1920

Rice investigations

Friend C. Quereau

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Agricultural Experiment Station
of the
Louisiana State University and
A. & M. College
Baton Rouge

RICE INVESTIGATIONS

*F. C. QUEREAU,
Asst. Director,
RICE EXPERIMENT STATION.

Baton Rouge
GLADNEY'S PRINT SHOP
1920

*Resigned Feb. 1918
RICE INVESTIGATIONS

BY

FRIEND C. QUEREAU
ASST. DIRECTOR

RICE EXPERIMENT STATION
CROWLEY, LA.

THE RICE EXPERIMENT STATION.

The Coastal Plain area of Southwest Louisiana came into special prominence as a rice producing section about 1896. The maximum production of this area was reached about 1905. Following this there was a decline in the average yield per acre for several years. This created a demand on the part of the rice farmer for scientific investigations along the lines of seed improvement, soil fertility, insect pests, noxious weeds, irrigation requirements, rice diseases, crop rotation, and cultural methods. In 1904 a bulletin was published by W. R. Dodson, W. C. Stubbs, and C. A. Browne, known as Louisiana Bulletin No. 77 on Rice. This is the latest bulletin published on rice by the Louisiana Station. Because of the fact that Bulletin No. 77 is at present out of print and because a large part of the information contained therein would be of service to the rice industry of Louisiana to-day, extracts from it will be used in this publication and a portion of it will be used verbatim.

In order to meet the demand for information on rice the Office of Cereal Investigations of the United States Bureau of Plant Industry conducted a number of cooperative experiments in various places in the rice growing sections of Louisiana and Texas. Experiments under the direction of M. A. Carelton, of the United States Department of Agriculture, and W. R. Dodson, of the Louisiana Station were conducted for two years on the Shoemaker Farm near Crowley. A large number of varieties of
rice which had been collected from the four corners of the earth by the Department agents were propagated, and the results from them were so promising that the Office of Cereal Investigation decided to give rice a permanent place in this office. C. E. Chambliss was appointed agronomist in charge of rice investigation in 1908. The United States Department was seeking a desirable location for its rice work. The Louisiana Experiment Station decided that rice should be given especial consideration in the Station work for the reason that a large portion of the state is peculiarly adapted to rice culture. Again it is believed that rice should receive some consideration for the reason that it would make certain level prairie areas, which under ordinary conditions is a cattle range, having a value of only a few dollars per acre, a prosperous rice farming country. It was, therefore, decided to invite the cooperation of the United States Department of Agriculture and establish an experiment station in South Louisiana which would devote its efforts largely toward the problems of rice culture. In a plan of this kind there is advantage to the State on the one hand of the vast scientific machinery of the Federal Departments, opportunity of securing seed and plants from all over the world, and eliminating the chance of useless duplication of experiments; and on the other hand such an arrangement would be advantageous to the Department because of the facilities provided by the State for carrying on experiments covering a long period of time and for closer contact with the people they are serving.

A satisfactory agreement was entered into and the Rice Experiment Station was established at Crowley, Acadia Parish, La., in 1909. In this agreement the State is to have control of the experiments pertaining to fertilizer, soil fertility, rotation of crops, red rice, and weed eradication, and irrigation. The Bureau of Plant Industry is to conduct all experiments in seed-rice propagation, plant diseases, insects, and certain irrigation experiments. Various problems which developed as the work proceeded were handled cooperatively or by the department having the facilities for best doing the work. J. M. Jenkins, assistant
agronomist, has charge of the work for the Bureau of Plant Industry at the Rice Station; and F. C. Quereau, assistant director in charge under Director W. R. Dodson, directs the work for the State. The following facts in connection with the Rice Station will be of interest to the rice farmer and may make more comprehensive the data herein-after presented.

The Rice Station is located one mile west of the federal building of the City of Crowley on the interstate highway, known as the Spanish Trail. The farm contains 60 acres.

Soil and previous conditions: The soil is Crowley silt loam underlaid with a heavy yellow clay. The grey silt top soil is from two to three and one-half inches deep. The soil is typical of the rice belt but is not as good as the average rice soil of Acadia Parish, which is from 3 to 10 inches deep. The land was continuously cultivated to rice for possibly 15 years previous to the purchase by the Experiment Station. The land was so badly infested with red rice and weeds that in many places on the farm white rice could not be grown. Red rice seed was mixed with the soil five inches or more below the surface, or as deep as the land had ever been plowed. The first problem was that of eradicating the red rice and other weeds. This was accomplished by cultivated crops and, where necessary, by hand methods. It was several years before the red rice could be completely controlled.

How laid out: The farm was laid out in plots ranging in size from one-eighth acre to one acre. The greater number of the plots were leveed. Irrigation canals and drainage ditches were constructed so that the land could be completely drained or irrigated at will.

Outline of experiments: About one-half of the farm was devoted to the work of the United States Bureau of Plant Industry which consists largely of the propagation of rice seed. A series of plots were established for experiments in the use of commercial fertilizer. Another series of plots were devoted to a system of crop rotations. Other plots were used for experiments with insects and plant
diseases, and miscellaneous highland crops. There are no experiments with livestock in the Station.

**Buildings:** The buildings consist of a barn used for work animals and the storage of machinery, a shop with the necessary farm tools, a water system, a laboratory, and a residence for the assistant director. A mill for the experimental milling of rice has been arranged for.

It is the purpose of this bulletin to give information, based on the results of the experiments outlined, which will be of service to the rice farmer and aid him in improving his methods of farming.

The Rice Station receives many letters from people who have never had any experience in rice raising who desire elementary directions as to the operations necessary to produce a crop of rice. A part of this bulletin will be devoted to giving this information, which will be based on Station experiments and upon the observed results of successful rice farmers in the Rice Belt.

**FERTILIZER EXPERIMENTS.**

**Object of the Experiments:** To ascertain the effect of the various combinations of commercial fertilizer on rice land, which through the continuous cultivation of rice yields have become reduced to a point where the cultivation of rice is no longer profitable. The data desired is listed as follows:

1. The elements of plant food most desired, and the amount most profitable to be applied.

2. The combination of elements of plant food most required and the amount of same which will produce the most profitable results.

3. The length of time that rice can be grown on the same land without rest, or a change of crop, through the use of commercial fertilizers.

4. What will be the final effect on the soil through the employment of the methods outlined above.

These are the problems on which the farmers desire information and which these experiments propose to answer.
Soil: The soil selected for the commercial fertilizer experiments had been in continuous cultivation to rice for about 15 years. This land would, without fertilizer, produce from six to seven barrels of No. 5 Honduras rice. The grey top soil of these plots is fairly uniform as was ascertained by planting a crop of rice over the entire area in 1909. The top soil is about two inches deep. Beneath the grey soil is yellow clay sub-soil.

Outline of experiment: Nineteen plots were used for these experiments. Each has an area of one-quarter acre. The plots were separated by substantial levees. At one end of the range of plots is an irrigation canal and on the other side a deep drainage ditch. All of the plots could be either irrigated or drained, as the case might require, within ten hours. Conditions were made as uniform as possible with reference to planting, draining, fertilizing, and irrigating. When possible, any one of these operations was performed on all of the plots the same day. All conditions were made as uniform as possible.

Fertilizers: No proprietary formulas were used in these experiments for the reason that it is believed that it is more profitable for the farmer to purchase the materials necessary and mix them on the farm with farm labor. All of these experiments were conducted with the idea of home mixed formulas. It is the common practice of the fertilizer manufacturer to emphasize the idea of the formula. The farmer knows very little as to the character of the materials which make up the formula. For example; the average farmer has a very vague idea as to the meaning of “superphosphate”, “Citrate soluble”, and “reverted phosphate”. These experiments are conducted with the idea of emphasizing the values of the materials which make up any formula rather than the formula and to encourage the purchase of the materials for home mixing when it is necessary to use more than one element.

All of the fertilizer used in these experiments was spread broadcast on the disced land previous to planting the seed. This was done for the reason that there is no machine on the market which will distribute commercial fertilizer
in the seed row with the seed but not in contact with it. Fertilizer when used in as large amounts as is necessary in experiments of this kind should not be in contact with the seed for the reason that if the land is dry, there is danger of loss of stand. In farm practice, however, where conservative application of fertilizer is used and when the soil is not too dry, the combined seed and fertilizer drill is believed to be the better method. This will be fully discussed later. In these experiments large applications were made for the reason that information was desired as to maximum quantities that it is profitable to use. Again, large applications give quicker results in showing the effect of the fertilizer on the soil.

The fertilizers used are 16 per cent. phosphate, 12 per cent. German Kainit, and a good grade of cottonseed meal. As a source of nitrogen ammonium sulphate is probably better as a rice fertilizer than cottonseed meal, but at the time that these experiments were inaugurated was not as easily obtainable.

**OUTLINE OF THE EXPERIMENTS.**

This entire experiment was run seven years. Rice was planted each year. Each plot received the same amount of fertilizer each year during the entire period. The plots were planted the first year, 1910; to Honduras, 1911 to Shin-riki, and the last five crops to Blue Rose. The plots were numbered as below and were given the applications of fertilizer indicated. The plots all have an area of one-fourth acre.

Plot 1. Two hundred pounds per acre of 16 per cent. acid phosphate.

Plot 2. Four hundred pounds per acre of 16 per cent. acid phosphate.

Plot 3. Six hundred pounds per acre of 16 per cent. acid phosphate.

Plot 4. Check plot—no fertilizer.

Plot 5. Two hundred pounds per acre of 12 per cent. German Kainit.
Plot 6. Four hundred pounds per acre of 12 per cent. German Kainit.

Plot 7. Six hundred pounds per acre of 12 per cent. German Kainit.

Plot 8. Two hundred pounds per acre of 16 per cent. acid phosphate and one hundred pounds of Kainit.

Plot 9. Phosphate four hundred pounds and Kanit two hundred pounds per acre.

Plot 10. Phosphate two hundred pounds and cottonseed meal two hundred pounds per acre.

Plot 11. Kainit two hundred pounds and cottonseed meal two hundred pounds.

Plot 12. Kainit four hundred pounds and cottonseed meal two hundred pounds.

Plot 13. Check plot, no fertilizer.

Plot 14. Stable manure, fifteen loads per acre, and four hundred pounds of phosphate, and one hundred and fifty pounds of Kainit.

Plot 15. Stable manure, fifteen loads per acre.

Plot 16. Phosphate two hundred pounds, Kainit two hundred pounds, and cottonseed meal two hundred pounds.

Plot 17. Phosphate four hundred pounds, Kainit four hundred pounds, and cottonseed meal two hundred pounds.

Plot 18. Phosphate six hundred pounds, Kainit six hundred pounds, and cottonseed meal three hundred pounds.

Following is a table giving condensed results of the experiment during the period, showing yields each year, variety of rice and cost of fertilizer:
<table>
<thead>
<tr>
<th>PLOT</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>COST PER ACRE</td>
<td>$1.60</td>
<td>$3.20</td>
<td>$4.80</td>
<td></td>
<td>$1.25</td>
<td>$2.50</td>
<td>$3.75</td>
<td>$2.22</td>
</tr>
<tr>
<td>1910 HONDURAS lbs. and bbls.</td>
<td>1,601 lbs.</td>
<td>1,814 lbs.</td>
<td>1,636 lbs.</td>
<td>1,140 lbs.</td>
<td>2,138 lbs.</td>
<td>2,073 lbs.</td>
<td>1,823 lbs.</td>
<td>Red Rice 1,186 lbs.</td>
</tr>
<tr>
<td></td>
<td>10.50 bbls.</td>
<td>11.20 bbls.</td>
<td>10.10 bbls.</td>
<td>7.10 bbls.</td>
<td>13.2 bbls.</td>
<td>12.8 bbls.</td>
<td>11.26 bbls.</td>
<td>7.33 bbls.</td>
</tr>
<tr>
<td>1911 SHINRIKI</td>
<td>1,798 lbs.</td>
<td>2,025 lbs.</td>
<td>1,539 lbs.</td>
<td>1,636 lbs.</td>
<td>1,652 lbs.</td>
<td>1,668 lbs.</td>
<td>1,117 lbs.</td>
<td>Red Rice 819 lbs.</td>
</tr>
<tr>
<td></td>
<td>11.10 bbls.</td>
<td>12.50 bbls.</td>
<td>9.50 bbls.</td>
<td>10.10 bbls.</td>
<td>10.2 bbls.</td>
<td>10.3 bbls.</td>
<td>6.9 bbls.</td>
<td>5.06 bbls.</td>
</tr>
<tr>
<td>1912 BLUE ROSE</td>
<td>4,584 lbs.</td>
<td>3,612 lbs.</td>
<td>3,447 lbs.</td>
<td>2,711 lbs.</td>
<td>2,859 lbs.</td>
<td>2,851 lbs.</td>
<td>2,593 lbs.</td>
<td>2,858 lbs.</td>
</tr>
<tr>
<td></td>
<td>28.30 bbls.</td>
<td>22.30 bbls.</td>
<td>21.90 bbls.</td>
<td>16.80 bbls.</td>
<td>17.6 bbls.</td>
<td>17.6 bbls.</td>
<td>16.01 bbls.</td>
<td>17.50 bbls.</td>
</tr>
<tr>
<td>1913 BLUE ROSE</td>
<td>2,540 lbs.</td>
<td>2,463 lbs.</td>
<td>2,609 lbs.</td>
<td>2,468 lbs.</td>
<td>2,708 lbs.</td>
<td>2,484 lbs.</td>
<td>2,676 lbs.</td>
<td>1908 lbs.</td>
</tr>
<tr>
<td></td>
<td>15.68 bbls.</td>
<td>15.21 bbls.</td>
<td>16.11 bbls.</td>
<td>15.24 bbls.</td>
<td>16.72 bbls.</td>
<td>15.4 bbls.</td>
<td>16.52 bbls.</td>
<td>11.78 bbls.</td>
</tr>
<tr>
<td>1914 BLUE ROSE</td>
<td>2,410 lbs.</td>
<td>2,268 lbs.</td>
<td>1,607 lbs.</td>
<td>2,378 lbs.</td>
<td>2,544 lbs.</td>
<td>2,536 lbs.</td>
<td>2,175 lbs.</td>
<td>Grass 1,315 lbs.</td>
</tr>
<tr>
<td></td>
<td>14.88 bbls.</td>
<td>14.00 bbls.</td>
<td>9.92 lbs.</td>
<td>14.68 bbls.</td>
<td>15.77 lbs.</td>
<td>15.66 lbs.</td>
<td>13.43 lbs.</td>
<td>8.12 bbls.</td>
</tr>
<tr>
<td>5 YR. AV. Lbs and bbls.</td>
<td>2,586 lbs.</td>
<td>2,436 lbs.</td>
<td>2,167 lbs.</td>
<td>2,036 lbs.</td>
<td>2,558 lbs.</td>
<td>2,324 lbs.</td>
<td>2,076 lbs.</td>
<td>1,611 lbs.</td>
</tr>
<tr>
<td></td>
<td>15.9 bbls.</td>
<td>15 lbs.</td>
<td>13.3 lbs.</td>
<td>12.5 lbs.</td>
<td>15.7 lbs.</td>
<td>14.35 lbs.</td>
<td>12.82 lbs.</td>
<td>9.95 bbls.</td>
</tr>
<tr>
<td>1915 BLUE ROSE</td>
<td>Grass</td>
<td>Grass</td>
<td>Grass</td>
<td>Clean</td>
<td>Clean</td>
<td>Clean</td>
<td>Clean</td>
<td>Grass 1,004 lbs.</td>
</tr>
<tr>
<td></td>
<td>1,260 lbs.</td>
<td>1,493 lbs.</td>
<td>919 lbs.</td>
<td>2,219 lbs.</td>
<td>2,219 lbs.</td>
<td>2,592 lbs.</td>
<td>2,413 lbs.</td>
<td>14.9 bbls.</td>
</tr>
<tr>
<td></td>
<td>7.78 bbls.</td>
<td>9.22 bbls.</td>
<td>7.53 lbs.</td>
<td>13.7 lbs.</td>
<td>13.7 lbs.</td>
<td>16.0 lbs.</td>
<td>14.9 lbs.</td>
<td>6.20 bbls.</td>
</tr>
<tr>
<td>1916 BLUE ROSE</td>
<td>Grass</td>
<td>Grass</td>
<td>Grass</td>
<td>Clean</td>
<td>Clean</td>
<td>Clean</td>
<td>Clean</td>
<td>Grass 1,942 lbs.</td>
</tr>
<tr>
<td></td>
<td>1,020 lbs.</td>
<td>874 lbs.</td>
<td>1,247 lbs.</td>
<td>1,717 lbs.</td>
<td>1,377 lbs.</td>
<td>1,798 lbs.</td>
<td>1,652 lbs.</td>
<td>11.99 bbls.</td>
</tr>
<tr>
<td></td>
<td>6.30 bbls.</td>
<td>5.4 lbs.</td>
<td>7.70 bbls.</td>
<td>10.60 bbls.</td>
<td>8.5 lbs.</td>
<td>11.1 lbs.</td>
<td>10.2 lbs.</td>
<td>9.0 bbls.</td>
</tr>
<tr>
<td>EXPERIMENT CLOSED 7 YR. AV.</td>
<td>2,173 lbs.</td>
<td>2,078 lbs.</td>
<td>1,858 lbs.</td>
<td>2,038 lbs.</td>
<td>2,238 lbs.</td>
<td>2,287 lbs.</td>
<td>2,295 lbs.</td>
<td>1,458 lbs.</td>
</tr>
</tbody>
</table>
Fertilizer Plots during harvest from Water Tower.

Fertilizer Plots, Station Buildings.
After six years of continuous application of Acid Phosphate fertilizer.  
Note the grass between the rows.

Check Plot—No fertilizer for six years—No grass between the rows.
Fertilized with 16% Acid Phosphate.
Table 1 gives data for seven years on plots 1 to 8 inclusive. Plots 1, 2, and 3 is an experiment with different applications of acid phosphate. Plot 4 is a check having no fertilizer. Plots 5, 6, and 7 is an experiment with different amounts of potash in the form of German Kainit. In plot 8 is a mixture of potash and phosphate.

The plots were all planted to Honduras rice the first year 1910. As Honduras has about the same period of growth as red rice it was found difficult to hand pick the red rice from the plots with this variety. Shinriki (Japan) was used the second year (1911) for the reason that red rice heads several weeks before Shinriki, making it therefore easy to observe and hand-pick the red rice and prevent a seeding on the land. It was found difficult to obtain good Shinriki seed. As Blue Rose had all of the advantages with reference to long growing season, and as it was possible to secure a uniform seed, the experiment was concluded with this variety.

Experiment with Acid Phosphate:

Plots 1, 2, and 3 were fertilized with 16 per cent. acid phosphate to the amount of 200, 400, and 600 pounds per acre, respectively. The effect of the phosphorus could be observed on these plots while the rice was growing. It will be seen from the table that the 200-pound application produced the most profitable results during the entire experiment. The 400 pound-application did not produce enough more rice to pay for the difference in the cost of the fertilizer. The 600-pound application did not make as good a yield as the 200-pound application. Through the entire experiment of seven years no weeds or grass grew on the check plot (No. 4). Water crab grass commenced growing on the phosphate plots during the fifth year. During the last two years that the plots were planted, 1915 and 1916, all of those having applications of acid phosphate were over 50 per cent. grass. Every effort was made to check the grass by harrowing the rice after it came up and by different methods of flooding. The grass was water crab grass and barnyard millet, both common to the rice fields of
<table>
<thead>
<tr>
<th>PLOT</th>
<th>COST PER ACRE</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
<th>15</th>
</tr>
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<tbody>
<tr>
<td>FERTILIZER</td>
<td>POUNDS</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>1910</td>
<td>HONDURAS</td>
<td></td>
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</tr>
<tr>
<td>Lbs. and Bbls.</td>
<td>Phos. 400 lb</td>
<td>$4.45</td>
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<tr>
<td></td>
<td>Kainit 200 lb</td>
<td></td>
<td>$4.40</td>
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<tr>
<td>1911</td>
<td>JAPAN</td>
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<tr>
<td></td>
<td>Phos. 200 lb</td>
<td>$4.05</td>
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<td></td>
<td>C.S.M. 200 lb</td>
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<td>$6.00</td>
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<tr>
<td>1912</td>
<td>BLUE ROSE</td>
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<td></td>
<td>Red Rice</td>
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<td></td>
<td>1,344 lbs.</td>
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<td>8.3 bbls.</td>
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<td>1913</td>
<td>BLUE ROSE</td>
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<td></td>
<td>Red Rice</td>
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<td></td>
<td>1,688 lbs.</td>
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<td></td>
<td>10.3 bbls.</td>
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<tr>
<td>1914</td>
<td>BLUE ROSE</td>
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<td></td>
<td>Grass</td>
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<td>1,483 lbs.</td>
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<td></td>
<td>9.16 bbls.</td>
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<tr>
<td>1915</td>
<td>BLUE ROSE</td>
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<td>Grass</td>
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<td></td>
<td>2,170 lbs.</td>
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<tr>
<td></td>
<td>13.4 bbls.</td>
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<tr>
<td>1916</td>
<td>BLUE ROSE</td>
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<td></td>
<td>Grass</td>
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<td>612 lbs.</td>
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<td>3.78 bbls.</td>
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<td>7 YEAR</td>
<td>AVERAGE</td>
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<td></td>
<td>Grass</td>
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<td></td>
<td>1,749 lbs.</td>
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<td>10.8 bbls.</td>
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<td>5 YEAR</td>
<td>AVERAGE</td>
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<tr>
<td></td>
<td>Grass</td>
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<td></td>
<td>2,170 lbs.</td>
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<td></td>
<td>13.4 bbls.</td>
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<tr>
<td>CHECK</td>
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<tr>
<td>1910</td>
<td>15 loads</td>
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<td>P. 400 K. 150</td>
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<tr>
<td>1911</td>
<td>Red Rice</td>
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<td></td>
<td>1,215 lbs.</td>
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<tr>
<td></td>
<td>7.5 bbls.</td>
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<tr>
<td>1912</td>
<td>Red Rice</td>
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<tr>
<td></td>
<td>1,253 lbs.</td>
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<tr>
<td></td>
<td>8.9 bbls.</td>
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<tr>
<td>1913</td>
<td>Red Rice</td>
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<tr>
<td></td>
<td>1,263 lbs.</td>
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<tr>
<td></td>
<td>7.8 bbls.</td>
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</tr>
</tbody>
</table>

**TABLE No. 2.**
Southwest Louisiana. The first five crops are averaged for the reason that they are considered profitable crops. The last two crops cannot be said to be profitable. It would seem, therefore, that grass may be a limiting factor in the use of phosphate fertilizer on land where rice is grown continuously without change or rotation for a period of more than five years.

**Potash Experiment:**

It will be observed in Table 1 that during the first year the results through the use of Kainit are very good and that during the succeeding years the yields are but little better than the checks. No weeds or grass grew on the potash plots during the entire experiment. The increased yield during the first year can only be accounted for in the possibility that the salt contained in the Kainit reacted on certain insoluble materials in the soil rendering them available to

### TABLE No. 3.

<table>
<thead>
<tr>
<th>PLOT</th>
<th>16</th>
<th>17</th>
<th>18</th>
<th>19</th>
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<tr>
<td>COST PER ACRE</td>
<td>$5.65</td>
<td>$9.90</td>
<td>$12.75</td>
<td>CHECK</td>
</tr>
<tr>
<td>FERTILIZER POUNDS</td>
<td>Phos. 200 lb Kainit 200 lb C.S.M. 200 lb</td>
<td>Phos. 400 lb Kainit 400 lb C.S.M. 200 lb</td>
<td>Phos. 600 lb Kainit 600 lb C.S.M. 300 lb</td>
<td>1,803 lbs. 11.13 bbls.</td>
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<tr>
<td>1910 HONDURAS</td>
<td>3,071 lbs. 18.96 bbls.</td>
<td>2,998 lbs. 18.51 bbls.</td>
<td>3,202 lbs. 19.77 bbls.</td>
<td>RED RICE</td>
</tr>
<tr>
<td>1911 SHINRIKI</td>
<td>RED RICE</td>
<td>RED RICE</td>
<td>RED RICE</td>
<td>RED RICE</td>
</tr>
<tr>
<td>1912 BLUE ROSE</td>
<td>3,385 lbs. 20.9 bbls.</td>
<td>3,395 lbs. 20.9 bbls.</td>
<td>3,418 lbs. 21.1 bbls.</td>
<td>2,397 lbs. 14.8 bbls.</td>
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<tr>
<td>1913 BLUE ROSE</td>
<td>50% Red. Abandoned.</td>
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<td>RED RICE</td>
<td>RED RICE</td>
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<tr>
<td>1914 BLUE ROSE</td>
<td>1,897 lbs. 11.71 bbls.</td>
<td>1,895 lbs. 11.7</td>
<td>1,770 lbs. 10.93 bbls.</td>
<td>1,928 lbs. 12.52 bbls.</td>
</tr>
<tr>
<td>1915 BLUE ROSE</td>
<td>50% Grass 1,183 lbs. 7.8 bbls.</td>
<td>GRASS 792 lbs. 4.8 bbls.</td>
<td>GRASS 251 lbs. 1.5 bbls.</td>
<td>No Grass 1,335 lbs. 8.3 bbls.</td>
</tr>
</tbody>
</table>
plants. Again, it has been observed that after land has been irrigated with brackish water that the yield of the following rice crop is much increased. The soil of these plots may be said to be in a puddled condition. Rice has been grown on them for a number of years before the land was used for this experiment and the vegetable content of the soil was very low. According to the soil analysis the soil of these plots contained an abundance of potash.

Results from Combinations:

No increase in yield was noted in plots where combinations of fertilizers were used. The results on Plot 8 are of little value for the reason that there seemed to be an area of red rice on this plot which was very difficult to eradicate. Red rice came up each year in such quantities that removing it damaged the crop materially.

Nitrogen in the form of cottonseed meal seemed to give good results with Honduras rice, but the yields were not increased in the same proportion with Blue Rose and Shinriki. (See Table 2.) In plots having phosphate in the mixture the same results with reference to grass are noted as in Table 1. There is no grass in Plot 13 which is a check plot. Neither is there grass in Plots 11 and 12 which are treated with Kainit and cottonseed meal.

The results on the plots treated with manure (Table 2, Plots 14 and 15) are not considered reliable for the reason that there was so much red rice germinated each year that in pulling it the yields were materially reduced. During the last three years of this experiment the yield was reduced at least 50 per cent. by grass in the rice. Straight head disease, which usually occurs on land that has been manured or that which contains a large amount of vegetable matter, did not occur in any of these plots.

Plots 16 to 19, Table 3, are interesting for two reasons: first, they indicate, as mentioned in a previous paragraph, that Honduras rice responds very readily to Nitrogen fertilizer; and second, the difficulty in eradicating red rice.

In 1909 a heavy crop of red rice was shattered on the land by a severe September storm. Following this the land
was plowed about five inches deep. The rice raised on these plots in 1910 graded No. 1. As will be noted in the table, when this stratum of red rice was plowed up the following year (1911) so much germinated that the rice could not be hand-cleaned without destroying the stand. The following year (1912) seed rice was produced. In 1913 the red seed was turned up again and the crop was cut for hay. In 1914 seed rice was again raised. The last two years of the experiment (1915-1916) the crops were of no value on these plots because of the excessive growth of grass. On Plots 17 and 18 the effect of the excessive use of fertilizer could be observed in 1915 and was very marked in 1916. The rice came up to a good stand. When six inches high it commenced to turn yellow and growth ceased. Grass grew so rapidly that the rice was soon destroyed. In 1916 the effect of the fertilizer was evident in the growth of the grass. One of the objects of this experiment was to secure data on maximum quantity of fertilizer that may be used and the length of time that it may be continued.

Experiments with Raw Rock Phosphate:

Eight plots were devoted to this purpose in 1912, and the experiment was continued three years and finally abandoned because of red rice. In this experiment rice was in a two-year rotation with corn and peas with a winter cover crop of oats. A comparison was made between raw rock phosphate, basic slag, and 16 per cent acid phosphate. The same amount of the element phosphorus was used on each plot. The raw rock was applied once in four years and the other fertilizers applied each year. During the four years all of the plots received the same amount of phosphorus. Fifty pounds per acre of muriate of potash was used on each plot each year. Raw rock was used with and without stable manure.

The results from this experiment are of little value because it was impossible to eradicate the red rice in a rotation with corn.

From the results obtained it would seem that raw rock phosphate is of little, if any, value on rice land. Basic slag
is not as good a phosphate fertilizer as 16 per cent. acid phosphate.

Experiments with Lime in Rice:

Two experiments were conducted with lime. In one a plot was planted to rice, with one-half of the plot treated with ground limestone at the rate of 2,000 pounds per acre. On another plot one-half of the area was treated with hydrated lime in the same amount. There was no difference in the yield of rice between the limed and unlimed sections. It was observable that the water plants other than rice did not seem to thrive as well on the lime as on the unlimed sections; in fact, the line of demarkation could be seen in the field. There was also a possible improvement in the physical condition of the soil on the limed sections.

Cyanamid Experiments:

Some experiments were conducted, in cooperation with a farmer near Crowley, with cyanamid. The experiment was not conclusive because of red rice. From the results that were observed in this experiment and in another experiment on reclaimed land near Florence, La., there is little to recommend cyanamid as a rice fertilizer.

Fertilizer Experiments on Reclaimed Land:

Because of difficulty in producing crops including rice on certain reclaimed marsh areas of Southwest Louisiana, it was thought advisable to conduct some fertilizer experiments on this type of soil. A cooperative experiment was conducted in 1916 with the White Lake Land Co. on the farm of A. P. Alley, two miles west of Florence, Vermilion Parish, La., in Unit 1 of the White Lake Reclamation Project.

The land of this experiment had been drained for three years. The original humus was from six to ten inches deep. At the time of this experiment it had been mixed with about six inches of the grey soil on which it rested. The soil was in good physical condition. From the appearance and the chemical analysis one would be led to believe that it would produce in abundance any crop adapted to this sec-
tion of the country. As a matter of fact unless fertilizer is used no crop would grow. The seed would germinate well and the plant make good progress until about five inches high at which time it would stop growing, turn yellow, and in a short time die. All crops including rice behaved in this way. It was definitely established that the trouble was not due to either disease or insects. At the time when it was first drained the soil was strongly acid but at the time of the experiment, three years later, there was no acid reaction to blue litmus except in the bottom of the deeper drains where there was undisturbed humus.

The results of these experiments are believed to be of enough importance to publish all of the notes in connection with each of the plots. Twenty plots, each having an area of 0.77 acres were used in this experiment. The plots were in two ranges of ten plots each, which will be indicated respectively as Range "A" and "B".

Range "A" South of Road on Alley Farm,
Rice Experiments, Ten Plots.

All of the rice on this range planted May 15, 1916. Seeded with a rice drill at the rate of 65 pounds per acre.

Plot 1. Fertilizer 100 pounds per acre 16 per cent. acid phosphate. Blue Rose variety. Good stand. Yield per acre, 2,656 lbs. (16.4 bbls.).

Plot 2. Fertilizer 200 pounds per acre 16 per cent. acid phosphate. Variety Blue Rose. Good stand. Yield per acre, 2,673 lbs. (15.5 bbls.).

Plot 3. Fertilizer 300 lbs. per acre 16 per cent. acid phosphate. Blue Rose variety. Good stand. Yield per acre, 1,863 lbs. (11.5 bbls.).


Plot 5. Fertilizer bone meal 150 pounds per acre. Variety Blue Rose. Good stand. Yield per acre, 1,620 lbs. (10.0 bbls.).
Plot 6. Fertilizer 75 pounds per acre phosphate-cyanamid. Variety Blue Rose. Good stand. Yield per acre 923 lbs. (5.7 bbls.).

Plot 7. Fertilizer 200 lbs. 16 per cent. acid phosphate, 100 lbs. cottonseed meal per acre. Variety Blue Rose. Good stand. Yield per acre 1,684 lbs. (10.4 bbls.).

Plot 8. No fertilizer. Check plot. Blue Rose variety. Good stand. Yield per acre 923 lbs. (5.7 bbls.).

Plot 9. Fertilizer 200 lbs. 16 per cent. acid phosphate. Variety Experiment Station selection No. 1162. Stand poor. This rice is a special selection which is earlier than Honduras. It is very uniform in size and shape of grain. This variety should have been planted in March to get the best results. Yield per acre 3,419 lbs. (21.11 bbls.).

Plot 10. Data on this plot of no value due to error in planting.

NOTE: A strip thirty-five feet wide was limed across the south side of all of these plots. Each plot in this section limed at the rate of 2,000 pounds per acre with ground limestone.

There was no increase in yield or any other effect observable on the limed sections.

Range "B". Plots North of the Road on the Alley Farm, Corn and Miscellaneous Crops.

All crops in this range planted March 11, 1916. Area each plot one-half acre.

Plot 1. Fertilizer none. Check plot. Planted to Fergusons Yellow Dent Corn. Yield per acre 4.20 bushels.

Plot 2. Fertilized with 1,500 pounds per acre ground limestone. Yield per acre 2.24 bushels.

Plot 3. Fertilizer 200 pounds per acre 16 per cent. acid phosphate, and 100 lbs. per acre German Kainit. Yield per acre 6.1 bushels.
Plot 4. Fertilizer 16 per cent. acid phosphate 200 lbs. per acre and lime 1,500 pounds per acre. Yield per acre 14 bushels.

Plot 5. Fertilizer 15 loads stable manure and 200 pounds 16 per cent. acid phosphate per acre. Yield 27.6 bushels per acre.

Plot 6. No fertilizer. Check plot. Yield per acre 2.4 bushels corn.

Plot 7. Fertilizer bone meal 200 pounds per acre. Yield per acre 6.18 bushels corn.

Plot 8. Fertilizer 200 pounds per acre 16 per cent. acid phosphate and 150 pounds cottonseed meal. Yield 13.4 bushels corn.

Plot 9. Fertilizer 200 pounds per acre 16 per cent. acid phosphate and 100 pounds cottonseed meal. Yield per acre 14.08 bushels corn.

Plot 10. Fertilizer 200 pounds per acre 16 per cent. acid phosphate. Yield per acre 19.4 bushels corn.

The above experiments would seem to indicate that 16 per cent. acid phosphate is the best form of commercial fertilizer that can be applied to reclaimed lands for either corn or rice. In the case of highland crops, farm manure balanced with phosphorus will probably produce the best results. It would seem that while this land contains an abundance of vegetable matter, it is of a peaty nature; therefore, the addition of animal and green manure adds the necessary bacterial life which this soil requires. It is suggested that cover crops be planted whenever possible on all of this type of land. Oats, if fertilized, is a good winter cover crops. Legumes such as cowpeas, soybeans, and velvet beans, if fertilized with acid phosphate, should be grown wherever possible during the summer.
How to Mix Fertilizers on the Farm.

The experiments outlined in this bulletin are from the standpoint of home mixing of fertilizers with farm labor. It has been the policy of fertilizer manufacturers to make the formulas and information with reference to commercial fertilizer as difficult as possible for the farmer to understand. If reduced to plain terms it should not be difficult for any farmer having knowledge of arithmetic to not only understand the meaning of formulas but be able to calculate the amount of the ingredients of any formula that he may desire to make up.

In 1914 a circular was published by the Rice Station giving these directions. The war has of course made a change in the price of the fertilizer, but the principle involved is the same. Therefore, the information contained in this circular is given herewith using the prices of 1914 and Crowley as the point of delivery of the materials.

Phosphorus:

- Found largely in the seed. Available phosphorus in soils makes plants vigorous and fruitful. Functions in the formation and movement of proteids.

South Louisiana soil is deficient in phosphorus. It will probably always be necessary to use this element of plant food in the form of commercial fertilizer.

The cheapest form of available phosphorus is in the form of 16 per cent acid phosphate. This will cost in bulk car lots, Crowley, about $12 per ton.

Potash:

Facilitates starch formation and makes the stems strong and hard. In some instances potash seems to harden the fruit. According to chemical analysis there is an abundance of potash in our soils. If, however, crops are not rotated and vegetable matter burned under, it is possible that it may become insoluble and therefore not available for the use of the plants. If land is planted continuously to rice, it is possible that some potash fertilizer will be required. If
land is changed, or if a rotation of crops is practiced, the addition of potash is not believed to be necessary.

Potash can be purchased in the form of German Kainit, Muriate of Potash, and Suphate of Potash. In ordinary times these materials will cost Crowley: Kainit, 12 per cent. potash, $12.25 per ton; Muriate of Potash, 48 per cent. potash, $39.50 per ton.

Cottonseed meal which is properly classed as a source of nitrogen contains in addition to the approximate 6½ per cent. nitrogen about 2 per cent. potash.

**Nitrogen:**

This is the most costly of all elements of plant food when purchased in the form of commercial fertilizer. Available nitrogen accelerates the growth of the leaf and stalk. It can be bought on the market in the form of cottonseed meal, blood meal, tankage, and sulphate of ammonia. All of these are good rice fertilizers. It is not advisable to use nitrate of soda on rice. Cottonseed meal contains about 6½ per cent. nitrogen, sulphate of ammonia 20 per cent., tankage 6 to 9 per cent., and blood meal 14 per cent.

The cheapest source of nitrogen is through the growing of legumes such as the cowpea, clovers, or the velvet bean. The farmer should prepare to ultimately secure all of his nitrogen through the legumes and purchase no nitrogen in the form of commercial fertilizers.

A good crop of cowpeas or soybeans, if turned under, not only contributes nitrogen contained in the vines but adds an abundance of vegetable matter which is very necessary to all rice soils. A crop of cowpeas will yield approximately 78 pounds of nitrogen, which, if purchased in the form of chemicals would cost about $14 per acre.

**Farm Manure:**

If cottonseed meal be fed to livestock and the manure properly cared for, the full feeding value of the protein is obtained, and a large percentage of the nitrogen is returned to the soil. If stock is lot fed and the manure hauled to the fields, there is a possible loss of from 25 to 50 per cent. If the stock are pastured on the fields which are to be culti-
ed, the loss is only from five to ten per cent. Thus, a ton of cottonseed meal, costing $28, could be fed to cattle and the farm would receive $25.20 worth of fertilizer in the form of nitrogen.

Animal manure when balanced with phosphorus is considered to be the best fertilizer in the world.

Summary:

1. Sixteen per cent acid phosphate at the rate of 200 pounds per acre seems to give the best results in the late varieties of rice such as the Japans and some of the Wright varieties.

2. From these results it would seem that it is not profitable to grow rice longer than five or six years in succession through the use of phosphate fertilizer.

3. Phosphoric acid seems to be the best fertilizer for all crops on reclaimed marsh land.

4. Nitrogen can be used to advantage on the early varieties such as Honduras. Small applications of nitrogen may be of advantage on land that is in a badly run-down condition when planted to other varieties.

5. Potash does not seem to be required in the form of commercial fertilizer.

6. Most rice land needs vegetable matter.

7. Home mixed fertilizers are the most profitable.

How to Estimate Any Fertilizer Value.

If acid phosphate contains 16 per cent. phosphoric acid, and there are twenty hundred in a ton, 20 multiplied by 16 (the number of pounds of available material contained in each hundred pounds) equals 320 pounds which is the normal amount of available phosphoric acid contained in a ton of acid phosphate. Divide $12 by 320; the result is 0.0375 which is the cost per pound of the phosphoric acid f. o. b. Crowley.
The same method is used in calculating the cost per pound of potash and nitrogen.

The cost of the available materials f. o. b. Crowley is as follows.

Available phosphate, 0.0375 cents per pound.
Available potash, 0.05 cents per pound.
Available nitrogen, 0.18 cents per pound.

Example. Make a 10-0-2 fertilizer. The first numeral refers to phosphoric acid, the second to nitrogen, and the third to potash. In the Rice Belt very little nitrogen is used because of the excessive growth of straw; therefore, the average farmer looks upon a "10-2" fertilizer as one containing ten per cent. of phosphoric acid and two per cent. potash. In other sections of the country the second numeral always means nitrogen.

Suppose that 10-0-2* fertilizer costs $14.75 f. o. b. New Orleans. Freight to Crowley in car lots is $2.50 per ton—less than car lots $5.00 per ton. Therefore, 10-0-2 fertilizer will cost in car lots delivered in Crowley $17.25 per ton.

What should the above fertilizer be worth, or how much would it cost to mix same on the farm with farm labor? If there are 10 pounds per hundred of phosphoric acid and twenty hundred in a ton, 200 pounds of the available material would be required; this multiplied by $0.0375 (see previous paragraph) equals $7.50. There are 2 pounds per hundred of potash and 20 hundred in a ton; therefore, 40 pounds of available potash are required which at 5 cents per pound, equal $2.00 plus $7.50 for the phosphoric acid, makes a total of $9.50 which is the value of the available materials in a ton of 10-0-2 fertilizer. To this add $1.00 which is a liberal price for farm mixing. The fertilizer can, therefore, be mixed on the farm for about $10.50 per ton.

What is required for 10-0-2 fertilizer. Take 1,250 pounds of 16 per cent. acid phosphate (see table) and 84 pounds of muriate of potash, making a total of 1,334 pounds and 666 pounds of any dry inert material that will do for filler; shovel three times through a sand screen, and there will have been manufactured one ton of 10-0-2 fertilizer.

*10% average Phosphoric acid, no nitrogen, 2% Potash (K₂O).
The “filler” has no fertilizing value and the charge for it should be very small, but even so there is no way of avoiding the payment of freight on a considerable amount of worthless material. The only possible value that “filler” may have is to make the fertilizer dry enough to run through the fertilizer distributor easily. Acid phosphate will usually spread without trouble. If it is necessary to use some material to take up the excess moisture, Basic Slag is good for this purpose. The Basic Slag can be purchased from $14 to $16 per ton. In this way it is possible to make use of a filler which has a high fertilizing value. Lime which has been well slacked in air may be used for this purpose if the lime has been properly slacked and if the fertilizer is to be used at once. Lime in any form should not be used with acid phosphate except with the advice of a chemist. Lime not properly air slacked will cause the phosphoric acid to “revert” to an insoluble form which is not so readily available to the plant.

From the above it may be seen that in purchasing a ton of 10-0-2 fertilizer at $17.25 per ton, that it costs $6.75 more than it will cost to make up the formula on the farm. Again granting that it is possible to purchase on the market 10-02 fertilizer for $10.50 per ton the item of 82 cents per ton freight on the filler cannot be avoided. With 666 pounds of filler in each ton the freight on same on a 30-ton car would be $24.50. The difference on a 30-ton car of 10-0-2 fertilizer at $17.25 and the home mixed article are $10.50 per ton, would amount to $202. If the application per acre is 200 pounds, the cost per acre on the ready mixed would be $1.72 and the home mixed $1.04.

Commercial fertilizer may be spread broadcast on the disced land before planting or it may be placed in the row with the seed by use of the combined fertilizer and seed drill. If there is no grass seed in the land, the one method is probably as good as the other. Observations lead us to believe that phosphoric acid accelerates the growth of certain water grasses and weeds as well as rice. If this is true, it is probably better to place the fertilizer in the row with the rice.
It is good business policy to purchase fertilizer in car lots. If it is dry, it will keep indefinitely; the car freight is one-half the local freight rate. If a car cannot be used in two years, it is well to go in with a neighbor and purchase a car. Acid phosphate should be purchased in bulk. The sack will seldom last until the fertilizer is used. It is easier and cheaper to handle in bulk. Any sacked fertilizer which is carried over to the year following will contain so many fragments of sack and so much lint that it is necessary to screen all of it before it can be used. The cost of the sacks for a ton of fertilizer in ordinary times is about $2.50 per ton.
TABLE FOR HOME MIXING
Any formula at a glance.

<table>
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<tr>
<th>Percentages or units desired</th>
<th>Percentages of Nitrogen from nitrate of soda</th>
<th>Nitrogen from blood</th>
<th>Nitrogen from cottonseed meal</th>
<th>Nitrogen from Ammonia Sulphate, 20% N.</th>
<th>Phosphoric acid from 14% acid phosphate</th>
<th>Phosphoric acid from 16% acid phosphate</th>
<th>Potash from muriate of potash, 48% potash</th>
<th>Potash from Kainit, 12% potash</th>
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</thead>
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</tr>
<tr>
<td>3</td>
<td>400</td>
<td>428</td>
<td>923</td>
<td>300</td>
<td>430</td>
<td>375</td>
<td>126</td>
<td>500</td>
</tr>
<tr>
<td>4</td>
<td>533</td>
<td>571</td>
<td>1,230</td>
<td>400</td>
<td>570</td>
<td>500</td>
<td>168</td>
<td>667</td>
</tr>
<tr>
<td>5</td>
<td>666</td>
<td>714</td>
<td>1,538</td>
<td>500</td>
<td>715</td>
<td>625</td>
<td>210</td>
<td>833</td>
</tr>
<tr>
<td>6</td>
<td>800</td>
<td>857</td>
<td>1,846</td>
<td>600</td>
<td>860</td>
<td>750</td>
<td>252</td>
<td>1,000</td>
</tr>
<tr>
<td>7</td>
<td>933</td>
<td>1,000</td>
<td></td>
<td>700</td>
<td>1,000</td>
<td>875</td>
<td>294</td>
<td>1,167</td>
</tr>
<tr>
<td>8</td>
<td>1,066</td>
<td>1,142</td>
<td></td>
<td>800</td>
<td>1,143</td>
<td>1,000</td>
<td>336</td>
<td>1,333</td>
</tr>
<tr>
<td>9</td>
<td>1,200</td>
<td>1,285</td>
<td></td>
<td>900</td>
<td>1,286</td>
<td>1,125</td>
<td>378</td>
<td>1,500</td>
</tr>
<tr>
<td>10</td>
<td>1,333</td>
<td>1,425</td>
<td></td>
<td>1,000</td>
<td>1,430</td>
<td>1,250</td>
<td>420</td>
<td>1,667</td>
</tr>
<tr>
<td>11</td>
<td>1,460</td>
<td>1,571</td>
<td></td>
<td>1,100</td>
<td>1,570</td>
<td>1,375</td>
<td>462</td>
<td>1,833</td>
</tr>
<tr>
<td>12</td>
<td>1,600</td>
<td>1,714</td>
<td></td>
<td>1,200</td>
<td>1,715</td>
<td>1,500</td>
<td>505</td>
<td>2,000</td>
</tr>
</tbody>
</table>

**Example:** To make a 10-2-2 fertilizer. First look in the 16 per cent. acid phosphate column opposite the 10 per cent. of the left hand column indicating the percentages will be found 1,250. Opposite the 2 per cent in the muriate of potash column 84 will be found. Opposite 2 per cent. in the cottonseed meal column will be found 615. Therefore, a ton of 10-2-2 fertilizer will require 1,250 pounds of 16 per cent. acid phosphate, 615 pounds of cottonseed meal, and 84 pounds of muriate of potash. This will total 1,949 pounds. It will therefore be necessary to add 49 pounds of filler to complete the ton. Any formula can be found in a similar manner.
Over 80 bu. Corn on Rice Land.

Corn Growing on Rice Land in Rotation with Rice.
Barchet Soy Beans is a Good Crop to Clean Land Badly Infested with Red Rice. This Variety Makes Very Good Hay and a Fair Yield of Threshed Beans.
ROTATIONS ON RICE LAND.

It will be remembered that the Station was established on land which would no longer produce rice profitably. The soil contained a great many weed seed and an abundance of red rice seed. The problem was to establish a successful crop rotation in which rice is a money crop. The rotation in order to be successful must eradicate the red rice with a minimum of hand cleaning. To that end four rotations were established. Two two-year rotations, a three-year rotation, and a four-year rotation. One two-year rotation is rice one year and corn and cowpeas the next with a winter cover crop of oats. The other two-year rotation is the same with the exception that the land is fallowed during the winter. The three-year rotation is corn and cowpeas, oats, peas alone, and rice. The method of planting is as follows. Corn and peas are followed by a winter cover crop of oats; the next year after the harvest of the oats, peas alone are planted. In the fall the vines are disced down and the land plowed fallowed during the winter and planted to rice the spring of the third year, completing the three-year rotation. The four-year rotation is rice two years and lespedeza two years which is comparable to the only rotation in common use, that of pasturing the land when it is not in rice.

The first year of this experiment, 1910, no fertilizer was used. The crops were not profitable. During the succeeding years the rice was fertilized at the rate of 200 pounds per acre with 16 per cent. acid phosphate, and the corn was fertilized with 200 pounds of phosphate and 100 pounds of cottonseed meal per acre.

Following is a table which gives a plan of the experiment showing the crops and the yields during the entire period that the experiment was run.
TABLE GIVING ROTATIONS AND YIELDS ON ROTATION PLOTS.

<table>
<thead>
<tr>
<th>PLOT</th>
<th>1910</th>
<th>1911</th>
<th>1912</th>
<th>1913</th>
<th>1914</th>
<th>1915</th>
<th>1916</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20</td>
<td>21</td>
<td>22</td>
<td>23</td>
<td>24</td>
<td>25</td>
<td>26</td>
</tr>
<tr>
<td>Rice</td>
<td>7.47 bbls.</td>
<td>7.77 bbls.</td>
<td>Corn 0000</td>
<td>Rice 8.0 bbls.</td>
<td>Corn 0000</td>
<td>Peas good crop</td>
<td>Rice 11.7 bbls.</td>
</tr>
<tr>
<td>Rice</td>
<td>2.18 bbls.</td>
<td>18.1 bbls.</td>
<td>Corn 13.7 bbls.</td>
<td>Rice 0000</td>
<td>Peas good crop</td>
<td>Rice 12</td>
<td>Corn 14.6 bbls.</td>
</tr>
</tbody>
</table>

NOTE—"?" means that low yield was due to bad stand or insects.
Plot 20 is a check plot on which no fertilizer is used and which up to 1915 no red rice was handpicked. Red rice is somewhat responsible for the low yield of rice up to this time. There was just as much red rice in the threshed sample in 1915 as there was in 1910. In 1916 the red rice was hand-cleaned from this plot. It was further reduced in the rice by late planting and by cultivating the land before planting to white rice. It will be noted that the yield was increased in 1916.

On the two-year rotation in plots 21 and 22 rice was planted one year and corn and cowpeas the next. This land was all in very bad shape. It had been cultivated to rice so long that little vegetable matter remained in the soil. It was not possible to plow shallow enough to keep out the yellow clay. It was found that fertilizer was necessary to produce a profitable yield of either rice or corn.

The other two-year rotation is on plots 26 and 27. The only difference is in the winter cover-crop. On both of these rotations the yields were fairly good when the season was favorable. No red rice was hand-picked until 1915, and up to this date no rice was produced on these plots which would grade better than No. 2. After the corn was laid by, red rice germinated between the corn rows and produced seed. The plan was adopted of cutting and shocking the corn as soon as the ears were mature and the leaves were “fired” about 18 inches on the ends. After the corn was shocked the middles were cultivated all that the planting of peas would permit. All red rice not growing in the peas was generally destroyed. The cutting of the corn and the cultivation was always productive of a good crop of peas. It is believed that the winter cover-crop of oats on 26 and 27 reduced the red rice to a very considerable extent. A large amount of red rice was destroyed by cultivation and the planting of the oats in the fall. The soil was filled with oat roots during the winter. When the oats were plowed under in the spring the disintegrating vegetable material caused the early germination and subsequent destruction by cultivation of a large part of the red rice which would otherwise come up in the white rice.
The same observations were made on the three-year rotation in plots 23, 24, and 25 that were made on the two-year rotations. Red rice germinated and produced seed between the corn rows and a small amount produced seed in the cowpeas when planted alone. The red rice was materially reduced but not eliminated by cultural methods in the three-year rotation. During the period that this experiment was run the red rice was reduced to a point where hand-cleaning was comparatively easy. The last two years of the experiment No. 1 rice was produced. The peas were planted in rows and cultivated. It was found that if the peas were cultivated from two to three times that a good crop could be raised in rice land. However, peas planted broadcast would not return the seed planted. The reason being that the soil being of a silty nature packs very tightly around the plant. Unless the plants are cultivated the air is excluded from the roots and they do not thrive.

In the four-year rotation (not shown in the table) rice was planted two years and lespedeza two years. This experiment was run seven years. The results were not satisfactory. The land planted to lespedeza was mowed in the summer so that the red rice could not produce seed. This corresponds to the common pasture methods. Enough red rice remained in the soil, however, so that no crop of rice in the seven graded better than No. 5.

A certain area on the Station used by the Bureau of Plant Industry, contained so much red rice that white rice could not be grown. Six clean cultivated highland crops were grown on this land. Rice was planted and a heavy yield of seed rice was secured. This indicated that a longer rotation than any of the above indicated is required for the eradication of red rice.

CONCLUSIONS TO BE DRAWN FROM THE ROTATION EXPERIMENTS.

1. Short rotations of 2, 3, and 4 years with rice do not seem to be profitable. This is not because the crops in question do not make profitable yields, but because of the high overhead expense necessitated by the frequent change
from rice to highland crops. When highland crops are raised deep ditches are necessary for drainage. When rice is raised on this land, some of the ditches must be filled and the entire area leveled in contour.

Attention is invited to the fact that through the use of phosphate fertilizer five profitable crops of rice were produced on land that was considered worn out, or below profitable production. It seems reasonable to believe that with clean land containing an abundance of vegetable matter, as would be the case after a number of years of highland rotation, that at least six and possibly seven profitable crops of rice may be produced in succession; this, of course, if care is exercised in the selection of seed, all red rice hand-pulled, and fertilizer used. It is therefore believed that the average rice farm should be divided into two parts. One part should be devoted to a rotation of highland crops for possibly six years and the other to rice for the same length of time. After which the rice and highland areas are interchanged. In this way the overhead expense of the ditches in the one case and the levees in the other would be materially reduced. As evidence to support this theory the writer could indicate a number of good conservative farmers in the Rice Belt who have attempted to rotate highland crops with rice and have failed because of the overhead expense which the short rotation has necessitated.

2. Corn is not a good crop to clean rice land for the reason that the red rice will produce seed after the corn has been laid by.

3. In order to eradicate red rice some clean cultivated crop such as soybeans or cotton should be used.

4. Cowpeas or velvet beans will produce a good crop on rice land if planted in rows and cultivated. Cowpeas will not produce profitable returns if planted broadcast.

5. Following is a suggested rotation for a 400 acre rice farm.
<table>
<thead>
<tr>
<th>Year</th>
<th>Crops</th>
<th>Drainage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1918</td>
<td>Highland rotation</td>
<td>Lateral</td>
</tr>
<tr>
<td>1919</td>
<td>Same</td>
<td>pumping</td>
</tr>
<tr>
<td>1920</td>
<td>Same</td>
<td></td>
</tr>
<tr>
<td>1921</td>
<td>Same</td>
<td></td>
</tr>
<tr>
<td>1922</td>
<td>Same</td>
<td></td>
</tr>
<tr>
<td>1923</td>
<td>Same</td>
<td></td>
</tr>
<tr>
<td>1924</td>
<td>Rice</td>
<td>plant</td>
</tr>
</tbody>
</table>

Use a winter cover crop of oats as much as possible. Use clean seed and hand pick all red rice and noxious weeds.

CONTOUR LEVEES
RED RICE.

Red rice is probably a true variety of rice for the reason that it is possible to cross it on a white rice and produce a hybrid. In earlier investigations with rice, botanists describe it as a rice species and give it the name of *Oryza Rufipogon*. Ordinary white rice is *Oryza Sativa*.

Red rice in the rough is a little smaller than the other varieties which are commonly grown. Under the rough outer husk the cuticle covering the grain is a dark red. Under the red cuticle the grain is a pinkish white. The milled sample, therefore, even though it be very highly finished, is dark in color. It is impossible to produce a first grade sample of milled rice if it contains a very high percentage of red rice. The six grades of rough rice are made largely on the percentage of red contained in the sample.

Red rice would not be so objectionable if it were possible to produce a good yield in the field. It has, unfortunately, developed all of the characters of a weed. In manner of growth it is spreading. White rice grows erect on a strong straw which will withstand a considerable amount of wind and rain when ripe. Red rice on the other hand has a very weak straw which breaks and bends almost before the rice is ripe. Again, red rice has developed the weed character of shedding the seed as soon as they are ripe. If red rice is cut just before it is ripe, the shattering in cutting and shocking is not excessive. After it has become dry in the shock, more than 50 per cent. will be lost in moving it from the field to the threshing machine. It is not believed to be possible to save more than 40 per cent. of the red rice which is produced in the field.

The red rice which is shattered is more or less mixed with the soil by the teams and implements of harvest. When well coated with silty mud the seed will retain its vitality indefinitely. Just how long this may be is not known, but there are a number of instances on record where the seed has germinated after being in the ground for 12 years. On the Station where seed rice is now being produced it is possible to secure a good stand of red rice by plowing one-
WHITE RICE.
Note the difference in the manner of growth.
RED RICE.
Note the difference in the manner of growth.
Hand-picking Red Rice. If clean seed is used and care exercised, Red Rice cannot get a foothold in the field.
half inch deeper than the land has been cultivated during the past seven years. The red rice problem is probably the most serious of any confronting the rice farmer of the Gulf Coastal Plain. Red rice is merely the result of careless methods on the part of the farmer of that region. In order to have red rice the seed must be planted. White rice does not turn into red rice as certain farmers are inclined to believe. It is possible that some red rice may be scattered by livestock. Manure from rice straw bedding which contains red seed may be the means of spreading a small amount on the field. The principal means of propagation, however, is that of planting the red seed with the white. It is somewhat difficult to secure rice seed which is absolutely free from red rice. Care should be exercised to reduce the amount purchased in the seed to a minimum. It is then comparatively easy and inexpensive to hand-pull the red rice from the field. As soon as the red rice heads it is easy to distinguish it from the white rice. To the farmer who desired to follow lax methods the red rice problem would seem an insurmountable one. To the careful farmer who adopts the proper rotation of crops in connection with livestock, red rice cannot be considered a difficult problem. If the land is clean—does not contain red rice seed—careful selection of seed and hand-cleaning in the fall will insure clean land and a good grade of rice. There are farms in the Rice Belt which have been in cultivation to rice for over 25 years and have never raised a grade under No. 1.

Methods Which Will Aid in Eradicating Red Rice in Badly Infested Fields.

1. Winter cover-crops. Mow the stubble as soon as the rice is threshed. This will aid in germinating the red seed which may be on the surface of the ground. If the stubble is not too heavy on the ground, double-disc the land twice. This will, under ordinary circumstances, produce a fair seed bed. The tractor disc heavily weighted is especially good for this purpose. Plant to native Louisiana Rust Proof Oats with a disc drill or sow them broadcast and finish covering
with a corrugated land packer after harrowing them in. If the stubble is too heavy on the ground to disc, the land should be plowed as shallow as possible and prepared and planted to oats. The disc is even better than the shallowest plowing for the reason that all of the red rice is "planted" on the surface. The fall rains will germinate a large amount of it, and a high percentage of the balance will germinate in the spring. If the stubble is not mowed but plowed in the ordinary way in the fall, the red rice seed will be turned under several inches and sealed up in the soil until that stratum is again plowed up in subsequent cultivations. For a striking illustration of this see the notes on Plots 16 to 19 in fertilizer experiment on page........ In this experiment seed rice was produced every other year and a crop of red rice destroyed every other year. If it is not possible to plant the oats, the stubble should at least be mowed and disced.

2. Winter cover-crops. It is believed that a winter cover-crop is a great aid in the eradication of red rice. As before explained, red rice will become embedded in the soil and will not germinate until the soil covering is broken admitting air and permitting the seed to sprout. The soil is filled with roots of the winter crop. When these roots disintegrate in the spring it aids in the germination of the red rice. Again, with reference to the winter cover-crop, it should be remembered that in the latitude of the Rice Belt bacterial action occurs in the soil, because of the absence of frost during a large part of the winter. Plant food which may become available through this action, if not taken up by the roots of the oat or other winter cover-crop, may possibly assume insoluble form unavailable for the succeeding rice crop. If this plant food is taken up by the oats and returned to the land in the spring, the food thus gathered is made available for the succeeding crop of rice. This should be especially valuable in the case of nitrogen which the rice plant makes use of only in the form of ammoniates. Under irrigated conditions decaying vegetable matter of course produces ammoniates through the action of the anaerobic bacteria. This being the case it would seem that the decaying oat plants would tend to feed the rice plant during
a large part of the growing season. It is believed, therefore, that the rice farmer should plant oats as a cover crop on rice land whenever possible.

3. Cultivated crops. On land badly infested with red rice preference should be given to clean cultivated crops until the red rice is under control. Soybeans and cotton are very desirable for this purpose. Sorghum and peas or velvet beans grown for silage are very useful because the crop is harvested and the land cultivated before it is possible for any volunteer red rice to produce seed. Corn, peas, and sweet potatoes may be used on rice land. It is necessary to cut and shock corn or cut it for silage in order to destroy the red rice between the rows by cultivation before the red rice has time to produce seed. In the case of all three of these crops it may be necessary to hand-hoe the red rice from between the rows.

4. Livestock. Livestock is a great aid in the eradication of red rice for the reason that red rice is a very good feed, and stock will eat all that germinates on pasture land. If land is pastured closely, little if any red rice will germinate after the second year. It should be remembered, however that the seed which is sealed up in the soil is not disturbed and will germinate the first time that the land is cultivated.

RICE INSECTS.

Root Maggot,
(Lissorphoptrus Simplex).

With reference to this insect it is believed to be worth while to publish the work done by J. L. Webb of the U. S. Bureau of Entomology. Mr. Webb, Mr. Hood, and Mr. Tucker, of the U. S. Bureau of Entomology, worked three years on rice insects. Following is the report of Mr. Webb:
NOTES ON THE RICE WATER-WEEVIL (LISSORHOPTRUS SIMPLEX SAY)

By J. L. Webb, Bureau of Entomology

(Reprinted from Journal of Economic Entomology, Vol. 7, No. 6, 1914)

The amount of damage done yearly to the rice crop by the rice water-weevil is extremely hard to estimate. In most cases no rice is killed outright. On the other hand practically every rice field is infested to a greater or less degree. The effect of an attack is the pruning off of the roots near the base of the stalk. In severe attacks all the roots may be cut off, in others only a few. Where the pruning is not too severe, the rice plant promptly throws out new roots, continues to live, and will mature. Yet we do not know just how much has been lost in weight or quality of yield. The difficulty is in finding a field of rice entirely free from attack with which to compare infested fields. In extreme cases the rice plants are killed and the loss is then more easily estimated. In general, however, the loss from this source is considerable and well worth active efforts in the way of prevention or elimination.

SEASONAL HISTORY AND HABITS

According to the writer's observations the adult passes the winter in dead grass, especially grass that is matted upon the ground. In order to find the weevils in hibernation the grass must be lifted up and thoroughly shaken out, allowing them to fall to the ground. Close examination of the debris is then necessary in order to distinguish the
weevils, as their general color is much the same as that of the dry grass. Great numbers of weevils pass the winter in this way. Mr. C. E. Hood, one of the writer's predecessors in the study of the biology of this insect, records the finding of large numbers of hibernating weevils in Spanish moss. The writer believes Mr. Hood's observations to be correct, but from his own experience he has come to the conclusion that dead grass is the more favored place of hibernation.

Emergence from hibernation begins early and ends late in spring. The earliest date known to the writer upon which an adult has been observed to be active was March 25. The latest date upon which adults have been found in hibernation was June 26. This gives a period of three months for the emergence of the entire generation of hibernating individuals.

The adult weevils are usually not noticed in spring until the first flooding of the rice fields. Then almost immediately they are to be found swimming about in the water among the rice plants or resting upon the leaves above water. Sometimes they rest upon the leaves apparently for hours, but when touched promptly "play possum", fall to the water and swim away. They appear to be equally at home either in or out of water. However, it is impossible for them to breed in any but water plants.

Dissemination from hibernating quarters probably takes place mostly at night. The writer has never observed weevils in flight during the day. He has observed them quite frequently flying to lights at night.

The first injury to the rice plant occurs upon the leaves and is done by the adult weevils, probably both prior to, and
succeeding oviposition. This injury takes the form of longitudinal feeding scars, the weevil eating out a longitudinal furrow in the leaf, just as broad as the spread of the mandibles. Only the thin epidermis is left where the feeding is done. Little real damage is done in this way, but the work is very characteristic of this species.

Copulation and egg laying apparently commence shortly after the adults reach the flooded fields of rice. When ready to deposit an egg the adult female crawls down the rice stem beneath the water and surface of dirt to one of the principal roots. Here she inserts the ovipositor, apparently by merely forcing the tip of this organ through the epidermis of the root. The egg (fig. 24) is then placed longitudinally just inside the epidermis. The egg is cylindrical, pearly white, and about one thirty-second of an inch in length. It is three or four times as long as broad and is barely visible to the naked eye. The writer, with the aid of a binocular microscope has found as many as three eggs laid end to end, apparently through the same hole in the epidermis. In other cases only one in a place was found. The microscope failed to reveal any evidence of the use of the mandibles in making the hole in the epidermis for the insertion of the ovipositor.

For the first few days of its existence the larva remains within the root in which it was hatched, feeding upon the inner root tissues and increasing in size. It advances along the root longitudinally, eating out a passageway as it goes. By the time it has exhausted the nutritive qualities of this first root, it is large enough to proceed farther and goes to another root undeterred by the surrounding mud. Whether it feeds little or much upon successive roots, practically all roots attacked are killed. Often several larvae are
found among the roots of a single plant (pl. 13) and work great destruction there. At this stage many of the larvae are easily disclosed by pulling up infested rice plants and shaking the roots in water until washed clean of mud. Some larvae always float on the surface of the water, while others sink to the bottom. When the roots of a rice plant are severely injured the leaves turn yellow, and according to Tucker may even fall over upon the surface of the water.

When full-grown, the larva is from one-fourth to one-half inch in length, very slender, and milk white. In preparation for the coming change, the larva gathers about itself an egg-shaped mass of dirt which it attaches to one of the healthy rice roots (pl. 13). The outside of this pupal cell is uniformly even and oval in shape. It would be interesting to know just how the larva accomplishes this result, but in the nature of things observations along this line were impossible. Within the pupal cell is a space from which water is excluded. Safe within this retreat, as if to make itself doubly secure, the larva spins a thin silken sac or cover about itself. The writer has found as many as fifteen pupal cells attached to the roots of one rice plant.

The pupa shows somewhat the form of the adult, but is entirely white like the larva. The duration of the pupal stage is probably from one to two weeks. When fully mature the adult breaks through the wall of the pupal cell, crawls up the root to which the pupal cell was attached, and so escapes to the open air.

The length of time the insect spends in each of these four stages is not definitely known. However, the time from deposition of the egg to the young adult stage in the spring has been approximately determined. In a plot of rice which was first flooded on June 1, 1912, the writer found a young adult in a pupa case on July 8, 1912. The egg could not have been deposited before the rice was flooded, and, supposing it to have been deposited the first day of flooding (June 1) the time occupied in reaching the adult stage by July 8 , was thirty-eight days, or five and one-half weeks. It is, of course, possible that even less time than this was actually occupied by the insect in passing through the different stages.
Larvae of L. Simplex on Rice Roots.

2 Pupal Cases of L. Simplex in Natural Position on Rice Roots.
Host Plants

During summer of 1912, the writer conducted a series of cage tests to determine in what native grasses the rice water-weevil would breed. Different species of grass were transplanted to flat bottomed, galvanized pans. The roots were well covered with dirt and the pans then filled with water. They were kept filled with water above the dirt during the tests. Two pans were used in each cage. Sometimes only one kind of a grass was used in a pan, sometimes more than one. After the water was placed in the pans adult rice water-weevils were captured in rice fields and about one hundred weevils placed in each pan. After allowing ample time for the weevils to lay eggs in the roots of the different grasses, and for these eggs to produce larvae, the roots of each kind of grass were washed out in water to determine whether or not rice water-weevil larvae were present. The following species of grasses were found to be infested by the rice water-weevil: *Echinochloa zelayensis* H. B. K., *Paspalum dissecutum* L., *Paspalum boscianum* Flugge, *Syntherisma sanguinalis* (L) Dulac, *Capriola dactylon* (L) Ktze, *Axonopus compressus* (Sw) Beauv., *Panicum hiaus* Ell., *Panicum dichotomyllum* Michx., *Jussioea suffruticosa* L., *Eleocharis obtusa* Schult.

The following species were found to be not infested: *Paspalum dilatatum* Poir, *Commelina sp.*, *Diodia virginiana* L., and *Eclipta alba* (L) Hassk.

The following species were found to be infested in the field: *Paspalum larranagae* Arech., *Paspalum plicatum* Michx., and *Cyperus flavicornus* Michx.

Method of Control

Careful experiments have demonstrated that drainage is still the safest remedy for the rice water-weevil. The proper time to commence drainage of the fields is from two and one-half to three weeks after the first flooding, while the larvae are still young. Drainage should continue for a period of two weeks. A shorter period of drainage will not kill the larvae, and a longer period will injure the rice. Farmers should not wait until the rice begins to turn
Applying Oil in the Irrigation Water to Prevent Root Maggots.

Oil at the Rate of 15 Gallons per Acre Was Applied With This Irrigation Water.
Plot to the left was oiled at the rate of 20 gallons per acre. The plot to the left was not oiled. The oiled plot made 22.6 bbls. per acre and the unoiled plot made 16.8. Note the difference in the size of the stools.

Typical Plants from the oiled Plot and the Check. Note the difference in the size of the roots.
yellow before commencing to drain. The damage is practically all done by that time, and the rice needs water to enable it to throw out new roots and recover from the attack of the insect.

Subsequent experiments by the writer indicated that the conclusions drawn by Mr. Webb to be correct. It has been found that if the drainage method is used that the land should be drained two weeks from the time of the first flooding. The land should be allowed, if possible, to become completely dry. No injury is done at this stage of the plant growth if the ends of the leaves turn yellow to a certain extent.

The drainage method is advocated in all cases where rice is planted on new land or on land that contains a large amount of vegetable matter. It is necessary to drain land of this kind in order to prevent straight head; therefore, if it is drained two weeks from the time of the first flooding the first generation of maggots are destroyed. By this means the drainage serves two purposes.

The Use of Crude Oil to Prevent Maggot Damage.

An experiment in the use of crude oil for the prevention of maggot damage was conducted on the Experiment Station for several years, and the results seem to indicate that it is a cheaper and more effective method of combating the insect than the drainage method. This, of course, on land where there is no danger of straight head.

The weevil which lays the eggs which produce the root maggot was observed to feed on the leaves of the plant, to swim on the surface of the water, and to otherwise act in a manner not unlike the ordinary hard-shell terrapin. As a small amount of crude oil will cover a very large area with a thin film, it was thought possible that if the oil were applied to the water when the rice is first irrigated that the weevil would be prevented from reaching the roots to lay the eggs which produce the maggots, and the damage to the rice would thus be prevented; the results of the experiments seem to indicate that this is correct.
The data on an experiment in 1912 will be given as an illustration. A plot was oiled at the rate of 38 gals. crude oil per acre. Oil applied with first drainage and the water maintained through the growing season. No rice was killed by the oil. The yield per acre was 21.2 bbls. The check plot on this water maintained through the season with no oil made 14.8 bbls. per acre. Another plot oiled at the rate of 20 gals. per acre made 22.6 bbls. of rice per acre. The check on this made 16.8 bbls. per acre. Examination of the plants just before harvest showed that on the check plots the roots were badly injured by the maggot. On the oiled plots there was no damage to the roots that could be observed. A great many farmers in Southwest Louisiana have used oil with similar results.

It is believed that 15 gallons per acre is a good average application. The oil should be applied to the first irrigation water. Oil is not necessary in subsequent irrigations. The best way to apply the oil is to set a barrel or tank over the lateral or flume. By means of a valve allow the oil to run into the water at a rate which will apply the desired number of gallons of oil to the area flooded in a given time. It is easy to arrive at this if the capacity per day in acres irrigated of the lateral or pump is known. As rice is usually flooded the first time when the plants have two leaves and are about 5 inches high, care must be exercised that the water does not get so deep in the lower parts of the field that the leaves are floating on the surface of the water and consequently in the oil. The leaves which float on the surface in the oil will likely be killed. If the leaf is erect, the oil contact with even a large amount of oil is only the thickness of the oil film; consequently, no harm is done. If oil is to be used, the initial irrigation should be delayed as long as possible. One of the dangers in the use of oil is heavy rain and wind storms. If the rice is small and there is considerable exposed water surface, the wind may drive the oil to one side of the field where it will collect along the levee so deep as to destroy a considerable amount of rice. If the wind is accompanied by rain, the rain drops may spatter the oil on the leaves to such an
extent that the rice will be injured. All of the oil experiments in 1917 were a failure due to a heavy wind and rain squall.

The oil used should be crude oil as it comes from the well. The lighter the oil the better it will spread on the surface of the water. Kerosene of low grade would probably be better than the crude oil. The heavy residue fuel oil from which the lighter oils have been distilled should not be used for this purpose.

*The Stink Bug (Pentatomidae).*

This insect causes the Brown Spot of rice grains. The insect punctured the husk in order to suck the juice of the rice grain when it is in the milk stage. The fungi which obtains entrance to the grain through the puncture caused the black spot on the grain. The damage of this insect is greatest in the late varieties of rice. This is because the stink bug increases in number as the season advances. These insects are worse some seasons than others. Like other insects they seem to be numerous in cycles, probably because they are periodically checked by their natural enemies. So far as known there is no remedy for them.

**RICE DISEASES.**

*Rotten Neck (Piricularia Oryzae).*

This disease gets its name from the fact that the most conspicuous lesions occur at the sheath nodes and at the region of the stem where it becomes the axis of the head. The first indication of disease is a dark spot on the “neck” of the head. This lesion causes a weakening of the stem so that the head breaks over at this point and hangs by the broken tissues. A wind or the reel of the binder will cause the head to fall to the ground and is lost. Another stage of the disease sometimes occurs when the plant is young—six inches to a foot high. At this stage the indications of the attack are brown spots on the leaves. These spots go entirely through the leaf. The spots enlarge and coalesce
until practically the entire leaf is involved. The lower and older leaves of the plant suffer first, and become entirely brown and dry and shriveled; afterward the younger leaves are affected and the plant is apparently dead. In some instances, however, a small percentage of the plants the closely wrapped bud portion is unaffected, and the plant under proper conditions may send up new shoots and continue growing.

The most of the varieties grown in the Rice Belt of Louisiana seem to be immune to the disease in the heading stage. If the conditions are right, however, it frequently does considerable damage in the younger stage. The conditions under which it has been observed to occur in the younger stage of rice growth are extremely dry weather during June and early July. If the weather is dry during this period and the rice is not irrigated before the ground is wet by a rain, the chances are that the disease will develop. In 1912 and again in 1917 this disease destroyed a considerable amount of rice in Southwest Louisiana. The writer has seen as much as 50 acres which, with the exception of a few plants here and there which were apparently immune, was entirely destroyed. In every case the rice was late and had not been irrigated when the first July rain wet the ground. In 1917 there were fields which were entirely dead with the exception of irregular streaks through the field. These irregular areas of healthy rice were apparently caused by water which leaked through the levees from adjacent irrigated fields. There is not believed to be a great deal of danger from this disease in the early period of growth if the rice is properly irrigated.

*Straight Head.*

It is not known whether this is a disease or a condition brought about by physical causes. It seems to occur largely on land that has been cultivated the previous year to some highland crop and contains a large amount of vegetable matter. The writer has observed fields, which the year before had been planted to cotton, in which every cotton middle was marked out through the rice with
A STOOL OF STRAIGHT HEAD.
TYPICAL STRAIGHT HEAD
Straight Head. The rice between was a normal crop. In land which has previously grown lespedeza or cowpeas the Straight Head may occur in irregular patches.

The rice in which Straight Head occurs is generally unusually thrifty. It is well stooled, of good color, and gives every indication of a large crop. When the heads first appear there is nothing abnormal. The heads, however, fail to develop grain in the husk but remain straight and green for a time and then turn brown. If the plants are undisturbed and there is sufficient moisture in the ground, a branch frequently occurs on one of the lower nodes near the crown which produces a small head filled with normal grains.

From observations which have been made it appears that Straight Head does not often occur on fields which some time during the growing season have been drained and allowed to dry. Again it does not seem to occur on rice which is watered late and which may apparently have suffered to a certain extent from late flooding. Until more exact information is available it is considered to be safe practice on land which contains considerable vegetable matter to either irrigate late, or drain the land and allow it to become thoroughly dry once during the growing season. On land that has been in highland crops for several years it is advisable to follow this plan for the first two years that the land is planted to rice.

HOW TO GROW A CROP OF RICE

Outside of the rice growing sections there seems to be an idea prevalent in the popular mind that rice growing is a fearful and wonderful operation. The Stations receive a great many letters from people living outside of the Rice Belt who desire information as to how the crop is grown. Again, people from the North purchase rice farms and request of the Rice Station information as to how to plant the first crop. At it is impossible to answer questions of this kind in a comprehensive way by letter the following information is given. The statements which are here con-
tained are based on experimental work, practical experience as a rice farmer, and upon the observed methods of some of the most successful rice planters in the Rice Belt.

*Contour of Land and Soil.*

In order to make use of modern machinery the water must be under control both with reference to drainage and to irrigation. The land must be level enough so that the irrigation water can be conveyed through surface canals. By this is meant two embankments or levees with the water flowing between them and above the level of the land to be irrigated. By this means the water can be let out of the canal into fields or laterals by opening a gate in the levee. Canals and laterals should always be constructed on the top of ridges or follow the higher parts of the field in order that the water may flow from one contour check to the other until the lowest part of the field is reached. In this way all of the land will be uniformly irrigated.

Rice soil should be of very fine texture underlaid by an impervious sub-soil. A silt loam or adobe with a clay sub-soil is a good soil for rice; the former is preferable because it is not so sticky and therefore more easily worked. There should be little, if any, under-drainage.

The average silt loam soil contains enough sharp sand so that it does not stick or roll up badly on the implements if worked wet; even a very rusty plow or other tillage implement will soon scour and work well. On soil of this type plowing can be done if necessary when the land is wet and the harvesting machines can be run in the mud or even in several inches of water.

The adobe and what is frequently called the "hogwallow" type of soil is frequently found in the Rice Belt. A soil of this type cannot be worked successfully when wet. In order to be sure of a crop of rice on land of this type it is necessary to have the drainage under absolute control. This type of soil is usually stronger; that is, it will produce heavier yields of rice, and will hold moisture better during a dry planting season than the silt type of soil. One of the characters of the adobe soil is that when it is dry the
surface checks forming particles about one-eighth inch in diameter. If handled properly, this character can be utilized as a mulch to conserve capillary moisture. Adobe soil is harder to plow; but if worked at the right time, the seed-bed is easier to prepare than in the silt soil. Again, the seed may be planted in the adobe soil and irrigated to hasten germination. This cannot be done in the silt soil for the reason that the soil will pack around the seed and exclude the air, preventing germination.

Preparation of the Seedbed.

Plowing. On silt loam soils it is advisable to plow the land in the fall as soon as the previous crop is out of the way. Turn under all possible vegetable matter. Fall plowing permits the air to get into the soil and accelerates the decay of vegetable matter causing it to break down into ammoniates which is the only form of nitrogen that rice can use.

It has been demonstrated by the Hawaii Station that rice will not make use of the nitrate form of nitrogen. At the first thought this may appeal to us as being very strange because we know that all of our other farm crops use the soluble nitrates. Vegetable matter in breaking down in the soil forms ammoniates first which break down into nitrates, this being the form in which all farm crops other than rice make use of nitrogen, the most costly of all elements of plant food. The reason that rice makes use of the ammoniates and not the nitrates is that rice being a water plant must necessarily grow under conditions which do not favor the development of the nitrates. Ammoniates form in wet and badly drained soil and nitrates develop best in well-drained soil. Because of the above facts it is easy to see the advantage of fall plowing and the plowing under of all possible vegetable matter.

The rice roots penetrate to a depth of from eight to twelve inches. Large rice roots have been found seven or eight inches below the plowing. This being the case, it is advisable to plow as deeply as conditions will permit. There is no doubt that the common practice of plowing two and
one-half inches in the Rice Belt is a mistake. On the other hand, it is not considered safe to plow deeper than six inches for the reason that harvest with the reaper will be difficult or impossible if the harvest season is wet or if it is difficult to completely drain the land. The lugs on the bull wheel of the binder must find hard ground or the machine will slip and the sickle will become choked with the tough green straw. These lugs always go deeper than the plowing if the land is soft. If a rice farmer contemplates plowing deeper than six inches, he should be prepared to equip his binder with a small engine in the event of a wet season.

The popular type of plow in the Rice Belt is the standard ten-inch two-bottom mouldboard gang with rolling coulters. The disc plow does not work well in the silt loam type of soil. Four mules will pull a ten-inch gang plow easily. The small tractor with a two or four-bottom gang is coming into popular use and is replacing the 40 and 60 h. p. tractors which were in common use a few years ago. The tractor probably will reduce the number of work animals used on the rice farm but it will not entirely replace them. Again the tractor will not work on wet land. It is better to plow land wet in the fall and turn under vegetable matter than to wait until the land is dry in the spring. If average rice land is plowed in the spring, it is necessary for rain to fall on it before it can be prepared for planting; therefore, if the season is very dry, the planting may be delayed. Fall and winter plowing, even though plowed wet, is easier to prepare than spring plowed land. This, of course, refers only to the silt loam type. The adobe soil should never be plowed wet, granting that this be possible.

Preparing the Seedbed.

The amount of work necessary to prepare the seed-bed for rice depends upon the amount of vegetable matter or humus that the soil contains. The longer that the land has been planted continuously to rice the less humus there is; and, therefore, the more difficult it is to prepare the seed-bed. Because of its better physical condition due to aeration fall-plowed land is easier to prepare than land that has been
freshly prepared in the spring. This was fully explained under "Plowing".

In preparing the seedbed the first implement used on the plowed land should be some form of clod crusher. For this purpose the two-section soil packer is probably the best implement that can be used.

The soil packer (see cuts) consists of a number of cast iron wheels "strung" or running loosely on a shaft. The rim of the wheel which comes in contact with the soil is "V" shaped. The entire set of wheels on the shaft presents the appearance of a corrugated roller. These sections of rollers are two in number fastened in a steel frame one section behind the other. There is a roller bearing at the end of each shaft. The corrugated or "V" rims break joints. In this way a hard clot which falls between the rims of the front section may not be crushed but merely pressed down in the soft earth. The rear section "breaking joints" with the front will crush the clod leaving the land completely pulverized on the surface. These machines are provided with a wooden box on the frame for the purpose of adding extra weight. The soil packer requires from two to four mules depending upon the condition of the soil. This machine may be used to advantage after the seed have been planted and again after the crop is up if the land is very dry. This machine is believed to be one of the best for the preparation of the seedbed that has ever been introduced into the Rice Belt.

A drag or "float" is also used for the same purpose. A float is constructed by nailing to any suitable frame six two by twelve planks from six to twelve feet long. The planks are laid clapboard fashion. Four mules are hitched to the side toward which the planks slant, sufficient weight is added, and the implement is dragged over the land.

A steel or concrete roller may be used for the same purpose, but neither the roller nor the float is as good as the corrugated soil packer for the reason that the former packs the soil leaving a smooth surface which gives up moisture readily. The latter leaves the soil in corrugations
Spreading commercial fertilizer broadcast. The plowed land should be disked prior to spreading the fertilizer.

The Float is a good implement for preparing the Seedbed.
which are full of small surface checks by which the capillarity is broken and the loss of moisture prevented.

The soil packer is followed by a disc harrow. It is usually necessary to disc the land from two to four times.

The disc is followed by the drag or spike tooth section harrow. This should be used from one to three times. This may be followed by the soil packer. The land should now be ready for planting.

The tractor is very useful in the preparation of the seedbed. For this purpose it is believed that the small
tractor is more desirable than the large for the reason that the 60 h. p. machine tends to pack the land like a steam roller, and it is believed materially reduces the yield of rice.

**Planting.**

The seed may be planted with the grain drill on land prepared as heretofore indicated or it may be sown broadcast on the disced land and harrowed in with the drag harrow.

About 90 per cent. of the rice in the United States is planted with the drill. The drill plants the seed in rows from six to eight inches apart and at a uniform depth. The drill may either be plain or have a fertilizer attachment. The drill also may cover the seed by five or six links of chain or rings which drag behind the shoe or disc or it may have press wheels. There are two types of drill in common use, each of which have certain advantages. These are the disc and shoe type. It is not necessary to go into a detailed discussion of the relative value of the different types, and it will be sufficient to say that the most popular drill is the combined fertilizer and seed, with discs and press wheels. The seed should go through a small shoe at the back of the disc which will insure all of the seed being at the same depth in the soil. Where there is no shoe the seed merely dropping into the furrow as it is opened by the disc, a part of the seed will be near the surface and part of them in the bottom of the disc furrow; again, if the soil is moist enough so that a little will stick to the back of the disc the seed will be thrown out of the ground. The press wheels are a great advantage for the reason that the soil being pressed tightly over the seed will hasten germination in very dry soil. As a matter of fact, seed will germinate when planted with the drill in land that is too dry to possibly sprout rice planted broadcast. The drill will save at least twenty pounds of seed per acre. From sixty to seventy pounds of seed per acre is used in drilling. From eighty to one hundred are used when the rice is sown broadcast.
The broadcast method of seeding is employed when the land is too wet to make use of the drill. It is usually only necessary to double-disc the land before broadcasting. The wagon end-gate seeder or the box seeder with a wheel at each end are the implements in common use.

It will be noted that broadcast rice is only thinly covered with soil; therefore, it cannot be of a uniform depth. Some of the grains which fall in depressions or disc marks will be covered with two or more inches of dirt while others will be merely covered. In a field which is planted broadcast some plants will be found with two leaves while others are just pricking through the surface. As much as ten days will elapse between the appearance of the first and last plants. As the greater number of seed are covered thinly with soil, it is very easy for the rice birds to pull the young plants. If they can get the plants out of the ground, the Purple Grackle, or large rice bird, will continue to pull the plants until they are three inches high. The drill, on the other hand, packs the soil over the seed so that the birds have considerable difficulty in pulling the plant so that the seed will come up with the stalk. The stalk will break off and the seed and root will be held by the soil which is packed over them.

After planting, furrows for drainage should be opened through the low parts of the field with a plow or middle-burster. This is for the purpose of draining the land in the event of a heavy rain and again when it is desired to drain the land for harvest. If water stands on the land before the seed germinates, there is danger of loss of stand. If the rice has commenced to germinate however, and if the seed is not too deep, it will come up to a good stand.

Irrigating land in order to germinate seed is not advisable on the silt loam soil of the Rice Belt. The reason for this is that the land is of so fine a texture that it is necessary to completely cover the land with water in order that the entire field be wet. In other words, if two trenches be made ten feet apart in the planted field and filled with water, the soil would not wet over two feet on each side of the trenches; about half of the space would be dry. In the
adobe type of soil the water would go through the soil from one trench to the other. In the adobe soil, therefore, it is possible, and it is the common practice, to irrigate to germinate the seed. This is not a safe practice on the silt loam types.

**Fertilizing Rice Lands.**

The two most important factors in successful rice culture are fertilization and irrigation. Unless the fertility of the soil is maintained through the proper use of fertilizer or by means of crop rotation, together with the use of some of the more important elements of plant food, profitable yields cannot be maintained. It should be remembered that it is easier to keep up the normal fertility of the soil by the constant application of plant food than it is to build up a soil that has been allowed to become impoverished through neglect. It should be remembered also that because of the expense of fitting up a farm for rice production yields should be maintained for the longest possible period of time, because rice being a water plant will thrive on land that is too low to grow other crops unless considerable money is expended in drainage. The drainage of rice lands so they will grow highland crops will cost almost as much as the irrigation of rice. On new land, therefore, profitable yields of rice should be maintained for at least eight and possibly ten years before the land is drained and planted to highland crops. It is of course understood that water to the amount of at least sixty acre-inches must at all times be available in order to produce a crop of rice.

**Fertilizer Requirements.**

It may be stated almost without exception that rice soils are deficient in phosphorus.

Rice requires level land near an abundant water supply; therefore, rice growing is restricted largely to the level coastal plain having numerous streams or underground water, or to the level bottom lands of some of our great rivers. Land of this kind is largely formed by sediment brought down by the streams from the higher lands above.
Such land in every case is rich in nitrogen, and it almost always contains an abundance of potash, but the phosphorus content is generally very low. The chemical analysis of most rice soils shows merely a trace of phosphorus. However, the phosphorus they do contain must be in a highly available form, being probably of animal origin, or no crops could be produced. As soon as this supply of phosphorus is exhausted there is a marked decrease in the yield of rice. It is therefore safe to say that all rice soils will require, sooner or later, the application of some form of available phosphorus in a chemical fertilizer.

**Applying the Fertilizer.**

Commercial fertilizer may be applied broadcast on the prepared land before sowing or drilling the seed, or it may be placed in the soil with the seed, making use of the combined rice drill and fertilizer distributor for the purpose.

If the fertilizer be applied broadcast, it should be spread on the disced land so that the harrow, soil packer, etc., in the preparation of the seedbed will mix it with the soil. If the fertilizer is underneath the surface of the soil, no amount of rain will wash it out. If, however, it is on the surface, a heavy rain may wash away a considerable amount of the available material.

The machine used for spreading commercial fertilizer broadcast is similar to the ordinary broadcast seeder. Instead of the fluted feed in the bottom of the hopper there are large plate fertilizer distributors. One of these machines will fertilize a strip ten feet wide and apply from 25 to 3,000 pounds of fertilizer per acre. These machines are sometimes called lime spreaders because they are used also for that purpose. They will spread any finely divided material.

If there are no weed and grass seed in the soil, there is little difference, so far as the effect of the fertilizer is concerned, between the broadcast method of application and where the fertilizer is placed in the row with the seed. During the growing season the plant roots interlace across the row and gather all of the plant food required. As a
matter of fact the rice roots generally penetrate to a depth of ten inches or more and will consequently absorb any soluble material that may be present. There is, however, this important factor to be considered. Acid phosphate seems to accelerate the growth of water crabgrass and other water weeds almost as much as it does rice; consequently, in the case of drilled rice the grass and weeds which grow between the rows may retard the growth of the rice.

The combined seed and fertilizer drill is constructed similar to the ordinary seed drill. There is another compartment in the rear of the seed hopper having in the bottom fertilizer distributers and tubes from same to the shoe of the drill. In the combined drills which are on the market at the present time the fertilizer and the seed are conducted through the same tube to the shoe; consequently, the seed and fertilizer are placed in the ground together. If not over 200 pounds per acre of fertilizer is used, and if the land is moist, there is no danger of loss of stand. However, if the land is very dry, as is frequently the case during the rice planting season, the seed will germinate before the acid of the fertilizer becomes diluted by the soil moisture; in such a case there is some danger of loss of the stand of rice. It is believed that there should be a separate tube to conduct the fertilizer to the heel of the shoe or disc so that the fertilizer falls in the furrow as it is closing behind the shoe or disc. In this way the fertilizer will be placed below the surface of the soil in the row with the seed where it will do the most good but not in contact with the seed. It would seem that the fertilizer would then be in a position to stimulate the rice plant first and aid it to grow faster than the weeds and grass which germinate between the rows of rice.

From observation the following is a good rule to follow. If the fertilizer is to be spread broadcast, the seed should be sown broadcast. The reason for this is that the fertilizer is distributed evenly through the soil. The plants from the broadcast rice develop as individuals. They are not crowded in the row as is the case of the drilled rice; consequently, the plants have more room to stool or tiller and
have a better opportunity to crowd out the grass. As has been mentioned before, however, there must be just the right amount of moisture in the soil in order to be sure of a stand of broadcast rice.

*Rice Irrigation.*

Rice may be irrigated in three ways: (1) The water pumped from streams; (2) the water pumped from wells; (3) tide-water irrigation.

The greater part of the rice raised in the United States is irrigated by pump from streams or lakes. The water is lifted from the stream by large centrifugal pumps to a surface canal by which the water is conducted to the fields through smaller canals or laterals. Some of these canals in the Rice Belt are 150 feet wide and from 25 to 30 miles long and irrigate as much as 25,000 acres of rice. One of the canals in the Belt has pumping capacity of 215,000 gallons per minute.

In the greater part of the rice-growing area it is possible to irrigate from deep wells. These wells are from 8 to 14 inches in diameter and from 125 to 350 feet deep. On a good well there should be at least 75 feet of screen in waterbearing sand or gravel. The water in a well of this kind rises within a few feet of the surface of the ground. If the water level is below 50 feet from the surface of the ground, it does not pay to pump the well for rice irrigation. The impellers of the centrifugal pump should be at least 10 feet below the normal water level of the well. A good well equipped with a pitless pump and from 40 to 75 horse power plant should furnish from 2,500 to 4,500 gallons per minute and have a capacity for at least 300 acres of rice.

Tide irrigation can be used only on land adjacent to freshwater streams where the tide causes the water to rise each day at least six inches above the level of the land to be irrigated. At low tide the water is below the level of the rice fields. A levee or embankment is constructed along the bank of the stream. There are automatic gates in the levee which control both the irrigation and the drainage.
When the water is high and it is desired to keep the land dry, the gates are not opened except at low tide. When the rice is to be irrigated, the gates are opened at high tide and closed at low tide. When the rice is flooded the gates are closed. A very small part of the rice growing area of the United States is irrigated in this way.

**Canals and Laterals.**

The main canals and laterals consist of two embankments or levees between which the water runs. The level of the water in the canal is always above the surface of the land to be irrigated. There are gates in the levees of the canals to distribute the water to the fields. Main canals and all laterals should follow highland or ridges in order that the water may be conducted from one field to another by gravity. The proper depth of the water in the field is governed by check levees which may be straight, making rectangular fields, or they may follow the contours of the land.

**Field Levees.**

There are two methods of making field levees. The one is to make square fields. The size of the fields is governed by the contour of the land, but usually ranges from 2 to 20 acres. They are constructed with a small road grader or with a plow and a "V"-shaped implement called a pusher which follows the plow, pushing the furrow to the top of the embankment under construction. No rice is planted on these levees, and they are not plowed or worked over with other implements. The disadvantage of this type of levee is that weeds and red rice will grow on it, and it offers a harbor for the muskrat and other animals which burrow holes which causes loss of water and other damage to the crop. Again it is necessary to cut a "road" by hand around all of the levees when the rice is ripe and ready for harvest. This for the reason that the bull wheel of the binder will not run in the levee ditch without slipping and it will not run on the side of the levee.

The second method is to build contour levees. The contour levee is a crooked embankment which follows the
contour of the field. By the use of this form of levee it is possible to maintain the water at a uniform depth of from 2 to 5 inches. The location of these levees may be established by instrument or by water level. If the water method is used, the water is turned on the field and when the water is 3 or 4 inches deep in the lowest part of the field a line of stakes is set on the points in the field where the water ranges one inch in depth. The embankment is made by following the line of stakes with a plow. The other contour are staked out in a similar manner. Levees of this type are low and wide. They are usually made by plowing together from four to six furrows with a walking plow. By plowing up about three times the levee is made. This should be done before the rice is planted. If the levees are made after the rice is planted, the instrument must be used in laying them off. These levees are prepared and planted as a part of the field. The rice will grow almost to the top of the levee; consequently, there is little if any land wasted. In plowing, planting, harvesting, etc., the implements work over the levees as a part of the field. Time is saved in being able to go a longer distance without turning, and it is not possible for weeds and grass to grow or animals to find a harbor on levees of this kind.

When to Irrigate.

The proper time to irrigate depends upon the variety, the season, and the time that the rice is planted in the spring.

If the season is normal, that is if there is enough rain to keep the land moist, water should not be applied until the rice is about six inches high. The plants should be high enough to shade the ground to a considerable extent so that the water will not become too hot which may result in the checking of the growth of the young plants. It may be, however, that the land is infested with weeds and grass so that it may be necessary to flood earlier. If the weeds and grass are to be destroyed, the water must be turned on as soon as the weed seed germinate. On land known to be very weedy, it is well to flood with at least five inches of
water as soon as the rice has developed two leaves. In this case all of the rice plants are covered with water. Within 24 hours the rice leaf will "stretch" to the surface and float. The water must be maintained at a constant level until the plant develops sufficiently to stand alone without the support of the water. It is easy to understand that if the water is turned off too soon that the plant which has been forced to grow six inches in 24 hours to keep from being drowned is not strong enough to stand without the support of the water. The first leaf which comes to the surface dies as soon as other leaves have developed. In normal irrigation the water should be turned off and the land allowed to become dry fourteen days from the time the first water is put on. The second flooding should be done when the plants show the need of it, and the water should be maintained until the rice is ready to drain for harvest in the fall.

As soon as all of the heads have turned down in the fall, the land should be drained. When the land should be drained depends entirely upon how rapidly the water will run off when the levees are cut. If the drainage is good, the water will run off rapidly; and if the rice is not far enough advanced, injury may result. Where the drainage is good the water should be held on longer than when the drainage is bad. This is a matter in which the farmer must exercise his judgment and for which no fixed rule can be laid down. The idea is to secure a dry field for harvest and at the same time not injure the quality of the rice by draining too soon.

**Highland Rice.**

*Oryza Sativa* is a water plant. The roots secure air after the manner of the reed family through tubes in the outer leaves; therefore, there is no such thing as a true highland rice of this species. It is true that any rice will grow well if planted in rows and cultivated like corn up to the heading season. If the rains make the ground very moist while the rice is heading and filling, a fair crop may result. Under the best possible conditions, however, not
over half the yield may be secured on "highland" that can be obtained on irrigated rice. It may be profitable to grow rice in this way for home consumption, but it will not pay from a commercial standpoint.

Harvesting Rice.

Harvesting rice should begin as soon as the heads are well filled and commence to turn down, or when the grain is past the milk stage. This depends upon the season and the contour of the land. If possible the land should be dry when the crop is cut. It is better to cut a good crop in the mud than a light crop on dry land because the water is turned off too soon.

While there is considerable rice cut by hand with the reap hook, by far the greater part of it is cut with the self binder.

The binder is very similar to the grain binder; the principal difference being in heavier construction and lugs on the bull wheel. Both the bull wheel and the grain wheel are cased with galvanized iron. This is to prevent mud from being carried up by the rim and spokes and clogging the machinery. The lugs are long enough so that the bull wheel will get traction on any rice land no matter how wet it may be. The straw of rice when cut is very green and heavy; therefore, the construction of the machine must be very heavy.

Six or seven mules are required to pull a rice binder. If the binder is equipped with a gasoline engine, from three to five mules are required. A binder will cut from 4 to 10 acres per day depending upon the crop and the condition of the land. Rice should not be cut while the dew is on it, or if it is wet from rain.

Shocking.

The bundles should be placed in shocks as soon as cut. A shock consists of from 10 to 20 bundles. The bundles should be set closely in the shock at the base in order to prevent the shock from twisting as the straw becomes dry. The cap consists of from one to two bundles and is the most
important part of the operation. As little rice as possible should be exposed to the sun. Rice which is exposed to the sun dries out too rapidly and many of the grains check or “suncrack” which causes them to break in milling, thus reducing the yield of best grade clean rice. It is believed that the best method of shocking is the small shock with the single cap bundle. It is possible to construct a shock of this kind with little if any grain exposed. If the large shock is used, with the double cap, all of the rice on the last cap bundle placed will be exposed to the weather; therefore, the last cap bundle should be placed on the south side of the shock with the heads turned to the north.

Badly shocked rice is not profitable in any season. In a wet season it means a heavy loss.
A well-shocked field of Rice. Note the small shocks, single caps, and no exposed grain. Rice exposed to the sun will dry too rapidly and check and "sun crack".

Note the Sprouts on the top of this Shock.
A shock like this is easier to build than a bad shock. The grain in a shock of this kind will keep for several months if the water does not stand around the base of the shock.
The bundles of these "hand stacks" were wet to the band when put up. The butts of the bundles, being exposed to the air, dry out in a short time so that the rice can be threshed without damage. It is advisable to use the hand stack when the season is bad. The cost is about eight cents per bag.

Handling Harvested Rice During a Wet Season.

It sometimes happens during the harvest season that excessive rains occur making it impossible to harvest and thresh rice without a certain amount of loss. If the water should stand around the base of the shock for a considerable length of time, the base of the bundle becomes saturated and sometimes rotten. The grain is well protected in the husk and will not sprout in cool weather unless it is completely covered with water. In the case of wet and rotten butts the rice should be hauled by wagon or on a slide to a high land and placed in a hand stack. The hand stack is made by first making a shock of the dry and cap bundles. A small stack is built on the shock. In this stack all of the wet portion of the butt end of the bundle is exposed to the sun and air. The stack is built up as high as a man can reach from the ground. When the straw is dry and the grain through the sweat the rice may be threshed. The cost of hand stacking is small. By means of the hand stack rice can frequently be saved in good condition when otherwise a large per cent. would be lost.
In some cases the weather is such that the grain in the shock is dry and ready to thresh but the butt of the bundles is so wet that the thresher will not handle it. In a case of this kind the wet portion may be cut off. This is accomplished by making a broad axe-like implement having a handle three feet long. The bundle is laid on a block of wood and the wet end is chopped off with one blow of the tool. These knives or choppers can be made out of old plow shares sharpened and fitted with a handle. A machine has been improvised for more rapidly handling the rice than by the hand-chopping method. The machinery of a mower with the blade attached is run with a binder gasoline engine or other convenient power which operates the sickle at a rapid rate. The blade is supported in a horizontal position with the fingers up at a convenient distance above the ground. By dropping the bundle on the blade the wet portion is cut off almost instantly. This machine is a great time and money saver when there is a large amount of wet rice to be cut.

**Threshing.**

There is little difference between the rice threshing machine and the wheat thresher. The rice thresher should have more separating capacity than the wheat machine and speed should be less in order that as small a per cent. as possible of the rice be hulled.

The rice, both straw and grain, should be dry and crisp when threshed. If the weather is very dry, it is possible to thresh as soon as the rice is cut. But this is not advisable for the reason that the grain contains considerable moisture which will collect in the sack after the rice is placed in the mill or warehouse and cause it to heat or mould. It is not advisable to thresh rice until it has been in the shock for at least two weeks. Stacked rice should not be threshed under thirty days from the time of stacking.

In the United States rough rice is handled largely in jute sacks which will hold from 162 to 200 pounds each. The unit of measurement of rough rice in Louisiana is the barrel of 162 pounds, in Arkansas the bushel of 45 pounds,
and in California the sack of 100 pounds. The latter is by far the most convenient and should be universally adopted. The bushel or any other measurement of odd pounds should be discarded for the decimal system.

**COST ESTIMATES IN RICE GROWING.**

Following is an estimate of the cost of producing an acre of rice. The method of calculating each item is given in detail.

It is believed that the estimate given is high for the present year and may be applicable to the coming year when cost of materials will probably be higher. It will be noted that 200 acres of rice are being produced on a 400-acre farm entirely with mule power. There is no doubt but that a tractor would decrease the cost of planting operations. No engine is used on the binder which would cut down the cost of harvest. Six dollars per acre is charged as water rent which on a 10 bag crop is not far from average but is higher than water would cost pumped from a well. Prior to the war water could be pumped from a well of 3,000 gal. capacity using coal for fuel for from $3.75 to $5.25 per acre, depending upon the rainfall during the summer months. The well owner gets the advantage of the usually heavy summer rains. Interest and taxes on the land not planted in rice but used for pasture is charged to the rice crop, but $3 00 rent on pasture is deducted from the cost per acre of growing rice. Cattle and other livestock are a source of revenue and should be used to reduce the cost of producing the rice because the cattle will convert red rice and other unsalable by-products of the crop into a very high-priced product. Again, it is entirely possible to produce corn, peas, sorghum, and oats on the land not in rice, all of which are revenue producers and materially reduce the cost of rice production. These are not given consideration in this estimate which is made on a basis that the farm is producing nothing but rice and pasture. One-half of the automobile expense is charged to the rice because the car is ordinarily used at least half of the time for other business and pleasure
which cannot be charged to rice. The farmer on a 400-acre farm is considered the manager. The profits of the business represent his salary.

**Mule Cost.**

A mule may work on a rice farm about 200 days out of the year. He will eat 18 lbs. of corn and 25 lbs. of straw per day, or its equivalent, for 10 months. This will amount to 194.7 bu. of corn and 3.75 tons of straw. The corn at $1.50 per bu. and the straw at $4.00 per ton will equal $157.05 for feed. Pasture and green feed will amount to $2.00. A harness to last five years with repairs will cost $18.00 or $3.60 per horse per year. $4.00 for vaccination and other medicine and shoes. The mule is worth $200.00 and will last 8 years. Deterioration $25.00 per year. Total cost per year of $191.65. If the mule works 200 days, the cost per 10-hour day is therefore 95 cents per mule.

**Plowing.**

A gang plow is worth $75.00 and will last 5 years; repairs paint shed room $20.00. Deterioration will be $15.00 per year. It will plow, including summer plowing, 150 acres per year. The plow cost is then 13 cents per acre.

**Discing.**

A disc harrow will cost $50.00 and will last 5 years. Repairs will be $15.00. It will prepare about 150 acres per year. The disc cost per acre will equal about 6½ cents. About 3 double-discings will be required.

**Harrowing.**

Will cost $15.00; will last 10 years; repairs $4.00. Harrow cost per acre about 12 cents.

**Corrugated D. Section Land Packer.**

Cost $60.00; will last 5 years; repairs $15.00; covers 12 acres per day; per acre cost 7½ cents.

**Fertilizer and Seed Drill.**

Cost about $140.00; lasts 10 years; repairs, etc., $40.00; cost per acre to drill 9 cents.
Maintenance and construction of levees, 50 cents per acre.

Labor, $1.50 per 10-hour day.

Binder Cost.

Will cost $200.00; repairs $100.00; will last 7 years and cut about 150 acres per year. Cost per acre 30 cents.

Miscellaneous.

Threshing 30 cents per bag. Hauling to market 10 cents. Warehouse and insurance 10 cents. Every rice farm should have at least $500.00 worth of tools in a well equipped shop. We find many farms with machinery to the extent of $5,000.00 or more and a tool equipment of less than $10.00. In this estimate tools will be charged at yearly interest on the investment.

How Cost Estimate Is Made on an Acre of Rice.

Plowing. Four mules and one man will plow four acres per day. Man at $1.50; mules at 96 cents each; plow 13 cents per acre. Plowing will cost $1.46 per acre.

Discing. One man and four mules at a cost of $5.34 will double-disc six acres per day (three double-discing are usually required to prepare seedbed; disc cost 12 cents. Cost per acre for three double-discings $2.68.

Harrowing. One man and four mules will single-harrow 15 acres per day (two harrowings required). Cost per acre 89 cents.

Pulverizing or Rolling. Four mules and one man will roll or pulverize 10 acres per day at a cost of $5.34 which will equal 54 cents per acre.

Drilling. Four mules and one man will drill about 8 acres per day, which will cost about 68 cents per acre.

Fertilizer. Two hundred pounds of 16 per cent. acid phosphate per acre; cost per ton $28.00; per acre $2.00.

Weeds and Red Rice. Pulling weeds (Coffee and Mexican to prevent either getting a foot-hold) and red rice $1.00 per acre.
Harvesting. One man and seven mules will cut about seven acres per day. Man $1.50; mules $6.72; binder 30 cents; oil 10 cents; total $8.32 per day or $1.19 per acre. Two shockers at $1.50 each is 42 cents per acre. Twine, 5 lbs. at 20 cents, $1.00. Total cost of cutting and shocking one acre of rice, $2.81.

Cutting Roads Around Field. Two men will cut around about 15 acres per day. Cost per acre 20 cents.

Threshing.

Ten bags at 30 cents equals $3.00 per acre.

Hauling to market, insurance, and warehouse, each 10 cents; $2.00 per acre.

<table>
<thead>
<tr>
<th>Itemized Cost of One Acre of Rice Estimated From Above. 1917-1918.</th>
<th>Estimated Cost 1910</th>
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| Plowing ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... ... 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INVENTORY.

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>400 acres land and improvements</td>
<td>$20,000.00</td>
</tr>
<tr>
<td>10 mules at $200 each</td>
<td>$2,000.00</td>
</tr>
<tr>
<td>10 sets harness at $15</td>
<td>$150.00</td>
</tr>
<tr>
<td>2 Gang Plows at $75</td>
<td>$150.00</td>
</tr>
<tr>
<td>2 disc harrows</td>
<td>$100.00</td>
</tr>
<tr>
<td>1 walking plow</td>
<td>$20.00</td>
</tr>
<tr>
<td>1 pulverizer</td>
<td>$60.00</td>
</tr>
<tr>
<td>I drill combination fertilizer</td>
<td>$140.00</td>
</tr>
<tr>
<td>1 binder</td>
<td>$200.00</td>
</tr>
<tr>
<td>1 levee plow</td>
<td>$50.00</td>
</tr>
<tr>
<td>1 lever pusher</td>
<td>$25.00</td>
</tr>
<tr>
<td>2 scrapers</td>
<td>$10.00</td>
</tr>
<tr>
<td>2 wagons and beds</td>
<td>$160.00</td>
</tr>
<tr>
<td>1 shop equipment</td>
<td>$500.00</td>
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<tr>
<td>One-half automobile expense</td>
<td>$200.00</td>
</tr>
<tr>
<td>1 farm fan</td>
<td>$35.00</td>
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<tr>
<td>1 platform scale</td>
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<td>1 wagon scale</td>
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<tr>
<td>1 end gate seeder</td>
<td>$15.00</td>
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<tr>
<td>1 manure spreader</td>
<td>$125.00</td>
</tr>
<tr>
<td>1 feed grinder</td>
<td>$50.00</td>
</tr>
<tr>
<td>1 12 h. p. engine</td>
<td>$400.00</td>
</tr>
<tr>
<td>1 buggy and harness</td>
<td>$125.00</td>
</tr>
<tr>
<td>1 driving and saddle horse</td>
<td>$175.00</td>
</tr>
<tr>
<td>1 saddle and bridle</td>
<td>$25.00</td>
</tr>
<tr>
<td>1 lot forks, shovels, and odd implements</td>
<td>$15.00</td>
</tr>
<tr>
<td>1 lot doubletrees</td>
<td>$15.00</td>
</tr>
<tr>
<td>Typewriter stationery, desk, fire-proof safe</td>
<td>$300.00</td>
</tr>
</tbody>
</table>

Total, $25,170.00

Interest on investment at 6 per cent............. $1,051.20
Less pasture 150 acres at $3.00 per acre......... $450.00

$601.20
As stated, farm accounting is difficult and friendly criticism will be welcome with reference to the above.

Attention is again invited to the fact that in the above estimate, irrigation from well is not considered, no tractor is used, no binder engine is used, revenue is not considered from the by-products of rice fed to livestock, and no consideration is given to oat pasture that may be grown on rice land during the winter. Other crops may also be grown for the reduction of feed expense.

NOTE. It should be noted that the figures showing estimated costs are for the years 1910 and 1917-1918 and do not apply to conditions in 1920. The reason for this apparent discrepancy is that the publication of this bulletin was deferred at the time on account of insufficient funds.