and to San Antonio, Tex., and San Francisco on the west. The system now comprises nearly 8,000 miles of leased wire which is operated each market day, supplemented by a large use of commercial wires, in collecting information on shipments, receipts, and prices, etc., from field stations.

The service now covers in a comprehensive way the following staple agricultural products: Livestock and meats, wool, fruits and vegetables, dairy and poultry products, hay, feed and seeds, cotton, and a weekly review service on grains. Farmers and others who desire to receive the market news reports issued by the bureau may write to their nearest branch office as shown on accompanying map (fig. 195), or to Washington. This market news service now fur-

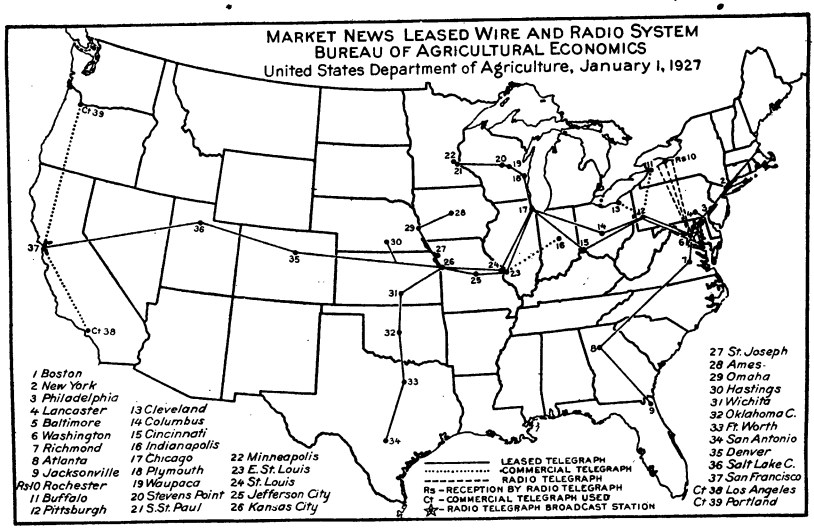

FIG. 195.—Location of stations having the market news service of the Bureau of Agricultural Economics

nishes the principal part of the market news and reports used by news associations, the farm press, country newspapers, and for radio broadcasting.

J. CLYDE MARQUIS.

RESEARCH Pays Dividends in Unforeseen Ways

It is often difficult to determine in advance what is and what is not worth while in scientific research. This fact occasionally causes the suggestion to be made that research work should be tested by its immediate utilitarian results. Such a standard of values would be entirely inadequate. Frequently the simplest and apparently the most unimportant observations turn out to be of great value. This has been so often demonstrated that it is never safe to call a scientific discovery useless, no matter how hard it may be to imagine any practical application for it. New truth generally proves useful eventually. The history of scientific conquests is full of instances. A good example is the way in which the Bureau of Plant Industry of the United States Department of

Agriculture found uses for an apparently unimportant discovery made nearly half a century ago by Karl Wilhelm von Nägeli, a brilliant Swiss-German botanist, in the course of a study of one of the fresh-water alga belonging to the genus Spirogyra, popularly known as "green slime" or "frog spittle."

This alga grows in ponds and slow streams and looks to the naked eye as fine, long, green silk thread. Under the microscope, the thread is made up of cylindrical-shaped cells placed end to end, with spiral bands of green cholorphyll and the protoplasm and nucleus showing clearly. It is thus easy to see the living cell in operation and von Nägeli planned to study its life processes under the microscope with the hope of learning just how they took place. He prepared aquaria with carefully compounded food solutions required by the Spirogyra, but after repeated trials he could not get the alga to grow. However, when he brought water in from the spring they grew beautifully. Here was a question, apparently not of great importance, but he wanted to know why the alga would not grow in his synthetic solution. To make a long story short, he finally traced it to the water which he drew from a bronze faucet in his laboratory and then to the faucet itself. He discovered that the water passing through the bronze faucet took up enough copper from the bronze to kill the Spirogyra.

Copper Solution Killed Algæ

After repeated tests he found that 1 part of copper in 50,000,000 parts of water was sufficient to cause the green spiral chlorophyll band to contract, turn brown and, later, the cell to die. This phenomenon he described as the oligodynamic effect of copper on Spirogyra. It opened up a new field of study as to the physiological effect of dilute poisons and their selective effect. Most plant and animal tissues would not react at all to such dilute solutions. The facts were printed in a small report. They were considered of scientific interest, but probably of no practical importance.

About 20 years ago the Bureau of Plant Industry received a letter from a cress grower up in the Alleghany Mountains asking help in controlling a pest that was destroying his cress. Cress growing in the district was quite a well-developed industry, representing large investments. The bureau sent a physiologist to examine the trouble. The pest proved to be Spirogyra. The conditions in the cress ponds were so favorable for the growth of the alga, as well as the cress, that the former smothered out the latter. In seeking a remedy, the work of von Nägeli was recalled and tests of copper sulphate, 1 to 50,000,000 parts, were tried. This small quantity completely destroyed the Spirogyra without in any way harming the cress. At a cost of a few cents this pest was easily controlled. Here, then, was demonstrated a highly practical result of work, which, at the time, appeared to be of no value, at least from a dollar and cents standpoint. The use of this knowledge is saving the cress growers many thousands of dollars annually.

The remarkable results obtained suggested that copper might be used to control other forms of algal infections of city and town water supplies. Certain forms of algal growth made the water in

large city reservoirs almost impossible to use at certain times of the year, causing not only great inconvenience, but great loss, as it was impossible to control the trouble. As a result of these investigations, it was found that all of these pests could be eliminated at small cost and with absolute safety to the users of the water. This saved not only many millions of dollars a year, but greatly added to the health and comfort of those who used the water. Hundreds of supplies were cleaned up, not only in the United States, but in foreign countries.

Mosquito Larvæ Killed Also

During this work it was discovered that the larvæ of certain species of mosquito were destroyed by these copper treatments, which also destroyed algal growth. A method of destroying these pests was, therefore, at hand that could be used in water supplies, including tanks, wells, and cisterns where it was not practicable to use oil. The method was used with great success in a yellow-fever outbreak in New Orleans and later during the construction of the Panama Canal.

During these studies it was observed that certain species of bacteria, which are, in fact, microscopic plants, were also destroyed by these dilute solutions of copper. Careful studies were therefore made of the effect of copper on pathogenic species like those causing typhoid and paratyphoid fever and Asiatic cholera. It was discovered that they were highly sensitive to copper and could be cleaned out of a water supply as easily as the algæ without the slightest danger to the users of water, if properly applied. Water supplies contaminated with typhoid were disinfected and made perfectly safe at small expense and the method has now become a standard sanitary engineering procedure.

As a result of this work the use of chlorine was similarly standardized and has also become a standard treatment for infected supplies. The copper treatment has been used in India, China, and the Philippines for disinfecting supplies contaminated with Asiatic cholera organism and amoeboid dysentery organism. The value of this is almost beyond computation. It may fairly be said to be the outgrowth of von Nägeli's studies so many years ago. It demonstrates how important it is to make such studies, even though they may not at the time appear to be of practical value. If von Nägeli had not asked the question, "Why do my algæ die?" and worked till he found the answer, we might never have had the knowledge we now possess.

One other example will be all that space permits. In 1883, a French botanist, Millardet, was studying a fungous disease of the grape, or the "vine," as they call it in France. He had some trouble in keeping the boys from stealing the grapes, and to scare them off he sprinkled on the vines a mixture of copper and lime, which made a bluish coating on the leaves and fruit. The boys thought this was poison and let the grapes alone. Millardet noticed, to his surprise, that the leaves and fruit on which he had sprinkled this copper and lime mixture were free from the disease, while the parts not treated were destroyed by the disease. This led to the discovery that dilute solution of copper destroyed the fungus causing the disease without in any way injuring the vine or the fruit.

From this discovery of Millardet was developed our modern knowledge of Bordeaux mixture and its uses in controlling fungous diseases of fruits, vegetables, and plants in general, saving hundreds of millions of dollars annually.

Research in other fields such as soils, fertilizers, plant breeding, animal breeding, animal diseases, insect pests, chemistry, meteorology, forestry, nutrition, and economics has yielded and is yielding and promises to yield facts of great possible value. We can not afford to lessen our efforts in research, but we must increase them if we are to meet the demands of the future. No investment made by the Federal Government and the States has paid larger dividends in the past and none is likely to give a larger return in the future.

The Scientific Method

Some one has said that research is the golden key that opens the portals to progress. It is the constant aim of all educational agencies to cause the human mind to develop in such manner that it may learn how to distinguish truth from error and how systematically to go about the job of finding the truth. This is research, and the method is the scientific method. It may be applied to the simplest things about us or to the most complex problems. It always proceeds from the known to the unknown. The known factor, to begin with, may be the merest clue, apparently worthless, but if it is the only known fact it must be the starting point to gain others through the processes of observation, analysis, and experiment or testing. These processes are frequently very slow and expensive, but there is no royal road to truth.

If we would know the truth we must be ready to make the sacrifice necessary to find it. The history of science is full of romance and self-sacrifice. Because of this spirit our modern world enjoys a well-being not dreamed of as possible, even to the most fortunate. Our knowledge of chemistry, physics, biology, geology, astronomy, and mathematics gives us a control of ourselves and of our environment that was undreamed of a few centuries ago. Still, we are only on the threshold of great new realms of knowledge and power to come within our grasp through the patient continuance of research.

A. F. Woods.

ROTATION a Sure Way to Reduce Production Cost

If you had land which produced low yields as the result of exhaustive one-crop farming would you simply buy fertilizers and continue the one-crop system, or would you diversify and practice a good rotation of crops? To be sure there are other decisions you can make; but to decide wisely in profitable soil management, you must know certain facts, among which are the following:

A one-crop system of farming ultimately leads to disaster.

Diversification and crop rotation lead to well-organized and profitable farming.

Soil productiveness can best be maintained when intertilled, small-grain, and leguminous or grass crops are grown in the order named and in recurring succession on the same land.