# SCIENTIFIC SECTION.

## DEVELOPMENT AND PROPER STATUS OF AGRONOMY.

M. A. CARLETON,

Bureau of Plant Industry, Washington, D. C.

Presidential Address, at the Washington Meeting, 1908.

Today we are assembled in the first annual meeting since the organization of the American Society of Agronomy—the first association of the kind in America, and one that will have, without question, a tremendous influence on agricultural investigation and practice. In recent years much has been said about agronomy. There are now many agronomists in this country. The use of the term has become common. Yet the question, What *is* agronomy?, if propounded to these same agronomists, would receive various and probably conflicting answers. There are at least two reasons for this condition, chief of which is that the growth of the subject has been so rapid that practice has far outrun definition and classification. Again, local conceptions of the term are colored by close relations in practice to certain other subjects, which are not the same in every locality. In Illinois agronomy is associated most closely with chemistry, in Iowa with physics and mechanics, and in Minnesota with animal husbandry.

That our ideas of definition and classification do not keep pace with practice is shown in the definitions given in recent dictionaries. The Standard defines agronomics as follows:

> "The science that treats of the distribution and management of land, especially as a source of national wealth."

Agronomy is defined as scientific husbandry, and an agronomist as one who applies agronomic principles to the management of land.

Webster defines agronomy as "the management of land; rural economy; agriculture." Agronomics is called "the science of the distribution and management of land."

According to the Century Dictionary agronomy is an *art*—the art of cultivating the ground; agriculture; while agronomics is a *science,* the science of the management of farms; that division of

the science of political economy which treats of the management of farming lands. An agronomist is one who is engaged in the study of agronomy or the management of lands. Agronome is given as a synonym of agronomist.

In Larousse's Grand Dictionaire Universel, *agronomie* is called (1) the theory of agriculture; (2) literally, the science of agricultural laws, or, more broadly, the science of agricultural administration or management.

Agronomy was therefore considered heretofore to have a very broad meaning, similar to that of agriculture, but to cover particularly questions of rural economy or land administration. According to this idea the farm management of today is purely agronomy, and yet in present courses of study it is not only placed entirely outside of agronomy, but is sometimes even separated from rural economy. Agronomy has acquired in recent years a narrower and special meaning. The location of activity is still in the field or farm, but all operation or thought has reference to the crop. It is easy to see the cause of this change. The rapid progress made in plant physiology and pathology and the diversity of plants now under cultivation have drawn attention to the importance of more study of the plant itself, and have shown that every improvement in crop production even though it may be a matter of soil treatment, must be made with reference to the needs of particular species or even varieties of plants.

According to the present conception in this country, agronomy as a science may be defined accurately as the study of field crops and their relations to the environment; as an art it is the management of field crops and the soils in which they grow. The derivation of the term is from two Greek roots, *agros,* a field, and *nemein,* to handle or manage, the literal meaning of the word being the handling or management of fields. In present use, therefore, we have not wandered badly from the original meaning, but have made the field crop, instead of the field, the unit of investigation.

Agronomy has been recognized in European countries as a definite subject of thought and action for a long period. In France the title "agronome" is common, and is applied to rural economists, managers of large estates, and to teachers and investigators of farm management, cultivation methods, etc. In Russia the use of the term is much like the present use in this country. The Russian agronom (spelled without the French final *e*), is a well-known official of the general government, having duties exactly like those of present-day agronomists in this country, but his work is much less specialized, as might be supposed. Often the same official will have charge for a certain district of all questions of plant pathology, injurious insects, cultivation methods, and soil treatment.

In this country the segregation of agronomy proper from general agriculture began with the new century. Before the year 1900 the

word was rarely heard or written. The Illinois Experiment Station was the first station in this country to establish the position of agronomist. In the U. S. Department of Agriculture appointments of agronomists and assistants in agronomy were first made soon after the organization of the Bureau of Plant Industry in 1901. Civil Service examinations for position of Scientific Assistant in Agronomy in this Bureau are now held twice a year, the questions covering chiefly grain, cotton, sugar-beet, and forage-plant investigations, dry-land cultivation, and farm management.

During the past decade there has been remarkable progress in investigations of crop production. Many special lines have been developed, and these again divided. The increase in the force of agronomists, compared with other investigators, at the experiment stations is shown as follows: In 1895 all investigations of farm stock and field crops were made under the name agriculture, except the segregation of three animal husbandmen. In 1900 there were three agronomists and eleven animal husbandmen, besides 20 specialists in dairying, 4 in agricultural chemistry, and 3 in soils. In 1905 the number of agronomists had increased to 50, while there were 58 animal husbandmen, 28 dairy specialists, 15 soil specialists, and 3 agricultural chemists. The present year there are 99 agronomists, 99 animal husbandmen, and 53 specialists in dairying, 25 soil specialists, and 11 in agricultural chemistry. Combining closely related subjects, there are, in the broader sense, 135 agronomists and 152 animal husbandmen.

The increase in the agronomic force, compared with animal husbandmen at nine important experiment stations, is here tabulated:

| Agronomists. | | | | Animal husbandmen. | | | |
|---|---|---|---|---|---|---|---|
| | 1900. | 1905. | 1908. | | 1900. | 1905. | 1908. |
| Illinois | 2 | 9 | 12 | Illinois | 2 | 11 | 12 |
| Pennsylvania | 2 | 2 | 5 | Pennsylvania | 3 | 4 | 11 |
| Cornell | 3 | 5 | 7 | Cornell | 2 | 4 | 6 |
| Wisconsin | 2 | 6 | 11 | Wisconsin | 3 | 4 | 15 |
| Minnesota | 2 | 2 | 6 | Minnesota | 2 | 2 | 4 |
| Iowa | 4 | 9 | 6 | Iowa | 6 | 8 | 8 |
| Missouri | 0 | 2 | 4 | Missouri | 0 | 4 | 9 |
| Kansas | 0 | 2 | 4 | Kansas | 1 | 3 | 4 |
| Nebraska | 1 | 1 | 4 | Nebraska | 2 | 3 | 4 |

In the U. S. Department of Agriculture there were no agronomists in 1900. At the present time there are about 100 at least. As in the case of the experiment stations, it must be understood that a number of actual agronomists have other titles, such as agriculturist.

## PROPER STATUS OF AGRONOMY.

There is no better time and place than the present to point out the importance of a clear and uniform conception of the proper status of agronomy. I will mention a number of common errors made with reference to the subject that are manifest. There appear to me to be others with respect to which there may be a difference of opinion. In the first place, agronomy is *not* simply "variety testing," though this is a common notion among non-agronomists. Variety trials simply to determine which gives the most bushels per acre belong to the days, only 20 years ago, when agriculture (agronomy) was defined as "an empirical art," yet agronomy has developed largely from these very old-style variety trials; and every agronomist today has dozens or hundreds of varieties or strains on trial, as a partial basis of his work, but results are reported by trained observers, not by farm superintendents, and scores of qualities, besides yield, are carefully studied. Agronomy is also not plant breeding, but includes it along with other equally important subdivisions. I have already defined agronomy as both a science and an art. As a science it investigates anything and everything concerned with the field crop, and this investigation is supposed to be made in the most thorough manner, just as would be done in any other science.

## QUALIFICATIONS OF AN AGRONOMIST.

The qualifications of an agronomist should therefore be of the highest order. There is a prevailing impression otherwise, partly because of the plain fact that so many aspirants have obtained admission to the ranks before being ready to wear the badge, because of insufficient training. They may be fitted for farm superintendents, but not for agronomists.

Referring again to the apparently simple matter of comparing yields of varieties, a trained investigator finds this to be really a complex problem. Under favorable or even ordinary conditions yield tests are wholly unreliable—even misleading. Extreme conditions furnish the true test, and the experimenter must be able to catch those qualities of obscure varieties that fit these conditions. The very popular Turkey winter wheat was grown by "variety testers" for over ten years without suspecting its good qualities. The principle of the correlation of characters lying at the foundation of all crop improvement is appreciated only by trained observers. The unmistakable marks are there, and they tell more to the "man who knows" than the measured bushel at the thresher.

The "Alaska" wheat fake was a case (not uncommon) of deceptive figuring. A single wheat plant of almost any common variety may produce 40 stools, but to multiply that by the number of plants

usually grown on an acre proves nothing, except that in this case it proved to be a dangerous pastime. It would hardly seem to require the training of an agronomist to detect this deception, but there is more in the subject than appears at first sight. Grow a number of plants of the same strain together and soon you hardly recognize the individual. Instead of 40 stools you get three to five, while other characters suffer similar changes.

We are here confronted with the very interesting complication of a *plant community,* otherwise known as the crop—the same thing we have always dealt with, but didn't know it. We had thought we were dealing with plants simply, not thinking of the crop as a whole. A change in the point of view is necessary. The same results proportionally can not be expected from a crop that may be expected from a single plant. The characteristics of people of a community are quite different from those of people who live alone, and so also the characteristics of a crop are different from those of single plants even of the same species or variety.

## BOTANY, PHYSICS AND GEOLOGY AS FUNDAMENTAL STUDIES.

These facts bring to mind the fundamental value of botany in agronomic training and particularly of that branch of it called ecology,—the study of the plant community. This much-neglected branch of botany thus becomes of the greatest importance for agronomy, and, in fact, may be considered in a sense the transition zone from general botany to agronomy, because the unit of study in botany is the plant, while the unit in both ecology and agronomy is the plant community.

The whole of botany, however, is indispensable. It is impossible for one to get the most out of the study of drought-resistant crops, *e. g.,* without up-to-date knowledge of transpiration and other facts in plant physiology. No satisfactory selection for disease resistance can be made without a knowledge of the diseases themselves and their effects upon plant nutrition.

One must be impressed by the frequent tendency to do things backward, more common, it seems, among Americans than in foreign lands, probably because of the intense desire of our people to get results quickly. The cart is so often ahead of the horse that we are accustomed to look for the cart first. Such is the course that has been pursued in much of the plant breeding of recent years in this country. No improvement in desirable qualities of plants is certain without knowing first the degree to which these qualities are already present in existing varieties. Yet men with little botanical knowledge of varieties and meager stocks for a foundation attempt much and get little. They are then led to investigate existing varieties more thoroughly and discover things they should have known before attempting breeding operations. There must be plenty of

available material. We can not improve qualities that do not exist already in some degree. The condition is like that of the pickaninny who asked for 'lasses. The mamma replied: "You chile, don't ask me for 'lasses, say *mo*-lasses," and was answered: "But how can I ask for moah 'lasses when I'se had *no* 'lasses?"

The careful student of plants also soon learns that different methods are necessary in handling different subjects. But, *know the plant* and its life history thoroughly, and the rest is easy. Plant breeding should especially be kept distinct from animal breeding. The whole aspect of study in each is in no wise similar. To confuse the two leads to much inaccuracy of expression and waste of energy. It may seem proper to the animal breeder to speak of the "blood lines" in a turnip as well as in Jersey cattle, but the agronomist will prefer the traditional idea of this vegetable as to its sanguinary character, both literally and figuratively.

In soil investigations, physics and geology are the fundamentals, while chemistry and bacteriology are also indispensable. I am getting away from home in discussing this subject, but if allowed to criticize, I would suggest that more attention be given to bacteriology and geology, particularly stratigraphic geology, than is often given in the training of soil physicists. Investigations in such subjects as soil bacteria, action of enzymes, humus formation, etc., may also profitably take the place of much of the elaborate survey work as at present conducted.

## SPECIALIZATION.

Agronomic training, therefore, if superficial, is not the kind that is demanded, and will soon not be accepted. The agronomist, in fact, looks deeper into things and closer than the botanist in all his study of plants, for he is studying varieties, not species, and must make closer comparisons and finer distinctions. Varieties as well as species also differ in the treatment required for them. For example, the proper cultivation of soil for spring wheat differs from that required for winter wheat.

If the agronomist must study everything relating to the crop, has he not more than he can do, it may be asked. This is no doubt true if his field of operation is not restricted. The increase in number of qualities and the complexity of environment may be counterbalanced by a decrease in the number of subjects or a limitation of the area covered. For example, instead of handling all field crops, only the cereals may be studied, or only one of the cereals or the cereals for a limited district. Specialization as to subjects or area is thus the only salvation for the agronomist in order to do thorough work. The special titles of "cerealist" and "tobacconist" are already in use. No doubt others, such as "cottonist" and "legumist," will soon be proposed.

I wish here to attack the impression seeming to prevail in certain quarters that the atmosphere of the higher grade of universities is necessary to produce a true investigator. This notion is similar to the old one that education in German universities was necessary for the best training. It is now recognized that the chief advantage of study in Germany is simply the influence of a new environment. So also our agricultural colleges of the best grade and other industrial institutions are equal to any of the universities in training for scientific work, and even have the advantage in natural science training because of the environment.

In preparing for agronomic work, whatever the previous training has been, an agricultural course is necessary to complete the education, and years of experience on the farm add to the student's ability. The academic course and the agricultural should be taken in different institutions, and no graduate of an agricultural college should be elected to a position in his own institution without intervening experience elsewhere. There is a splendid opportunity for research work in the broad science of Agronomy, no doubt more so than in other sciences, as it is a newer subject.

There is a world of facts to learn in the study of a single crop. The simplest things, too, furnish ground for the deepest study.

While agronomy is not a mere test of varieties, on the other hand we shall never get away from that kind of work conducted in the proper manner. A writer, discussing the use of the Adams research fund recently in a well-known journal, does so in an able manner, but makes a statement to the effect that "we can not continue to compare varieties of cabbages or strawberries to determine which are best for the market gardener, but may be able to show him how he himself can improve varieties," etc. The latter is certainly true, but whether we or he make the improvements, it is impossible to do so without a thorough comparison of existing kinds, and there are always so many new qualities arising and new strains produced or discovered that these comparative studies will be endless. A year ago one of the experts of the Bureau of Plant Industry resigned and accepted a position in a prominent university, where there is excellent opportunity for research work. He does no undergraduate teaching and is a recognized leader of investigation. Recently the writer had the pleasure of inspecting the field experiments of himself and assistants, and discovered as an interesting fact that the principal part of their work is a comparison of varieties or strains. All correlations are discovered in this way, and there will always be new ones to find. One hundred years from now the best trained investigators will still be "comparing cabbages and strawberries."