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INTRODUCTION

The Farm Forum on Public Policy presents a discussion, once each year, on one or two questions that are of general interest to the public and directly related to Agriculture. Statements representing different viewpoints are presented by individuals who are competent to discuss the questions under consideration. Members of the audience are then encouraged to ask questions of the speakers and to make comments on the topics being discussed.

The intention of the program is to present information, encourage discussion, and stimulate thinking on matters that are of concern to farm people and the general public. No attempt is made to arrive at definite conclusions or develop answers to the questions discussed. It is believed that the information presented and participation in the discussions will help those in attendance to exercise sound judgment in arriving at their own conclusions.

To enable those who attended the Fourth Annual Farm Forum to consider the papers presented in more detail and to afford those who were unable to attend the forum an opportunity to read the papers, they are published in this bulletin.

J. H. Longwell,
Dean and Director

Twenty-Five Years More of Our American Economy

Dr. John D. Black
Harvard University

Your presiding officer has asked me to discuss with you the report of the President's Materials Policy Commission published in five thin volumes last June under the title RESOURCES FOR FREEDOM. I do this not as one of those responsible in any way for the planning and development of this report, but mainly as one of the general body politic. My specific contribution to it was a 102-page mimeographed analysis of the agricultural and land-use part of the assignment, which was condensed by the staff of PMPC, which included my Harvard colleague Professor Arthur Maass, into the five pages in Volume I called "Improving Agricultural Resources," and the 14 pages in Volume V called "Future Demands on Land Productivity." I did, of course, have a chance to review these condensed statements before they were published, but they are not altogether what I myself would have chosen to put into such summary statements. My orientation might have been somewhat different.

One has to understand at the outset how the PMPC came into being and what it set out to do. I scarcely need tell you that in Would War II this country did not have enough of a considerable list of materials needed even for its own armed forces and supporting civilian population, to say nothing of the allied nations. This was even true to some extent in our short participation in World War I. Even wheat and sugar were in short supply in 1917 to 1919. When the fighting began in Korea, this nation was faced with the clearly possible need of having to maintain a large military establishment for decade after decade for who knows how long, and also supplementing the supplies of some of the other Free Nations. Did we really have all the resources needed for such a sustained effort? To analyze the defense aspects of this problem and suggest plans for meeting the situation, the National Resources Security Board had already been set up in 1947. But if defense was going to need to be continued decade after decade, account must also be taken of the needs for expansion of the general economy. President Truman's letter to Chairman Paley of the PMPC states the problem as follows:

> By wise planning and determined action we can meet our essential needs for military security, civilian welfare, and the continued economic growth of the United States. We cannot allow shortages of materials to jeopardize our national security nor to become a bottleneck to our economic expansion. The task of the Commission, therefore, will be to make an objective inquiry into all major aspects of the problem of assuring an adequate supply of production materials for our long-range needs and to make recommendations which will assist me in formulating a comprehensive policy on such materials.

I believe the Commission should study, together with any other asspects deemed by it to be pertinent, such questions relating to production materials as:

(1) The long-range requirements outlook.
(2) The long-range supply outlook.
(3) The prospect and estimated extent of shortages.

(4) The consistency and adequacy of existing Government policies, plans and programs.
(5) The consistency and adequacy of private industry practices.

In analyzing these items consideration should be given to the needs and resources of the nations with which the United States is cooperating closely on military security and economic matters.

In setting forth on this task, the Commission came to the wise conclusion that it had better choose a definite period, one neither too immediate nor too long into the uncertain future, within which to do its balancing of prospective needs and supplies. It chose the year 1975.

The first question needing to be answered was: How big will our economy be in 1975? A major factor in this is: How long will our population be at that time?

It would be hard to find a more difficult question than this one. The population scholars of twenty-five years ago were making their forecasts on the basis of the rate of decline of birth rates and death rates in the immediately preceding decades. Then came the Big Depression of the 1930's in which marriage rates and birth rates declined sharply. By 1945-1950, most of the population scholars were basing their forecasts partly on these more rapid rates of decline, and coming out with statements that the population of the United States would level out at less than 175 million before the end of the century and eventually start to decline. The population surge that set in as usual during World War II was somewhat stronger than expected and in particular has continued longer and stronger than expected since. Some workers in this field are now saying that a new pattern of family sizes is developing and we cannot really forecast that the population will ever stop growing. The Commission took a middle position on this subject and assumed a population of 193 million in 1975.

The next major factor is the rate of growth of output. The Commission chose for this roughly the average rate of growth in the preceding fifty years. This includes of course the period of greatly retarded growth in the 1930's, but also accelerated expansion of two war periods. There are some who are saying that this is too conservative an estimate, that we now know how to prevent severe business recessions and, knowing this, no party in power in this country will dare let a recession become severe. Others are still thinking in terms of the "economic maturity" and "stagnation" doctries of the late 1930's. On this subject, the Commission also chose a middle ground. Gross National Product actually increased an average of 3 per cent a year from 1900 to 1950, and the Commission allowed for 1950-1975 an average of 2 1/2 per year per man-hour combined with a 15 per cent shorter work week -- not quite a 4-day week of 7 1/2 hours per day, because perhaps it realized that farmers and a lot of other folks will find a good bit of work to do in the other three days.

Even at the 2 1/2-per cent rate, the Gross National Product would double in 1950-1975, reaching a total $547 billion, and average per-capita income would rise from $1300 to $2000 in 1950 purchasing power dollars, a 54 per cent increase.

The inputs for this doubling of national output would not, however, need to double. The dollar of input of 1950 yielded 80 per cent more output than the dollar of 1900 input (assuming the same price level). Therefore the demand for raw material was projected to increase only 50 to 60 per cent.

The Commission's summary table of prospective 1975 consumption indicates an increase of 53 per cent for all raw materials, 64 per cent for all raw materials except agricultural foods, of 39 per cent for all farm products, of 42 per cent of agricultural foods, and 25 per cent for the non-food farm products, including cotton, wool, tobacco. The expected substitution of synthetic fibers for cotton and wool explains this low estimate of 25 per cent for the non-food farm products.

The comparable figures for other inportant groups are minerals, total 90 per cent; iron and ferro-alloys, 75 per cent; non-ferrous metals 80 per cent; mineral fuels, 97 per cent; construction materials, 35 per cent; forest products, 17 per cent, this latter divided into 50 per cent for pulpwood, 10 per cent for saw logs, and a decrease of 18 per cent for fuelwood. The reason that the forecast for iron and ferro-alloys is not larger is the increase of nearly 300 per cent expected in bauxite (aluminum).

Why the low figures of 39 per cent for farm products and 18 per cent for saw logs as compared with 64 per cent for other raw materials? Most of the answer is familiar -- that as incomes increase per capita a smaller fraction of it is spent on food. Clothing and housing increase more with income than does food, but substitution of other materials for cotton, wool and sawtimber are expected to be large offsetting factors.

Does this country have the resources with which to meet such a large increase in demand for minerals? The PMPC is optimistic on this subject. "The outlook," it says,"although serious, is not as bleak as that. Our material position is flexible and we have opportunities to improve it along three main lines;

> We can get more materials and more energy from our domestic resources by pushing back the technological, physical, and economic boundaries that presently limit the supply.
>
> We can alter our patterns of using materials by more efficient designs and processes--and by shifting the burden of use away from scarcer materials, toward more abundant ones.
>
> We can get more materials from abroad, on terms beneficial to ourselves and other free nations."

The report then proceeds to define the lines of action which must by followed to meet these demands for minerals under the following heads:

1. Exploration and Discovery of New Deposits.
2. Fuller Use of Known Resources.
3. Using Lower Quality Resources.
4. Finding Work for Presently Unemployed Resources.
5. Synthesizing New Materials.
6. Shifting the Load from Scarce to Abundant Materials.

7. Making Materials Work Harder and Longer.
8. Giving Materials a Second Life.

All of these have to do with obtaining in effect more materials from domestic resources. It then goes on to state very emphatically that the United States "will find it increasingly worth while to turn abroad for more supplies of many basic materials, particularly minerals.....By 1975 we will probably need to import several times as great a value of various metals as at present." To this end there must be freer exchange of such materials among the nations.

> The hard political facts of the mid-twentieth century add further great weight to the proposition that it will be to the mutual advantage of all freedom-loving peoples of the earth to work toward a great economic and political cooperation founded on the principles of mutual help and respect. Such cooperation can succeed only if it is based on a clear understanding of the varying needs and resources of all the nations concerned, and of the opportunities which lie in mobilizing the strength of all to meet the particular weakness of each.

With respect to the future in the indefinite longer run, the Commission speaks as follows:

> This Commission began its report with an expression of faith--faith in growth, in enterprise, in the future of freedom. It ends it with a reaffirmation: the materials problems may never be solved but it can be compensated. We will accomplish this, however, only if we recognize that as physical resources decline, the resources of ingenuity must rise up to serve mankind in their stead.

As indicated at the outset, the Commission is considering the war and defense needs along with the ordinary needs of economic expansion. It devotes Chapters 27 to 30 of Volumne I to these aspects of the problem, beginning first with patterns and problems of demand and supply in wartime. It stresses greatly the need for maintaining stockpiles of many types of materials and maintaining stand-by facilities and technology.

The Commission concludes with a description of a continuing task, and its final proposal for performing this task is incorporated in the following paragraph:

> That the National Security Resources Board be directed, and provided with adequate funds, to collect in one place the facts, analyses, and program plans of other agencies on materials and energy problems and related technological and special security problems; to evaluate materials programs and policies in all these fields; to recommend appropriate action for the guidance of the President, the Congress, and the Executive agencies; and to report annually to the President on the long-term outlook for materials with emphasis on significant new problems that emerge, major changes in outlook, and modifications of policy or program that appear necessary. To the fullest extent consistent with national security, such reports should be made public.

Let us now turn to the agricultural part of this assignment, the significance of which for agriculture is going to be considered with you by Dr. Sherman Johnson in the next number of the program. All of you are aware of the important part which Dr. Johnson took in the preparation of the joint "production potential" analysis made by the Bureau of Agricultural Economics and the States. There is this major difference between the BAE-States analysis and the one made by the PMPC, namely, that the first limits itself largely to production outlook, whereas the second projects demand as well as supply and balances the two against each other. Also, the BAE-States analysis limited its projection to a much shorter period than 1975. However, the two analyses of production potential have very much in common and are thoroughly consistent with each other in their conclusions. Those working on the PMPC analysis had access to most of the state reports before they reduced their statements to final form for publication. But the differences between them were with respect to individual products and not with respect to the aggregate. Both analyses undertook to assemble and integrate the judgments of the major workers on the various lines of agricultural production as to what the yields per acre and per animal unit of the different livestock species would be if the technological changes now known were generally adopted. The BAE-States report then undertook to estimate how much of this adoption could be adopted in five years if farmers generally set about doing it at once. Its conclusion was that a 25 per cent increase in output would be possible.

The PMPC analysis undertook to project what the increase in output would be from increased yields per acre and per animal unit by 1975 if farmers generally set about adopting the technology now known and kept on with this effort until 1975. It did not specifically allow for development of new technology and its adoption during this 24-year period, but of course it is never possible to distinguish sharply between known and unknown technology because so much of it is just partly known at any one time. No doubt the estimates obtained did assume further improvements on technology which is already in process of development.

The final PMPC estimate as to what production increases would be from increased yields by 1975 was 86 per cent, divided between 56 per cent for food crops, 61 per cent for non-food crops, 85 per cent for feed crops, 62 per cent for forage crops, 48 per cent for livestock products per animal unit and 16 per cent for livestock output per unit of feed.

The percentage changes named are labeled A-estimates in Table 5 in Report 7 of Volume V of the PMPC report. In parallel with them is given another series of estimates which is increase in yields that will be achieved by 1975 if the farmers of this country improve their technology at the rate at which they have been doing it in the past. These estimates are called B-estimates. The B-estimate paralleling the 86 per cent A-estimate is 33 per cent. The B-estimate for all food crops is 27 per cent; for all non-food, 32 per cent, etc.

Consumption of farm products in 1975 was projected by two different methods. One of these was to project the percentage of the disposable income per capita spent on food in the past. This percentage, in the years from 1929 to 1950, was as low as 21.3 in 1941-1944 and rose to 24.6 in 1947-1949. There is no clear trend either upward or downward in this period but

a slight indication that the percentage will decline a little over a stretch of 25 years. If 20 per cent of the disposable income were spent on food in 1975, this would increase the total food consumption of this country by 47 per cent from 1950 to 1975.

The other approach is to project the consumption of individual products on the basis of changes from year to year with income and other factors in the decades from 1920 to 1950. This gave an average increase for all food products of about 11 per cent higher than what consumption in 1950 would have been except for the abnormally high price of meat. This increase of 11 per cent multiplied into the 28 per cent increase in population would result in a 41-per cent increase in food consumption. One must distinguish clearly, however, between an increase in expenditures in food and increase in food consumption. The expenditures include any increase in services sold with the food, in further preparation of the food for consumption, and the like. The difference between 41 per cent and 47 per cent may be a reasonable allowance for the increase in these services and preparation of the food.

Some of those who have reviewed this analysis, however, are of the opinion that the difference between 41 per cent and 47 per cent is not enough and that the 41 per cent increase in actual food consumption is too high. In terms of the indexes of per capita food consumption compiled by the Bureau of Agricultural Economics, the 41 per cent in per capita food consumption would represent an index number of 127 as compared with 100 in 1935-1939, around 114 just at the end of the war, 119 in 1946, and 112 in 1950, this last figure being low because of high meat prices. Some of these working on this problem in the Bureau of Agricultural Economics have come out with projection of per capita food consumption in 1975 considerably below 127. There can be no positive answer as to which is the more reasonable projection. The PMPC analysis uses the 127 index number and 41 per cent.

Parallel analysis for the non-foods comes out with a percentage increase of 25 per cent as compared with 41 per cent for foods. The combined figure for foods and non-foods is 38 per cent.

The percentage increases for individual products and groups of products given in Table 3 of Chapter 5 of the PMPC report range from 9.7 for potatoes to 15.1 for butter, to around 17 per cent for cotton and wool, to 34.1 for all dairy products, 30.8 for eggs, 49.4 for all meats, 66.3 for chickens and turkeys, 62.6 for processed vegetables, and 91 per cent for citrus fruits.

Table 10 in Report 7 of Volume 5 attempts to project the prices that would be needed in 1975 in order to bring forth the quantities projected as likely to be consumed in 1975. This analysis was made by projecting the trends in "modernized" parity prices from 1910-1914 or since 1919-1928 for some products, forward to 1950. The conclusion reached was that in the aggregate prices slightly under modernized 1975 parity will call forth the necessary production. The following concluding paragraph from Report 7 is highly important in this connection.

Two points should be emphasized in connection with this conclusion. First, the 1975 parity prices assume high level employment and therefore a demand for farm products that will keep their prices close to the parity level. However, labor and materials will not be in as great demand and short supply as they were in December 1951, when the Nation was in the midst of an all-out effort to increase its production potential. Thus, farm prices assume that a vigorous program of research and extension, with supplemental credit and other aids, will be in operation. Without the first assumption, prices will fall and the intensification of agricultural production will be checked. Without the second, and with full employment, prices will run higher than indicated in Table IX but net farm income will be lower. The agricultural sector of the economy is likely to attain its highest net return at the price levels indicated in this analysis and the volumes of output which accompany them. Thus farmers and producer groups who have heretofore put all emphasis on keeping parity prices at levels up to and exceeding 100 per cent should begin to think instead in terms of income rather than prices.

One important difference between the conclusions for agricultural products and for mineral products needs to be brought to the reader's attention. This relates to prospective changes in imports and exports. It is expected that with the increase in income per capita, more coffee, tea, bananas, and other fruits not produced in the United States will be consumed in larger quantities and that therefore the imports of farm products will increase a little more than in proportion to the population. No doubt also some types of vegetable oils will also have increased imports. But it is not expected that imports of food will increase because of any shortage of food-producing resources in the United States. No doubt also some food products like sugar will continue to have comparative advantage in production in larger areas abroad than in the United States and will continue to be imported, and may even be imported in proportionately larger amounts. On the other hand, advances in technology may give advantage to some products now imported in considerable volume. For example, kenef grown in Florida and Puerto Rico may displace jute from India and Pakistan. We may even reduce our imports of wool because of mixing more and more synthetic fibers with wool.

No doubt some will be wondering why this country should not be looking forward to greatly increased exports in view of its high production potential. The PMPC report anticipates little if any increase in exports in the near future, partly because the importing countries of Europe are trying to be as nearly self-sufficient in food production as possible and partly because other lines of production in the United States pay such high wages to labor and yield such high returns to capital that agricultural prices have to be so high that agricultural products are priced out of the foreign market. Conceivably this situation may change somewhat within the next few decades but probably not enough to affect the situation greatly in this period.

The foregoing analysis of potential supply has been in terms of increased output due to higher yields. It is entirely possible that land not now in farms could be improved at a cost that causes it to be substituted for some of the land now being farmed. No doubt some shifting of this sort will take place. The report concludes, however, that no net increase in land in

crops is likely to be called for. The growth of cities and related developments may take as much as 15 million acres out of present farms in the next quarter century and this probably will need to be replaced, by clearing, draining, or irrigating something like an equivalent acreage. Should the population keep on growing after 1975 at rates not much below those now in prospect, surely some additional land will need to be brought into farms. About 100 million acres of such land is within easy reach of present agriculture. Most of it, in fact, is within the boundaries of present farms and needs only to be converted into improved pasture or cropland.

The final point to be stressed is that even according to the PMPC analysis there is a gap between the 38 per cent increased agricultural output likely to be needed in 1975 and the 33 per cent that will come if we merely continue present rates of adoption of improved technology. Closing this gap calls for an expanded and invigorated program of research and extension work in agriculture.

Volume I devotes its final two pages of Chapter 7 to the facilitating of the needed production gains through the instrumentality of the Land-Grant College system, Agricultural Extension Service, the Soil Conservation Service, and the Farmers Home Administration, and particularly through integrating the work of these agencies. It also stresses the need for more adequate farm credit under terms suited to the needs of farm development.

It will be apparent from the foregoing summary that the primary concern of the PMPC with reference to agriculture is with agriculture as a source of raw materials for industry and food for the working population. The report states, however, that "any broad study of raw materials.....must touch on agricultural land, the ultimate source of many non-food raw materials. Moreover capacity to produce foods as well as materials for industry must be considered together, for if demand for food should strain resources, production of agricultural non-foods would suffer." Another kind of orientation might have conceived of agriculture as a more integral part of the economy.

Achieving the Needed Output of Farm Products

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The President's Materials Policy Commission Report outlines the possibilities for growth and progress in the American economy during the next quarter century. A discussion of the possible meaning of these changes to agriculture logically begins with a measure of our potential needs for farm products. A projection of prospective needs in turn rests on certain basic assumptions concerning the political, social, and economic environment in the years ahead.

In my discussion I shall accept essentially the same framework of assumptions as were outlined in the Materials Policy Commission Report. Perhaps it will be helpful to recall, however, that this report assumes progress toward peacetime conditions, also high level employment and high consumer purchasing power. It does not assume that economic stability will prevail from now on until 1975, but rather that there will be ups and downs of reasonable proportions, with high level employment the prevailing pattern. It should be emphasized, however, that the conclusions reached would not be valid in case we should encounter either deep depression or all-out war.

Three major elements are involved in analyzing our prospective needs for farm products within this framework: (1) The prospective population (2) per capita consumption of farm products, and (3) the level of exports and imports. The Materials Policy Commission Report assumes a population of 193 million by 1975. That projection is accepted for this discussion, with the recognition that a larger or smaller population increase would modify both the level of market demands and the need for production increases.

We then come to the question of changes in the per capita consumption of farm products. It would be possible, of course, to project farm product needs on the basis of prevailing consumption levels. But surely it would be more reasonable to expect changes in consumption both in food and non-food products over the next quarter century. This would be especially in keeping with the expanding economy projected by the Materials Policy Commission.

When we begin to consider the kind of changes to expect we find ourselves on rather shaky ground. We know, for example, that food consumption per capita in 1952 is running about 12 percent above the average of the years 1935-39. But those prewar years were low-income years, and we know that food consumption per capita is closely related to consumer incomes. The Materials Policy Commission projection assumes rising real incomes, but can we be sure that recent historical relationships between disposable income and food consumption will prevail? Perhaps it would be more reasonable to expect that food consumption would rise less rapidly with future increases in real income because a larger proportion of the population already has fairly satisfactory diets. Moreover, there are possibilities for technological improvement on the consumption side that might tend to

hold down per capita food consumption as it is usually measured. Progress in waste prevention also would mean that more people could be fed from a given food supply without sacrifice in diet levels.

When it comes to nonfood farm products we seem to have even more difficulty than with food. In some quarters there is considerable optimism concerning development of new industrial uses from farm products. But we need to consider the fact that agricultural raw materials have to be produced and sold at prices that are competitive with nonfarm sources. This may be a difficult hurdle to overcome for many of the uses that are physically possible. For example, we know how to produce fuel alcohol from agricultural products, but so far it has not been possible to produce it at a price that will compete with other sources of motor fuels. As a partial offset to the effect of new industrial uses of farm products we have increasing substitution of synthetic products for natural fibers and for oils.

After a careful examination of all of the factors affecting per capita consumption, Rex F. Daly of the Bureau of Agricultural Economics recently estimated per capita use of all farm products (both food and nonfood) by 1975 at about 117 percent of 1935-39. This is somewhat lower than the Materials Policy Commission estimate, but we need to recognize that it is not possible to arrive at a very precise figure. Both estimates point toward substantial increases and give us some indication of the range of possibilities.

Perhaps the most difficult question of all is an appraisal of the possible trend of exports and imports and projection of the export-import balance of agricultural products. Within the assumption of gradual progress toward peace, however, it would be reasonable to expect gradual rehabilitation and accompanying expansion of farm output in other countries. Many of the less developed countires have prospects for increasing agricultural production; and if they can realize on their potentials we might look forward to somewhat lower demands on the food and fiber supplies of this country than we have experienced in the recent period of war, rehabilitation, and defense. On the other hand, we might expect a gradual increase in imports of products not profitably grown in this country, to provide for the projected increase in population and to meet demands of a gradually rising level of living.

If the above projections of exports and imports of agricultural products should materialize, international trade would not be a large factor in the total requirements picture. Exports would be likely to represent less than 10 percent of our total output. Foreign markets would continue to be important for products such as cotton, tobacco, and wheat, but exports would not constitute a heavy drain on our production resources. This appraisal rests on the assumption that physical needs have to be backed up with purchasing power before they become market opportunities. I would readily grant that world conditions could change in such a way that there would be a substantial increase in foreign demands upon our farm plant. But under peacetime conditions this would require international arrangements which cannot be foreseen at the present time. Those arrangements would involve translating physical needs for farm products into actual market opportunities for American farmers.

After reviewing available materials on foreseeable demands for farm products by 1975, I would say that under peacetime conditions a projected increase in demands of 30 to 40 percent above 1950 levels would be a reasonable assumption. This projection includes allowance for population increase, for higher per capita consumption, and changes in exports and imports. The Materials Policy Commission Report projects a 40-percent increase. Rex Daly's recent work in the Bureau of Agricultural Economics comes within a range of 30 to 35 percent.

There is, of course, no certainty as to the level of future needs. A wide margin of error is necessarily involved in such projections. Nevertheless we need to make the best appraisal that we can of future prospects because provision of productive capacity to meet foreseeable food and fiber demands is a high priority responsibility of agriculture. Our concern, however, does not end with seeing that foreseeable demands are met. As a Nation we must also provide for unforeseen emergencies. This calls for contingency reserves of productive capacity that can be drawn upon if unforeseen needs develop. Such reserves are a second line of defense in protecting the existence and progress of our society. In the present state of world uncertainty it becomes tremendously important to make provision for unforeseen demands. But this involves a difficult problem of reconciling private and public interests which we shall take up again at the close of this discussion.

We also need protection against unforeseen production disasters such as the drought of the 1930's. Larger reserves of storable commodities are one of the protective measures that need to be developed.

Let us turn now to the question of how we might meet the foreseeable demands for farm products in the next quarter century. I should confess to begin with that I am an optimist with respect to our ability to meet an increase of 30 to 40 percent in farm output by 1975, assuming average growing conditions. I do not consider the task an easy one, but if research, education, and other programs are geared to facilitate the needed increases, no major obstacles are likely to be encountered. We are not approaching any physical limitations on production expansion. But physical achievement of the needed increases is one thing. The key question is whether it can be accomplished within a framework of economic progress. That is, can we do it without encountering higher costs in terms of using more labor and other resources per unit of product?

There are many people who feel that it may be difficult even to obtain the physical output that seems to be needed. They stress the fact that there is very little land available for further development and that the land now in use is rapidly deteriorating. We do have more land that could be used for crop production if it were needed, but the potential increase in acreage will not provide a large part of the projected increase in farm production. Perhaps we can count on a net increase of about 25 million acres of cropland by 1975. This is only about 6 percent of our present cropland acreage. The really important potential therefore lies in higher production per acre and per animal. Conservation and improvement of land is essential because higher crop and pasture yields result partly from the improvement of land now in crops and pasture. But more than land improvement is involved. Nonfarm resources have been substituted for land at a rapid rate in recent years. The greatly expanded use of fertilizer, machinery, pesticides, improved crop varieties

and many other technical changes are a part of this substitution. For example, in 1952 farmers are producing 43 percent more output than the average of the years 1935-39. To do that they are using about the same acreage of cropland, 17 percent fewer hours of labor, but their machinery inputs are about 3 times prewar and they used 3 1/2 times as much fertilizer. Of tremendous importance are the research, education, and other services that make possible the new combination of farm and nonfarm resources.

Compared with prewar years farmers have substituted nonfarm resources for both land and labor in the sense that output has been increased without much change in cropland and with actual decreases in inputs of labor. This resource substitution has profound implications for the future. How far can it go? What are the effective limits? We cannot say at the present time. But the area limitations on our land resources do not seem to establish effective limits on our productive capacity. The more important limits involve our knowledge of improved technology and the facilities for adoption by farmers of our present "know-how."

Herein lies the promise of achieving the needed increases of food and fiber without encountering higher unit costs. But let me point out that it is a promise rather than an inevitable consequence. There are obstacles to be overcome. We need to consider those obstacles and plan ahead to remove those that limit output expansion in line with market demands. We also need to develop contingency reserves of productive capacity that can be drawn upon in case of unforeseen emergencies.

At any one time the price-cost relationship is likely to set definite limits to increases in output. The much higher proportion of cash operating expenses to total costs that is involved in resource substitution becomes a serious obstacle to adoption of improved practices for many farmers. And if they adopt the new methods the risk of loss becomes greater in years of low production or prices. Cash expenses averaged 40 percent of total cost of farming in the years 1919-21 and more than 50 percent in 1949-51. This means that under unfavorable price or production conditions the break-even points in farming are much higher than in the old days of horsepower and hand-labor operations. Frequently prevailing prices and costs are not a reliable guide to future prospects. And income incentives are necessary for additional investments and also for annual maintenance of the higher level.

When agricultural scientists announce a new discovery the farmer legitimately asks two questions: One, "Will it work?" and the other, "Will it pay?" Frequently the farmer encounters some difficulty in incorporating a new experimental result into his farming operation, but perhaps even more often the question as to whether it will pay remains unanswered. For example, some of our recent studies indicate an investment cost of $60 to $70 per acre to establish improved pastures in some areas of the South and the annual maintenance cost for lime and fertilizer alone runs from $15 to $20 per acre. The small farmer with limited resources of his own and little credit encounters considerable difficulty in making such an adjustment. Farmers must have adequate information concerning the probable cost and returns and profitableness to them of such improvements before they can

consider them. And financial means or credit availability are necessary for such undertakings.

It is quite evident that research, education, and other programs are essential to maintaining high level production and to achieving further increases in output. Research has developed the techniques that made possible the tremendous increase in output that has already been achieved. Educational programs have brought research results to the attention of farmers, and credit, price support, soil conservation, and other programs have facilitated adoption of production-increasing improvements. Without minimizing the importance of the other programs we need to recognize that research is the key element in this chain reaction. This group is well aware that we cannot expect immediate results from new research programs. Also that research must precede the actual need for higher output. The time required for research to bear fruit is illustrated by the fact that crop production per acre showed little change up to the beginning of World War II. Since that time a combination of factors made it possible to reap the rewards of both early and current research efforts.

We shall need to depend upon research to increase production without proportional increases in costs. This means research directed toward development of new production-increasing opportunities, toward appraising alternative ways of expanding production as needed, and to pointing out the most efficient ways and the most profitable adjustments for farmers as well as how they might be achieved.

Although research is the starting point in agricultural improvement, education is equally necessary to bring the results of research to the attention of farmers in a way that facilitates rapid adoption of improved practices.

The Extension Service in this State is to be congratulated for its pioneering efforts in developing an educational program that helps farmers fit together improved practices into a "balanced farming" program. Your balanced farming work has achieved not only a national but an international reputation as well. I am aware of the fact that so many foreign visitors want to learn about the Missouri balanced farming program that they probably have overtaxed your capacity for handling them, but this also is educational work of very high priority because the United States as the leader of free nations has responsibility for helping with agricultural improvement in other countries.

Efficient production in line with market opportunities is a part of agriculture's responsibility but it can be achieved in different ways. The kind of agriculture that will be developed in this country and the rural environment for farm people in the years to come will depend to a considerable extent on our recognition and working out of certain improvement goals with respect to agriculture. Some of these goals have become quite generally recognized in recent years and we have made progress on their achievement. Others are just beginning to be recognized and will require much more analysis, and especially public discussion before they are generally accepted as a part of agricultural policy.

There is time for discussion of only a few of these improvement goals. We might begin by saying that the desirability of public support for

agricultural research and education is generally recognized. But we have grossly underestimated its contribution to agriculture and to the general public. We have also underestimated the size of the research and educational job if agriculture is to provide adequately for foreseeable needs, have reserve capacity for unforeseen needs, and if farm people are to participate as equals in our free society.

Recognition of its desirability and providing for equality of economic opportunity is another improvement goal. Attainment requires an agricultural economy in which farm people have opportunity to earn real income equal to those available in other occupations for the same skill and managerial ability. This is important if farming is to attract and hold its proportionate share of capable youth who are choosing their life occupations. The struggle for recognition of this principle has been a part of nearly all of our legislation affecting agriculture. The more recent efforts go back to the events which followed the depression of 1921. We have made progress since that time but achievement is difficult especially in the poorer farming areas. Adoption of improved methods in those areas frequently involves larger farms and fewer workers in agriculture. The road to nonfarm employment, therefore, must be open and attractive to those who are not needed on farms if the people who remain are to attain satisfactory incomes.

A third improvement goal involves recognition of the need and provision for minimum protection against hazards beyond the control of the individual. Again the disastrous price decline of 1921 followed by the even more complete price debacle in the early 1930's, brought home the need for protection against drastically lower prices caused by forces external to agriculture. The ramified price support provisions which are a part of existing legislation constitute some insurance against drastic reductions in farm prices, but there is need for further improvement. The widespread and persistent droughts of the 1930's emphasized the need for better protection against natural calamities which also are outside of the control of the individual farmer. Crop insurance programs (still in the developmental stage) are designed to furnish some protection against natural hazards. Further development is needed of measures for protection against both price and production hazards. Perhaps we even need further public discussion of the desirability of such protection.

The fourth improvement goal which we have come to recognize is the need for conservation and improvement of the farm plant. Public concern with conservation problems goes back at least to the turn of the century, but full recognition of the need for conservation in the public interest has become more crystallized in the last two decades. We are still in the early stages of our thinking about conservation, however. This is especially true with respect to the economic aspects, and of how effectively to combine conservation and use of resources. The chief obstacle to more rapid achievement of conservation farming is the conflict between public and private interests which arises from the farmer's need for current income and the fact that his interest in farming does not extend over a long enough span of years to obtain the full benefits of conservation. If we can succeed in making conservation farming the most profitable plan of operation for the individual farmer a powerful incentive to rapid achievement of conservation farming will be provided.

Part of the conservation objective involves protection of resources for meeting foreseeable demands for farm products. We have pointed out, however, that public concern does not end with seeing that foreseeable demands are met. Contingency reserves of productive capacity are necessary to meet unforeseen needs. Provision for such reserve capacity necessarily is a public responsibility because the market for farm products will not yield a return on the necessary investments. Market prices are based on foreseeable demands and farmers make their living by meeting those demands. But a contingency reserve of productive capacity has the purpose of providing for unforeseen demands. So far this part of the conservation problem has received very little recognition. We need to work our way through it and arrive at a satisfactory reconciliation of the public and private interests involved.

We have done the least thinking of all about a fifth improvement goal, namely, human conservation. Perhaps the reason for that is that we have considered human conservation largely an individual problem. I would heartily agree that many of the decisions involved in human conservation should be left to the free choice of families and individuals. But public responsibility also enters in and we need to reach a better understanding of what is involved in human conservation. To me it involves taking the steps that are necessary for development of the full potentialities of the individuals that constitute our population. In the struggle for men's minds that is going on in the world today, one of the essential differences between communism and democracy is recognition of the dignity and worth of the individual in a free and democratic society. But that dignity and worth cannot be maintained unless there is opportunity for fulfillment of the capacities of the individuals growing up in our society, and for the maintenance of that opportunity throughout their active lives.

One of the basic requirements of human conservation, of course, is provision of food, clothing, and shelter, at a minimum standard of adequacy. The depression of the 1930's taught us the importance of adequate diets. More recently we have become concerned with adequate housing. But what about health, and provision of health facilities for our rural population? We have made much progress, but we still seem to have a long way to go in many areas. And protection against the results of catastrophic illness is totally lacking.

Facilities for basic education is, of course, the cornerstone of improvement and progress in rural areas. In most farming communities we have come a long way from the intermittent attendance at the "little red school house" that was fairly common when I was a boy. I believe that we have not given adequate credit to the better basic education of farm people for the rapid improvement in agriculture in recent years. To recognize this does not detract from the great contributions of 4-H work and adult education. But there is room for still further improvement. One aspect of education that seems almost totally unexplored is development of aptitude testing as a guide to young people in choosing their life occupations. Can it be developed to indicate to young people those who are most likely to make successful farmers? This is certainly a field in which we cannot afford to blunder but to me it represents a challenge.

Education needs to include more than training in making a living. It should include an understanding of the world in which we live and also learning how to live in this complex civilization. That involves training for citizenship, development of a sense of responsibility to our society and alertness against encroachment upon the freedoms that are part of our cultural heritage and essential to continuation of our democracy.

I have emphasized the importance of reserve productive capacity to meet unforeseen needs. Reserve capacity is needed in all of the resources using in farming. Our most precious reserve is the health and intelligence of farm people. Human conservation involves protection of these basic resource elements. Constant improvement in living conditions on our farms will yield immeasurable benefits under any conditions but we also know from our experience in World War II that farm people can accomplish near miracles if they are convinced of urgent needs.

Agricultural Policies Needed to Safeguard Our Long-Run Welfare in this Process of Expansion

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My first reaction when the chairman of the forum committee, Professor O. R. Johnson, asked me to participate on this program was, that we could save you the time and anguish of listening to long speeches as the answer could be found in one sentence--pay the farmers a fair price for their products and they will produce the food for our expanding population.

You know and I know it is not that simple. There might be some question as to what constitutes a fair price.

Dr. Black and Dr. Johnson have given us the benefit of the thinking of some of our best informed leadership as to what we may expect during the next 25 years, and the impact it will have on agriculture.

No doubt, many of you have some reservations as to just how fast the expansion may be and what it may mean to you as individual farmers. However, I believe all of you will agree that the rapid changes which have been taking place in our economy are not likely to come to an abrupt end. The picture 25 years from now will be vastly different than it is today. How well we cope with this situation depends largely on our early recognition of the problems involved and finding suitable solutions to them. What are some of the major problems confronting us? What policies should we follow in attempting to meet them? Here are only a few as they have occurred to me:

1. How can we maintain a price system for agriculture which will permit maximum flexibility and at the same time protect farm income against sudden price decline.

The remarkable accomplishments of our agricultural and food industries in the past--accomplishments which have permitted us to feed more and more people with a smaller and smaller farm labor force--have been achieved in a framework of highly competitive and flexible price system.

Dr. Black has indicated that the increased demand for agricultural production during the next 25 years may be as much as 40%. This increased output, must not only be large, but it also must be selective. Our eating habits are changing. We are eating more and more fruits, vegetables and livestock products, but less grain products and potatoes. Therefore, it is important that we have a price system that will respond to the nation's changing conditions and particularly to changes in consumer preferences.

The welfare of agriculture is tied very closely with the general economy. Therefore, policies that help maintain high productivity, employment and income in the entire economy is essential to progress in agriculture.

However, we now have an agriculture subject to a degree of price cost risk and vulnerability never before experienced. The recent break in beef cattle prices is evidence of what can happen to individual farm commodities even though the general economy is operating in high gear.

We are also faced with the continuing price-cost squeeze due to the effects of inflation and as we have commercialized agriculture, we depend more and more on non-farm products in our operations and living. Farm records show that where only a few years ago, operating costs amounted to less than 10% of the capital investment, on the average farm, it now exceeds more than 50% on many or most farms. Therefore, only one or two bad years could freeze many farm operators out of the picture.

Therefore, it appears that our problem of learning how to employ the price system as an effective regulator of production and at the same time protecting the incomes of the farm producers from the disastrous price fluctuations is a major one.

2. A second problem which may have some bearing on the first will eventually need to be reconciled. That is the apparent philosophy and practice of passing the rewards of technological improvements in industry back to the worker, while at the same time passing the rewards for improved technology in agriculture forward to the consumer.

Bureau of Agricultural Economics figures for 1951 show that the average income per person engaged in agriculture was $1790.00 while the wage income per person employed in industry was $3416.00. Since 1910 the incomes of persons engaged in agriculture have gone up 4 1/2 times while industrial wages have gone up over 5 1/2 times.

I do not pretend to have the answer. However, somewhere along the line, it seems to me that we will need to reconcile these differences in our philosophies, particularly if the people who produce our agricultural products are ever to achieve an income and level of living enjoyed by other segments of the economy.

3. A third problem in this general field deals with the philosophy that consumers of this country appear to be developing with respect to the cost of food. As a consumer, I certainly have no quarrel with the philosophy that the American consumer must have cheap food. As a matter of fact, food is cheap in America in terms of the effort required to earn it. There is no place on the face of the earth where the working man spends such a small proportion of his working day for the food he eats, and where he has so large a proportion of his working day left to earn other things to make life so pleasant.

It takes the average American about 9 minutes to earn a quart of milk compared to an hour and 10 minutes for the worker in Russia. The American worker gets his loaf of bread in 10 minutes, while in Russa he spends an hour and 20 minutes. It takes the American worker a half of an hour to get a pound of butter, while the Frenchman does it in two hours and a half, and in Russia, if he can get butter, he does it in nine hours.

The answer to this question may be a matter of public relations; however, as more and more of our consumers depend on non-farm occupations for their income, the political implications of the problem becomes more disturbing to agriculture.

4. A fourth problem on my list is that of developing a more realistic and enduring foreign trade policy. During recent years American farmers have been exporting approximately 4 billion dollars worth of products annually.

On the surface, it may not appear too important whether or not we continue to export such quantities in the future. However, while the total exports represent only a small proportion of the agricultural production in this country, the picture is entirely different for individual commodities. We normally export 45% to 50% of our cotton, 25% to 30% of our wheat, 30% of our tobacco and prunes, 15% of our rice and 10% of our lard.

The exports of agricultural products are only incidental to the major value of our foreign trade--namely, the influences trade may have in cultivating friendship with other nations, and the role it may play in world peace.

Most foreign countries are depending more on imports of our equipment and industrial products than they are food. This calls for more employment in non-farm industries in this country, and to that extent increases the domestic demand for our food products.

All of the benefits derived from foreign trade must be taken into account in determing our future policies. I say this with full realization that the final results may create problems for individual producers or groups of producers in this country. An excellent example is the recent problem in connection with the importation of cheese from the Netherlands. Representatives of their government have told us, that unless we continue to import approximately 1 million dollars worth of cheese annually, it may mean the loss of 10 million dollars worth of total exports to them.

The problem immediately becomes one of how can we, as a nation, protect the individual domestic producer without at the same time thwarting opportunities for trade with other nations.

5. This brings me to my fifth point, or the problem of production efficiency. As Dr. Black has pointed out, American agriculture does not have any considerable acreage of additional farm land available. Therefore, the increased production must come largely from higher yields per acre and increased production per animal unit.

As pointed out earlier, farmers are in a precarious price-cost position. Maintaining and improving net returns from farming must come largely from improvements in efficiency of production, and the utilization of labor and capital on the farm. This is true whether we have boom conditions or something less. Since tomorrow's program will be devoted to this subject, I will not attempt to go into details. I would like to point out however, that the opportunities for meeting this problem are much greater through expanding the volume of production per farm and per farmer rather than cutting actual costs.

This may mean less emphasis on the emotional factors about the family sized farm and more consideration to the farm as an economic unit.

To me this does not mean the family size farm is outmoded or going out of the picture. It merely means that the family farm is rapidly becoming big business.

As an example, one of our farms in North Missouri where members of our County staff assisted the family in developing a Balanced Farming program only five years ago based on what they considered a two man operation, is now being operated by the owner-operator with only an occasional exchange of labor during peak harvest periods.

6. This leads me to my sixth point which is the relationship of capital investment to income. A study made by Dr. Suter and James E. Dillion of our Agricultural Economics Staff shows that in 1951 the average capital investment on 37 farms studied was $35,511.00. The average income on these farms, that is, returns to labor, was $3816.00. The farms with an average capital investment of $23,830.00 had a labor income of $2695.00, while those farmers who achieved an income of $5000.00 had an average investment of nearly $52,000.00 per farm.

This high initial investment plus the added cost of making the necessary improvements and paying the necessary production costs is rapidly becoming one of our major agricultural problems. It may mean some revoluntionary changes in our ideas about financing agriculture. I do not plan to discuss this in detail as Dr. Frank Miller has it as his assignment on tomorrow's program, however, I do want to call it to your attention and urge that you give full attention to his discussion.

The Contribution of Agriculture in This Expansion: Possibilities in Soil Improvement and Crop Production

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The discussion yesterday presented to us the problems of the prospective population increase during the next twenty-five years and the amounts of food and fiber which will be needed to provide the quantity and quality of food required to adequately nourish the total population and to furnish the materials necessary to clothe them. Today we will examine some of the apparently more important factors affecting the maintenance and increase in farm production and attempt to arrive at an estimate of whether potential increases in farm production will help keep pace with the requirements of population increases.

Considerable confusion has been introduced into the subject of food and fiber needs of the country and the ability of American farmers to produce, by the introduction of large amounts of emotion and biased speculation by numerous groups with special causes to support. Adherence to established principles and the application to our problems of informed imagination tempered with sound judgment, are required to enable us to work out the answers.

One way to approach the subject is to review the record of farm production during the last several years, to examine some of the more important factors affecting that production and estimate the possible effects of these factors in future production.

During the decade 1941-50, the average annual total farm production in the United States exceeded by 30 per cent the average annual production during the years 1935-39. During this same interval production per farm worker increased by 33 per cent and production per acre by 22 per cent. This total production fed and clothed the country's population more adequately than at any previous time, met the requirements of the American armed forces, and furnished substantial portions of the needs of the civilian and military people of allied countries and of other nations. This higher level of farm production is being maintained and at present appears to be a permanent increase.

The more favorable weather, countrywide, of the 1940's is estimated to account for not more than 25 per cent of the increase. The remaining gain is attributable to numerous technological factors, a few of which are obvious.

An important factor is the rapid replacement of horse power with tractors and the development of machinery adapted to tractor power. Between 1935 and 1950, the number of horses and mules declined from 20 million to eight million, while tractors increased from 1,200,000 to 3,500,000. This decrease of 12 million horses and mules released 35 to 40 million acres of land from producing horse feed to the production of feed for other classes of livestock or food or fiber for human use.

Tractor powered farm machinery requires fewer operators, works more rapidly, can be used continuously for longer times, can be applied in more timely fashion, and enables the operator to perform a more thorough job of soil tillage than is possible with horse power. Improvement of farm machines for special purposes, such as cultural operations and harvesting, materially increase the efficiency of farm operations.

The use of improved crop varieties has contributed materially to increased production. Large and profitable gains in plant fruitfulness have been made in all crops having appreciable economic value. Such increases have resulted more frequently from the breeding of new varieties having characteristics of greater economic value; but in some very important cases the addition has occurred by the introduction of new species.

Remarkable among all crops for increased yields is hybrid corn. It is generally estimated that the national corn crop has gained 20 per cent in average acre production from the use of hybrids. In Missouri our old long-time average of 25 to 28 bushels per acre has risen in the last decade to about 40 bushels, a gain of 12 to 15 bushels per acre. About one-half of this gain may be attributed to the higher productivity of hybrid varieties and the other half to other factors. Hybrid corn breeders believe that a further gain of 10 to 15 per cent can be accomplished through presently known methods of breeding, and that our advancing knowledge of genetics and breeding techniques may lead to another "break through" in corn breeding equal in importance to that already known. This affords a possible further increase of 30 to 40 per cent over present yields.

Soybeans are a new crop, practically unknown to Missouri farmers in 1920. The average acre yield of soybean seed in Missouri has approximately doubled in the last ten years. Total state production has risen from a quantity two small to be reported in 1930 by the agricultural statistician, to approximately 35 million bushels in 1952. An average gain of five bushels per acre is credited to the use of improved varieties now in use. Another gain of three to five bushels is probable within the next decade, on the basis of present genetic procedures. Further possible genetic discoveries could substantially raise this estimate.

The fact that the small grains have been subject to selective improvement by man for a much longer time than is the case with corn, probably accounts in part for less spectacular gains with these plants than with corn, which has been under cultivation for a relatively short time. Plant breeders have produced varieties of small grains with improved growth habits and higher grain quality, but they are engaged in a race with plant disease in which they are able to stay only slightly ahead of new varieties of these diseases. Basic research in the genetics of grain plants, such as that now being conducted at the Missouri Station on the wheat plant, may provide the plant breeder with the means of making substantial progress in improving these crops.

The improvement of pastures has been revolutionary in effect upon Missouri farm economy. This is not an occasion for discussing the pasture theme, but we may at least say that seasonal pasture capacity per acre in terms of live weight gains in beef cattle has been doubled in the last 20 years,

and has shown similar improvements in terms of the acre production of other classes of farm animals. It is calculated that if all means now available for pasture improvement were utilized, the state-wide capacity of our pastures would be doubled. Twenty years ago a season's average of 100 to 150 pounds per acre gain in beef cattle was a common standard. Today an acre gain of 200 to 300 pounds on pasture that is known as improved is common.

The increased use of fertilizers, especially when based on soil tests, accounts for substantial crop yield increases. In Missouri the use of commerical fertilizers increased from less than 200,000 tons in 1946 to about 500,000 tons in 1950.

Other productive factors that must be recognized are water management practices; more effective control of insects and disease; weed control; reduction of wastes in harvesting; supplemental irrigation; improvement of soil tilth by crop sequences; and rural electrification.

The majority of the new techniques that have been applied to farm production have the dual effect of increasing the quantity of crops and accelerating the rate of depletion of soil fertility. These two effects are basic to the primary objective of producing the amounts of food and fiber required to adequately feed and clothe the people of the country.

A large amount of production is necessary in order to provide every person with a sufficient quantity of food and clothing. But quantity is not a complete measure of the adequacy of nutrition or of clothing.

Research has given us a reasonably complete idea of the nutritive requirements of man and domestic animals. Nearly all the nutrients required by the animal body come directly or indirectly from plants. The nutrients are used by the animal for:

1. The maintenance of the body
2. Reproduction
3. Growth
4. Physical activity
5. Production of products

To supply the body requirements the individual must consume the amounts and kinds of food that will supply adequate quantities and proportions of energy (carbohydrates and fat), protein (amino acids), vitamins, and minerals. In addition, sufficient oxygen and water must be supplied. All these substances are essential to the normal functioning of the body. A deficiency of any one of them, below a minimum level, will reduce the efficiency of normal body function to some degree. Prolonged deficiency of a single nutrient, or multiple nutrient deficiencies for a shorter time, will lower the thrift of the body and may eventually cause death.

We have learned that a balanced diet can be provided most efficiently by including a variety of foods of both plant and animal sources. A complete protein (essential amino acids) can be provided most effectively by including meat, milk, eggs, or fish in the diet. The evidence also indicates

that a higher level of total agricultural production can be maintained with an animal type of agriculture than is possible with a crop or cereal type.

The body does have remarkable capacity to adjust itself to nutrient deficiencies. The populations of many countries exist continuously in a state of under-nourishment, and a considerable portion of the people of this country consume poorly balanced diets.

The point is quite clear that adequate nutrition of the population requires a sufficient amount of all the nutrients. Hence the production of a wide variety of food plants and animal products is essential.

The amount and nutritive value of crops produced depend upon the area of land in cultivation and the fertility of the soil. According to the 1950 census, 345 million acres of land were producing cultivated crops in the United States in 1949. Assuming the addition of 40 million people by 1975, additional food equal to that now produced on 92 million acres at the present level of production will be required by that time.

Estimates indicate that about 30 million acres can be added to that now in cultivation by putting into effect programs now planned in flood control, drainage, clearing and irrigation. About 15 million more acres may become available because of the elimination of more horses and mules. This total of 45 million acres of land leaves the amount needed, 92 million, short by 47 million acres. This is the amount needed to produce food for 20 million people, or one-half the expected increase.

At the present rate of soil loss from erosion, it is estimated that 12.5 per cent of the 345 million acres now in cultivation will be gone by 1975. This amounts to 43 million acres. This loss just about offsets the gains in acres estimated above.

The foregoing comments serve to emphasize the obvious fact that a problem of major importance is erosion control. But the most effective methods of controlling soil erosion which are at the same time consistent with improvement of soil fertility and sound economics under Missouri conditions, may not be so well understood. Research work started at the Missouri Experiment Station 35 years ago points the way to some of the answers. Soil losses in corn were 106.5 tons per acre annually, 39.9 tons in small grain, and 1.7 tons on bluegrass sod. More recently, on the McCredie Field, the relationships of soil fertility levels, tillage practices and cropping systems to the reduction of water runoff and soil losses have been developed still further. These studies show that soils in which organic matter and plant food have been increased in a deep layer of soil not only show remarkable gains in crop yield but also absorb much greater amounts of water, thus reducing water runoff and soil erosion to minor amounts.

Mechanical devices for erosion control, such as contour cropping and terraces, have an important place under special conditions, but their usefulness appears to be much more restricted than improved soil management.

Although the physical losses of soil through erosion are more spectacular, the losses of soil fertility through long continued removal of

crops is a far more serious matter in determining total production and quality of crops.

The dozen major crops produced in the United States in 1950 removed from the soil:

Nitrogen (N) 8,675,000 tons
Phosphorus (P_2O_5) 2,783,000 tons
Potash (K_2O) 9,130,000 tons

Assuming that these twelve crops represent 80 per cent of all crop production, these amounts of these elements may be raised 25 per cent. Quantities of other minerals also were removed.

Fertilizers known to have been applied to the land are equivalent to one-eighth of the removal of nitrogen and potassium and three-fourths of the phosphorus. Legumes added an unknown quantity of nitrogen to the soil.

Put on the acre basis, the removal of the grain of a 50-bushel corn crop takes away about 40 pounds of nitrogen, 7.5 pounds of phosphorus, and 7.5 pounds of potassium. Other crops remove comparable amounts of plant food.

This loss of plant food must be replaced if yields are to be maintained, and they must be more than replaced if increased production is to be expected.

If the food and fiber required by the 190 million people by 1975 are to be produced, the soil losses due to erosion must be avoided and the plant food lost through crop removal must be replaced.

Atmospheric nitrogen is being converted for use as fertilizer in large amounts, but far larger production capacity than is now available must be provided to meet the soil requirements. Large deposits of phosphates and of potash also have been located, but they also require processing at a greatly accelerated rate. While these deposits are not likely to be used up in the next 25 years, they are not inexhaustible.

Depletion of soil fertility not only results in lower crop production but in reduced nutritive value of the crops. Domestic animals and man are known to suffer nutritional deficiencies when forced to subsist on plants produced on soils deficient in calcium, phosphorus, iodine, iron, copper, cobalt or nitrogen. Specific conditions, called nutritional diseases, are known to develop from nutrient deficiencies. In addition, undernourished individuals become much more susceptible to infectious diseases than do well nourished ones. Hence it becomes doubly important that soils contain a high level of plant food in order to produce the quality and amount of crops required for the nutrition of man and animals.

Diseases of plants are becoming increasingly important in their effects on production. The principal methods of plant disease control up to the present time are by 1) the use of chemicals and 2) development of disease resistant varieties by selection from existing varieties or by breeding.

Both methods are effective to some degree, but neither one is perfect. Until recent years most known plant diseases were caused by bacteria or fungi, but lately virus diseases are recognized as causing severe losses. Research in the causes, effects and methods of prevention and control of plant diseases offers an unlimited and rewarding field.

Destructive insects cause varying but frequently serious damage to crops. Constant vigilance is required to anticipate probable insect outbreaks and apply preventive measures. Much more research is needed in the prevention and control of insect damage to crops.

A source of increased farm production of considerable size in Missouri and the entire United States lies in the increased efficiency of recovery and use of crops which are now wasted. Many farms produce considerable amounts of forage in fence rows and uncultivated fields that are not used. The greater use of grass silage will preserve large quantities of nutrients that are lost every year in efforts to make hay in rainy weather. Considerable increases can be made in the efficiency of grain harvesting machinery by improvements in construction of new machines and better adjustment of existing machines. A large portion of efficiency in farm production often is lost under cover of the labor-saving banner.

Producers of cotton, the principal fiber crop produced in this country, encounter problems similar to those of other farmers with respect to soils, varieties, disease, and insects. Because cotton production is less readily adaptable to mechanization than many other crops, cotton farmers encounter particularly severe labor problems. Synthetic fibers, produced mainly from wood pulp, are becoming an increasingly strong competitor of cotton. Spokesmen for cotton producers state that unless research workers can solve their more serious problems quickly, cotton production will decline substantially.

Missouri farmers have, in past years, become familiar with and put into practice many of the new techniques in farming. Substantial adjustments have been made in land use and in the amounts of various crops produced. For example, during the last twenty-five years the acreage planted to corn has been reduced from 6.5 million acres to 4.25 million acres. The land now in corn is the naturally more productive land. By increasing the use of fertilizer, using hybrid varieties, and improving tillage practices, the present total amount of corn production is nearly equal to that on the greater acreage in earlier years. The land taken out of corn production was the less fertile, more erosive land. This has been seeded chiefly to grasses and legumes for pasture or hay production and provides for considerable reduction in soil erosion, maintenance or improvement of soil fertility, and increased crop and livestock production. This adjustment undoubtedly also has increased the total production of protein in the state.

The possibilities for increasing corn production in Missouri can only be surmised. In this dry year, 1952, one group of about 350 farmers, pretty well distributed over the state, has produced an average of 97 bushels to the acre.

The addition of soybeans to the list of Missouri crops was a notable step. The phosphorus and potash requirements of this crop are slightly

greater than those of corn. When the straw is plowed into the soil this crop adds to the soil about the same amount of nitrogen that is removed in the seed. The 1952 soybean crop will provide about 350,000 tons of protein that is higher quality than any other plant protein.

None of these changes that have so materially affected Missouri agriculture could have been anticipated 25 years ago. The changes that may occur during the next 25 years can only be surmised. At this time no crop that may have the impact on agriculture that hybrid corn or soybeans have had, is in evidence. While some readjustments in land use may be made, no major shifts comparable to those of the last 25 years are anticipated.

Approximately one-third of the land area of the state is in timber, and this proportion seems likely to be permanent. Substantially all virgin timber has been cut and present stands have comparatively small commercial value. The income derived from the sale of forest products in 1950 was about 40 million dollars. This return from one-third the land in the state makes a poor comparison when placed opposite the total agricultural income of one billion, 200 million dollars for the same year.

Programs for the protection and development of timber already are being put into effect on privately and publicly owned land, and by 1975 the annual value of forest products should be 75 to 85 million dollars.

Probably substantial increases will be made in the production of vegetables, especially near the larger cities. Fresh vegetables are excellent sources of a number of vitamins and some of the mineral elements. They are most nutritious and most palatable when consumed soon after being harvested, hence the desirability of producing them near the point of use.

If the need arises Missouri can produce large quantities of rice in the Mississippi and Missouri River bottoms. Information is now available and a few farmers already are producing this crop. If high protein feeds remain in insufficient supply, Missouri farmers are in the fortunate position of having a good home-grown source of protein at hand. The value of lespedeza seed as a protein concentrate has been determined. When 40 per cent protein oilmeals cost $90 a ton, lespedeza seed is worth about $65 a ton as a protein feed.

Many Missouri farmers have put into practice the newer knowledge of soil tillage, fertility improvement, and soil and water management. As additional useful knowledge becomes available Missouri farmers likely will apply it. Application of these practices by farmers depends largely on satisfactory income and availability of financing from lending agencies. The next 25 years undoubtedly will see improved soil management applied to substantially all Missouri farm land, and along with it the various mechanical water management practices will be applied where they are practical.

Rural electrification probably will have become well adjusted to the requirements of Missouri farmers by 1975. The value of electricity in improving farm homes and farm family living, as well as helping in farm operations, is already pretty well worked out. Each farm family must make its own

application of electrical power.

Undoubtedly considerable changes will take place in the kind of farm machinery in use and its application to farm operations. The binder and threshing machine have almost disappeared, and it is probable that the hay baler will be replaced by other forage harvesting machines. The corn picker-sheller has already appeared and may replace the picker. Grain and forage drying equipment probably will be used on many farms.

Farming is a dynamic, constantly changing business. Farmers deal with living plants and animals, farm operations are strongly influenced by variations in season and weather and consumer demand for farm products changes continually. Because of the changing nature of farming, attempts to anticipate future developments in agriculture must be general in nature. Farmers, individually and collectively need to keep abreast of new developments that affect agriculture and with the practices and methods that will enable them to increase the efficiency of their operations.

Research has been the basis of advancement in agriculture, and it continues to be the most effective method of finding answers to the problems of farmers. The educational program of the Agricultural Extension Service takes the information obtained in research directly to individual farmers and assists them in applying the techniques which are most useful to them.

Missouri farmers can continue to look to the University of Missouri College of Agriculture to conduct the research and extension programs that have assisted them up to the present time.

The Contribution of Agriculture in This Expansion: Possibilities in Animal Contribution to Food Needs

Director J. W. Burch
University of Missouri

The question of animal industry's contribution in our expanding economy through the next 25 years divides itself into two major fields. On the one hand we have the tremendous possibilities of discovering new approaches to the problem and new ways and means of utilizing our natural recources to greater advantage for all our people. This includes the research and experimental work of our laboratories, feed lots, and breeding pens. On the other hand there are the possibilities of vastly greater actual application of known facts in the feed lots and breeding herds of the nation, as well as the translation of all possible new information into action by farm people. The two necessarily go hand in hand. I am inclined to look with optimism on the ability and capacity of our experiment stations to delve into the unknown for new truths, and I am equally optimistic in regard to the willingness, intelligence, and know-how on the part of our farm people to accept and utilize the new information that may be made available.

In the preparation of this paper, I have requested members of the Experiment Station staff of the Animal Husbandry, Dairy and Poultry Departments to give me their views of possibilities in their respective fields. I have also requested our Extension people to add their ideas relative to the ability and willingness of our farmers to utilize information that we have available for them. What I have to say, therefore, is not merely my own opinion. Any look into the future of necessity has some aspects of speculation. In our speculations, however, I think we are justified in mentioning the fact that we have in Missouri one of the most efficient and productive experiment stations in the world. I believe that in Balanced Farming we have found a tool to do a highly efficient job of translating the recommendations of the experiment station into action on the farms of the state. And, as indicated previously, I have an abiding faith in our Missouri farmers and in their desire and capacity to take full advantage of everything that we have to offer them, insofar as we keep our economy sufficiently balanced to make it worthwhile and profitable for the individual farmer to apply new practices and procedures.

In this entire picture I am not unmindful of the contribution that industry and labor have to offer. Much of our increase in the capacity to produce in the last half a century is based on improved equipment and machinery and on techniques which are dependent upon modern machines. We may expect, I am sure, that there will be additional improvements in the future and that our increased production per man will outstrip our increased production per acre. Admittedly, however, there are inherent dangers in the development and expansion of the new machine methods of farming. If we should have a repetition of the disparity between prices of farm products as compared to prices of things purchased by farmers that we had in the 20's and early 30's, the economic problems would be accentuated in our modern machine type of farming.

Suppose we have a look at what seems possible in the livestock field which contributes more than 3/4 of the total cash income of Missouri farmers. Most of Missouri is naturally better adapted to the production of pasture and forage crops rather than grain. Therefore, we may expect livestock enterprises to continue to be dominant in the Missouri system of farming.

Perhaps we should admit at this point that more people can be fed with grain than can be fed with meat and livestock products. World history, however, indicates that the meat eaters have been the virile, dominant people and that those nations which have depended on cereals instead of meat to make up a large part of their diets have not kept pace. Therefore, it may be emphasized that livestock farming is not only good for the people who live on the land, but that an increase in livestock products such as meat, milk and eggs makes possible better nutrition and a higher standard of living generally for the entire population. It is common knowledge, also, that farm people in Missouri and other corn belt states must assume responsibility for producing a surplus of animal products if the people in the more populous areas are to have an adequate diet with respect to both quantity and quality of food.

It must be kept in mind, too, that the feeding of a relatively small amount of concentrates to livestock makes possible the better utilization of large quantities of feed such as pasture and roughages, which otherwise would be of no value in the human diet. A good illustration of this is found in the beef cattle experiments at the Missouri Station, where 400-pound calves are made to weight 1,200 pounds or more by further utilization of pasture, hay and silage and after being fed as little as five bushels of corn at the close of the grazing season and then sell on the market as choice slaughter cattle. For the present, therefore, so far as Missouri is concerned, it would appear that at least the major part of the crops produced on the farm will continue to be fed to livestock.

General adoption of livestock production "know-how" developed by research at experiment stations and demonstrated by the experiences of the most efficient producers would almost result in reaching the animal products goals set up for the next quarter of the century even without the increased amounts of feed which may be expected to result from soil improvement and improved crop production.

In the production of pork, for example, approximately five pigs must be saved per litter in order to pay production costs. In 1924 the average number saved was 5.2; in 1950 this was up to an average of 6.4. However, the records of Missouri farmers cooperating with the Extension Service show that they raise an average of 7.9 pigs per litter. If 60% of our hog producers did as well as this best 20% now do on the average of pigs saved per litter, there would be a saving of around 4 million bushels of corn equivalent, which would give us a 5% increase in pork produced.

The average hog producer in Missouri now uses from 17 to 18 bushels of corn to carry a pig from weaning to marketing weight. The records of our farmer cooperators show that a saving of at least 5 bushels per head is practical. If 60% of our hog producers did as well as this best 20%, the feed we are now using could produce an additional 1 million market hogs, or an increase of 20%. This, added to the 5% given above, would mean a total increase of 25%

that could be made if another 50% of our hog producers did as well as our best 20% are now doing in saving pigs and in feeding efficiently.

Better operators produce 100 pounds of pork with good pasture and not to exceed six bushels of corn or corn equivalent. In a like manner, the average percentage of calf crop in 1950 was 85 and the lamb crop was 89, as compared to the near 100 and 150 percent obtained by top cattle and lamb producers respectively. Numerous similar examples could be given for all phases of livestock production including the breeding of more productive animals; improvement of feeding methods to eliminate waste and provide better balanced and more productive rations; careful attention to sanitation and other means of controlling animal diseases; and a business-like adjustment of the numbers and kinds of livestock to the resources of land, labor and equipment as is found in the Balanced Farming program.

Results of research work in the field of hog breeding suggest the possibility of much greater efficiency in converting feeds into edible pork. While this work is in its infancy and it is entirely too early to make any predictions, we may, I think, confidently look forward to improvements in this field that will somewhat parallel those in the field of hybrid corn.

Of the so-called red meat producing animals, hogs may be expected to use a large proportion of the corn produced, or made available, in Missouri because of the distinct advantage which this class of animals has over cattle and sheep with respect to the amount of edible product produced per unit of feed consumed in the feed lot. Good pastures, along with proper management, can reduce the amount of total concentrates required per unit of gain by 25 percent or more, and the protein concentrate needed by 50 percent or more.

One has only to spend a day at one of the Missouri feeder calf sales to get an idea of the tremendous possibilities for more efficient and greater total production of beef from the roughages and grains now available. It is perfectly obvious that if all our livestock men were doing as good a job off producing calves as are some of the men who consign the better calves to these sales, we could provide more and better roasts and steaks. Perhaps there is no better place to look for possibilities in this field than to those beef cattle men who cooperate with our County Agents and Animal Husbandry Specialists in keeping production records.

The average Missouri calf weights from 375 to 400 pound at weaning time and has been produced entirely on roughage (grass and hay) that has been converted into milk or eaten by the calf. Records from the Missouri Beef Production Project indicate that the weight of these calves can be increased by 25 to 40% (or to 500-550 pounds) with only that additional feed eaten in the form of grass by the calves and some possible increase in the amount of hay consumed by the cow. Based on the assumption that 10% of the present calf crop attains that weight at present, if 40% of our herds reached that standard with our present cow numbers we could produce 50,000,000 additional pounds of beef to weaning. This increase may come from better pasture or earlier calves, or a combination of both.

Farmers' records indicate that the average calf gains 1 1/2 pounds a day from birth to weaning. These calves are dropped in the last half of April. By a simple change in management practice to having the calves dropped in early February, 100 pounds extra weight can be added to the calf at weaning.

Research points additional gain to be made from selection of breeding stock on a production basis, similar to the improvement in milk production.

The production of beef from weaning to marketing by the use of forage and a minimum amount of grain assures a continued increase in beef production tied closely to the improvement in the carrying capacities of our pastures and the present grain crop. A fair assumption would be 100 pounds of beef per acre for the present carrying capacity of our pastures. Farmers' records demonstrate the possibility of trebling this, but on a conservative basis of increasing the carrying capacity to 200 pounds per acre, we should have 50% of our grazing cattle on good pasture and should increase production by 100 pounds per head or 30,000,000 pounds additional beef from grass.

With improved techniques and increased production of feed grains, an increase of 40% or more in our hog production could be easily attained.

Missouri farmers have often demonstrated their ability to meet ever-changing conditions. With new information and improved management practices put into action through a Balanced Farming Program, there will be no question of the meat supply 25 to 50 years ahead, especially if prices are such as to give fair returns without use of artificial incentives.

Work at the Missouri Experiment Station has shown that there are numerous systems of fattening cattle which use maximum amounts of roughage and require minimum amounts of concentrates. Such systems, if applied throughout the state, would go hand in hand with our pasture improvement program in increasing beef cattle production.

It has long been recognized that there is a wide range in the efficiency of animals in the utilization of feed for meat production. Major projects along this line are, therefore, in progress at the Missouri Station with beef cattle and swine. These are part of the cooperative regional projects which include the experiment stations of 13 north central states and the United States Department of Agriculture.

The Missouri Station was one of the first to conduct extensive animal breeding research in the field of physiology and reproduction, the results of which have already been of real value to livestock producers. There still remain many important unanswered breeding problems, so these studies have been expanded and are expected to supply useful new knowledge on this important subject.

Fundamental studies are also in progress on the nutritive requirements of animals. These include not only the use of vitamins, antibiotics, trace minerals, etc., but also have to do with the ever-present problem of economical sources and relative value of protein and energy-producing feeds. Also increased attention is now being given to ruminant digestion and related problems with the objective of learning more about how both good and poor

pasture and roughages may be made more effective.

Closely related to the more efficient production of meat is the more efficient utilization. With the attention of more adequate meat processing facilities, the Department of Animal Husbandry is now able to: 1) better evaluate the carcasses and cuts of beef, lamb and pork as they are affected by various feeding, breeding and management practices; 2) determine consumer preferences for grades and weights of carcasses and cuts, especially as they relate to the amount and distribution of fat in the carcasses and cuts; and 3) study the best methods of conserving the palatability of dehydrated, fresh, cured and frozen meats and how to control their nutritive value.

In the field of poultry production we find a no less encouraging prospect than in the livestock field. Our poultry people here at the College of Agriculture tell us that in their opinion, if feed is available and a favorable poultry feed price relationship prevails, the poultry industry of Missouri will have no difficulty in increasing the production of poultry and eggs by 42 percent by 1975. This increase can be secured primarily by improving the efficiency of our flocks in producing meat and eggs.

If our hens continue to improve in egg production from now until 1975 as they have been improving during the past 20 years, it is estimated that production per hen will have increased by 30 percent. Assuming a 30 percent increase in egg production per hen by 1975, we shall need only an increase of 9 percent in hen numbers to give the 42 percent increase in production. We estimate that the 42 percent increase in egg production can be realized with an increased feed requirement of only 15 percent.

From these figures, it is obvious that we are assuming we can get a major part of the increase from higher production per hen. So let us analyze this further. At the present, our egg production in Missouri is around 170 eggs per hen. This is 50 eggs per hen higher than 20 years ago. We are assuming that by 1975 we can increase this rate of lay another 50 eggs per hen.

While this additional 50 egg increase may look rather large, we must realize that our best egg producers today are already securing this kind of production. The Star Flocks in the Missouri Farm Flock Improvement Project for the past five years have averaged 68 more eggs per hen annually than the average Missouri flock.

With this higher rate of lay, we get more efficient production. When we boost egg production by 50 eggs per hen annually above our present average rate of lay, we reduce the feed required to produce a dozen eggs by one to one and one-fourth pounds, or by 8 percent.

So it appears that if we continue to increase the annual production per hen during the next quarter of a century at the same rate as during the past 20 years or so, we can produce the 42 percent added eggs with only 9 percent more hens and 15 percent additional feed.

We estimate that efficiency in poultry meat production will continue to increase at the same rate as it has during the past 25 years. We believe this assumption is correct because many individual producers have already at-

tained the efficiency in meat production that we are assuming the whole industry will reach 25 years from now. That efficiency is a pound of live poultry for each 2.6 pounds of feed.

Assuming that the industry continues to market the same size birds, the number of head of poultry must be increased by 42 percent, but we estimate that as a result of the expected efficiency in feed conversion, the feed required to produce this 42 percent more meat will need to be increased by only about 10 to 15 percent.

In making these calculations, we are using a figure of 3.5 pounds of feed as the average amount now being required to produce a pound of broiler. We are estimating this to be an average for all broilers produced in Missouri. Actually, in a recent study of records on nearly 2/3 of a million broilers produced in Missouri, this group of growers produced a pound of broiler for 3.3 pounds of feed. But we assume that these records are possibly a little better than the average for the state. However, it is of real interest to know that the top third of this group of broiler growers, from the standpoint of efficiency of converting feed into pounds of meat, produced a pround of broiler on 2.93 pounds of feed. Additional evidence pointing to the possibilities of further increasing feed efficiency is found in a recent broiler test at one of our state universities with twelve different breeders participating. In this test, the birds averaged 3.11 pounds at ten weeks of age, with a feed efficiency of 2.6.

Based on the above figures, we are predicting that we can increase the pounds of broilers produced by 1975 by 42 percent with only a small total increase in feed needed. This will be possible because of increased efficiencies which we expect to occur during the next 20 to 25 years.

Accurately kept Dairy Herd Improvement Association records on some 881 herds, including 12,618 cows, give us an indication of possibilities for increasing milk production. The average for these 12,618 cows is 8,198 pounds of milk annually as compared to an average of only 4,656 pounds of milk for all cows in the State. In other words, these men who really study their business and use their production records to point the way for a better job of feeding, breeding and management generally, actually produce 76 percent more milk per cow than does the average farmer. However, even in this D.H.I.A. group, we have some herds that have not yet brought their production up to where it should be. If we take the top 15 percent of these better herds on test, we find that they produce from one cow what the average farmer gets from two cows. Naturally, the labor returns on these high producing herds is 3 to 5 times as much per cow as the average farmer gets.

This year in an "efficient-production" contest for herds in Dairy Herd Improvement Associations, the five herd owners who come out on top of the list produced 1,542 pounds of milk per acre for each acre of their farms. When we compare this with the dairy farmer with 160 acres of land, who keeps a herd of 20 average cows producing only 582 pounds of milk per acre, we can see possibilities for a tremendous increase in dairy products. If it were possible to get all herds in the state handled as efficiently as the five top herds in the efficiency production contest, Missouri dairy farms

would increase production by more than 250 percent. Or if this is applied to one farm in ten, it would give a 23 percent increase in production.

There are, of course, a number of factors that influence the production on dairy farms. Perhaps foremost in this list is the breeding of the herd. Our program of artificial insemination, supplementing the regular breeding program of the state, suggests rapid strides in this area in the years to come. Healthy herds, improved rations, good farm and herd management, and proper care of the product all play their part in getting more wholesome, nutritious dairy products onto the table of the consumer.

The health of the herd is an important item in this list. We cannot make the strides that we should unless we find a solution to brucellosis, as well as other health problems that not only reduce production but result in a less wholesome product. We can and must whip brucellosis.

It is estimated that 20 percent of the herds and over 5 percent of the dairy cattle on farms are infected with brucellosis. This reaches a total of over 1,250,000 cows. Authorities agree that infected cattle on the average produce 20 percent less than they otherwise would. This lost production amounts to about 1 and 3/4 billion pounds of milk annually or the equivalent of the production of 325,000 producing cows. These figures are, of course, for the United States.

Brucellosis is only one of the important diseases taking its toll of dairy production and profits. Other diseases which are slowly yielding to research and new drugs are mastitis, diseases in young calves, and diseases of the reproductive organs. As we get these problems whipped, we can confidently expect to add materially to our total production.

Of the 22 million dairy cows in this country, 3,500,000 are bred artificially to 1,163 selected sires. These sires were selected on the basis of their 21,000 tested daughters that averaged 10,333 pounds of milk, which is almost double the 5,326 pounds of milk produced by the average cow in the United States. The dairy breeding program is really in its infancy. We have every reason to believe that it will move much more rapidly in the future than it has in the past.

It is not enough, however, to have a good breeding program supplemented with the other individual practices that we ordinarily think of as associated with efficient milk production. These several practices have to be put together in the right balance. The Glen Craig farm in Wright County is a good example of what I have in mind. After two years in a Dairy Herd Improvement Association during which improvements were made in pasture and winter roughage with ample supplies of good pasture, alfalfa hay, and silage, there was a slight decrease in the amount of milk sold. Then the problem was attacked from the standpoint of management. After some needed changes were made in the management of the herd, the production of 29,000 pounds for the period January 1 to May 1 was stepped up to 51,000 for a similar period the following year. Without any change in breeding or in the cows involved and with virtually the same feed and the same amount of labor involved, the production was increased by 22,000 pounds of milk. The changes were very simple: the cows were given a dry period for rest, and

during that period were given a grain ration to build up reserves; the practice of allowing the calves to nurse for six weeks was stopped; and there were some minor changes made in the grain ration during the milking period. This is what we call good Balanced Farming and it applies to any kind of a farm.

We may confidently look to marketing and consumption habits to increase the available amount of wholesome food from our dairy herds. Formerly, much of our milk was separated with the skim milk being fed to hogs or in many cases going into the sewer. Actually, of course, the main food value of milk is left in it after the butter fat has been removed.

It is apparent from the foregoing that increases in eggs and poultry meat up to 40% may be had, with around 15% increase in feed; that a 40% increase in milk production may be expected, if one dairy herd out of five would come up to the production levels that our best dairy herds now have, and that equally sharp increases may be expected in beef and pork. This is providing that the price incentive is present and that adequate Research and Extension are provided. Most of the increases in animal products mentioned in this paper are based on efficiencies in the field of animal production. The increased production of pasture, roughage and grain that may be expected through greater research and greater application of the findings of research to farms will also add greatly to the possibility of the increased production of the high protein foods of animal origin.

In addition to what I have mentioned this morning, there is a vast amount of research under way at Missouri and other experiment stations that has not yet progressed to the point where any considerable application is being made on our farms. Drs. Turner, Brody, Lasley and others here at Missouri are working on problems which may revolutionize our animal production in the next 25 years.

Moreover, on thousands of Missouri farms the possibilities for increasing production, and at the same time living a more satisfying and wholesome life, with the drudgery virtually eliminated, are being demonstrated through the application of Balanced Farming methods.

How Can Food Production for Forty Million More Americans Be Financed?

Dr. Frank Miller
University of Missouri

Dean Longwell has told us that the addition of forty million people to our present population will raise food requirements by the quantity that can be produced on 92 million acres at present yields. He also pointed out that 30 million acres can be added to the area of tillable land by putting into effect present programs of flood control, drainage, land clearing and irrigation. An additional 15 million acres can be salvaged for food production by further decreases in the number of horses and mules. The improvements and the salvage will total 45 million acres which is less than one-half of the 92 million needed to meet requirements. These calculations do not make allowance for the loss of 43 million acres through errosion. If no decrease in the rate of land destruction is possible, development projects and salvage through shifts from feed to food and fiber will about equal losses leaving us some 90 million acres short of requirements in 1975. Truly economics is the dismal science.

Despite this pessimistic forecast, Dean Longwell did not appear to be downhearted. He pointed out that the application of scientific knowledge already tested and found to be practical under field conditions would double the gain of cattle on pasture. This procedure would add 100 to 150 pounds of gain per acre to our beef supply. Missouri has approximately 10 million acres of open permanent pasture. If it is assumed that this area can be made to produce additional gains of 100 pounds per acre, the lower figure suggested by Dean Longwell, pasture improvement can add one billion pounds of weight on cattle which can be converted into 500 million pounds of carcass beef or enough to feed 7.9 million people or nearly one-fifth of the anticipated increase, at current rates of beef consumption; and Missouri is only one of 48 states where the application of scientific knowledge can increase supplies.

The possibilities of increased production of grain crops are tremendous too. In Missouri, better varieties, the retirement of low producing land to other uses, improved crop rotations, the use of fertilizer and timely farming operations raised the average yield of corn from 27.2 bushels in the 1920's to 33.4 in the 1940's. This is a small gain when compared to the possibilities through complete application of the facts now available to farmers. In 1952 the average corn yield in the state is estimated at 40 bushels per acre. A group of 350 farmers distributed over the state produced an average of 97 bushels an acre or 2.4 times as much as the state average. If corn yields were doubled on the 4.5 million acres usually planted to this crop, production would be increased 148,500,000 bushels. This quantity would make it possible to produce 965 million additional pounds of dressed pork or enough to feed 14.2 million people at current rates of consumption. This number is more than one-third of the 40 million estimated increase in population, and Missouri is seventh in corn production. It the entire United States is considered, corn production would have to be increased only 1.4 per cent to provide 40 million people with 68 pounds of pork per capita. Much more than this quantity can be provided through application of scientific procedures which have already been proved.

In recent years the American people have consumed approximately 3.2 bushels of wheat per capita. At this rate 40 million people would require 128 million bushels of grain. From 1946 to 1950 net exports averaged 405.8 million bushels or almost 3.2 times this requirement.

This brief review of the situation shows that meat, dairy products and bread can be supplied for 40 million more people without a serious strain on our resources. It will be necessary, however, to bring new land into production and to use the acreage already in farms more intensively. The farmers of the United States are using approximately 361 million acres to produce the 52 principal crops grown. If the estimated increase of 40 million people materializes, this area will need to be expanded 25 per cent or yields of crops increased one-fourth on the present area in order to hold the levels of living of our people constant and maintain shipments of agricultural commodities abroad. Both procedures can and will be used. The extent to which each procedure is used will depend upon government policies and programs and returns in relation to cost.

Practically all of the arable land in the United States is already in the hands of private owners. Only the less workable and more difficult areas remain unimproved and available for settlement. Expansion of crop production into these areas requires large expenditures for improvements such as reservoirs, irrigation ditches, drainage canals, dikes, levees, roads, bridges and other community service facilities. A considerable part of the work will be paid for out of public funds. Clearing and drainage costs will vary from $50 to $160 an acre. The cost of applying water to land is some cases runs as high as $300 an acre. In many instances the land already is privately owned. Either the settler must buy a farm and they pay the development cost, or the expense of improvements must be paid out of public funds. In either case the cost is high. These facts lead to an inquiry into other means of meeting the requirements of an expanding population.

Only recently have we begun to conserve and improve the productivity of the soil, to give attention to the capital required for water control structures, to fertilize the land instead of the crop, and to provide the livestock necessary for proper utilization of larger yields of grass and hay crops. More is known about fertilizers now than has ever been known before. Soils with a high exchange capacity can be made to produce larger crops than they ever produced before, even when first brought under cultivation. In many instances the cost of full treatment, that will increase yields up to 100 per cent or more, is $50 to $60 an acre as compared to $50 to $300 for clearing, drainage or irrigation. Money is required to build water control structures and to buy and apply soil amendments; but the requirements of 40 million more Americans can easily be met by this procedure. The land is in private ownership. Who will supply the money and on what terms?

At least four approaches can be made to the solution of this problem. First it will be necessary to assemble data to show what the results are on farms where water control structures and soil amendments that balance the plant nutrients so no one element is a limiting factor in crop production have been applied. Costs and returns will be the central theme of this inquiry but increases in physical units of products must not be ignored.

A second field of inquiry should deal with credit institutions. The old concept of value based upon the original and indestructible qualities of the soil still dominates the thinking of leaders in the field of farm mortgage credit. As a matter of fact, there is no such thing as indestructible quality of land. The result that man gets from applying labor and capital to land depends upon the manner in which factors are applied and the capacity of the land to respond. Information already available shows clearly that the physical volume of products can be increased greatly, in many instances more than doubled, by applying capital in the form of lime, fertilizer and water control structures to land. Farm operators on low producing soils with capacity to respond to treatments must have funds with which to start an improvement program. Incomes are too low on many of these farms to permit families to accumulate capital for starting the improvement program.

These loans may be needed for shorter periods of time than the 33 year mortgages of the Federal Land Banks and for a longer time than the three year maximum for production purposes. Since the improvements go on the land, it is logical that the loan should be secured by a real estate mortgage. If this procedure is to be applied, new farm appraisal methods must be used. Under present practice, appraisers for lending agencies are trained to find the normal value of a farm based on the income that can be derived from it when under typical operation. The appraiser places a value on the property as he sees it the day the farm is visited. In many sections of the United States the long-time average yield of a crop like corn on untreated land is no more than twenty bushels an acre. Yields of other crops are proportional to corn. Under these conditions a farmer has very little money to spend for land improvement. The rate of saving is slow or capital does not accumulate at all. The farm operator has very little to sell. Most, and probably all of his income must be used to pay current operating and living expenses.

With complete fertility treatment to bring the plant nutrients into balance and with the water control structures needed to check erosion actually built so the soil can be kept at home, the carrying capacity of pastures on many of these farms can be doubled and corn will yield fifty or more bushels per acre through the years. Yields of other crops will go up in proportion to pasture and corn production. Under these conditions, a farm which is adequate in size for efficient employment of the family labor force will bring in a surplus of income over expenses, and this surplus can be used to pay the cost of soil treatments and water control structures. The problem is, where to get the money for the initial start.

Here are some of the changes needed in appraisal procedure. The present concept of safety in extending credit is to keep the loan small in relation to the sale value of the property which is pledged as security so the principal can be recovered, even at a lower price level, if the borrower cannot or does not meet the interest and principal payments. The real measure of soundness of a loan, however, lies in the excess of income over operating and family living expenses. It is this surplus that provides the money out of which a debt can be serviced. All of us recognize the fact that farm incomes vary from year to year. The principal causes are variations in crop yields and in prices. The United States may never have another depression as severe

as prevailed in the 1930's. Most of the good farms that were acquired by lenders in that period were sold later without financial loss and many of them at a profit. If a farm is adequate in size and the soil is productive, the agency that acquires it as the result of default should have no difficulty in finding another man to take over the business and pay off the obligation. The ease with which this transfer can be made will depend upon the productivity of the land.

Let us suppose that a farmer is buying a 240 acre farm that will be appraised for $9,000 in its present condition. A complete soil renovation and water control system on this farm would cost about $7,200. Under the 65 per cent limit of the Federal Land Bank, the maximum loan would be $5,850 which is not enough to put the farm in first class operating condition, even for a buyer who is able to pay cash for the place at the current market price.

Now let us suppose that the cost of making the improvements is recognized as a part of the value of the farm. If the cost of the improvement program ($7,200) is added to the appraised valuation ($9,000), the new value for loan purposes is $16,200, and 65 per cent of this amount is $10,530 or enough to carry out the $7,200 improvement program and pay a part of the original normal value. The improvements that can be made with the larger loan will come near doubling the productivity of the farm. Because of this fact, the larger loan is safer than the $5,850 loan based on the original normal value without the soil treatments and other improvements needed to raise its productivity. Crop yields on a 240 acre farm that would be appraised for no more than $9,000 are low. Corn will yield no more than 25 bushels or more per acre. Twenty-five bushel corn will return very little more than the labor and equipment costs involved in producing the crop. If one-half of the additional 25 bushels or 12 1/2 bushels is used to improve the living standards of the family, and to pay the extra expenses incident to harvesting, storing and marketing the larger yield, there is still 12 1/2 bushels left to service the debt. This quantity at as low a price as 60 cent a bushel would take care of a debt of $150 an acre or 3.4 times the debt load imposed by the $10,530 mortgage. At first glance these figures are startling, but experience has shown that money invested in complete soil treatments and water management brings an average of $2.70 return for each dollar spent.

Only recently have we begun to realize the relationship between a well-balanced farm business and the flow of income that can be derived from it. It does not seem logical to finance the purchase of land with a farm mortgage and then to deal with livestock and equipment as if they were entirely independent items in a farm business. Why not base all loans on the entire organization of the business and when a farm is sold transfer and finance it lock, stock and barrel as a well-balanced unit? This procedure would avoid the practice of establishing a good organization on a farm with livestock well suited to the feed supply when the land is in uses that will preserve its productivity--a first class dairy business, for example--and then dispersing the herd, scattering it to the four winds, and selling the farm, already well-equipped for dairying, to somebody who has no interest at all in this type of enterprise.

A third approach to this problem of increasing production on existing cropland so 40 million additional Americans can be well fed, properly clothed and comfortably housed is to begin with expenditures that bring quick returns and finance the improvements out of increased income. Population is increasing gradually. Higher levels of production can be achieved through the use of small loans or savings to start a highly productive practice such as the use of fertilizer. The larger volumne of production often will bring enough additional income to pay the improvement costs. If a farmer already has some livestock, the herd can be expanded, about as rapidly as the feed supply can be increased, by retaining farm-raised breeding animals. This procedure can be used to reduce the amount of money needed. If watched carefully, expansion in production can keep pace with the increase in requirements resulting from population growth.

A fourth procedure than can be used in financing the necessary expansion in agricultural production is to interest people with savings in financing well-balanced farm businesses for young people who want to farm but lack capital. Farmers Clubs can be found in most of the cities in the midwest. Members of these organizations are keenly alert to scientific developments in agricultural production. Many of them are financing businesses for young farmers and many more of them would assume this responsibility, if they could be assured of a high level of performance by the farm operator. Apprenticeships in operating farms are practically unknown in the United States, except the training young men get while working with their fathers on home farms. The Danes do the job much better. In that country, a young man who wants to borrow money from a cooperative bank for the purchase of a farm is assigned to a skilled farm operator for a three-year period of training. During this time he is required to assume responsibility for all phases of the business. If he shows ability to manage the farm efficiently, he is eligible for the loan. If his performance is poor, credit may be denied.

The task of financing the production and distribution of farm commodities to take care of the needs of our increasing population is not insurmountable. Forty million additional people can be fed, clothed and housed without severe pressure on our resources. Care should be exercised to avoid waste. The cost of expanding production on land that is already in agricultural uses will be much less than the cost of clearing, draining and irrigating new land.

At least four procedures can be used to solve the problem of greater output of agricultural commodities from land now in farms.

1. Make people conscious of the methods that can be used to increase production and give them the facts concerning costs and returns.

2. Revise lending procedures so the man who is on low producing land that will respond to scientific treatment can get the money to make the initial start toward a complete program of soil treatment and water management.

3. Encourage farm operators to begin programs of land improvement with practices that bring large immediate returns and finance the remainder of the work out of increased income.

4. Encourage people with savings to invest in well-balanced farm businesses where the land is fertilized and water control structures are in place and make these operating units available to young people who know how to farm, but lack capital.

It should be kept in mind that the manager is the active factor in setting up and directing an economic enterprise. He decides how many acres of land will be used and how much capital and labor will be applied to it. Efforts to increase skill in management are fully as important as a search for ways to make money available. The organization of Farm Management and Balanced Farming Associations is a step in the right direction. As the task of applying scientific knowledge to agriculture becomes more complex, apprenticeships in management will become an absolute necessity. We can meet the needs of an increasing population, if all of these facts are kept in mind.