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OUR JOB AHEAD[1]

By Professor RICHARD BRADFIELD

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THERE has been considerable discussion of the advisability of holding our annual meeting this year. Some saw the physical difficulties involved and favored cancellation. The majority, perplexed by the numerous new problems confronting them as a result of the war, felt even more keenly than normally the need to talk over their problems with their colleagues in other institutions. All felt that to justify a meeting at this time especial emphasis should be placed upon problems connected with the war. Such problems have been the dominant theme of our program.

To-night, I shall exercise my prerogative as your President to speak to you about the job that lies ahead of us as agronomists in the post-war world. My remarks are based on the premise that the war will end eventually in a victory for the United Nations. I would not care to think about any other type of post-war world.

I think I can justify speaking about post-war problems in the midst of the war. This is a war of ideals. We need a clear conception of what we are fighting for, if we are to put our best efforts into the war. We need to express our objectives clearly so that the rest of the world can know what they are and can support us if they believe as we do. The problems of the post-war period will be just as difficult, possibly even more difficult, than those of the war. Internal dissension tends to disappear during a war. It will tend to rise again after the tension of war eases and we begin to consider the superficially

[1] Presidential address, American Society of Agronomy, St. Louis, Missouri, November 12, 1942.

less urgent problems of peace. The necessity of war was obvious after Pearl Harbor. The maladjustments of peace may fester for a generation before erupting. We won the last war but lost the peace. We must make this victory complete!

If the victory is to be complete and the peace a lasting peace, it is none too early for all of us to be thinking about it. It is well to have special post-war planning boards to work out details, but in our democracy, the final word is with the people. Our leaders will be helpless unless they have a clear mandate from the people. And finally, if these are not sufficient reasons for speaking about post-war problems in the midst of war, I shall confess that I am, by nature, an idealist, a day dreamer, one of whose joys in life is to plan for a better world.

As agronomists, we all recognize the importance of environment on the course of development of all living organisms. Before considering the problems of the agronomist in the post-war world directly, let us first consider briefly some of the factors in the post-war environment in which he must work. Both the physical and the social-economic-political factors of the post-war environment will be quite different from those of the pre-war world. How different in detail remains to be seen, but certain dominant aspects are clear.

On the physical side, we know that this is a war in which machines have played a more important role than ever before. "Too little and too late" has resulted in defeat after defeat for the United Nations. We have now come to realize that to win this war will require the most Herculean effort ever made by the American people. That "battle of production" is being won.

In his inspiring address before the American Chemical Society in September, Stine[2] pointed out that "the pressures of this war are compressing into the space of months developments that might have taken us a half-century to realize if necessity had not forced the pace.

"Those pressures are unprecedented. The developments are unprecedented. Give us a victorious peace and the freedom of enterprise it should guarantee and our progress will be unprecedented. One does not need to venture into prophecy to sketch the bold lines of what that progress can be. They have already been traced. Already our world of 1940, in which we took such pardonable if mistaken pride, is so distant in the past that it has become an antiquity, as seen through scientific eyes. The inconceivables of two years ago are to-day's realities."

A few specific examples cited by Stine will clarify the picture. The crude rubber production of the world was raised to a million tons a year in the last century. We expect to develop a like capacity for synthetic rubber production in the United States alone in the next two years. In 1943, our production of aluminum will be almost seven times that in 1939, which was over fifty years after Hall's discovery of the electrolytic process for its manufacture. This capacity will be sufficient to build in one year three times the number of passenger cars now operating on all American railroads.

By the end of next year, we shall be producing one hundred times as much magnesium as we produced before the war. In 1915, it was worth $5.00 a pound. To-day, it can be produced for 22½ cents! This makes it even cheaper per cubic foot than aluminum!

We were already referring, before the war, to the years immediately ahead as "the age of plastics." At the end of the war, the newest and most versatile of the plastics will be available on a scale beyond all previous conceptions. Our iron and steel capacity, already ample for all pre-war requirements, is being greatly expanded and will doubtless be more than sufficient to meet all post-war needs. The large scale development of improved alloy steels will be invaluable for many specialized needs.

Synthetic fibers of a great diversity of properties will be available in abundance. The synthetic organic chemist will be prepared to supply scores of new organics at new price lows. Motor fuels that promise to deliver fifty per cent. more power than the present 100 octane grade will be available. There has been a great increase in our capacity to produce electric power. Our machine tool industry has been vastly expanded. We have more men trained to operate them than ever before. In short, we shall have the raw materials, the power, the machines, and the trained men to perform the feats of industrial production of which men have long dreamed. This must suffice for the physical aspects of the picture.

Let us next take a glance at the prospects in the social field. President Roosevelt has said that we are fighting for four freedoms—freedom of speech, freedom of religion, freedom from fear and freedom from want. In the United States, we have all enjoyed the first three of these freedoms as our birthright. But while there has been less want in the United States than in any large country in the world, millions of our people have known want even in the last 25 years. Freedom from want for the common man throughout the world will prove the most difficult of all the freedoms to provide. That freedom can not be won on the battlefield nor at the peace table. Winning the war and writing the peace can set the stage. The widespread approval accorded Vice President Wallace's designation of the century ahead as "The Cen-

[2] Charles M. A. Stine, SCIENCE, 96: 305–11, 1942.

tury of the Common Man" is, I think, an indication that the American people, at any rate, are willing to strive for freedom from want. At the Eighth Scientific Congress in Washington in 1940, Tolley[3] declared that "a central problem of our generation is that of bringing to the people at large the great potential blessings that science has created in the last century." A similar opinion has been expressed by many other qualified scholars.

The satisfactory solution of this problem will require the sympathetic cooperation of all the people. We are learning to pull together during the war; we must continue to do so after the war. None of us should expect to have his wants handed him on a platter. Each must learn to contribute his share to the nation's and to the world's stockpile. There is an unprecedented demand for technically trained men to win the war. They will be needed just as much to win the peace. Scientists must come to grips with the intricate and, as yet, unsolved problems of distribution as well as production. The public must come to realize that, while it may be costly to keep our industrial and agricultural machinery running, it will be costlier still to let it stop! The last Depression is still close enough to serve as a mild warning of what could happen.

In brief, it seems to me that the evidence at hand indicates a widespread approval of the ideals expressed in the Four Freedoms by the leaders and by the people of the United Nations. The most difficult of the freedoms to attain is freedom from want. The social, economic, and political problems involved are intricate and difficult but not hopeless. While physical resources seem ample, many important production problems await solution.

So far, I have attempted to set the stage. Let us now consider the role the American agronomist should play on this new, post-war, world stage. I say world stage advisedly, for I am convinced that the post-war services of American agronomists will not be confined within the United States.

I shall use the term "agronomist" in the same sense that it is used in our society. I conclude from reading our constitution that an agronomist is one interested in increasing and disseminating "knowledge concerning soils and crops and the conditions affecting them."

The primary "wants" of mankind are food and clothing. Both of these are directly or indirectly products of the soil and, hence, of concern to the soil scientist. Both are also dependent, directly or indirectly, largely on field crops and, hence, of interest also to our crops specialists. In broad, general terms, we are largely responsible for the technical developments in the production of mankind's "bread and butter." I shall leave the salad and a part of the dessert to the horticulturists! Because of the very basic nature of our specialty, agronomists and agriculturists, in general, will have unprecedented opportunities to help in shaping the future of society.

Let us first consider briefly our domestic problems. The agronomist's chief responsibility in this connection is to help the farmer develop principles and practices which will enable him: first, to produce enough food, feed, and other crop products of high quality to meet all demands; second, to improve his efficiency of production so that his products can be sold at a fair price and still yield a fair profit; and third, to maintain the productive capacity of his soil. We shall need to consider each of these points in a little more detail.

We are just beginning to emerge from a period in which several important crops, wheat and cotton in particular, were produced in much larger quantities than we were able to consume or sell at profitable prices. The demands of the Lend-Lease program are gradually reducing the surpluses of most commodities, and rationing of other products is already under way. There seems to be little question of our ability to produce in this country adequate amounts of all of the principal crops suited to our diverse climate. There is evidence of need of some adjustment in the types of crops produced in order to bring the supplies more in line with the requirements of an adequate diet for our entire population. Considerable attention is being given to the possibilities of industrial utilization of agricultural waste products and surpluses. There will doubtless be some progress in that direction. Agriculturists should keep in mind, however, that the modern industrial chemist can destroy markets for agricultural products as well as create them. Just imagine that you owned a rubber plantation in the East Indies, and I think you will see what I mean!

Before the war, our export market for most agricultural products had sunk to an all-time low. There seems to be little evidence to indicate that it can be regained in a world at peace. I see little reason to doubt that we can produce in this country all the agricultural products that we can consume or that we can hope to sell.

This does not mean that our job is done. It merely indicates that our major peace-time problem is not that of increasing our volume of production. Much can be done to increase the diversity and to improve the quality, particularly the nutritional quality, of our foods and feeds. Our people are more interested in adequate nutrition than ever before. The high nutritional standards in our armed forces will doubtless do

[3] H. R. Tolley, *Proc. of 8th Am. Sci. Congress*, Vol. 5, p. 279. 1940.

much to improve the food habits of the men when they return to their homes. Better tools for assaying the nutritional value of foods have been developed and are rapidly being improved and simplified. We know but little about the effect of various environmental factors upon these different quality factors in foods and feeds. Different genetic strains of crops differ widely in the content and nature of their vitamins, fats, proteins, and carbohydrates. They offer the plant breeder an almost virgin field in which to exercise his talents. In the future, yields of dry matter and protein content will not be accepted as adequate criteria for judging the relative value of any given agronomic treatment or of a new variety or strain.

I have often been impressed by the wide range in the production cost figures obtained by farm management specialists for different farmers in the same community. Some of our New York farmers can produce 100 pounds of milk for half what it costs their neighbors. Even in the midst of the depression, a few farmers managed to make a little money. Increased efficiency of production of crops is a goal that the agronomist should keep constantly before him. I can think of no circumstances under which the farmer is liable to suffer because his production costs are too low. Economical production is sound in peace or war, in prosperity or depression. In the competition for a market, everything else being equal, the most efficient producer will win out whether the competition is between neighbors, between regions, between products, or between a domestic and a foreign producer. Artificial subsidies and barriers may bolster the inefficient producer temporarily, but it is futile to rely upon them as a permanent policy.

When I try to analyze in detail the various steps involved in crop production, there does not seem to me to be a single step that we can sort out and say, "This step is perfect. Nothing can be done to improve it." Processes which we may regard as satisfactory to-day may be challenged to-morrow in light of new information. I was taught that one of the important objects of plowing was to cover crop residues. Now, many agronomists are trying to find out how to plow without covering the "trash." Much of our farm machinery is in the same stage of development as the early automobiles with a dashboard and whip socket. Machines designed 50 years or more ago for operation with horses have been slightly altered to adopt them for use with the tractor. We need to make a thorough study of all the operations required in growing a crop from seedbed preparation to harvest, and after we have decided what operations are necessary for the most efficient production, we should solicit the assistance of the agricultural engineer and the farm machinery manufacturer for designing and making the implements required. They can not do their job until we have done ours. A few years ago, we were dissatisfied with the fertilizer distributors on the market. A complaint was made to the agricultural engineers. They asked us where we wanted the fertilizer placed with respect to the seed. We had to admit that we did not know but agreed to find out. Our joint committee on Fertilizer Application was set up. Cooperative experiments involving many crops, many soils, and many climatic conditions were carried out. Within a couple of years, the engineers were given their answer, and the next year, improved fertilizer distributors were available. Many farm machinery manufacturers are now using their factories for making war machines. The time would seem propitious for getting the basic information necessary for the intelligent redesigning of farm machinery. Far-sighted leaders in the field are already at work on the problem and, I am sure, would welcome the suggestions of agronomists.

The most important factor affecting crop yields in this country is still the weather. It is far more effective than any legislative control program. Many prospective agronomists are now studying meteorology in connection with the air service. They may be able to do something with the weather when the war is over. Even if they fail us, and the post-war weather remains uncontrollable, I feel that the agronomist should be able to help the farmer become more independent of the vagaries of the weather. There was a heavy hay crop in much of eastern United States this year. But the heavy rainfall, responsible in a large measure for the heavy hay crop, continued during hay harvest. As a result, much of the hay rotted in the field and much of that saved was seriously damaged by the rain. Shall we always be so helpless? Shall we always, under such circumstances, have to risk the loss of a crop which requires a whole season to grow just because we do not get an additional eight to fifteen hours of sunshine at harvest time?

Several possible solutions are being studied, grass silage, artificial drying, and barn curing; all these seem worthy of further investigation and of more widespread farm trials.

As a direct result of the war, the capacity of our synthetic ammonia plants has been enormously increased. There seems little question but that after the war there will be available for use as fertilizer at least twice as much nitrogen as we have ever used and at a price much less than we have ever paid. A national joint committee, made up of representatives of several interested organizations, has been set up to consider the possible agricultural uses of this material.

Many of you participated in this conference held in connection with this meeting. The possible industrial and agricultural implications of this development are considered by some industrial leaders large enough to have an effect on our post-war economy, "comparable to the discovery of a sixth continent."

When we consider what most of our pastures are and contrast that with what they could be, when we think of how the lespedeza rotations have affected the agriculture of Missouri and neighboring states in the last few years, when we think of what hybrid corn has done for the corn belt in the last decade, when we consider what a small percentage of the plants in the world we have tried seriously to introduce into our agriculture, I'm sure we would all agree that there is still much the agronomist can do to help the American farmer increase his efficiency of production.

I am also convinced that American agronomists have a very important international service to perform. The world seems much smaller than it did two years ago and many of its distant lands much closer to us. When the war is over, there will be millions to feed, large communities of people to be resettled, and farms to be supplied with seed, fertilizer, machinery, and livestock. A roster of qualified personnel for assisting with such work is already being prepared.

In addition to these emergency problems at the close of the war, there will be a need for American agronomists to help many countries with a primitive agriculture and, in many cases, a population larger than it can support at a satisfactory level. After long experience in public health work in such countries, the leaders of some of our large philanthropic foundations have become convinced that the best way to improve the health and general well-being of such people is to first improve their agriculture.

A high proportion of the world's farm population is still using techniques that were in use in Biblical times. Contrast the human effort that goes into the production of a bushel of wheat on one of these primitive farms with that in our wheat belt. To prepare the seedbed, the soil is "tickled" three or four times with a wooden plow drawn by a pair of oxen, the seed is broadcast by hand, the wheat is harvested by cutting one handful at a time with a sickle, it is then carried or hauled to the threshing floor, often the bare ground in an open field, where it is threshed with a flail or by treading with animals! Think of doing all this work for an average yield of eight bushels of wheat per acre! Yet wheat is being grown in this way by thousands of farmers within one day's flying time from here!

American agronomists can be of great service to the governments and educational institutions of such countries. The movement was spreading before the outbreak of the war. It will be resumed at accelerated speed after the war. Foreign students, in increasing numbers, will come to our shores for special training. Scholars from all countries should be made welcome. I hope our price level can be kept in close adjustment with that in other countries so that travel and study in America will not be beyond the reach of the ambitious young people in other countries. I would like to see our American universities far outrival the German universities of half a century ago in their influence upon science and upon the thinking of the world.

And why not? We have or can have the same academic freedom of which they were once so proud. We have or can have an equal quality of intellectual leadership. We have or can have physical facilities for research which will be unsurpassed in any country. I would have the scholars of the world love America. I would have them go back to their countries and instil some of that love of America in their students and other countrymen. Such friends would be America's strongest armor, her best insurance for a lasting peace. Can you conceive of any investment that would yield greater returns to America in the way of international understanding and good will than the education of a Madame Chiang Kai-Shek?

The soil scientists of America had made a good start toward better relations with their colleagues in other countries, even before the war. Their International Congress, held in Washington in 1927, and the excursion throughout the United States which followed, gave many foreign scientists their first opportunity to study our soils and to become acquainted with us. The Second Congress in Russia in 1930 stands out in the memories of many of us as one of the outstanding treats of our professional careers. The seeds of the present conflict had been sown before our Third Congress at Oxford in 1935. An undercurrent of rumors and distrust was apparent to all. At the meeting of the Soil Microbiology Commission in New Brunswick, New Jersey, in August, 1939, a cordial invitation to participate in the Fourth International Congress to be held in Germany in 1940 was presented. The German Organizing Committee had, even at that time, planned with characteristic thoroughness every detail of the Congress and of the excursion to follow. A few days later, war was declared, and a few weeks later, the Congress was postponed. Many of the pioneers in this society will be missing when the war is over. New leaders must be found to take on the responsibility for its revival after the war. The job will require men of great tact and understanding.

It seems to me to be especially important for us to develop a better acquaintance and understanding with

our colleagues in Latin America. A start was made at the Scientific Congress in Washington in 1940 and at the Agricultural Conference in Mexico City this summer. These conferences should be followed up with a democratic organization of the agronomists of these countries.

There is in my mind no question about the enlarged opportunities for service and the responsibilities for leadership at home and abroad that will be within the grasp of American agronomists at the end of the war. The next question is: "Do we have the men to do the job?" A decade ago, the market for young agronomists seemed to be about saturated. Able young men, well trained, equipped after years of sacrifice with a Ph.D. degree, were doing odd jobs until a real job in their field was open. A little later, the Soil Conservation Service was established. Within a short time, it had a budget greater than the soils divisions of all other state and federal organizations combined, and it was scouring the country for men with some agronomic training. The demand for well-trained men continued keenly up until the outbreak of war. Now nearly every institution or organization employing agronomists has several vacancies on its staff. Many of us are gradually becoming reconciled to the idea that many of the vacancies will have to remain unfilled until the war is won. Some of us can get a little relief by hiring men away from other institutions, but such tactics will not help the over-all shortage and should probably be confined to the normal traffic.

The graduate student enrollment in most institutions is only a small fraction of normal. It will doubtless tend to get lower as long as the war continues. At the close of the war, many of those who were planning a career in some field of agronomy will return to our graduate schools. Many who have accepted "temporary" positions in defense industries will tend to lose touch with developments in agronomy and will probably remain in industrial work. In view of these facts, I am inclined to think that the demand for able, well-trained agronomists will exceed the supply for at least ten years after the war is over. The only thing that I can think of which would "glut" the market would be a very drastic reduction in the support given some of our federal agencies or state institutions.

Let us consider a little further the potential post-war demand for agronomists. There are never enough "top notch" men to satisfy the demand. The demand will be keener than ever after the war. We shall need a few dreamers, far-sighted men, who can see the paths we should take and lead us and the country at large to see the potentialities for mankind that lie hidden in our soils and crops. We are, as a whole, a rather practical group, tied rather closely to the conventional approaches to our problems. For those of us who have to deal daily with farmers and their practical problems of the moment, this is highly desirable. But if we are to break new trails, we shall need a few visionary men, men broadly trained not only in the basic sciences, but in the humanities as well.

A few days ago, I heard a nationally known farm leader say that he was going to resign from several important positions so that he could have time to think about some of these problems that are going to confront agriculture after the war. In his address to chemists referred to above, Stine said, "We are going to need to be visionary to the point of audacity." If agriculture is to keep pace with industry, agriculturists must be equally bold and farsighted.

I anticipate but a modest expansion in the number of agronomists on our college, university, and experiment station staffs. I will not even risk a guess about the future for agronomists in the United States Department of Agriculture. There is, however, another broad and practically virgin field in which the professional agronomist could render valuable service. I am convinced that a half-dozen or so extension agronomists will not be able to meet the demands for help from farmers of a large state which will arise after the war. There should be at least one professional agronomist available for consultation in every important agricultural county. In some counties, the county agent himself is qualified to handle the agronomic problems which come up in his county. More commonly, his own training is too limited, and the demands on his time are too numerous to enable him to do the work satisfactorily. These county extension agronomists would not necessarily have a Ph.D. degree. They should have a good farm background, a strong undergraduate major in agronomy, topped by one or two years post-graduate work in soils science, especially soil management, field crop production, farm management, and allied fields. They should be able to handle most of the individual farmers' problems. They would have the responsibility for supervising all agronomy demonstrations in their counties. Only the more difficult situations would be referred to the state extension specialist. The latter would function more largely through the county agronomy specialists in his region and through group meetings of farmers. Plans somewhat similar to this are already in operation in sections of the country. In areas where large farming corporations are operating, such organizations could well afford to have a professional agronomist on their staffs. I understand that the sugar planters of Hawaii have established systems of agronomic management and control much more elabo-

rate than I have outlined here, and they have found that it pays. Estates as small as 1000 pectares in East Prussia frequently have university trained specialists in agronomy and animal husbandry on their staffs. Our agriculture consists, and will probably continue to consist, largely of relatively small, individually owned and operated farms. Some expansion of the already firmly established county agent's staff would seem the most efficient way of providing this added professional service where it is needed.

I cannot refrain at this point from commenting briefly on the organization of agronomic work in this country. The great bulk of our research and teaching in agronomy is supported by public funds. The great majority of the members of our society are employed by county, state, or federal agencies. As public servants, there are two different points of view as to how we should conduct ourselves:

The first is that we should confine our activities strictly to our field of specialization. In other words, "stick to our last."

The other is that we, as specialists in the public service, have a certain definite responsibility for helping to develop public policy in the field of our specialization. Agronomists are still citizens and, as such, cannot escape the responsibilities of citizenship.

I feel that one of the most outstanding public services ever performed by an American soil scientist has been performed by Dr. H. H. Bennett. As a result of years of experience in studying soils, especially those of the south, he was convinced that something more had to be done to stop erosion, or the agriculture of large sections of our country would be seriously impaired. In just about a decade, he has succeeded in persuading Congress that something should be done about it, and he has made the country erosion-conscious. The nation unquestionably owes him a debt of gratitude. We need more men with his vision.

We have recently had numerous new agencies set up in the United States Department of Agriculture—many of them largely as emergency measures and presumably of temporary duration. As originally conceived, each had a rather distinct function to perform, a function which no existing organization was adequately handling. Being liberally supplied with funds, these organizations expanded rapidly. Many of them soon extended into every section of the country. Each is tending to become a Department of Agriculture within a Department of Agriculture. The result has been confusion, working at cross purposes, and friction. A very considerable proportion of the time of some of our ablest men in the agronomic field is spent in trying to iron out difficulties which should never arise. I am convinced that no intelligent man could study the existing organization of the work being done in this country in the broad field of soil science and field crop production and justify it. Agronomists in these various agencies are earnest and sincerely anxious to do their work well. I have no solution to offer. But I am sure that none of you, especially those of you with administrative responsibilities, could ponder over "our job ahead" without having this problem of the organization of our work appear as a very vital part of the task.

A few months ago, I wrote a friend in Germany, a soil scientist who has traveled in this country and is well known to many of you, that with our traditions of democratic freedom in America, we found it difficult to understand how the intelligent German people could submit to the tyrannies of Hitler. His reply was that with our bountiful resources in America we might be able to afford liberty and democracy but that Germany is a much poorer country and must be more efficiently organized to survive! I have thought of this letter many times since the outbreak of war. Is it necessary to sacrifice efficiency in order to maintain our democratic freedom? We will all have to admit that, at times, things seem to move much more slowly in a democracy. We do more cutting and trying, more experimenting, and more compromising. We give more weight to the views of minorities. This retards action, but I think we will all agree that it increases the probability that we shall come out with the right answer in the end. Let us hope that this applies to the organization of our agronomic work. Let us hope that the present confusion represents, from the long-time point of view, merely a transitory experimental stage which will lead soon to the development of an efficient, well-integrated program. Such a development is necessary if we are to fully discharge our duties to the public. It is necessary if our services are to be more effective in helping post-war agriculture vie with post-war industry in supplying the wants of mankind.

OBITUARY

GEORGE WASHINGTON CRILE

DR. CRILE was born in Chili, Ohio, on November 11, 1864, and died in Cleveland on January 7, 1943. He received his A.B. degree at Ohio Northern University in 1884 and his M.A. and M.D. degrees at the University of Wooster, 1887.

Dr. Crile served his alma mater as lecturer and professor of physiology and also as professor of clinical