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THE BETTER ADAPTATION OF EDUCATIONAL AND INVESTIGATIONAL EFFORT TO THE AGRICULTURAL SITUATION[1]

I

OUR subject takes us at once to the very heart of the agricultural college movement. A more important subject in relation to agricultural progress could hardly be stated.

In a single brief paper one can touch only a few of the outstanding phases of the question. Sometime before very long, let us hope that a thorough study will be made of agricultural research and education as now conducted in the land grant colleges. This should be done by persons who are familiar with the land grant education movement and who understand the needs of the country. These institutions have been operating about half a century, some of them longer. They have endeavored to adapt themselves to ever-changing conditions and demands. They have made countless changes in curriculum and in subjects of investigation, in response to pressure of the moment. The original legislative acts have been supplemented repeatedly. Conditions throughout the country are changing rapidly and now are vastly different than when the first laws were passed. Problems have multiplied. Numerous other agencies have been created to do work that relates more or less directly to the work of the land grant institutions. And we have learned much from experience.

Before we can satisfactorily answer the question as to how well agriculture is being served by its special institutions in all the states and what changes should be made, there should be a study of the basic laws, financial support, the physical plants, the personnel in service, policies, the results obtained, the industry itself and the difficulties, drawbacks and needs encountered by farmers; and there should be an effort to look into the future. The whole problem should be studied with the purpose of better fitting the work of the institutions to the needs of the times. This would mean the reduction of some phases of work, the elimination of other, and the magnification of some and the development of some new activities, all in the interest of better service to agriculture.

There is good precedent in the recent study of medical education financed by Rockefeller funds and

[1] Address of the retiring vice-president of Section O—Agriculture—the American Association for the Advancement of Science, Washington, December 31, 1924.

which has resulted in better methods in education in medicine. Another precedent is furnished by the present study of engineering education financed by Carnegie funds. A leader in the latter effort refers to the interest of engineering educators, in defining the educational functions of the engineering colleges, in articulating the curricula more effectively with the needs of the engineering profession and of industry on the one hand, and with the preparation and characteristics of our entering students on the other hand, and in securing accurate knowledge concerning the nature and extent of occupational demands for engineering graduates.

These precedents suggest the extent and the value of a similar study of agricultural research and education as conducted under federal laws, supplemented by state laws and supported by both federal and state funds. This study should yield as large benefits as either of the other two. Some would say larger benefits. The importance of having the study conducted by men who are competent has been mentioned. It is obvious that ample funds should be available and ample time should be allowed so that the work would not need to be done under pressure.

II

It is fortunate that the laws underlying and limiting the research and educational work of the agricultural colleges do not prevent the institutions from keeping pace with the needs of their special constituencies. The only limit is in the appropriations. In some states this is serious. In many states it is detrimental to best results.

III

We are entering the third great epoch in the history of American agriculture. Profound changes are taking place and without much notice from the public. The first epoch was characterized by diversified production for the farmer's own home and for limited nearby markets—within driving distance. This began when the Pilgrims landed on the shores of New England and had to cut away the trees to make room for their crops. The second epoch came with the development of long-distance transportation. It might be called the period of quantity production. The aim seemed to be to produce as much as possible. The newer agricultural sections in the west prospered—at least the people on those farms seemed to think they prospered. Their costs were low and they gave no consideration to the value of plant food. At the same time the older agricultural sections in the east languished. Their costs were not so low and they were forced to consider plant food because they purchased much of it. World prices prevailed. Agricultural products constituted about one half of the exports from this country. But the exports have been decreasing.

In 1880 40 per cent. of the wheat crop was exported. In 1900 30 per cent. was exported. In 1910 the exports were 11 per cent. of the crop. During and after the war the wheat area was increased 50 per cent. and exports went as high as 43 per cent. of the total crop in 1921. But in 1923 exports had dropped to 25 per cent. of the crop.

In 1900 10 per cent. of the corn crop was exported. In recent years the exports have varied between one half and five per cent. of the crop.

In 1880 52 per cent. of the cheese manufactured in this country was exported. In recent years the exports have been down to one or two per cent. of the output.

The part played by research and education during the epoch of quantity production is generally understood and appreciated. The workers, many of whom have passed on, are honored for their service. But some criticize them for increasing production. It is hardly more reasonable to say these faithful workers were responsible for the large surplus and the exports than it would be to say that firemen were responsible for the growth of cities. The fact is that there were economic reasons for the increase of production and for the growth of cities. The firemen prevented disasters which would have checked the growth of cities by utterly destroying certain sections with corresponding ruin for the unfortunate people who happened to live or work in the path of the flames. And the scientists in agricultural colleges and experiment stations likewise prevented disasters which would have checked the quantity of production by destroying certain crops or animals with corresponding ruin for the unfortunate farmers who happened to live in the section where the pest or the scourge occurred.

The older college workers well remember the time and effort and expenditures given to different diseases or insects that threatened to ruin completely great numbers of farmers if not controlled. The fire blight of apple was recognized as being serious about 1880; the potato scab about 1890; the wilt of cotton about 1899; the chestnut blight about 1906; the flag smut about 1919; the take-all about 1920; and the San Jose scale about 1880; the cotton boll weevil about 1890; the potato leaf hopper about 1915; the Japanese beetle about 1916; the European corn borer about 1918.

Many others could be mentioned, and the list could be doubled by adding animal diseases, soil problems and questions of management.

The experiment stations, under great pressure, have solved many such problems and are still at work

on many. Other similar problems will appear as the years pass. If the experiment stations and the colleges did not deal successfully with such problems as these, the people through their legislatures would take drastic action.

We are now entering the third epoch in the history of agriculture in America. It is to be characterized by good business methods and these include especially those practices which spell high-class permanent agriculture. Most investigators and teachers in the stations and colleges are well aware of the situation and of course this statement applies to the workers in the national department of agriculture. Occasionally, however, some one is found working in one of our institutions who is investigating or teaching in the past. He does not know of the profound changes that are going on. Really such a person is not engaged in agricultural work but in applied history, and he should be transferred to the history department, if they will take him.

The reasons why agriculture is changing from a period of quantity production, with a constant surplus and with world prices prevailing, to a period of good agricultural business are overwhelming. Here are a few of them:

(1) Land values have increased.
(2) Taxes have increased.
(3) Cost of farm labor has increased.
(4) Cost of building has increased.
(5) Cost of farm supplies has increased.
(6) Cost of transportation has increased.

Some of these increases have been very large; for example, increases of taxes, which are indicated by national disbursements. The national expenditures in 1880 were 268 million dollars and in 1920 they were 6,142 million dollars. In the same period of forty years the population a little more than doubled. The great increase of expenditures is only partly accounted for by the war. Omitting war expenditures, that item increased in far greater proportion than the increase of population.

(7) Attention now must be given to the value of plant food. The reserve in the soil is our capital. It is being seriously depleted. The value of plant food at market rates carried out of one state in the agricultural products shipped beyond the borders is about 30 million dollars annually.
(8) World prices will be kept as low as other countries can keep them. To do this they are exercising their best ingenuity and expending large sums of money to discover more scientific knowledge and to apply this to agricultural production. Most of us fail to realize the great progress that is being made in developing agricultural science in other countries.
(9) Our standard of living is higher than it used to be and it is capable of being further improved. Farmers will not and should not accept a lower standard of living than is allowed to other comparable groups or classes.

It seems that to any one who has faith in the future of our country the reasons just given must be convincing. Our agriculture must be put upon a better business basis. We must know the business side of it better and be guided more by business records. All the many factors going into the cost of production must be considered, even to the plant food that is taken away by the crop.

IV

Agriculture conducted on business principles, with a view to permanency and with due regard to the important relations between rural life and national life, will be characterized by five outstanding features or lines of progress. Research or education which does not serve directly or indirectly to strengthen one or more of these lines is below 100 per cent. efficient. It would be interesting to see percentage marks that would truly represent the worth of research efforts in the name of agriculture and now in progress, and with due allowance for a reasonable share of research work along fundamental lines which might apply in some unexpected way to the solution of agricultural problems in the future. And it would be equally interesting to see percentage marks representing the real worth of our various courses of instruction in agriculture.

The five essentials for the kind of agriculture we want to see and the kind we should encourage in every way possible are:

(1) Careful business methods.
(2) Maintenance of fertility.
(3) Good homes and surroundings.
(4) Fair legislation.
(5) Patriotic citizenship.

Careful business methods mean records of transactions and their proper interpretation. Conclusions can not be drawn from figures alone. The teacher asked Johnny this question, "There were nine little pigs in a pen. Five got through the fence. How many were left in the pen?" He promptly answered, "None." "Why, Johnny," she said, "you don't know subtraction." "Well, teacher," he answered, "you don't know little pigs." He must have been a pig club boy.

The records should show low cost of production and efficient marketing. And the farm records compared with official statistics and estimates should show balanced production—that is to say, due regard to what

others are doing elsewhere in this country and in other countries.

Complaint is sometimes made that research and instruction in agriculture are responsible for overproduction and low prices. This is an appeal for ignorance to which intelligent farmers never will respond. They know there can be no excess of knowledge in good agriculture. The chief purpose of land grant institutions insofar as production is concerned is not to increase production but to reduce the cost of production. And much more work needs to be done along this line.

Creditable progress has been made toward better marketing. Cooperation is increasing. The margin between producer and consumer is being reduced in some cases and to the advantage of both producer and consumer. Much more progress needs to be made along these lines. More problems need to be solved and more instruction in the fundamentals and practice of marketing and cooperation and all business transactions needs to be given.

The second point of emphasis is the maintenance of fertility. This seems to be the hardest problem of all. We are told how other natural resources have been wasted, notably natural gas. Due chiefly to indifference and greed there have been wasted in one gas field, according to Van Hise, about 70,000,000 cubic feet of gas daily for a period of years. This was equivalent to the daily loss of 10,000 barrels of petroleum. Authorities say we have wasted natural gas at the rate of 1,000,000,000 cubic feet daily. Now that natural gas is about gone these losses are being appreciated and they do not increase our respect for the supposedly intelligent and patriotic people who were responsible.

The losses of soil fertility are comparable with the losses of natural gas but are more serious. Substitutes will be found for other natural resources. Waterfalls, wind, tides, sunshine and other sources of heat and power will take the place of fuels that are being exhausted. Clay and cement products and perhaps aluminum and other materials can take the place of iron and wood. No substitute has been found for fertility. Shaler writes that areas in Kentucky not tilled to any considerable extent more than one hundred years can not be brought back to their original fertility in any foreseeable time. They "must return to the forested state and, in that condition, through the ages, slowly gather again the mantle of soil."

Van Hise writes:

> The surface layer of soil, manufactured by the processes of nature through millions of years, is the most precious natural resource of the nation. Of all our duties to our descendants that of maintaining the soil unimpaired in thickness and in richness is the most serious . . . the conservation of the natural resources of the country, if accomplished, will only be possible through education. The beneficent effects of the public land grant for education, even from the point of view of conservation, extend beyond possible computation.

How well are we in our institutions meeting this challenge? It would be a great benefit to us if some one like Dr. Van Hise could tell us to what extent we measure up to his high standard and how we might better our service.

Much could be said regarding the third point—good homes and surroundings. Good schools and active churches are included. This relates intimately to the standard of living which should be as high for the farmer as for any large industrial group. The average standard of living in the country should be as high as in the city.

Great leaders of agricultural thought are emphasizing that in many places the standard of living in the country should be raised and if farm incomes can not provide for this even with improved methods, then this is evidence that fundamental readjustments should be made. The situation is being helped through instruction in home economics and because of the growing conviction that rural children are entitled to as good school training as is given to urban children. And it is being helped by repeated emphasis by President Coolidge and other national leaders on the fact that education and religion are both vital to our national progress now as in the past.

The term "fair legislation" has special reference to agriculture. Experience shows that the public needs instruction along this line. A business man's first reaction to the proposition that there should be a farm loan law was likely to be that such a law would be special class legislation. When he was reminded that the farmer's turnover is low and the usual short term loans could not apply, then he saw the need and supported the measure. The whole subject of legislation in relation to agriculture including appropriations needs further study and many facts should be widely promulgated. A large proportion of legislative enactments affect agriculture directly or indirectly.

To conduct agricultural research and education with proper reference to the needs of the time requires ample financial support. But the necessary appropriations are very small in comparison with the financial returns and they are very, very small in comparison with expenditures made by the public voluntarily for items that are generally regarded as of trivial importance.

For example, the total annual income of all land grant institutions and all branches of work conducted

in these institutions is about one hundred million dollars, and this is about one tenth as much as was expended in a recent year in this country for candy or one eighth as much as was expended for cigarettes or one seventh as much as was expended for perfumery and cosmetics.

The federal appropriation for state experiment stations is about one and one third million dollars annually or almost the same amount of money as one manufacturing concern spends in one year for advertising in about thirty leading magazines and papers, one brand of soup. The federal appropriation of about six million dollars toward the support of extension work is almost the same amount as is paid for advertising the products of one automobile concern.

The amount of taxes is always important and the reduction of taxes is always desirable. But the fair distribution of the tax burden and the honest and efficient use of tax funds are still more important. These questions are now very prominent. More knowledge should be secured through research and the knowledge we have should be more widely distributed.

Patriotic citizenship is mentioned as the fifth requirement of the ideal permanent agriculture. This implies no criticism of farmers. The whole nation is subject to criticism when only half the voters come out to vote at a presidential election, but probably farmers are least at fault. The whole nation is subject to criticism in reference to law observance and here again probably farmers are least at fault. We need a revival of our spirit of patriotism and of our devotion to the ideals of the founders of our nation and we need to increase our genuine sympathy for our neighbor. Who can or will set a better example in these phases of good citizenship than the farmer?

V

With an increasing abundance of knowledge, whether gained through accident or painstaking research or from long practice, and with our great organizations for dispensing this knowledge, agriculture still will be handicapped until that knowledge which is most needed is accepted and put into use by rural people. No one thinks that all farmers should be college graduates nor that all business men should be college graduates, but sometimes we are asked, "How many farmers should be college graduates?" The question might be answered in this way: There should be as many college graduates in a given number of farmers having a given capital as are found in a similar group of business men having approximately the same total capital. Certainly there should be at least as many well-educated farmers in an average agricultural community as the number of well-educated doctors, lawyers, storekeepers, insurance agents and others who are dealing constantly with the farmers.

This nation wants to avoid peasantry. Men and women of the farm because of their equal ability should take places side by side with urban residents in public affairs and in the public service. In some states and localities this fine relationship already exists and in not a few cases the farmers are doing more than their fair share. In other places the opposite is true. No one should be disqualified simply because he is a farmer.

Only a few of the many adaptations of research and education to present agricultural problems and needs have been mentioned. Excellent progress has been made and much more needs to be done. Enough has been said to show the need of a thorough study of this whole question as was first recommended in this paper.

We must keep our faith in agriculture and strive always to bring it more near to the ideal permanent agriculture which will be as great a benefit to all the people as to the farmers themselves.

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FUNDAMENTAL CONCEPTS IN PHYSICS IN THE LIGHT OF RECENT DISCOVERIES[1]

THE EIGHTEENTH CENTURY: THE CENTURY OF MATERIALISM

THE physical scientists of the eighteenth century were diligent discoverers in an unexplored field. The facts they established remain for the most part with us to-day, but the point of view has completely altered. The mental attitude of the eighteenth century scientist may be characterized as materialistic to a degree which is difficult to realize at the present time.

Most of us have been taught that the subject-matter of physics is twofold—matter and energy. That was the orthodox nineteenth century doctrine, but the attitude of the eighteenth century was different. The scientists of that day studied matter only. The concept of energy was not recognized. Forces of all kinds—gravitational, mechanical, electrical and magnetic—were regarded as properties of matter. The concept of force was strictly subordinate, secondary and auxiliary to that of matter.

Gravitation in fact, continued to be thus regarded

[1] Abstracts of a series of three public lectures at the Carnegie Institute of Technology on January 6, 7 and 8.