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THE STATUS AND FUTURE OF THE AMERICAN AGRONOMIST¹

ON the occasion of this fourth annual meeting of the American Society of Agronomy it is of interest to note that our membership has now grown to more than two hundred and that our published proceedings are finding their place not only in the private libraries of American agronomists, but also on the shelves of the libraries of the leading colleges and universities of the country. Indeed the time seems to have arrived when this society should seriously consider supporting a journal. We have definitely put our hands to the plow. It behooves us, therefore, to be diligent, to push this society into the front rank of the scientific societies of the land, and to guard jealously against any and all influences which may interfere with the highest development of its individual members and thereby restrict its opportunity for public usefulness.

It must be recognized that no scientific body can be brought to its highest plane nor be made of the greatest service to our American people unless the ideals of its individual members are high. The future of agronomy in this country is, however, not only dependent upon such ideals, but also, in a very great degree, upon the administrative attitude of the institutions which we serve.

To the professor who, a generation ago, was covering in his way the whole range of agricultural science, the field of the present-day agronomist may seem narrow; but those who have kept pace with the march

¹ Presidential address before the American Society of Agronomy, November 13, 1911.

of recent events must be impressed with its breadth and by the fact that even greater specialization is foreshadowed in the near future, when the subject of agronomy may readily resolve itself into several distinct fields of effort.

The student of farm crops can no longer be content with a knowledge of what belongs to the art of crop production, but must now be well grounded in systematic botany, especially in its relation to the bacteria and fungi, and to the plant families which embrace the weeds, grasses and the common farm crops. He should understand and follow the work in breeding which is being done throughout the world.

In order to deal with many of the problems with which he will be confronted as an investigator and which he should be able to fully grasp as a teacher, fundamental training in physiological botany becomes essential. Indeed, this is only the beginning, for the agronomist has not only to deal in detail with the plants which contribute directly to the food supply of man and of our domestic animals, but also with an extensive soil flora almost undreamed of a half century ago, upon the study and control of which, for the furtherance of agriculture, the world is to-day barely entering. The agronomist of the future must not only deal with the effect of these soil plants upon each other and upon the higher plants in their parasitical and symbiotic relations, but also as producers of ammonia and nitrates, and as destroyers of compounds of sulfur and of nitrogen within the soil.

As suggested by the recent investigations of soil amebæ by Hall and his co-workers at Rothamsted, he must also deal with microscopic animal denizens of the soil which may militate against, or, as perhaps may yet be found, aid in the growth of certain beneficial fungi, and other micro-

scopic flora. In fact, the end is not yet, for chemistry now plays its rôle in furnishing the agronomist carbon bisulfide, and other substances for combating unfavorable animal life in the soil. Chemistry also plays its part in controlling and regulating the chemical reaction, and hence the dominance or decadence of various types or even of individual representatives of the soil flora.

There is reason to believe that we are to-day but entering upon the study of the organisms and of the conditions best suited to ensure the assimilation of atmospheric nitrogen by non-symbiotic means.

The whole question of the use of fertilizers and of their action is daily becoming more complex. It was a simple proposition when one supposed that it was merely essential to learn what elements crops removed from the soil and then to supply a proper part thereof, without special reference to the particular compounds used to supply them. To-day, cognizance must be taken of the effect of the associated compounds. The sulfuric acid and chlorin combined with ammonia in ammonium sulfate and ammonium chlorid may have a highly toxic effect from the outset, or such effects may soon develop in certain soils if care is not taken to maintain a proper basic condition. The subsequent effect of organic nitrogenous manures is quite different on some soils from that of nitrate of soda. Even though the avoidance of chlorin and sulfuric acid, when combined with ammonia, is of vital importance under certain circumstances, it is often less necessary under the same conditions if they are in combination with potassium, calcium and magnesium. For still other crops, or on another soil, they may nevertheless be used with good effect.

Another illustration is afforded by nitrate of soda. The residual effect of re-

peated annual applications may result in the most marked soil improvement, rendering successful the cultivation of a whole series of crops where they could not be grown successively before. The same treatment, even for a long series of years, may still fail to correct the existing soil conditions enough for other groups of plants. The continued use of nitrate of soda on another soil may cause it to become puddled until it is rendered practically unfit to be a habitat for most agricultural plants. For certain plants, such as the radish and beet, the residual sodium from nitrate of soda may perform valuable physiological functions which would be lacking, or of slight importance, in connection with certain other plants. Raw rock phosphate may be valuable as a fertilizer on the black soils of the Illinois corn-belt and for crops usually grown there, but for the light sandy soils of the Atlantic coast and for certain trucking crops its use at prevailing prices could perhaps not be recommended. To add to this complexity certain text-books proscribe the use of lime with superphosphates, or on soils where undissolved phosphates are to be used, and yet there may be soils on which liming is essential to the most economical use of each. It is, in fact, not enough that the agronomist should bear in mind and master all of these details, but now he is called upon to consider the specific requirements for lime and other substances, of hundreds of varieties of plants. He must also consider the alleged toxic root excreta and methods for rendering them innocuous, and he must take cognizance of the catalytic action of manganese and other elements not heretofore grouped in the galaxy of fertilizers and soil amendments. He must now consider the effect of legumes and other plants upon those growing in association with them and the effect

of given crops upon those which follow. The whole question of maintaining conditions favorable to nitrification is of prime importance in certain sections of the United States, and in this connection chemistry is again the handmaid of agronomy; yet in certain of the semi-arid regions of the middle west excessive nitrification is said to have become a scourge which is wiping out many of the most promising orchard industries. It must be evident that the agronomist must therefore be something of a climatologist, for in certain of these features the weather conditions are the chief governing factors.

The successful agronomist must also deal effectively with a host of plant parasites which may attack the roots, the base of the stems, or the other aerial parts of the plants. Some of these may be killed by poisons, whereas others can not. Even the sucking and boring insects furnish a problem in themselves, long after the entomologist has determined the essential features of their life history. Just as "every animal has its fleas and these have fleas to bite 'em," so the plants have their many animal and fungus parasites, with which the agronomist is forced to deal.

Since the soil is one of the chief concerns of the agronomist, and it is known to be teeming with many forms of microscopic life of beneficial or injurious character, it is important to take cognizance of the possible effect upon this life of the various kinds of organic matter and of fertilizers which may be introduced into the soil from time to time.

Notwithstanding the recent assertion that practically the same minerals are found in all soils, that plants feed from very weak solutions, and that the soil solution is being continually renewed, we cannot complacently fold our arms and watch the workings of the divine providence in

the production of food for the human race; for some soils appear still to lack enough available plant food at certain stages of growth, and others give rise to conditions, naturally, which require chemical and physical amelioration. It is an incontrovertible fact that soils derived from given kinds of rocks have usually distinct needs, whereas such treatment may be wholly neglected in the case of soils derived from rocks of a different character. For these and other obvious reasons the agronomist, in order to be well equipped to meet situations which may arise in another state, or in a new position to which he may be called, will find it of distinct aid if his fundamental educational equipment includes geology, mineralogy and physics in its special application to the many problems of the soil.

The agronomist will be brought face to face with emergencies and questions involving physical chemistry, the foundation for which is supplied not only by general chemistry, but also by knowledge of mathematics involving the calculus.

Finally, above and before all should be placed the subject of English, the call for which in some station bulletins is obvious, and in the use of which none can be too proficient.

It may be argued that the fundamental educational requirements as presented encroach upon other domains of science, that they are too comprehensive and are more exacting than the conditions demand. Nevertheless our progress as agronomists can not attain its maximum by depending wholly upon men who are trained only in a narrow specialty. Those engaged in given lines of agronomical research must have a sufficiently broad training in order to grasp the significance and bearing of factors lying frequently much outside of their strict domain. Had not Hellriegel

possessed an outlook broader than that circumscribed by the mere limits of chemistry, it is problematical if the discovery of nitrogen assimilation through the intervention of microorganisms might not have remained a problem for ourselves.

It is not enough that the teacher or investigator in agronomy be skilled in its art, but he must be trained in all of the natural sciences which are closely related to crops, fertilizers, soil amendments and to soils themselves in all of their several relations. The man who looks forward to service in the west or middle west can not neglect the chemistry of fertilizers in their relation to the special crop and to the special soil, for the fertilizer problem is advancing westward at a rapid rate and many of the present-day needs of the east will, in the near future, become the needs of much of the west and middle west.

From what has been said it must be obvious that the ordinary college course can not be considered an adequate preparation for the life work of the agronomist, whether he be engaged in teaching or in research, but that this must be supplemented by at least three years' work at the university. Conversely, it must be equally obvious that he who would succeed in the fullest degree in his scientific achievements in the domain of agronomy must also be familiar with the subject as an art, and if this knowledge was not acquired at home on the farm, before the beginning of the college course, it should surely be made a part of his equipment before entering upon the university course.

The demands of the times make imperative not only a knowledge of the art of agronomy and the possession of the foundation contributed by the college and university, but they demand that the teacher or investigator keep continually in touch with the work of others in this and other

countries, and to this end a reading knowledge of French and German, and if possible of other foreign languages, is essential. The argument that it is sufficient to merely read the abstracts of papers is specious. The investigator should never be content with anything short of the original, since ideas as to the relative importance of the different parts of an investigation are often widely variable, dependent upon the outlook or particular experience of the abstractor. It, therefore, not infrequently happens that a point which may be passed over as insignificant is vital to the work of some investigator, who, if confined solely to consulting the abstract, might never be able to profit by it.

It is obvious that the teacher must have sufficient time at command for daily recreation if he expects to maintain himself in condition to present his subject matter year after year to his classes in a clear and forceful manner. The same thing is necessary for the investigator in order that he may be keen and alert in the pursuit of his problems. He is then in condition to recognize points of attack which the man pressed and wearied with many duties might pass by unnoticed. To him who would be a strong, full man, capable of imparting inspiration to his students or of attacking problems of research with the true enthusiasm which is essential to success, time must not only be allowed for renewal of physical strength and for abundant reading, but *also for undisturbed and consecutive thought*. This means that no institution can long expect to be a leader in the field of education or in research, if its policy is to demand so much by way of other duties or so many hours of teaching that its employees can become leaders neither in thought nor in research in their chosen specialties. A university president, in a recent address, announced that those

teaching at his institution were hereafter to be measured for their fitness by their output in research. Such a policy, while prompted by a commendable spirit, might be more nearly applicable in a new institution in which the teaching demands are reasonable, but it is likely to work the grossest injustice if applied immediately in a college where worthy professors have grown old in a treadmill of exacting service, which has left no time for gathering inspiration nor for work of research. Such men, if given the opportunity at the right time, might have won a national or world-wide reputation as investigators, for they may have been original, diligent and fired with an enthusiasm which the institution itself gradually smothered and snuffed out. Such men should not be cast aside like an exhausted sponge, for the institution and the state owe them a debt which they can not repay. Again, a college professor can not always do his best work if made to feel that his tenure of office depends upon his yearly output in research. Such avowed watchfulness by a president or by a committee on efficiency is likely to lead to superficiality, to hasty publication, or to create unrest disastrous to research of a high order and to bring many disastrous consequences in its train.

Object lessons of spoiled investigators are especially common, in many of the smaller colleges, and even in many of the larger ones; yet the time may never come when it will be safe to measure the fitness of all men for college teaching solely, or even chiefly, by their research output. Nevertheless, one can not but recognize the desirability of encouraging teachers to practise exhaustive reading on special subjects, or to undertake special advanced research, whenever the demands of their positions and the attendant circumstances render it possible.

From what has been said it would appear that all teachers, and those who are selected to conduct research, should have at least three years of university training superimposed upon the college foundation. In saying this the writer recognizes that some of the best men in the country have not had this experience, but yet have won an enviable reputation in their respective lines, even in certain cases outstripping many who have enjoyed a more extensive fundamental training. It must, nevertheless, be recognized that such men have succeeded not in consequence of their handicap, but in spite of it! They were close observers, diligent students, and were possessed of original and judicious minds.

Admitting that the university training is a great desideratum in all cases, the problem presents itself of lending sufficient encouragement to young men so that they will be willing to devote three of the best years of their lives, and a large sum of money, to university study.

At almost every session of the Association of American Agricultural Colleges and Experiment Stations some college or university president or station director has bemoaned the difficulty of finding adequately trained men to fill the higher positions, especially in research. Indeed, the Secretary of Agriculture, the Hon. James Wilson, has repeatedly stated in public addresses that the Department of Agriculture finds it impossible to secure in this country men adequately qualified for many of the positions in the federal service, on which account his department is forced to train its own men. This leads to the query: Why does not the same principle of supply and demand hold as in lines of industry? It is a fact, which I think will be disputed by none who are well informed, that this country furnishes exceptional opportunities to-day for the young man just out of

college. Perhaps, indeed, if some of them, like men known to the writer, were forced to begin, after completing a four-year college course, at a salary of from \$16 to \$20 per month, all of which was required for board and clothes, they might be willing to make greater sacrifices than at present in order to insure for themselves a future, by securing a university training at whatever cost. To-day, however, the young graduate can readily command an initial salary of from \$800 to \$1,200, and many have been advanced within from two to three years to salaries as great as, or greater than, those paid in other reputable colleges to much older and more experienced men who have enjoyed a university training.

When these young men look about them in the institutions with which they are connected they may even find others at the heads of departments who have never enjoyed graduate study. They may also find those who have made the sacrifice, struggling by all sorts of means to add enough to their insufficient incomes to enable them to support a small family, with few comforts, no luxuries, and even with deprivation and need before them, in case of unusual illness or misfortune. It is no wonder, under such circumstances, that he thinks "a bird in the hand is worth two in the bush" and prefers to go on accumulating, rather than to spend three years' time and the savings of other years in order to secure the mere intellectual advantage of further study. As I have several times pointed out in public addresses, there can be no permanent remedy for such a condition short of an assured pension for those who have given ten to fifteen years of efficient, faithful service to such colleges and stations, or there must be occasional half-year intervals of freedom and a marked and progressive increase in compensation for the older and experi-

enced men. As concerns pensions, one that does not become assured until the end of a thirty-year period of service, while a great boon to those who finally receive it and a welcome aid to the president in unloading undesired or superannuated professors, nevertheless fails to furnish that assurance of security in case of disability or later financial difficulties which encourages the professor to satisfactorily equip his library, to travel, to study and to surround himself by the broadening influences which are essential to his greatest intellectual development and to his greatest usefulness to the students who come under his instruction. In this matter of pensions and conditions surrounding them we have a valuable lesson to learn from Germany.

It has been argued by some that the early assurance of a pension robs the prospective recipient of initiative and enthusiasm in his chosen profession and encourages a letting up of his intellectual activities. To such an advance this argument the writer begs to enter an emphatic denial of the justness of the accusation, for from his personal acquaintance with professors in many of the leading German universities and his observation of their spirit of research, he is convinced of the utter incorrectness of such a position. Indeed, nowhere in the world could one find greater devotion to duty, greater willingness to make personal sacrifices, or greater zeal in investigation, than among the professors of these German universities; who can look forward complacently to the future if disabled, and in any event with the comfort and knowledge that their families, after their work is done, will be cared for properly as a reward for a lifetime of faithful public service.

Finally, this society will do well to encourage the development in our universities of higher and broader graduate courses

in the applied sciences related to agriculture. Let us use our influence as a body to secure from the Carnegie Foundation, for the teacher and investigator in the smaller land-grant colleges, the same fair and just recognition for quality and amount of public service rendered as is accorded to the teacher of mathematics or of the classics in the older classical colleges of the country. If necessary, let the American Society of Agronomy urge upon congress the provision of a pension system for the land-grant college, based upon a reasonable probationary limit of service as a condition for its becoming assured. If to this these colleges will add the sabbatical year, or will allow a full half-year in every five, and will give adequate and progressive advances in salary with the years of service, we shall soon see plenty of young men fitting themselves well for the work of teaching and research.

In closing I would not fail to emphasize that young men entering our profession should do so with the missionary spirit and with the desire to serve their fellows uppermost in mind, but the situation to-day is such that many who set out with courage are forced, out of justice to their families and through failure to secure the reasonable comforts and necessities of life, to seek, against their will, such financial returns in other callings as are rarely the reward of the agricultural teacher and investigator.

H. J. WHEELER

*THE INTRODUCTION OF PHYSICAL CHEMICAL CONCEPTIONS IN THE EARLY STAGES OF THE TEACHING OF CHEMISTRY*¹

THE question I have been asked to discuss is not a new one, but is, in my opinion, one of fundamental importance. Whenever any

¹ Paper read before the American Chemical Society in Washington, December 27, 1911.