methods for the wheat, in the head-row and in the centgener work we see thoroughly analogous results, while in the mass breeding the development was found more rapid to a point of marked increase in yield; but during the last two years we developed new methods in special infection which allowed us to practically destroy any one of what we suppose to be our best resistant varieties or strains. We found, for example, that the *Uredo* spores of rust appear to confer a grade of immunity or resistance which does not appear to be lasting in the sense noted for flax wilt or flax rust. We found that that resistance which appeared to be strong against the *Uredo* spore attack has been practically nil against *æcidium* spore attack. In this work no plant in our breeding garden has a chance to escape being dusted with the spores throughout the growing season, yet we have every hope that some strains are going to be able to weather through this strenuous breeding test, though, as yet, there is not nearly the promise afforded by flax.

The work has convinced me of one fact, namely, that the theory that the *æcidium* stage of *Puccinia graminis* acts as a reinvigorator of stem rusts of wheat is correct. The barberry bush should be eliminated in the interest of bread-hungry humanity.

I may add that no variety of so-called rust proof wheat which I have received from any distant region has shown any indication of being able to resist our method of disease introduction. Biffin's wheat failed to reach a sufficient maturity to produce heads, and the strains produced by crossing by Mr. E. C. Parker, of Minnesota, and thought to be quite resistant, have also proved practically unable to produce seed. It may be said for Mr. Biffin that he has not made any claim that his wheats would prove to be resistant to *Puccinia graminis*.

A NOTE ON RICE BREEDING.

CHARLES E. CHAMBLISS, *Rice Expert, Washington, D. C.*

In the South Atlantic States, where rice was introduced into this country, the success of securing and maintaining the quality of one variety of rice by the use of good seed and thorough cultivation led to the improvement of this cereal by extended cultural methods rather than by plant breeding. To this day on the rice plantations of South Carolina and Georgia, the earlier methods, so far as labor permits, largely prevail. This is particularly true of those methods which from long usage appear to be important factors in producing a grain that, for years, has been classed among the leading rices by the markets of the world. In the

past, the rice planter of this section centered his energies upon the production of a kernel that would mill well and cook well—striving for recognition on the markets, but giving little thought to yield, which always made ample returns until the appearance of blast.

While this disease has undoubtedly reduced annually the yield in South Carolina for at least thirty years, the loss from this fungus has not been of such serious proportions as to cause general alarm until within the last ten years. Besides the actual loss of grain, greater losses resulted during this period by the abandonment of valuable rice lands, because of the uncertain future of the industry. These conditions were brought to the attention of the United States Department of Agriculture in 1904, and plans were at once made by the Bureau of Plant Industry to determine the exact cause of the disease and to devise means for the immediate control of it. At this time, the organism, which produces the disease was not known. It has since been isolated and studied by Dr. Haven Metcalf.

Because of the perfection to which Carolina Gold developed under the climatic and soil conditions of the South Atlantic States, it was practically grown to the exclusion of other varieties, and whatever seriously affected it, occasioned alarm. On account of its susceptibility to blast, the agriculture of these lowlands appeared irreparably ruined; for the soil of these lands and other conditions seemed better suited economically to the cultivation of rice than any other crop. It was therefore imperative that every effort should be made to prevent the loss of a rice of great merit, which grew nowhere else as on the delta lands in South Carolina and Georgia. Accordingly, the Office of Grain Investigations, of the United States Department of Agriculture, took up this problem in the spring of 1908.

While the desirability of securing a strain of Carolina Gold that will resist blast is apparent, it is also equally important to know what variety, or varieties, will flourish under the conditions that have developed the superior qualities of Carolina Gold, and at the same time show resistance to blast. For this purpose one hundred and eighty-five varieties of rices were planted in South Carolina last spring, and thus was instituted a search for varieties that showed possible resistance and for varieties in which were combined the qualities approximating those in Carolina Gold.

These varieties were planted in rows two feet apart. They received the same cultivation and were treated alike in the application of water for sprouting, stretching and maturing. Six of them matured by July

20 and escaped injury from blast, but the majority did not ripen until after full exposure to the disease in its most virulent form. Of these, forty-three showed resistance. In five instances, no signs of blast could be found among the individuals of varieties that stood between rows containing 80 per cent of affected plants on one side, and from 40 to 50 per cent on the other. This might be taken as an index to complete immunity. The other varieties that escaped stood between rows where the infection was not heavy and may, therefore, show susceptibility next season under conditions more adverse.

This season's preliminary work has revealed the existence of varieties that are apparently resistant, and of varieties that by their earliness of maturity escaped infection, and, though fragmentary, will serve materially in inaugurating systematic breeding of rices next year for resistance to blast, earliness of maturity and yield.

The methods of cultivating rice in the prairie region of southwestern Louisiana, where, for decades, rice had been grown for home consumption, were completely revolutionized by settlers from the great wheat fields of the Northwest, who saw great possibilities for this cereal, if water could be had in quantity and at the time it was needed to mature the crop. They not only used the agricultural implements of the wheat fields, but applied to rice the cultural methods of the crop that they were familiar with. In a few years, many farmers made fortunes. As a result of this success, the yield of rice in Louisiana was increased tenfold within twenty-five years. The acreage, however, for each farmer was entirely too large, which meant of course a neglect of the essentials of good husbandry. Too much was left to nature which was lavishly generous, and without tradition to guide them or any standard of their own, they seemed to have had no other object than to secure a yield which would bring good monetary returns. On soils that were extremely fertile and under conditions that met every requirement of the plant, good crops were made for a short period, but on account of their non-adaptability to the localities in which they were grown, the poor preparation of seed beds and scanty cultivation, appreciable deterioration was soon noted in every variety that had been planted. This had the effect of producing discontent and a floating population among the settlers. As fast as new lands were opened up, there would begin a general exodus from the older lands. This lessened the chances for a study of the conditions that militated against making a good rice, and of devising methods to overcome them. As a consequence, there is not a variety grown on a commercial scale in Louisiana and Texas today, with the possible

exception of Honduras, which seems well adapted to lands contiguous to the Mississippi River, that can be considered well suited to its environment.

As a basis for the improvement of the rices of the Southwest, the office of Grain Investigations, of the United States Department of Agriculture, began in Louisiana in 1905 the testing of more than three hundred varieties of rices, which through various sources had been collected from nineteen countries of the world. This work has led to the selection of twelve varieties which possess desirable qualities for field conditions, and has furnished data, which will be used next year in breeding a hard translucent kernel, that, under present milling methods, will produce a larger percentage of head rice, a need which farmers and millers acknowledge to be worthy of effort.

FIELD METHODS IN WHEAT BREEDING.

M. A. CARLETON, *Washington, D. C.*

The chairman of the Committee on Breeding Cereals has asked me to present a résumé of methods in wheat breeding to date. This is a very broad subject and the present condition of wheat breeding operations is somewhat tangled. I have decided therefore, with the consent of the chairman, in order to be at all thorough, to discuss only one phase of the subject—that of field methods.

Probably in no other line of agricultural experiments have we conducted our operations with less guidance from those who have had experience, than in cereal breeding, and yet in no other line of work is it more important to make a proper beginning. With a view of helping those who are now beginning their wheat breeding work I hope to present some definite principles derived from the experience of many workers, that will give a basis for concerted action and uniformity of operations in the future.

Only fifteen years ago no wheat breeding of any consequence had been done in this country leading to the establishment of distinctly additional wheat varieties of proved value, except that of C. G. Pringle and A. M. Jones. Today from twenty to twenty-five public and private experimenters are working on this line. Nearly every man has some one method distinctly his own, and when we consider all operations in detail we find there are nearly as many methods as there are experimenters.

As an official of the U. S. Department of Agriculture, in charge of work in coöperation with other institutions in various States and Terri-