costs in crop production. Opportunities will exist to further substitute machinery for labor as depreciated machines are replaced with new and larger ones.

Commercial agriculture already is represented by farms with sales of $10,000 or more. By 1980, commercial farming will be typically represented by farms with sales of $20,000 and over. Even the number of farms with sales between $10,000 and $20,000 is expected to decline. While family farms will be most numerous, by 1980 there will be a very large increase in two-man and three-man farms over the entire country. The distribution of commercial farms will change so that most of them will be large rather than small units. By 1980, we may expect federal minimum wage rates to apply to farm labor. Moreover, as agricultural workers benefit from improved education, guidance and occupational mobility, farmers will have to pay wages and provide fringe benefits competitive with nonfarm labor.

This is a condition which has not existed under the historic "backup of labor" in agriculture, but it certainly is in prospect under current economic growth rates and developing shortages of skilled workers. These higher relative wage rates will accentuate the trend toward substituting machines, equipment and other capital items for labor -- although this trend will be partly offset by the fewer and larger farms of the future.

Summary

In summary, I project some rapid change for the period ahead in agriculture. A lot of adjustment and change has already been realized -- for example, in the numbers and sizes of farms, in the mechanization of operations, etc. In this sense, the absolute amount of change can't be as large as in the past. To reduce the number of farms as much as during the last 50 years would give us a minus number. But relatively, the change will be just as large. And it will have greater implications in extending the commercialization of the agricultural industry, in making technology and management more sophisticated and responsive to change. Certainly farming will be a competitive industry, partly because the level of managerial skills will rise greatly. In the next generation, high school graduates will be close to the equivalent of college graduates of the past generation. Too, as mentioned previously, farms will obtain an increasing proportion of their managerial services from the input firms which supply them. The latter will, and already are beginning to have advanced systems analysis divisions for these purposes. I predict, by 1980, that all leading commercial farms of any complexity will be using the services of electronic computers to devise annual plans. This system of planning will allow the manager to compare literally hundreds of production alternatives and to select the one most suitable.

Farming will have, in the period ahead, some major tasks in digesting the change which is taking shape. This, however, is not unusual and is nothing more than most other major industrial sectors and professions are now, or will be, involved in. It is both the price and reward of economic growth. Farming would be droll and uninteresting if it were not progressive enough to become equally enmeshed with other advancing sectors in changes which accompany economic growth. This growth has now progressed so far, and is so much more in prospect, that it will dominate farming in the future. Economic growth will do so as it continues to change the relative prices of inputs, encouraging the use of more and more capital in agriculture -- and as it continues to generate scientific and technological phenomena which have important spill-over effects in farming. These forces are so strong and dominant that they "will take agriculture along with them."