This paper -- originally listed as a technical paper -- will not treat potential technical or engineering changes in farm machinery and other agricultural capital equipment. It will treat demands for capital and management, however, from economic points of view and will, in the process, touch pointedly some probable structural changes in agriculture.

Background Information

As background for discussion, I am going to spend the first few pages briefly describing some projections to 1980 for a few major characteristics of U. S. agriculture. Projections to 1985 would be much better, since direction signs as far ahead as possible -- and 1985 is only eighteen years ahead -- are helpful.

United States Population

The total United States population, which serves as the primary market for the products of United States agriculture, will total approximately 250 million compared with 198 million now -- an increase of about 26 percent. All of North America, in fact, is growing at roughly similar rates and, as a result, continental demand for the product of our agricultural enterprise should itself be a major growth force for agricultural industries.

World Population

The so-called "population explosion," which will result in a doubling of the world's population by 2000 A.D. at current rates, has been so widely discussed that we won't go into detail about it here, except to assume -- in the light of U. S. action under the "Food for Peace" program -- that our country will act responsibly in helping to feed the rest of the world. Such assistance, of course, will show up in our exports -- and promptly. We can't wait five or ten years to get ready.

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Exports of Farm Products

Exports of farm products, since the early fifties, have more than doubled, substantially as a result of government assistance. Exports without government assistance, however, since the mid-fifties, have increased by well over 50 percent, and such exports continue to account for 50 percent or more of the total -- and could account for a larger percentage.

North American plus export demands for the products of agricultural enterprise in the United States will, in the next ten to twenty years, reach record highs and provide markets never before served by United States agricultural producers.

Farm Population

Farm population has been declining steadily in the United States since its peak in the mid-thirties. It will continue to decline. In fact, as a description of a portion of our population, it will become very small or even disappear by being defined out of existence. It may become indistinguishable because of changes in address identifications -- such as urban or rural -- or vocational descriptions. It is now less than 7 percent of our total population. By 1980 -- if it is distinguishable -- it will probably be 3 percent or less of the country's expected total population. This small segment may be difficult to identify, and its problems will differ greatly from those of the past.

Total U. S. Land Area

The total U. S. land area is relatively fixed, but the total land in cities, highways, airports, urban and suburban utility requirements, and forestlands -- much of which will be parks or greens -- will increase. As a result, land available for agriculture will decrease slowly; and croplands planted and harvested in the next fifteen years will decline, at least temporarily, as soon as the current planned crop acreage increases have been digested. It is not necessary to point out, but I shall, that crop acres harvested in the United States from about 1920 until 1956 totaled 350 million acres, plus or minus ten to fifteen million. Since then, the total declined to 290 to 300 million acres following the establishment of the Soil Bank in 1956. Keep in mind that the essentially horizontal trend, at 350 million acres, maintained for many years, while draft animal population was declining by some 17 million head and the acreage used for their feed was declining by 80 million acres. Is it any wonder that the United States had more production than it
could use? It is likely, however, that we will not for many years plant or harvest as many acres as in the years just before the Acreage Reserves were established.

Number of Farms

The number of farms, as defined by the Census, reached a peak in 1920 and then started to decline. The decline was arrested in the thirties when, during the Great Depression, people returned to farms briefly as urban employment slackened, but following the recovery, the downward trend continued. In 1964 only 1.8 million farms sold products valued at $2,500 or more; less than 900,000 sent products to market with a value of $10,000 or more. It is safe to say that the number of farms will continue to decrease, and by 1980 the total of economically productive farms probably will not exceed 500 to 600 thousand. New developments could cause this total to decline to a substantially lower total by the target date or shortly thereafter and produce our country's total needs more dependably and less expensively in terms of the ratio of inputs to outputs.

Agricultural Employment

The trend of agricultural employment has been steadily downward, except for the Depression period. In the last twenty-five years the number of farm workers has been cut in half. The trend will continue downward. Where it will level out is impossible to predict. It is probably enough to say that what we now consider as agricultural employment -- even within so short a period as fifteen years -- may be redefined and show up in nonagricultural industrial classifications. Month after month, the Farm Labor release of the Department of Agriculture drives home the fact of declining farm employment. The April 10, 1967, release -- sounding much like the monthly releases of the last few years -- indicates that the nation's farm labor force in the week of March 19-25, 1967, totaled 4.4 million persons, a record low for the date. For a number of years, agricultural employment declined relatively slowly, in the neighborhood of 3 percent per year. For the last several years, the year-to-year decline has been 7 to 12 percent.

This downward trend has been both effect and cause. Workers have been attracted to nonfarm jobs, and agricultural machines have been substituted. At the same time, the cost-saving and productivity-increasing
capacity of machines has been eagerly sought to eliminate costly, troublesome, and undesirable work. There is still a long way to go.

Recent minimum wage legislation is speeding further decreases in agricultural employment.

For people in agriculture, these trends are convincing confirmations of the rapid declines in opportunities for individuals to work in agricultural enterprises. Greater proportions of the labor formerly used in agriculture will, in the future be used in servicing agriculture and in the processing and distribution of food and fiber. The sons and daughters of long-time workers in agriculture, however, will do well -- in view of the outlook for the future -- to search for job opportunities in areas well beyond those directly or even indirectly related to agricultural operations. In the future, serving and supplying agriculture will be little different from serving and supplying other industries. If this is true, the services demanded can be provided as well by people without a farm heritage as by farm-raised people. In short, the distinctions we have credited so long to farmers or persons raised on farms are rapidly disappearing.

Average Size of Farm

The trend in the average size of U. S. farms has been continuously upward. In the years ahead, it will continue its upward course, and where it will stop nobody knows. Farms are currently being consolidated in the U. S. at the fastest rates in history. To project the average to 1980 is hazardous; more importantly, it is meaningless. It is meaningless because the trends toward industrialization and specialization of both the enterprise and labor will result in farms of very different sizes, depending upon the commodity produced.

Tractors, Combines, Pickers, Balers, and Choppers on Farms

The total number of tractors and other traditional important machines on farms increased in growth-curve fashion from their introduction early in the century into the early 1960's. Totals of most of these machines are now declining, but such totals for all of agriculture have little meaning. The important machines -- those that should be counted -- are those on highly productive agricultural enterprises. Such machines are less than ten years old and probably not more than five years old.
Income from Agriculture

The trend of cash receipts from agriculture has been steadily upward since 1940, and I believe that the trend will continue. Such income will be divided among substantially fewer recipients and will be large enough that agricultural enterprise, as an industry, can stand on its own feet -- side by side with other industries -- to a greater extent than at any time in our history. Many argue that some other industries don't stand on their own feet. I would answer that "along with agriculture, it's time that they did."

So much for these types of projections. We could extend them and, in fact, should prepare them in much greater detail. We don't have space here and now to do this, however, even if all the data collection and research had been done -- which, in my judgement, it has not.

Projection Methods -- Trends, Adaptation, a Philosophy

Projections of the types I have been discussing should not be considered as precise forecasts. They can be best used as general guides. As extrapolations of previous trends, all of the kinds of forces which historically have affected the trends of the factors being projected are implicitly assumed to be present in the future and, therefore, to affect the projections. Unfortunately, much of the research in agriculture has failed to take account of the changing nature of agriculture and most such projections are not borne out by experience.

If the farm machinery industry and the agricultural capital suppliers of the future provide the inputs expected of them, they must certainly make their plans with reasoned consideration of many types of projections. Let me discuss some of the projections we have made, and then I want to discuss some of the changes which may take place.

Since it takes John Deere -- or any of the major farm machinery manufacturers -- five to seven years to develop, test, and put into production a major new machine, it is important that we be as nearly right as possible in the projections of the various characteristics of these machines for as far as fifteen to twenty years ahead. As an illustration, the decision to develop and produce the new series of tractors which Deere put on the market in 1960 was made in the Fall of 1953. At that time, the new power sizes determined as essential were well in advance of anything then being produced and went only as far as the power introduced in our Model 4010, which was
approximately 84 horsepower. Our designs and our tooling, however, were such that it was possible, in a relatively short time after the introduction of the new series, to introduce the Model 5010 at 121 horsepower.

Recently, we have had to produce estimates of unit requirements of tractors by horsepower sizes for 1975 and 1980 as guides to engineering development. In making these projections, we have had to depend upon trends and the factors of change implicit in them, but we have had to go beyond this, however, and introduce new technical methods of projection as well as make some assumptions about the potential changes in the structure of agriculture, the capital requirements of agriculture, the operating characteristics of tractors and other agricultural machines and equipment and their servicing requirements. In short, we've had to develop new philosophies of the nature of change in agriculture.

The most interesting development statistically in preparing our projections has been analyses of the annual shifts in power size distributions of tractors, as reflected in log-normal curves of annual sales. It is impossible to extrapolate the trends of such distributions by usual methods. Imagination in adapting methods from other fields may pay off. Time, plus our use of confidential data, does not permit my describing detailed conclusions.

In general, I can say that the power of tractors will continue to increase at the drawbar but also to provide for an increasing variety of hydraulic aids, for heating, cooling, and ventilating of drivers' cabs, for powering communication equipment, etc. The resulting machines will be increasingly productive and functional. They must also be considered as being as attractive to the manpower which runs them as the newer types of machinery being installed in factories in other industries. This is a most important consideration for agriculturists in attracting the skilled labor to whom they will entrust operation of high-valued capital items.

The projections of requirements of farm machines carry with them some corollaries. The machines must be of a high degree of reliability. This requirement has led to the institution in most of the large farm machinery companies of rigorous programs of inspection, quality control, and reliability standards. It has also led to the reassessment of servicing

\[1/\]Such methods are described by the Belgian, Karl Daoves, in "Voraus­bestimmungen im Wirtschaftsleben," Essen. Girardet. 1951.
requirements and the provision of spare parts. The cost of high-unit-value machines of these types requires -- just as the high-cost capital equipment of other industries -- maximum use on 'round-the-clock schedule when feasible. Our projections, then, go beyond the simple statistical extrapolation of trends to the reasoned consideration of many of the aspects of production and distribution to which they may be related.

Since this is not a research paper or a paper reporting the results of research -- but is rather one aimed at eliciting ideas and stimulating imagination as a basis for developing new research directions and programs -- I'd like now to shift gears for a few minutes to raise one of the most important questions related to changes in machinery, buildings, equipment, etc. I want here to talk about two major problems. One of them is the objectives or goals of agricultural enterprise in the United States, and the other has to do with meeting these goals.

Goals of Agriculture -- Objectivity vs. Tradition

In my experience, research in agriculture traditionally has been done with many implicit or unstated -- usually unrecognized -- assumptions. One effect of the presence of such assumptions in research may be to minimize its objectivity.

To illustrate this point, suppose we were to say that in the future the objective of agricultural policy in the United States should be to minimize resource inputs relative to product outputs, that is, to minimize unit costs of production, yet remain economically viable and competitive in domestic as well as world markets.

Suppose then, we were to start from scratch and to say, "What steps shall we take to organize an agricultural enterprise to accomplish these goals?" If the group here today, for instance, were to decide to engage together in such an enterprise with the goals suggested, we would be wise to start by making -- or contracting with a professional group to make -- a feasibility study similar to those produced for groups in other industries (or companies) when they plan to initiate new, potentially profitable enterprises.

Starting with this point of view, we must determine what product to produce. We will have to take into account the location and size of the market for the product and what specifications and qualities of the product the markets want. We will have to determine from scratch -- without an
inventory of capital in any form -- the specifications of soils (if soils are required), weather or water conditions, buildings and equipment, etc., that we must acquire. We will have to take into account current competitive costs and terms of capital, taxes, wage rates of able people, and -- most important of all -- management.

Since all of us cannot be the managers, we will have to choose one person who is the best manager. He may not necessarily be the best agronomist, but he probably will turnout to be the best businessman we can find and afford -- however we define "businessman." To find him, we certainly will have to compete with a great variety of other agricultural and nonagricultural enterprises. Whether or not we find him on what has been a farm and whether his training will have been in a college of agriculture, a school or business, or a college of arts and sciences will be immaterial. What we will need will be the skills of management -- however or wherever developed.

We will then proceed -- if we are to get capital at minimum costs -- to go to the public to whom we will sell shares in order to get necessary funds, and our loans will have to come from institutions for long terms and at rates which will be competitive with those charged to other industries.

In the future, if we treat agriculture as an industry with the same kinds of basic objectives as are established for other industries, these are the kinds of steps we will have to take. I neither have seen in writing nor heard in oral presentations by agricultural economists more than traditional discussions of such steps. Research related to these organizational processes is the responsibility of you educators. Your research programs and curricula should be changed to move in the directions that will provide answers and training along the lines of requirements which will be essential for the future, or we ought to study the rapidly advancing work of others in financial organizations and corporation finance and advise our students to be bold in crossing disciplinary lines for exposures to such fields.

Illustrative of the need for such steps is the experience of the Midwest Farm Corporation. A group of eastern Iowa farmers, lawyers, doctors, engineers, and businessmen obtained an intra-state corporate charter in March 1965 to operate a large, straight corn production enterprise. Traditional opposition to both the corporate form of organization and to the agricultural methods proposed combined to delay the sale of shares by the local group, as well as the additional financing necessary for the start of the operation.
After long months of restudying every phase of the plans and searching for professional financial assistance, a contract was made in the Summer of 1966 for a feasibility study with Arthur D. Little, Inc. No agricultural group with experience along such lines and known to investors could be located.

The feasibility study, on explicit conservative assumptions, estimated that the potential return, after taxes, on original stockholders' equity in this enterprise was 12.1 percent for the first year, 13.8 percent for the second year, 17.5 percent for the third year, and 18 percent for the sixth and later years. Time doesn't permit reporting more details of the report. Suffice it to say these are figures of truly growth proportions. The study was presented to a group of prospective investors by a midwest financing firm early this year. The stock was completely subscribed, and the actual operation on nearly 2,000 acres is under way. This example alone suggests many questions needing research.

If I were to describe the contrast with what we have been doing in traditional agricultural economics, I would sound negative. Let me take that risk in order to make some of my points clear.

1. The word "farm" no longer can be adequately defined. To use it may be increasingly misleading.

2. Agriculture is not monolithic. It involves a great variety of activities. Many of the enterprises within agriculture are competitive. There is no common interest among all agricultural sectors or varieties which can possibly lead to a solid voting block, as at one time there was. Many activities formerly classified as farming now make up specialized industries. Hatcheries long since have moved to urban areas. The broiler industry, save for some restraining ordinances, could probably better be in the urban areas than where it originated. In the future, with the appropriate use of chemicals and knowledge of sanitation, the dairies -- and even some of the animal-feeding operations -- can be located within urban areas. Their location will depend, aside from existing restraints, largely upon the economics of the movement of milk or carcass versus the movement of feed and waste.

3. Agricultural management is not an inherited characteristic. Agricultural enterprises must seek and compete for management against other industries. Is this really possible? I was told by a most successful farmer the other day that farmers are afraid of competition. But, management is being taught with increasing effectiveness, and a great deal of research is under way in the field.
4. The continuity of good management is essential to long-term credit and low or prime interest rates. How should agriculturists organize their enterprises in the future to provide multiple-generation good management and the opportunities other industries have enjoyed for assured and economical capital costs? To accomplish such goals, freedom from restraining controls will be essential.

5. Access to agriculture is still possible but under more difficult conditions than in the past. Much has been made over the years of the importance of the sons of farmers being able to become farmers. Is there any reason why access guarantee should be provided for agriculture? It is not provided or guaranteed for any other industry.

6. Agricultural labor will receive wage, fringe benefits, and security guarantees similar to those provided by other industries.

The points I have just been making are some, but not nearly all, of those which implicitly appear to lie in the basic thought and hence to underly practically all research by agricultural economists. If United States agriculture in the period ahead is to attain the position in world agriculture and world trade which it deserves, the objectives must be changed and clearly recognized as promptly as possible.

Statistics -- Measurements Related to Objectives

Now, let me turn for a moment to another aspect of research relative to inputs of capital goods in agriculture.

Statistics on these subjects are of varied reliability. For many years, the Bureau of the Census has produced regularly figures on production and shipments, in units and values, of a great variety of farm machinery and equipment, including tractors. By certain statistical assumptions with respect to prices paid by farmers for such machinery, it has been possible to estimate farmers' annual investments in this type of equipment.

Data on farmers' investments in other types of capital equipment however, such as buildings -- including barns, silos, service shed, storage sheds, etc. -- and the equipment necessary for irrigation or conservation practices have not been easily or reliably available. In neither of these cases, however, has investment by producers responsible for major portions of production been available. In 1955 the Bureau of the Census, for the
Department of Agriculture, conducted a Farmers' Expenditure Survey, which provided some information -- but only some -- on this general subject.

Annually, the Department of Agriculture produces a Balance Sheet of Agriculture in which estimates of a variety of assets are provided. These estimates are made by a number of procedures which long since have been in need of review and, in my belief, renovation. As in the case of the production and shipments figures, the Balance Sheet figures likewise are not classified by size of enterprise so that the whole of agriculture, within which I am sure there is great waste in use of capital, is not reflected in the figures.

If it is important to know -- and I think it is -- more about changes in the future in investment in the various agricultural capital items, then it is important that new statistical programs be developed and that some of the older programs be modified. I mention this now because plans are being laid now for the Census of Agriculture of 1969.

The Census of Agriculture is a traditional instrument. It, too, ought to be brought up to date to treat agriculture as an industry. The Directors of the Census are continuously willing to listen to proposals for changes and will, in this instance, welcome suggestions about information needed to aid in measuring the degree of attainment of the objectives of a modern United States agriculture.

I listened at the recent meetings of the American Farm Economic Association to Professor Cochrane talk about gaps in agricultural data. I remember hearing no single word along the lines I have been discussing. His whole interest appeared to be having more information that will help in government programs of production control rather than in providing the information which will free agriculture -- to make it what, in my judgment, it should be. What can this group do to further the program of an improved Census of Agriculture? It is getting late, for decisions will be made within the next six to twelve months which will set the course for a new type of Census or continue it in the context of tradition.

If information relative to the capital inputs of agriculture is going to be important in the future and if its main source will be production and shipments figures, as has been the case in the past, it will be necessary for those of you who use these figures to be aware that the "Farm Machinery and Equipment" industry is probably producing a continuously declining portion of the total capital equipment used by agriculture.
The changing nature of agriculture is the reason for this, the increasing size of operations and the changing nature of methods of handling and distributing agricultural products are largely accountable. Field agriculture is becoming increasingly a materials-handling operation. This is true whether we are talking about moving soil in preparation for planting, or the harvesting, handling, and shipping of product. Increasingly, a number of these functions are being performed by equipment made by a wide variety of industries whose production and shipments figures are listed under different classification numbers and names and are not included in farm machinery and equipment. To sort out these various pieces makes the possibility of obtaining accurate, overall figures increasingly hazardous. Attention to the appropriate collection and collation of information is extremely important now if appropriate data on this subject are to be obtained in the future.

If agriculture in the future is to be treated like other businesses or industries, changes in government itself may be helpful. The Department of Agriculture may be partitioned and re-combined by some future Administration much as has been proposed for the Department of Labor and Commerce by the present Administration.

Conclusions

I have told you that I believe that the future of agriculture is bright in terms of the demands upon it for its product. Agriculture is in the midst of great change and bears increasing responsibility as an industry or collection of industries in helping to supply world needs. To meet these responsibilities, the most important input factors will be management and access to capital as efficiently and economically as other industries. To obtain management and capital at economical costs, agriculture, the industry, will become increasingly industrialized and specialized and will compete in the general markets for managing manpower.

The measurement of the capital requirements of agriculture will require new statistical approaches and techniques, and it is time now to do the research required. In this paper, I have not mentioned the research on the steps necessary to move from traditional agriculture to the new agriculture. To make the new agriculture most productive, broad and new approaches to production research, as well as different kinds of research on the personal problems that accompany shifts of people from agriculture, will be required.