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Rice: history, preparation of soil, planting, flooding, harvesting, noxious weeds in the rice fields; Feeding rice bran and rice polish and determination of digestible nutrients

William Carter Stubbs

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BULLETIN
OF THE
AGRICULTURAL EXPERIMENT STATION
OF THE
Louisiana State University and A. & M. College.
W. C. STUBBS, Ph. D., Director and State Chemist.

RICE:
History, Preparation of Soil, Planting, Flooding, Harvesting, Noxious Weeds in the Rice Fields; Feeding Rice Bran and Rice Polish and Determination of Digestible Nutrients.


ISSUED BY THE LOUISIANA STATE BOARD OF AGRICULTURE AND IMMIGRATION,
J. G. Lee, Commissioner.

BATON ROUGE, LA
PRINTED AT THE TRUTH BOOK AND JOB OFFICE.
1904
The Bulletins and Reports will be sent free of charge to all farmers,
by applying to Commissioner of Agriculture, Baton Rouge, La., or to the
Director of the Station, Audubon Park, New Orleans, La.
PREFACE.

The rapidly increasing production of rice in this State, and the numerous inquiries made by prospective purchasers of land with a view of entering upon the cultivation of this plant, has caused an unusual demand for literature on this subject. Bulletin 61 has been exhausted in supplying this demand, and the inquiries continue to come in such abundance as to justify a republication of this bulletin, revised and extended to include additional information gained through recent experiments, especially pertaining to the feeding value of the by-products of the rice mills.

New weeds have appeared that call for discussion. Other points have developed which enables us to make this publication more valuable than the preceding bulletin referred to.

The United States Department of Agriculture has issued two bulletins from the pen of our able and distinguished citizen of Lake Charles, La., Dr. S. A. Knapp. Besides the information gathered from a long experience and observation in the rice fields of Southwest Louisiana, he has recently visited the Philippine Islands and Japan, on a special mission of the Department of Agriculture at Washington, to study the rice industry of those islands and to select that variety which would probably be best adapted to the environments of the Louisiana planter.

Many tons of rice seed were imported by him, and through the Department of Agriculture and members of Congress, distributed throughout the rice districts of the United States. This thorough study of the rice industry of other countries, added to a previous knowledge of and familiarity with our own, pre-eminently qualified this able scientist to speak upon the rice question.

"The Present Status of Rice Culture in the United States," Bulletin No. 22, of the Division of Botany; and Farmers' Bulleti-
tin No. 110, "Rice Culture in the United States," are the two bulletins mentioned above, and should be in the hands of every rice planter.

Much of the information relative to the preparation of the soil, planting, etc., in this bulletin, has been obtained from successful rice planters either by personal interview or correspondence.

Besides the general information relative to the planting, growing and harvesting of this crop, this bulletin will contain a great deal of information relative to the noxious weeds found in the rice fields of this State, gathered by Prof. W. R. Dodson, botanist of the stations, in personal trips of investigation throughout the rice districts of the State. These weeds are fully described and illustrated, with suggestions as to their destruction, etc. This will be found in Part II of this bulletin.

Dr. Brown and Prof. Dodson have conducted experiments determining the digestibility of rice bran and rice polish, and feeding experiments have been carried on using the bran as the chief carbohydrate concentrate in beef production. Dr. Browne has also investigated the adulteration of rice by-products, and the results of the above investigations are given in Part III.

This station has previously issued four bulletins on rice: No. 15, "Rice;" No. 24, "Rice and Its By-Products;" No. 50 (second series), "Red Rice," and No. 61, "Rice Preparation, Cultivation, Flooding, Harvesting; and Noxious Weeds in the Rice Field." All of these bulletins are out of print, except No. 50, of which a few are still available.

Bulletin 113, office of Experiment Stations, on "Irrigation of Rice in the United States," by Frank Bond and George H. Keeney, contains valuable information on irrigation.
The botanical name for our common rice is *Oryza sativa*. The word *Oryza* was coined by the Greeks from the Asiatic word “eruz,” and our modern nations have modified it into “rice,” “riz” and “reis.”

There are five species of rice described by botanists, though it is probable that they are only varieties: *Oryza sativa*, our common rice; *Oryza mutica*, dry or mountain rice; *Oryza praecox*, early rice; *Oryza glutinosa*, clammy rice, and *Oryza rufipogon*, red rice.

The common rice is the only one cultivated in Louisiana, though the red rice has contaminated it to a large extent in many of our rice fields and greatly injured the value of the former.

The antiquity of rice is very great, as the origin of its name indicates, and its native habitat is unknown.

It is cultivated largely in India, China and Japan, and also sparingly in Europe. In Carolina it has long been a staple commodity, its introduction into this State being made as far back as 1698, “by a small bag of paddy given as a present from Dubois, treasurer of the East India Company, to a Carolina trader.”

It is also said that a Dutch vessel from Madagascar brought rice subsequently to the same State and to this is attributed the presence of two kinds there now.

**CROP OF LOUISIANA.**

The rice crop first assumed noticeable proportions in this State directly after the war, when the abandoned sugar plantations suggested the possibilities of growing rice on a large scale. The success attending the first ventures stimulated others to follow, and soon every abandoned acre on the Mississippi river and its bayous were utilized in the culture of rice. In 1885, attention was called to the successful efforts of the Duson Brothers, now of Crowley, La., in growing and irrigating a large
field of rice near their old home. This beginning attracted settlers from the West and Northwest, who brought with them the latest machinery used in the wheat fields, and began at once to adapt them to rice culture. Success attended their efforts and rice culture became revolutionized. The character of the soil, the availability of water for irrigation, and the introduction of improved machinery, all rendered the problem of rice culture in Southwest Louisiana easy and profitable. Thousands flocked into this section to go into this profitable industry, and the area in rice has increased till Louisiana is by far the leading rice producing State of the Union.

In 1896 Louisiana produced 127,600,000 pounds of clean rice, while North and South Carolina grew 27,901,440 pounds, and Georgia 10,464,000 pounds. In 1899 Louisiana produced 107,792,000 pounds, North Carolina, 2,560,000 pounds, South Carolina 23,054,720 pounds, and Georgia 3,584,000 pounds.

In 1902 the crop was about 535,000,000 pounds of rough rice, of which Louisiana and Texas produced more than four-fifths.

It is estimated that the crop of Louisiana and Texas for 1903 will almost reach three million bags, of 160 to 170 pounds each. Should each bag mill 100 pounds of clean rice, the crop will approach 300,000,000 pounds of clean rice. This will not be four and a half pounds per capita for the population of the United States.

**IMPORTS INTO THE UNITED STATES.**

[Preliminary reports of Department of Commerce and Labor.]

<table>
<thead>
<tr>
<th>ARTICLES IMPORTED.</th>
<th>Year ending June 30, 1903.</th>
<th>Ten months ending Oct. 31, 1903.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pounds</td>
<td>Dollars</td>
</tr>
<tr>
<td>Rice</td>
<td>78,307,010</td>
<td>1,731,915</td>
</tr>
<tr>
<td>Rice flour, rice meal, and broken rice.</td>
<td>91,349,174</td>
<td>1,329,558</td>
</tr>
<tr>
<td>Total</td>
<td>169,656,184</td>
<td>3,061,473</td>
</tr>
</tbody>
</table>

It will thus be seen that our domestic supply is considerably less than our consumption, and there is yet an abundant room for the expansion of this industry without fear of overstocking our supply. Again the consumption of rice per capita is increasing, so also is the population of the United States. It may therefore be asserted that, under most favorable conditions, there is hardly
a possibility of our domestic supply reaching the national demand within the next ten to twenty years. The present tariff of about two cents per pound upon cleaned rice, also encourages its increased production.

There is one difficulty to contend with in completely supplying domestic consumption. The Chinese and Japanese on the Pacific coast consume some forty million pounds of rice annually, nearly all of which is imported. Some effort has been made to gain this trade to Louisiana and Texas, and considerable quantity of rice has been sold by putting it in the kind of packages demanded by these people. However, they demand a small grain, which we are not producing to any considerable extent. No doubt by the proper methods of packing, and the cultivation of the proper variety of rice, we will be able to supply this trade and stop the importation to meet this demand. During 1902 this country sent to Porto Rico over fifty-two and a half million pounds of rice. There seems to be no doubt but that under reciprocity we shall be able to dispose of a large quantity of rice in Cuba in the future.

**LAND SUITABLE FOR RICE CULTURE IN LOUISIANA.**

Rice can be grown upon any land in this State which can be irrigated. According to the geological survey of this State, there are about 13,000 square miles of alluvial and 3,000 square miles of prairie lands in this State. The topography of most of these areas permit of the easy inundation of water. Nearly every acre of the alluvial lands is adjacent to the Mississippi river or its outlying tributaries, which will supply inexhaustible amounts of water. The Red, the Ouachita, the Mason, the Bœuf and the Tensas could all be used for flooding rice fields on their banks. Mr. Alexander and Mr. Grew, of Ouachita, have recently grown successfully large rice crops, a few miles below the city of Monroe on the Ouachita river, using the water of the latter for irrigation, and Messrs. J. and M. Wade have been growing it on the Choudrant bottoms for several years.

The alluvial section of lower Louisiana is now chiefly devoted to sugar cane, though a goodly area is cultivated in rice. The alluvial lands of North Louisiana are exclusively cultivated in cotton and corn, though most everywhere adapt-
able to the growing of rice. Taking the alluvial and prairie sections of this State and estimating that half could, with some expenditure of money, be brought under cultivation and irrigation, there would be available for rice culture in this State, should there be a profitable demand for this crop, at least four to five million of acres. Estimating the yield of each acre at ten barrels, this would give a crop of forty to fifty million barrels; or at 100 pounds clean rice per barrel, four to five billion pounds of clean rice; or twelve times the present consumption of rice.

As with all crops, rice should form a part of a system of rotation to produce the best results, hence not more than one-half of above estimate should really be counted on through a series of years.

The above will show, however, the large area available for rice whenever the exigencies of our country demand its dedication to this cereal.

The prairies of Southwest Louisiana are fast becoming one vast rice field. This section is comparatively level, with numerous streams permeating it, from which large pumping plants are sending the water through numerous canals on to the fields. It is also underlaid at 150 feet to 300 feet by a stratum of gravel, which, when penetrated, as it is, by numerous wells, affords an abundance of water for irrigation. This stratum of sand and gravel crosses the State from east to west, just above (geologically) the upper group (Grand Gulf) of the Tertiary formation. It runs from near Leesburg on the west, to north of Washington on the east, and has a breadth of many miles and depth of many feet. The rainfall upon this area percolates the gravels and sands which dip beneath the prairies and furnish an ample supply of water for irrigation of fields, or for the use of the thriving towns and villages found in this section. By boring an eight or ten-inch well down into these gravels, the water rises sufficiently near the surface to be pumped by machinery onto the fields or into the stand pipes.

This prairie section is underlaid by an impervious clay subsoil, which aids greatly in economizing the water used and permits the fields to be drained at harvest. Hence the adaptability of improved self-binders in harvesting this crop.

The alluvial lands of the State have not this impervious sub-
soil, and hence require more water for irrigation and cannot always be drained at harvest, so as to permit of the use of this improved machinery. Hence a greater part of the crop is cut by hand, thus requiring more labor and entailing greater expense in harvest.

They have, however, these advantages: The water supply is always ready and abundant, and the land, sloping gradually toward the swamps; permits of a flow by gravity from front to rear, without the intervention of costly canals.

Both sections have their advantages and disadvantages, and there are planters in each who are reported to be making good profits from rice culture each year.

In Southwest Louisiana there are a large number of wells which, by the aid of proper pumping machinery, are irrigating each eighty to one hundred and fifty acres of rice. These artesian wells are being multiplied daily, and by their use are permitting the cultivation of lands remote from streams and out of range of canals. Also permitting the cultivation of lands whose topography prohibited the economical flooding from canals.

LIST OF RICE CANALS.

The following is a partial list of canals in Southwest Louisiana. Very few wells are included in this list, as it was found almost impossible to get anything like complete data. It is believed the list is fairly complete for the more important plants. Where we have not been able to hear directly from the companies the data is taken directly from the Rice Journal and Gulf Coast Farmer for January, 1903:
<table>
<thead>
<tr>
<th>Name and Office of Company</th>
<th>Total Horse Power of Boilers</th>
<th>Total Horse Power</th>
<th>Capacity of Pumps, Gallons per minute</th>
<th>Fuel</th>
<th>Main Canal, Feet</th>
<th>Length, Miles</th>
<th>Length, Acres</th>
<th>Estimated Acreage for 1904</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Acadia Parish</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abbott Bros. Canal &amp; Improvement Co. Crowley</td>
<td>4</td>
<td>3</td>
<td>45,000</td>
<td>Oil</td>
<td>14</td>
<td>45,100</td>
<td>5,000</td>
<td>5,000</td>
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<tr>
<td>Abbott, Duson Canal Co., Crowley</td>
<td>15</td>
<td>8</td>
<td>2150</td>
<td>Oil</td>
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<td>6</td>
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<td>Oil</td>
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<td>75</td>
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<td>4</td>
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<td>40</td>
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<td>Freeland Rollen Canal, C. J. Freeland, Crowley</td>
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<td>6</td>
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<td>Green-Schoemaker Canal, Crowley</td>
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<td>10</td>
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<tr>
<td>Hurd &amp; Wright, Crowley</td>
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<td>1</td>
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<td>Oil</td>
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<td>40</td>
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<td>Miller Morris I. and L. Co., Ltd., Crowley</td>
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<td>16</td>
<td>120</td>
<td>Oil</td>
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<td>40</td>
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<tr>
<td>Riverside Irrigation Co., Ltd., Jennings</td>
<td></td>
<td>1</td>
<td>125</td>
<td>Oil</td>
<td>15</td>
<td>40</td>
<td>8,000</td>
<td>8,000</td>
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<tr>
<td>Roller Canal Co., Crowley</td>
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<td>125</td>
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<tr>
<td>Union Canal Co., Jennings</td>
<td>1</td>
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<td>125</td>
<td>Oil</td>
<td>15</td>
<td>40</td>
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<td>Wilder Canal, P. D. Wilder, Mermentau</td>
<td>3</td>
<td>2</td>
<td>125</td>
<td>Oil</td>
<td>15</td>
<td>40</td>
<td>8,000</td>
<td>8,000</td>
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<tr>
<td><strong>Calcasieu Parish</strong></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Allen Canal, W. Allen, Lake Charles</td>
<td>1</td>
<td>12</td>
<td>35</td>
<td>Oil or Wood</td>
<td>1</td>
<td>25</td>
<td>140</td>
<td>600 Capacity</td>
</tr>
<tr>
<td>Arcenaux Canal, estate J. H. Rhodes, Welsh</td>
<td>1</td>
<td>1</td>
<td>75</td>
<td>Ivens Pump</td>
<td>1½</td>
<td>30</td>
<td>780</td>
<td></td>
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<tr>
<td>*Bunker Hill Canal</td>
<td>1</td>
<td>1</td>
<td>150</td>
<td>Ivens Pump</td>
<td>1½</td>
<td>30</td>
<td>780</td>
<td></td>
</tr>
<tr>
<td>*Calcasieu River Irrigation Co., Kinder</td>
<td>2</td>
<td>1</td>
<td>125</td>
<td>Ivens Pump</td>
<td>1½</td>
<td>30</td>
<td>780</td>
<td></td>
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<tr>
<td>*A. A. Call Canal Co., Ltd., Shoefelt, Joplin, Charles</td>
<td>2</td>
<td>1</td>
<td>300</td>
<td>Coal</td>
<td>15</td>
<td>140</td>
<td>3,600</td>
<td></td>
</tr>
<tr>
<td>Chaupique Irrigation Canal, H. C. Drew, Lake Charles</td>
<td>2</td>
<td>1</td>
<td>150</td>
<td>Coal</td>
<td>15</td>
<td>140</td>
<td>3,600</td>
<td></td>
</tr>
<tr>
<td>W. R. Conklin Canal, Jennings</td>
<td>2</td>
<td>1</td>
<td>300</td>
<td>Coal</td>
<td>15</td>
<td>140</td>
<td>3,600</td>
<td></td>
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<tr>
<td>T. O. J. and T. L. Co., Crowley</td>
<td>2</td>
<td>1</td>
<td>125</td>
<td>Coal</td>
<td>15</td>
<td>140</td>
<td>3,600</td>
<td></td>
</tr>
<tr>
<td>Farmers' Canal, N. A. Land and Timber Co., Lake Charles.</td>
<td>1</td>
<td>150</td>
<td>1</td>
<td>125</td>
<td>1-15 inches</td>
<td>100,000</td>
<td>Coal, Wood, Oil</td>
<td>30</td>
</tr>
<tr>
<td>---------------------------------------------</td>
<td>---</td>
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<td>---</td>
<td>-----</td>
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<td>----------------</td>
<td>---</td>
</tr>
<tr>
<td>Gauthier Canal, A. M. Gauthier, Jennings.</td>
<td>2</td>
<td>800</td>
<td>5</td>
<td>900</td>
<td>32</td>
<td>32</td>
<td>100,000</td>
<td>Oil</td>
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<tr>
<td>Grand Canal Co., Ltd., Crowley.</td>
<td>4</td>
<td>32</td>
<td>2</td>
<td>33</td>
<td>4</td>
<td>4</td>
<td>5000</td>
<td>Oil</td>
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<tr>
<td>Holton &amp; Winn, J. W. Mercer, Jennings.</td>
<td>7</td>
<td>1200</td>
<td>3</td>
<td>1000</td>
<td>80,000</td>
<td>Oil</td>
<td>2</td>
<td>100</td>
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<tr>
<td>Houston River Canal Co., Ltd.</td>
<td>2</td>
<td>300</td>
<td>2</td>
<td>300</td>
<td>80,000</td>
<td>Oil</td>
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<td>100</td>
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<tr>
<td>Illinois Canal and Rice Co., Ltd., Jennings.</td>
<td>2</td>
<td>300</td>
<td>2</td>
<td>250</td>
<td>30,000</td>
<td>Oil</td>
<td>2</td>
<td>100</td>
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<tr>
<td>Indian Bayou Canal, P. W. Daniels, Pres., Welsh.</td>
<td>2</td>
<td>300</td>
<td>2</td>
<td>250</td>
<td>2-18 inches</td>
<td>100,000</td>
<td>Oil</td>
<td>2</td>
</tr>
<tr>
<td>Keystone Canal Co., Ltd., Jennings.</td>
<td>1</td>
<td>300</td>
<td>2</td>
<td>150</td>
<td>150</td>
<td>Oil</td>
<td>2</td>
<td>100</td>
</tr>
<tr>
<td>Laccasine Irrigation Co., Jennings.</td>
<td>2</td>
<td>120</td>
<td>2</td>
<td>200</td>
<td>1-24 inches</td>
<td>2-18 inches</td>
<td>Oil</td>
<td>2</td>
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<tr>
<td>C. B. Lake &amp; Co., Ltd., Canal, Lake Charles.</td>
<td>2</td>
<td>80</td>
<td>3</td>
<td>315</td>
<td>4-18 inches</td>
<td>30,000</td>
<td>Oil</td>
<td>2</td>
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<tr>
<td>Mayville Canal Co., Ltd., Jennings.</td>
<td>2</td>
<td>300</td>
<td>3</td>
<td>335</td>
<td>60,000</td>
<td>Oil</td>
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<td>100</td>
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<td>McFarland Co., Ltd., Jennings.</td>
<td>2</td>
<td>700</td>
<td>3</td>
<td>135</td>
<td>40,000</td>
<td>Oil</td>
<td>2</td>
<td>100</td>
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<tr>
<td>D. McFarland Canal, Jennings.</td>
<td>2</td>
<td>120</td>
<td>1</td>
<td>105</td>
<td>15,000</td>
<td>Oil</td>
<td>2</td>
<td>100</td>
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<tr>
<td>Missouri Rice Co., Irrigation Canal, Lake Charles.</td>
<td>5</td>
<td>600</td>
<td>1</td>
<td>20</td>
<td>24 in x 24 in</td>
<td>2-18 inches</td>
<td>Oil</td>
<td>2</td>
</tr>
<tr>
<td>Model Farm Canal, Dr. A. J. Perkins, Lake Charles.</td>
<td>2</td>
<td>200</td>
<td>2</td>
<td>200</td>
<td>20,000</td>
<td>Oil</td>
<td>2</td>
<td>100</td>
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<tr>
<td>*North American Rice Co., Lowry.</td>
<td>2</td>
<td>500</td>
<td>2</td>
<td>525</td>
<td>90,000</td>
<td>Oil</td>
<td>2</td>
<td>100</td>
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<td>Norwood Rice Pt., Taylor, Evans &amp; Carhart, Jennings.</td>
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<td>200</td>
<td>2</td>
<td>320</td>
<td>40,000</td>
<td>Oil</td>
<td>2</td>
<td>100</td>
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<tr>
<td>Oak Grove Canal, L. Kaufman, Lake Charles.</td>
<td>1</td>
<td>120</td>
<td>1</td>
<td>120</td>
<td>40,000</td>
<td>Oil</td>
<td>2</td>
<td>100</td>
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<tr>
<td>Robinson Canal, E. M. Clark, owner, Welsh.</td>
<td>1</td>
<td>375</td>
<td>3</td>
<td>135</td>
<td>40,000</td>
<td>Oil</td>
<td>2</td>
<td>100</td>
</tr>
<tr>
<td>Sabine Canal Co., Vinton.</td>
<td>1</td>
<td>450</td>
<td>1</td>
<td>350</td>
<td>40,000</td>
<td>Oil</td>
<td>2</td>
<td>100</td>
</tr>
<tr>
<td>*Southwestern Rice and Irrigation Co., Jennings.</td>
<td>6</td>
<td>480</td>
<td>3</td>
<td>675</td>
<td>40,000</td>
<td>Oil, Coal.</td>
<td>12</td>
<td>100</td>
</tr>
<tr>
<td>Unkels Canal, P. J. Unkels, Welsh.</td>
<td>2</td>
<td>100</td>
<td>2</td>
<td>100</td>
<td>60</td>
<td>Oil</td>
<td>2</td>
<td>100</td>
</tr>
<tr>
<td>Watertown Farm and Irrigation Co., Crowley.</td>
<td>1</td>
<td>120</td>
<td>2</td>
<td>120</td>
<td>25,000</td>
<td>Oil</td>
<td>2</td>
<td>100</td>
</tr>
<tr>
<td>*S. W. Wood &amp; Co., Lake Charles.</td>
<td>2</td>
<td>250</td>
<td>2</td>
<td>250</td>
<td>25,000</td>
<td>Oil and Wood</td>
<td>12</td>
<td>100</td>
</tr>
</tbody>
</table>

**Cameron Parish.**

| E. I. Hall Canal, Jennings.                   | 2 | 120 | 4 | 120 | 150,000 | Oil | 2 | 100 | 10,000 |
| Lakeside Canal, Lakeside Irrigation Co., Jenkins. | 2 | 200 | 2 | 200 | 16,000 | Oil | 2 | 100 | 6,000 |
| LaGonda, Houck Bros., Lakeside.               | 1 | 65 | 1 | 60 | 16,500 | Oil | 2 | 100 | 6,000 |

**Vermillion Parish.**

| Abbeville Canal, Abbeville.                   | 3 | 1500 | 4 | 1200 | 150,000 | Oil and Coal | 18 | 200 | 20,000 |
| Hunter Canal, Crowley.                        | 1 | 1000 | 3 | 1500 | 215,000 | Oil | 12 | 100 | 25,000 |
| L. & H. Canal, Gueydan.                       | 4 | 1000 | 3 | 1000 | 5000 | Oil | 12 | 100 | 5000 |
Besides the above, the Union Relift Company, with a capacity of 200,000 to 225,000 gallons per minute, throws the water over a dam in Bayou Plaquemine Coulee and thus makes it available for three of the above plants.

**Varieties of Rice.**

There is an immense number of varieties, varying in quality, yield and time of maturity. The station has imported a number of Japanese varieties and found some of them, though planted in early spring, would not mature before being killed by frost. There was a great variation in time of maturity of the varieties received.

There is also a difference in size, shape, color and composition, and flavor of the grain, and those varieties are selected which are best adapted to our environments. Varieties are sold on our market for seed under the following names: The Carolina, the Honduras and the Japanese. There are strong reasons for believing that these are not confined to distinctly three varieties, since all imported rice seed are usually called either "Honduras" or "Japanese." Dr. Knapp has the following on varieties of rice: "The Gold seed South Carolina rice sells for as much as any rice on the market. The ordinary lowland rices are much better in quality than the ordinary (non-irrigated) upland rice, provided they are grown on soils which can be drained, but there is a great difference in different varieties, especially in the hardness of the grain. The most desirable rice, from the standpoint of the grower, is one which will produce the largest amount of 'head rice,' that is, unbroken grains. Upland rices or lowland rices of poor quality break up during the process of milling, so that the percentage of head rice often averages only forty to thirty, or sometimes even as low as ten per cent. of the entire crop. The Japanese rices average better than the American as far as their milling qualities are concerned, and for this reason it is desirable that the Japanese rices be more extensively introduced into this country, provided they maintain here the same characteristics as in their native country."

Honduras rice is generally raised on the alluvial lands, while the Japanese rice is mostly cultivated in the prairie section. The Honduras rice ripens about two weeks earlier than the Japan, but.
grows ranker and is more apt to blow down and become tangled and give rise to trouble in harvesting. It is becoming very general in some sections of the prairie to plant both kinds, so as to give a longer harvesting season, as well as to get the benefit of an earlier market.

Whatever variety is selected for seed, it should be pure, free from red rice and the many obnoxious seeds described elsewhere in this bulletin.

Just here a suggestion might be made to those going into rice culture upon lands which have never been cultivated in rice before. If you will select a perfectly pure seed, particularly free from red rice, and grow it with care, keeping it up to its original purity, you will find a market for it as "seed rice" far beyond the price paid for milling rice. This is due to the demand for pure seed, so much of it in Louisiana being adulterated with that intolerable nuisance, "Red Rice." It has been shown by a previous bulletin how difficult it is to exterminate this red rice when once established in the fields.

**CULTIVATION OF RICE**

varies in different sections of the State and sometimes in different communities in the same section. The alluvial sections as a rule pursue an entirely different method from preparation of soil to the harvesting of the crop, to that followed by the planter upon the prairies.

**IN THE ALLUVIAL SECTIONS.**

The ditches for drainage run from the levees to the rear at distances of from 100 to 200 feet apart. As before mentioned, the land slopes gradually from the levees to the swamps. This slope, nowhere precipitous, varies in different fields. Cross embankments at intervals to suit this slope, are thrown up with a plow and perfected with the hoe, or shovel, so as to hold back water enough to cover the plants in the upper part of the plat. These embankments cross the old ditches with either plank or earth dams. The size of the plats thus made by the ditches and cross embankments varies with slope of the land and distance between ditches. Usually they are too small to permit of the successful handling of improved machinery in harvesting the crop.
Two methods of preparing the soil are followed, known as the "dry" and the "wet." In the former the lands are plowed in the fall and winter and thoroughly harrowed and seed sown broad-
cast (or with drill) and harrowed in, similar to planting of oats or wheat. The seed is usually sown in the last days of March or early in April. This method prevails on the upper coast.

In wet culture the fields are flooded and plowed in water. The rice is sown and harrowed in the wet. The water is then withdrawn to permit the rice to germinate. The sowing made directly after plowing is usually done in April or in May. Care must be exercised to prevent the young plants from scalding by the sun at this late period. This custom is practiced by those planters who cultivate black or buckshot clays, because after wetting the soil an ordinary pair of mules can break the land, whereas if dry it will require a four or six-mule team for the same work. However, wet culture has many difficulties unless carefully and judiciously performed.

After the plants are up a few inches high the ground is gradually moistened and the water kept just a little below the tops of the plant until the latter has obtained a good size, when the field is flooded from six to twelve inches deep and kept so until ready for harvest, unless some other disaster overtakes the crop. Should weeds and grass abound they are either pulled out by hand or they are scythed down with the rice, and by flooding, the former are checked or killed and the latter pushed into vigor. During growth a constant but imperceptible flow of water is kept going through the fields. When harvest approaches the water is withdrawn and pumps stopped. The water is now, by law, drawn over our levees through syphons, which, during high water, work automatically, dispensing with expense of a pump.

Ordinarily the water is pumped into a pond on the river side of the levee, formed by an artificial dam so as to bring the surface of the pond higher than the surface of the field next to the levee. The syphon is started and works continuously as the water is pumped from the river into the pond and the surface kept high enough to maintain the operation through gravity. See illustration.

The plowing is usually from four to six inches deep, and a sack of 162 pounds of seed is planted on from two and a half to three and a half acres.
Harvest usually takes place on the river in August. The rice is cut by hand with sickles, laid upon the stubble to cure and afterwards bound into sheaves and put into shocks, where they remain until hauled to the thresher.

In some instances the shocks are bunched till a small stack is formed containing a wagon load of sheaf rice. These stacks are allowed to stand till the rice passes through a "sweat." The rice begins to heat soon after it is bunched, becomes moist from water driven off from the composition of the stem and leaves and grain, the temperature rises till a maximum is reached and then gradually subsides and the stack dries out. This process is probably due to enzymic fermentation, and if it does not occur while in the sheaf it will begin as soon as the grain is put in bulk. When it occurs while the rice is in sheaf, the grain dries out better, hardens better and makes a better milling rice and a better quality of finished product, as it takes a higher polish and shows a whiter pearl grain.

Generally, however, the planter is anxious to get rid of his crop as soon as possible, fearing damage from unfavorable weather.

Improved implements for planting and harvesting the crop have been tried in the alluvial sections, but have not been generally adopted, due to reasons already assigned.

As a rule the river planters strive to place their rice on the market as early as possible, to catch the benefit of the good prices then prevailing.

It is extremely difficult and perhaps unprofitable to cultivate a field continuously in rice on the river. The flooding waters are so filled with grass and weed seeds that the soil soon becomes so charged with these obnoxious plants as either to render the expense of removal excessive, or if left alone, destroy the crop. Hence a rotation of dry culture is imperative every few years.

It is the general custom to grow two crops of rice and then devote the land to something else for a year or more, or let it lie idle for a year, while the strictly aquatic weeds die out.

**CULTIVATION IN THE PRAIRIE SECTION**

is the evolution of the last 12 to 14 years, and, as has been shown, has been produced by the local factors of environment. In the first place, the impervious subsoil permits of rapid drainage and
drying out, when the water is withdrawn. Again, the topography of the country gives large areas of level land, on which improved implements can be used to great advantage. With an abundance of water from canals and artesian wells, added to the above, one finds in this section almost ideal conditions for growing large and profitable crops. Accordingly gang plows, all kinds of harrows, seeders (broadcast and drill) and self-binding harvesters are universally used, and with the exception of flooding the growing crop, and providing levees to hold the water, the culture of rice in Southwest Louisiana varies but little from that of wheat in our Northwestern States. The land is broken with gang plows drawn by four or more mules, and thoroughly pulverized with harrows, and seed sown either broadcast or with drill, at rates of one sack (162 pounds) to three to four acres.

The following intelligent replies to inquiries addressed to Mr. J. F. Shoemaker, of the firm of Green & Shoemaker, of Crowley, one of the most progressive and experienced rice planters in the State, will probably convey information of a practical character to those contemplating embarking in rice culture:

Question—Number of mules to a 500-acre rice farm?

Answer—Twenty; these will run five gang plows. In favorable seasons less might answer for preparing the soil, but this number will be required in harvesting the crop, which would take three harvesters with six mules each, unless ground be unusually good, when five to each machine might do. This leaves only two supernumeraries to take the place of the sore and lame ones which are almost always present on a large farm.

Question—Plows to break with?

Answer—In bad seasons, five 12-inch gang plows would be required to break 500 acres, but in ordinary three, and in very favorable seasons even two would do the work. Would not advise less than three.

Question—Harrons to pulverize?

Answer—The disc and spring tooth harrows are generally used in preparation of the ground. If plowing be done in fall or winter the soil becomes quite compact and requires a surface scarification before seeding. Nothing equals the disc in such work, although if the ground is not too compact the "spring
tooth" will do well and pulverize finer than the disc. Where the
disc is used it is necessary to follow with a smoothing harrow.
Would not dispense with any of them. I keep three of each, which
are ample for a 500-acre rice farm.

Question—Do you plow shallow or deep?
Answer—In breaking the native sod I usually plow two
to two and a half inches. After lying for a few weeks the soil
is disced several times, each time in different directions, finishing
with a smoothing harrow to pulverize even the smallest lumps.

If the sod be broken too deep, it is very difficult to get
pulverization necessary for a good seed bed. Hence two and
a half inches is deep enough. After one crop is taken off, a
little deeper plowing is necessary. I never aim to plow over three
inches, although some have plowed four or five inches deep and
claim good results. Objection to deep plowing is in harvesting;
the drive wheel of the harvester will go as deep as you have plowed,
unless the ground be very dry. Suppose that after we have taken
off a number of crops we may have to go deeper for best results.

Question—Is land flooded before plowing or harrowing?
Answer—It has been done where the ground was so hard that
it could not be plowed dry. It is only resorted to as an alternative
of letting the ground lie idle.

Question—Are seed sprouted before sowing?
Answer—I have never known it to be done, although the
natives used to do it when the custom prevailed of sprouting the
seed and sowing in a pond. This was before the days of irrigation.
Should seed be sown in water it will rot, hence they sprout
before sowing.

Question—Earliest and latest time for planting?
Answer—April 1st to June 10th. Although some plant up to
the first of July, such late planting generally meets with failure.
If I could set a date I would say planting from April 10 to May
15 for the best results. Honduras will stand planting earlier than
the Japan, being a larger and stronger grower, and will make bet-
ter headway from the start. Where a person sows both kinds the
Honduras should be planted first, and it can then be easily taken
off first in the harvest.

Question—Do you prefer to broadcast or drill your seed?
Answer—Formerly seed were sown broadcast. In recent
years the drill is very generally used and is regarded as an improvement over "broadcast." With the drill a more uniform stand is obtained, which means ultimately larger yields. With the drill a good percentage of seed required is saved (some estimating as much as 20 per cent.) by putting it at an even depth, insuring simultaneous sprouting of every seed and a uniform stand.

Question—What machines for planting?
Answer—There are two makes each of the "broadcast" and the "drill." The former are bolted to the rear of a wagon and attached to the wheel of the latter by a chain and sprocket which gives it motion as the wagon is drawn. Cost $12.
The drills are of two makes, either of which do well, and cost $80.

Question—How long after planting before watering?
Answer—Depends largely on the weather and condition of the ground. If the latter be moist and the weather warm so as to produce a good growth, four to six weeks will make it high enough for water. If ground is dry and there is a slow growth of the plant, ten weeks would find it small for flooding. In the latter case, if water be abundant, it would be well to flood and draw off the water as soon as ground is soaked. A person having several cuts can fill the highest one, and then pass the water to the next, and so on, till all are wet. It is necessary to fill the cut full of water before passing it to the next in order to get the highest points wet. By this process a minimum of water is used.

Rice should not be flooded over its top, but fields may be treated as above without detriment to the young plants. When rice on the lowest part of the field is large enough to stand a few inches above the water, then ought permanent flooding be started.

Question—Do you prefer deep or shallow flooding?
Answer—I give each cut a fall of six inches and I fill this cut so that the rice on the highest part will be one inch under water. Some construct their levees so as to have only five-inch fall, which is better, provided it does not give too narrow cuts. Some give greater fall than six inches, but by doing so I believe they get too much water on the rice in the lowest parts. Too
much water causes a weak straw. Experience has taught me
that too much water causes the rice to fall down, when the
water was withdrawn for harvest. Nor were my yields as good
in deep water as in shallow water, even where the general ap-
ppearances were the same. If I could control the depth desired, I
would say not more than four inches. Rice being indigenous to a
hot climate, needs much heat, especially at the roots. If the water
is too deep it prevents the proper amount of heat at the roots.
This is detrimental to the filling of the grain.

Question—In any average season how long do you flood?
Answer—Not far from three months.

Question—How long before harvest do you draw off the
water?
Answer—About the time the rice is passing into the dough
and the heads begin to turn down, which is usually about ten to
fourteen days.

Question—What harvesters are used, and area per day?
Answer—The Deering and McCormick are the harvesters
commonly used. They cut either five or six feet, and the area
cut per day varies with the conditions of crop and ground, within
wide limits, say from five to twelve acres.

Question—How many hands are needed to shock with each
harvester?
Answer—Varies with the weight of crop and conditions of
the ground; generally two.

Question—Usual method of threshing?
Answer—By same machines used for oats and wheat. The
usual price of threshing, when the farmer supplies the hands,
is ten cents per sack of about four bushels. Only the three
hands that run the machine are furnished by the thresher; rest
by the farmer, which, if threshing from the shock, will be about
seventeen men, viz.: three pitchers in the field, six teamsters to haul
rice, two band cutters, two stackers, two to fill sacks and move
from the machine, and two to sew up sacks and pile them. Be-
sides these there should be men and teams to take the rice to
shelter or to mill. If the rice be taken from the stack, six men
less are required. Some are now using what is called a self-feed
attachment to the thresher. These attachments give very satis-
factory results and reduce by three the number of men required.

Question—Rice mills, number and size?

Answer—Mills are being rapidly built in every part of the rice district; therefore accurate data cannot be given. In Acadia parish there are 19 mills of a capacity of 400-500 sacks per twelve hours; Calcasieu parish has 8 mills ranging from 100 to 800 sacks in twelve hours; Vermillion parish has 5 mills of 400-500 sacks per twelve hours each. I cannot give you further data.

Question—Cost of rice lands?

Answer—Varies according to location. In our immediate neighborhood they are higher than elsewhere. Some cannot be bought for $100 per acre. As one goes further out he can buy for fifty, forty, thirty, which are prices for all rice lands tributary to Crowley. In Vermillion and Calcasieu parishes, I believe lands can be bought from twenty-five to fifty dollars per acre, depending on distance from railroad, availability of water, character of land (level or rolling), etc.

Question—Fertilizers for rice?

Answer—Some have been using fertilizers on soil that has been cropped for several years, and all claim good results.

Answer—Rotation has been practiced but little. A change from rice to most any other crop would require a complete reversal of the conditions that obtain in the rice field. Where levees have been constructed drainage ditches must be dug, and vice versa, when one changes back to rice. It is therefore hardly probable that rotation will ever become a general practice.

Question—Are your lands giving way under constant culture of rice?

Answer—Differences of opinion exist. Some claim lands are deteriorating, while others claim no deterioration, and a few improvements from fertilizers held in the bayou waters used for flooding. However, I find that some who have grown rice the longest are resorting to the use of commercial fertilizers and claim that it gives them good returns for the money spent.

Question—Machines for building levees?

Answer—The Burton grader has proven the best for building levees in the field. With eight or ten mules will build two miles per day; cost about $75. There are many different implements for building levees, but none so complete as the above.
Question—Cost of digging canals?
Answer—There is a great variation, from 25 cents to $20 per rod; the latter price only for very small portions of a canal. The average cost of a canal is about $1 per rod, aside from fluming.

Question—Charges per acre for water?
Answer—In times past the price was two sacks per acre. Now the universal price is one-fifth of the crop. By this arrangement the farmer and the canal men share alike the fortune or misfortune of the season.

Question—Are wells a success for irrigating rice?
Answer—Many wells have been put down to a depth of 175 to 300 feet to a bed of coarse sand and gravel. Most of these wells have been a success, though a few have met with failure. Some of the best single wells have irrigated as much as three hundred acres, while the average is about 160 acres. Some claim that the well water is superior to that of the bayou, but in this there is a conflict of opinions, some claiming that the water from the bayou carries in solution a large amount of fertilizer adapted to the growth of the rice. (This subject is discussed from analyses of the waters in another part of this bulletin.—Ed.)

The above questions were answered by several leading planters, but the replies were nearly similar to those given above. Hence only those given by Mr. Shoemaker are inserted, and it is believed that these will be of great value to those seeking investments in rice lands. Supplementary to the above, a few words may be given relative to fertilizers and rotation, both of which will some day be required upon the rice lands of Southwest Louisiana, not only to increase the yield of rice, but the latter especially to cleanse the fields already foul with obnoxious weeds.

Before discussing these subjects, analysis of the products of an acre of rice will throw some light upon the requirements of this plant for fertilizers.

**COMPOSITION OF RICE AND ITS STRAW.**

The proportion of rice grain to straw varies between wide limits. If the ground be very fertile, with an excess of nitrogenous manures, the amount of straw will be large; often excessive. A comparison of many experiments with rice conducted
by this station, shows fluctuations from 1,582 pounds to 2,300 pounds of straw to each 1,000 pounds of threshed rough rice. In these experiments every effort was made to cut the rice at a uniform height, for it is almost needless here to remark that the proportion of straw to grain will still further vary if the rice be cut at unequal heights, leaving stubbles of varying length in the field. The average proportion of straw to rice with yields of about twelve sacks of 162 pounds each per acre, is about two to one.

Therefore a field yielding per acre twelve sacks of 162 pounds each, or 1,944 pounds of rough rice, will carry with it about 3,888 pounds of straw.

One hundred pounds of rough rice will contain 1.19 lbs. nitrogen, .321 lbs. phosphoric acid, and .16 lbs potash; and 100 pounds straw has .756 lbs. nitrogen, .26 lbs. phosphoric acid, and 42 lbs. potash. Therefore, a yield of twelve sacks of rice with its accompanying straw will require a total of:

<table>
<thead>
<tr>
<th></th>
<th>Nitrogen</th>
<th>Phos. Acid</th>
<th>Potash</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,944 lbs. rough rice</td>
<td>23.13 lbs.</td>
<td>6.24 lbs.</td>
<td>3.11 lbs.</td>
</tr>
<tr>
<td>3,884 lbs. straw</td>
<td>29.49 lbs.</td>
<td>10.09 lbs.</td>
<td>16.31 lbs.</td>
</tr>
<tr>
<td>5,828 lbs. Total</td>
<td>52.62 lbs.</td>
<td>16.33 lbs.</td>
<td>19.42 lbs.</td>
</tr>
</tbody>
</table>

Compare this with an average crop of twenty bushels of wheat, with its accompanying straw, which gives:

<table>
<thead>
<tr>
<th></th>
<th>Nitrogen</th>
<th>Phos. Acid</th>
<th>Potash</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,200 lbs. wheat</td>
<td>28.32 lbs.</td>
<td>10.68 lbs.</td>
<td>7.32 lbs.</td>
</tr>
<tr>
<td>2,000 lbs. straw</td>
<td>12.00 lbs.</td>
<td>2.40 lbs.</td>
<td>10.20 lbs.</td>
</tr>
<tr>
<td>3,200 lbs. Total</td>
<td>40.32 lbs.</td>
<td>13.08 lbs.</td>
<td>17.52 lbs.</td>
</tr>
</tbody>
</table>

It will therefore be seen that one sack of rice, with its straw, will require 4.38 lbs. nitrogen, 1.36 lbs. phosphoric acid, and 1.62 lbs. potash, while two bushels of wheat with its straw requires 4.03 lbs. nitrogen, 1.30 lbs. phosphoric acid, and 1.75 lbs. potash.

These comparisons will show that a sack of rough rice, containing 162 pounds, carries with it and its straw, about the same quantity of fertilizing ingredients that two bushels of wheat weighing 120 pounds, with its straw, contains.

But since the yield of rice per acre is so much greater than that of wheat, the total draft upon the soil is about the same.
With these figures one can learn something of the fertilizing requirements of the rice plant, and it is important to note that its greatest draft is made upon the most costly of all fertilizing ingredients—nitrogen (over 50 pounds per acre with a yield of twelve sacks). The phosphoric acid and potash are not excessive, only about 16 pounds of former and 19 pounds of latter.

Cotton seed meal at the rate of 700 pounds per acre will supply the nitrogen and more than supply the phosphoric acid. It will only supply fourteen out of the nineteen pounds of potash required.

The above is a theoretical calculation of the amounts required by the crop. No allowance is made for the amount which can be supplied by the soil and the irrigation waters. But it should be remembered that good husbandry requires maintenance of soil fertility, and to do so there must be restored to the land those elements which the crops annually remove, and rice is no exception to this rule.

IRRIGATION WATERS.

The principal sources of supply come from rivers, lakes, bayous and artesian wells. The analyses of these waters were made at the experiment station, and are herewith given in tabulated form. From these analyses the amount of plant food supplied by irrigation during one season can be determined pretty accurately, when the amount of water used per acre is known. It is assumed in Louisiana that each acre of rice during irrigation receives daily what is nearly equivalent to one-half inch rainfall, or about 13,500 gallons. If the period of irrigation extends over ninety days this would be equivalent to a rainfall of 45 inches. Deducting the average amount of rainfall for our summer months, which is not far from 20 inches, and there will be 25 inches, or 675,000 gallons, of irrigation water required for each acre of rice. This amount will weigh over 2,800 tons (5,625,000 pounds). By looking in table the amount of plant food supplied by irrigation during the entire season, can be calculated when the quantity of water applied is known.
<table>
<thead>
<tr>
<th>Localities</th>
<th>Sources of Supply</th>
<th>Solid Matter</th>
<th>Ash</th>
<th>Organic Matter</th>
<th>Free Ammonia</th>
<th>Albuminoids</th>
<th>Nitrates</th>
<th>Nitrites</th>
<th>Lime (CaO)</th>
<th>Acid (P.O.)</th>
<th>Phosphoric Acid (F.O.)</th>
<th>Potash (K.O.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jennerette</td>
<td>Art. well, 700 feet</td>
<td>480.0</td>
<td>400.0</td>
<td>80.0</td>
<td>0.10</td>
<td>-0.96</td>
<td>0.50</td>
<td>0.02</td>
<td>39.40</td>
<td>0.64</td>
<td>6.62</td>
<td></td>
</tr>
<tr>
<td>Mandeville</td>
<td>Art. well, 220 feet</td>
<td>179.4</td>
<td>150.4</td>
<td>29.0</td>
<td>0.09</td>
<td>0.06</td>
<td>0.2</td>
<td>none</td>
<td>3.66</td>
<td>0.21</td>
<td>4.46</td>
<td></td>
</tr>
<tr>
<td>Lake Charles</td>
<td>Art. well, 500 feet</td>
<td>245.0</td>
<td>219.0</td>
<td>26.0</td>
<td>0.09</td>
<td>none</td>
<td>0.20</td>
<td>none</td>
<td>3.60</td>
<td>0.21</td>
<td>4.46</td>
<td></td>
</tr>
<tr>
<td>Gueydan</td>
<td>Bayou Queue De Tortue</td>
<td>545.0</td>
<td>440.6</td>
<td>103.0</td>
<td>0.18</td>
<td>0.28</td>
<td>1.357</td>
<td>trace</td>
<td>16.40</td>
<td>0.69</td>
<td>5.43</td>
<td></td>
</tr>
<tr>
<td>Jennings</td>
<td>Mermentau river</td>
<td>348.0</td>
<td>299.0</td>
<td>49.0</td>
<td>0.082</td>
<td>0.3456</td>
<td>6.736</td>
<td>trace</td>
<td>39.66</td>
<td>1.28</td>
<td>5.43</td>
<td></td>
</tr>
<tr>
<td>Fenton</td>
<td>Art. well</td>
<td>286.6</td>
<td>180.6</td>
<td>106.0</td>
<td>0.023</td>
<td>0.45</td>
<td>0.692</td>
<td>none</td>
<td>38.40</td>
<td>1.45</td>
<td>4.26</td>
<td></td>
</tr>
<tr>
<td>Covington</td>
<td>Art. well, 610 feet</td>
<td>161.6</td>
<td>133.0</td>
<td>28.6</td>
<td>0.08</td>
<td>none</td>
<td>0.04</td>
<td>trace</td>
<td>15.40</td>
<td>0.69</td>
<td>8.27</td>
<td></td>
</tr>
<tr>
<td>Ponchatoula</td>
<td>Art. well, 232 feet</td>
<td>237.0</td>
<td>188.0</td>
<td>39.0</td>
<td>trace</td>
<td>0.205</td>
<td>0.80</td>
<td>0.60</td>
<td>11.50</td>
<td>1.43</td>
<td>6.40</td>
<td></td>
</tr>
<tr>
<td>Ponchatoula</td>
<td>Art. well, 100 feet</td>
<td>512.6</td>
<td>450.0</td>
<td>62.6</td>
<td>1.98</td>
<td>0.20</td>
<td>1.00</td>
<td>0.40</td>
<td>2.0</td>
<td>10.24</td>
<td>11.64</td>
<td></td>
</tr>
<tr>
<td>Abita Springs</td>
<td>Art. well, 585 feet</td>
<td>184.0</td>
<td>154.0</td>
<td>30.0</td>
<td>.05</td>
<td>none</td>
<td>0.24</td>
<td>0.06</td>
<td>0.7</td>
<td>0.74</td>
<td>4.80</td>
<td></td>
</tr>
<tr>
<td>Kenner</td>
<td>River</td>
<td>340.0</td>
<td>190.0</td>
<td>50.0</td>
<td>.005</td>
<td>.365</td>
<td>0.15</td>
<td>.005</td>
<td>.365</td>
<td>.15</td>
<td>0.05</td>
<td></td>
</tr>
<tr>
<td>Frierson</td>
<td>Art. well</td>
<td>1154.0</td>
<td>711.0</td>
<td>443.0</td>
<td>8.55</td>
<td>0.36</td>
<td>0.504</td>
<td>none</td>
<td>34.00</td>
<td>0.835</td>
<td>trace</td>
<td></td>
</tr>
<tr>
<td>Belcher</td>
<td>Art. well</td>
<td>1050.0</td>
<td>870.0</td>
<td>172.0</td>
<td>0.073</td>
<td>1.14</td>
<td>0.368</td>
<td>none</td>
<td>30.00</td>
<td>0.64</td>
<td>0.84</td>
<td></td>
</tr>
<tr>
<td>Bon Amie</td>
<td>Art. well, 198 feet</td>
<td>253.9</td>
<td>200.4</td>
<td>53.5</td>
<td>0.17</td>
<td>0.24</td>
<td>0.17</td>
<td>none</td>
<td>5.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strader Station</td>
<td>Art. well</td>
<td>619.0</td>
<td>533.4</td>
<td>85.6</td>
<td>3.08</td>
<td>0.50</td>
<td>1.214</td>
<td>trace</td>
<td>43.30</td>
<td>2.90</td>
<td>3.91</td>
<td></td>
</tr>
<tr>
<td>Baton Rouge</td>
<td>Art. well, 785 feet</td>
<td>246.7</td>
<td>209.6</td>
<td>37.1</td>
<td>0.089</td>
<td>0.116</td>
<td>0.033</td>
<td></td>
<td>8.63</td>
<td>0.551</td>
<td>2.21</td>
<td></td>
</tr>
<tr>
<td>New Orleans</td>
<td>Rain water</td>
<td>.190</td>
<td>.99</td>
<td>.500</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.63</td>
<td>0.551</td>
<td>4.20</td>
<td></td>
</tr>
<tr>
<td>Lake Charles</td>
<td>English bayou</td>
<td>116.5</td>
<td>85.0</td>
<td>31.6</td>
<td>0.041</td>
<td>0.067</td>
<td>1.93</td>
<td>0.25</td>
<td>6.20</td>
<td>0.64</td>
<td>4.20</td>
<td></td>
</tr>
<tr>
<td>Livingston</td>
<td>Denhem Springs</td>
<td>223.0</td>
<td>199.0</td>
<td>24.0</td>
<td>0.048</td>
<td>0.056</td>
<td>0.080</td>
<td>none</td>
<td>12.50</td>
<td></td>
<td>trace</td>
<td></td>
</tr>
<tr>
<td>Natchez, Miss.*</td>
<td>Art. well</td>
<td>0.120</td>
<td>0.036</td>
<td>none</td>
<td>0.00</td>
<td>none</td>
<td>0.00</td>
<td></td>
<td>.64</td>
<td>0.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Near Head Pearl River</td>
<td>Ozone Spring</td>
<td>.002</td>
<td>.056</td>
<td>.080</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.00</td>
<td>0.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Meridian, Miss.*</td>
<td>Reservoir</td>
<td>.005</td>
<td>.136</td>
<td>.130</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.00</td>
<td>0.00</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* John Lewis Porter, New Orleans.
If we assume the rainfall to be 20 inches during the time the rice is under irrigation and that all the rainwater is retained on the field, this would represent 4,500,000 pounds of water per acre. From the foregoing analyses we make the following estimates by way of illustration of the fertilizing elements contained in these waters per acre irrigated:

<table>
<thead>
<tr>
<th></th>
<th>Nitrogen</th>
<th>Phos. Acid</th>
<th>Potash</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 inches rain fall</td>
<td>7.75</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25 inches Mississippi river water</td>
<td>6.67</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total on river lands</td>
<td>14.42</td>
<td></td>
<td></td>
</tr>
<tr>
<td>English bayou, Lake Charles, La</td>
<td>12.549</td>
<td>3.60</td>
<td>23.62</td>
</tr>
<tr>
<td>Total on land irrigated with this water, 20.299</td>
<td>3.60</td>
<td>23.62</td>
<td></td>
</tr>
<tr>
<td>Bayou Queue De Tortue, Gueydan</td>
<td>9.061</td>
<td></td>
<td>20.70</td>
</tr>
<tr>
<td>Total on land irrigated with this water, 16.811</td>
<td></td>
<td>20.70</td>
<td></td>
</tr>
<tr>
<td>Artesian well, 500 feet, Lake Charles</td>
<td>1.631</td>
<td>1.181</td>
<td>24.35</td>
</tr>
<tr>
<td>Total on land irrigated with this water, 9.381</td>
<td>1.181</td>
<td>24.35</td>
<td></td>
</tr>
<tr>
<td>Amount required for 12 sacks rice</td>
<td>52.62</td>
<td>16.33</td>
<td>19.42</td>
</tr>
</tbody>
</table>

In the above analysis no account is taken of the sediment carried in suspension by the river waters. This, in the Mississippi river, according to analysis made by Humphrey and Abbott, constitute 1-1500 of the weight of the water. Therefore, the Mississippi river waters would furnish, besides the above, in solution, a sediment of 3,750 pounds to each acre irrigated. This sediment has goodly quantities of organic matter containing nitrogen, as well as some phosphates and potash, and unquestionably aids in maintaining the fertility of the soil.

It will be seen from these results that a considerable quantity of nitrogen, potash and some phosphoric acid is conveyed to the field in the irrigation water and the rainwater, but whether this is a valuable source of these elements is not determined. It has been claimed by some parties that the well and bayou water would practically supply the demands of the rice crop. It will readily be seen that this is impossible. Again from the above-
estimates we must subtract the estimate of the contents of the water that is drawn from the field just before harvest, which will be at least one-tenth or more of the entire amount of water supplied. We have no data as to the comparative contents of the irrigation water as it leaves the field. Here again comes in a number of variable factors that would complicate estimates and determinations. Through "chemical affinity" the soil is able to absorb a certain amount of salts from aqueous solution when the water filters through it. This power decreases as the point of saturation is approached, and also varies with the density of the solution from which the salt is being absorbed.

Again the roots of the plants exercise a selective power in absorbing salts, and we have no reason to believe rice is different in this respect from other plants. In taking up a given quantity of the salt, it may take up more or less water than contains that amount of the salt, according to the density of the solution. In very dilute solutions the plant may absorb the salt faster than it does the water in which the salt is dissolved. In dense solutions it dissolves the water faster than it does the salt. In short when plants are growing in water cultures that are very dilute they absorb the necessary salts and leave the solution more dilute. Plants growing in water cultures of considerable density absorb the water faster than the salt and leave the solution more dense. The irrigation water contains the nutritive elements referred to in very dilute form, and it may be that the chemical affinity of the soil and the selective power of the plant retain in the field a portion of these nutritive elements. On the other hand the soil may contain nutritive elements beyond the point of saturation of chemical affinity, and the water that is drawn away from the fields or leaks from the levees may be carrying away much more fertility than it carried to the field. Quite extensive research work on this subject would be necessary before one could speak with authority on the value of the fertilizing elements contained in the irrigation water.

FERTILIZERS FOR RICE.

Nitrogen.—All cultivated crops utilize the nitrogen required in the form of nitrates and these are abundantly formed in every fertile soil by the process of nitrification, the work of micro-sopic organisms. Both the organisms involved and the conditions under
which they perform the work of the conversion of the organic nitrogen into nitrates, have been frequently and thoroughly studied.

One of these conditions requires drainage or removal of excessive water, which destroys or drowns the microbes.

Therefore the process of nitrification cannot take place in an inundated field and the application of fertilizers containing organic nitrogen, such as cotton seed meal, tankage, dried blood, stable manure, etc., cannot be converted into available nitrates in a flooded rice field.

If applied, the fields should be left dry and in good tilth, sufficiently long to promote nitrification enough to supply the prospective wants of the future crop. How long a time should be required for this, is not yet definitely decided. Perhaps a thorough preparation of the soil with the application and thorough incorporation of such fertilizers as cotton seed meal, dried blood, stable manure, etc., early in January, with occasional subsequent cultivation with disc or other harrows, in case the soil becomes compact, until the rice is planted, would accomplish their conversion into nitrates. During this time the fields should be well drained.

In some instances attention has been called to fields that have been in rice for a number of years where the stem and leaf growth has gradually become more vigorous, as if the supply of nitrogen was becoming more abundant rather than being depleted. The probable explanation of this is as follows: For centuries the soil was water soaked and became very compact. Nitrification had been reduced to a minimum degree. When the soil was plowed and reclaimed from the prairie, the surface began to assume a condition of tilth, air penetrating it as deeply as plowed, and nitrification has been bringing the locked-up nitrogen into an available form. The tillage and drainage has improved the natural condition of the soil. This effect, however, must soon cease to be exemplified.

It must be remembered that nitrogenous fertilizers produce rank growth of stem and leaves, and where there is already trouble from rice blowing down, these fertilizers should be used with caution. Probably more nitrogenous fertilizers may be used with Japan rice than with Honduras, since the latter is prone to produce larger and taller stems naturally.
It can be said in general that land that produces sufficiently large straw does not need nitrogenous fertilizer. If the straw is small and weak it needs nitrogenous fertilizer.

When the straw and heads are already well proportioned and fertilizer is applied, nitrogenous fertilizer should always be added with phosphate fertilizers. Where dry culture is practiced between rice crops, the supply of nitrogen may be supplied by cultivating cow peas, or other leguminous crops. However, good drainage between the time of harvest and the following flooding of the next crop will materially augment the amount of available nitrogen, by allowing nitrification to take place.

**Phosphoric Acid.**—This ingredient, in which many of our soils are deficient, and which exists in very small quantities in the irrigation waters, as will be seen from reference to the table of analysis, cannot be resupplied to the soil in any way except in the form of commercial fertilizer. There is none in the air and practically none in the water. Phosphoric acid is necessary, especially to fill out the grain. It also helps to make a stronger, more stocky stalk. Nearly all of our rice lands could be profitably fertilized with a good phosphoric acid fertilizer. Where rice produces a fairly good or even rank growth of stalks and fails to mature seed, it is no doubt in nearly all cases due to a deficiency of available phosphoric acid. The available phosphate has been exhausted in supplying the requirements of the excessive nitrogen component and when time comes for the grain to mature this element is lacking and so no gran is produced. Such results are most frequent in new land, and diminish as the excess of nitrogen is used up.

It may be said in general that wherever the heads fail to develop as heavy grain as should be, it indicates a deficiency of phosphoric acid and this element should be supplied in commercial form. Acid phosphate, ground bone, dissolved bone, are some of the most common forms of commercial fertilizers rich in phosphoric acid.

**Potash.**—It is probable that we can almost overlook this element in our fertilizers for rice in many localities, while it may be beneficial to some extent in other soils. By reference to the tables given it will be seen that the waters of the bayous and wells are
fairly rich in potash, indicating that it has been dissolved out of
the soil over which the water has passed. Most of our soil is rich
enough in potash, and it is safe to begin the use of commercial fer-
tilizers without considering the potash component.

Another suggestion as to a probably successful mode of ap-
plying fertilizers, particularly to those fields from which there is
no escape of the applied water. Nitrate of soda is a commercial
form of fertilizer, containing fifteen to sixteen per cent. nitrogen.
It is extremely soluble in water, and in form readily assimilable by
all growing plants. This commercial salt might be applied in small
quantities continuously to the water at the flood gate. It would
soon diffuse itself through the entire mass of water and go with
the latter to every part of the field. High grade acid phosphates,
containing its phosphoric acid in water soluble form, and some
form of the German phosphate salts, also soluble in water, might
both be applied with nitrate of soda. On a small area, the above
suggestion is well worthy of a trial, particularly in Southwest
Louisiana, where the impervious subsoil would prevent leaching,
and no irrigation waters are permitted to waste.

**Stable Manure.**—Some parties have applied stable manure
to rice fields in heavy applications and caused the rice to produce
an excessive growth of stem and it would fall down and produce
no rice. Instances of this kind are evidences of bad judgment.
Stable manure is rich in nitrogenous matter, and should not be
applied too heavily. A few loads per acre is sufficient, and it is
well to add some acid phosphate with this. Where mounds have
been leveled down, stable manure is a most valuable fertilizer to
put on the spots that would otherwise remain unproductive. All
the stable manure on the rice farms can be profitably used if used
judiciously.

**Rotation of Crops.**

It is evident that since we are removing more of the fertility
of the soil in each crop than is being replaced, continuous culti-
vation of our fields must eventually become unremunerative. No
soil can stand such drain without detriment to its fertility ulti-
mately. Aside from this consideration, the increasing foulness of
our fields suggests a rotation of crops for the destruction of noxious
plants. The irrigation waters are scattering the seeds of these
plants over every farm. Red rice is a constant enemy to the production of prime quality of grain. Again a rotation with dry crops would ameliorate the mechanical condition of the soils, and increase by nitrification the available nitrates therein. If a leguminous crop, like the cow pea, could be made a part of the rotation, there would be added to the soil, by turning it in, at least 100 pounds of nitrogen per acre. By applying to this crop acid phosphate and potash, at the time of planting, it would be largely increased in quantity and quality, and by turning in the entire crop greatly add to the fertility of the soil. Such a practice might present a solution to the difficult problem of how to fertilize rice.

In Java the crop rotation practiced is, first, sugar cane; second, leguminous crop; third, rice; fourth, leguminous crop; fifth, rice; making a three years' course with two crops of rice, two of legumes and one of sugar.

The rainfall there furnishes about 9 pounds of nitrogen annually per acre. The irrigation water for the two crops of rice is applied at rates of 18,000 gallons per day for 120 days for each, containing in the alluvium deposited, one per cent. soluble potash and two-tenths of each phosphoric acid and nitrogen. Prinsen Gerligs has found that the fertilizing ingredients of irrigation water varied within wide limits, being very great after heavy rains in the country supplying them. Enough phosphoric acid and potash for the two crops of rice and sugar cane are supplied in the irrigation waters, but it was necessary to grow two crops of legumes in order to supply the deficient nitrogen. Several leguminous plants are popular in Java, among others, our common beans, peanuts, and soja beans.

A rotation involving a hoed crop like sugar cane and a leguminous crop like cow peas, with rice, would not only aid in retaining the fertility of the soil, but in extirpating the obnoxious weeds.

The major portion of the rice section in the prairie region does not produce good corn, cotton and sugar cane. But we believe this is mainly due to the mechanical condition of the soil and lack of drainage, and the productiveness will increase from year to year under proper management. Small patches of cane and corn in garden spots are often seen as fine as can be produced anywhere. It can hardly be doubted that the proper study
and attention would develop crops well suited to the system of rotation.

The large tracts of land owned by corporations and worked by tenants who shift from one community to another present a greater problem in this regard than does the case where the man owns and cultivates his own land.

With the sugar houses turning out large quantities of cheap molasses which are available as carbohydrates, the cotton seed furnishing the meal so rich in protein, the rice mills with their valuable by-products, rice bran and polish, with the possibilities of hay production on almost every farm, it is hoped that the rice planters may be induced to add stock raising to rice farming, which will help to bring about rotation, and add to the income a source of profit from the production of fat beeves for the market, home-raised pork, and butter and milk to at least supply the domestic demand.

STACKING RICE.

Of late there has been considerable discussion in regard to the advisability of stacking rice before threshing. This subject was briefly referred to in another section. The advantage in stacking comes from protection from the weather before threshing and from stack curing. If properly done the fermentation that takes place during the stack curing improves the milling quality of the rice, but if improperly done it may injure the grain from stack burning. We produce here two letters from practical rice growers which present a very good discussion as given in current rice literature:

"If the rice is dry and the weather favorable and one is unable to get hands or a threshing machine for some time, he had better stack. When a machine can be secured, thresh out of the shock without delay.

If there are no good places for stacking on the ground in the field, it will pay to use platforms to build stacks on. Use 6x8-inch sills and 2-inch planks for the floor. I would not advise the use of covers for well built stacks. If covers are used, they should be made of heavy, oiled or tarred tarpaulin.

The main point in stacking rice is to keep the center full. If
you wish to build a medium sized stack, make it oval. I would not
make it too small, say from fifty to seventy-five shocks.

The small shocks recommended on page one of the August Rice
Journal will do for wet or unsettled weather. It takes less time
for a small stack to dry, and the rice is not so liable to heat. From
the first to the fifteenth of October is the best time to put rice into
large stacks, if large ones are used. If small stacks are used, put the rice into them as soon as the rice is harvested.

Two teams with one pitcher in the field and one stacker can
handle from ten to fifteen acres per day. At the ruling wages,
the cost would be $9.50 per day. The cost for 100 acres would be
from $60 to $95. I would say that it would cost from $50 to $75
per 100 acres to haul rice from the shock to the thresher, if the
thresher does good work with no delays. The farmer who owns a
threshing machine and saves his own grain first is the "lucky man."
—W. D. Spencer, in Rice Journal and Gulf Coast Farmer.

"I believe it will always pay to stack rice. I do not think plat-
forms under stacks pay in this territory. I have had good success
stacking on the ground. You can generally find high ground near
enough to stack on in this country.

When a stack is not finished at night and there is danger of
rain, a large canvas, like a separator tarpaulin, is fine to throw over
the stack. Under no other circumstances is a cover needed. If a
stacker knows his business, his stacks need no cover, since they can
be finished with rice itself so as to leave only two sheaves exposed
to the weather.

Keep the center of the stack full, at least four feet above the
outside. Do not tread near the outside of a stack. For this coun-
try I think round stacks that will hold, say, one hundred bags, are
the best. Set four of them so they can be tabled at one setting of
the machine.

I do not think the small stacks mentioned are as good as large
stacks; but when for any reason a man cannot put up large stacks,
they are very good substitutes. When a man has to wait for a
thresher, he should be stacking right along. The best time to begin
is just as soon as the rice is dry enough to stack, which will be as
soon as the natural juices and moisture are out of the straw—en-
tirely out, not when the straw is just wilted.

It will cost about $95 per 100 acres to stack rice where every-
thing is convenient. If it must be hauled some distance, it will cost more, say $120 per 100 acres. On the average I think it will cost about $100 per 100 acres to haul rice from the shock to the thresher.

A man should go over the field after every wind storm and put on the caps that have blown off. Where some shocks have settled crooked or have broken down, they should be doubled into small stacks, as shocks once broken can never be reset to stand.” — M. Romain, in Rice Journal and Gulf Coast Farmer.

**MEMORANDA OF WEIGHTS, MEASURES, ETC.**

As the rice comes from the thresher it is put in sacks, which hold about 4 bushels.

A sack of rough rice weighs from 160 to 190 pounds, depending largely upon the quality of grains.

A bushel of rice weighs 44 pounds.

A barrel of rice is estimated at 162 pounds.

An acre yields from 6 to 12 sacks, and in exceptional cases double this yield is secured.

A sack of rough rice will mill about 100 pounds of clean rice.

A pocket of rice is 100 pounds of clean rice, and is the form in which the product is almost exclusively sent to market.

Price of rough rice ranges from $1.50 to $4.75 per bag, according to amount of red rice, weed seeds, quality of grain, etc.

A harvester will cut from 6 to 10 acres of rice per day.

A threshing machine will thresh from 300 to 500 sacks of rice per day.

Cost of threshing is about 10 cents per sack.

**SOURCE OF NITROGEN AS FOOD FOR THE RICE PLANT.**

Some experiments were made by Mr. Dodson and Mr. Glenk for the purpose of determining whether the rice got any of its nitrogen in a form other than as nitrates, and also to determine whether nitrification was retarded or stopped by flooding the fields.

For the determination of the first point, a number of artificial soils were prepared, in which the nitrogen was supplied in different forms.

Pots were filled with pure white sand, which had been washed with distilled water and sterilized. This served as a matrix, and
the rice seeds were planted in the sand and kept moist till germination and growth to the proper height for flooding. The jars were then kept full of the nutritive fluid. After the plants were a few inches high they were left in the garden, exposed to normal sun and rain. As the pots became much warmer than the sun after a couple of weeks the pots were imbedded in the soil, and provision made to exclude soil or soil water from contaminating the cultures. No protection from dust was provided. Nitrogen was furnished as NO₂, NO₃, NH₃ humus, and as soil. The pot containing NH₃ made quite a vigorous growth, indicating the utilization of nitrogen in this form.

Numerous tests were made for nitrites and nitrates in the soil of irrigated rice fields. It was found that toward the close of the irrigation season practically no nitrite was left in the soil, indicating that the first step in the process of nitrification had been arrested.
PART II.

RICE WEEDS IN LOUISIANA.

The rice fields of Louisiana offer conditions peculiarly favorable for the growth and dissemination of weeds that normally inhabit wet or flooded soils. Quite a number of weeds increase with such rapidity and grow so luxuriantly in the rice that expensive methods of getting rid of them are often imperative. All flowering plants that have a harmful effect upon the cultivation, development, harvesting or marketing of the rice crop will be designated as rice weeds. Besides what are commonly called weeds, grasses, sedges, and even red rice, would come under this head. In this article it is our purpose to discuss the weeds that have proven to be most menacing to the rice crop, with such information as has been obtained regarding their reproduction, dissemination, and general life habits, and to point out some of the advantages of various methods to be adopted for their extermination. While we shall have occasion to refer to the weed seeds at the rice mills, the weed question must be solved primarily by the rice grower, and the most of the discussion will be from the standpoint of a planter.

It is self-evident that a crop with weeds in it produces a less quantity and of an inferior grade to what it would without the weeds.

The weed takes up valuable fertilizing elements that rightfully belong to the rice plant, occupies a space that should be occupied by a rice plant, and the shade produced interferes with the fullest development of the rice. The presence of weed seeds in the rice causes more trouble between the producer and the buyer than most any other one source of contention. It is hard for the miller to tell how much is going to be lost in cleaning the rice of seeds, or how much will remain with the grain when it comes out as a fin-
ished product. It is simply a matter of self protection that he should cut down the price very materially on account of the presence of any considerable quantity of seed from various weeds.

Besides these losses the efforts directed toward the destruction of weeds in the rice fields in Louisiana amounts to a great many thousand dollars annually.

The planter should not only be conversant with the habits of the weeds already infesting his rice fields, so as to adapt his methods of dealing with them to best suit the various conditions that obtain in different years, but he should know the most baneful weeds that are liable to invade his territory from without, so that the new enemies may be recognized and measures adopted to secure their extermination before they have become widely disseminated.

It is not infrequent that the knowledge of the life habits of a weed will enable one to successfully hold it in check at a minimum of expense, whereas, without such knowledge, efforts at extermination, being blindly directed, will be all but useless.

It goes without saying, that weeds are more prolific and harder than cultivated plants. It is chiefly their persistency that renders them noxious.

The production of a large number of seeds, the adaptation for sure and wide dispersion of same, the preservation of the vitality of the seed under adverse circumstances, the ability of the plant to withstand unfavorable conditions as to light, warmth and moisture, the undesirability of the plant as food for animals, their freedom from fatal fungus diseases and insect enemies, are the principal characters that enable our worst weeds to obtain such predominance. Fortunately few individuals possess all these characteristics. As it is not practically possible to prevent all weeds from maturing seeds, nor to kill all seeds that mature, the planter must direct his efforts along both lines of extermination. A general understanding of the life habits of weeds, supplemented by close observation, will enable him to direct his efforts in a most effectual manner.

DISSEMINATION OF WEED SEEDS.

(1) BY WATER CURRENTS.

Water is a very important agent in distributing seeds, and especially is this true in the rice sections of the State. Some of
the worst and most widely distributed rice weeds are primarily dependent upon water currents for their distribution. The seeds of the "curly indigo" (Aeschynomene Virginica) are always accompanied by a portion of the seed pod, which acts as a float, carrying them on top of the water, and as the pod breaks into as many segments as there are seeds, wide dispersion is assured. The seed of the "tadpole grass" (Rhynchospora corniculata) has a large, long spear which prevents it from sinking till it becomes thoroughly soaked. The "alligator head" (Diodia teres) is covered with fine hairs, which are repellant to water and prevent the seed from becoming wet for a considerable time, and the air bubble which is consequently formed about the seed will cause it to float on the surface of the water.

One seed from each pod of the "turtle back" is encased in a little boat, as it were, resembling a turtle shell, which may float the seed to remote parts of the fields. The very small seeds, like those of the seed box, sea weed, etc., and some grasses, are so small that a gentle current of water will carry them almost indefinitely, unless some obstruction stops them. It is only when the water becomes still and the seeds thoroughly soaked that they sink to the bottom.

Few of them germinate till the field is drained, and consequently do not develop till after the harvest, or till the following year. Some of them, however, may be drifted against the levees, and a slight recession of the water leaves the seeds in condition favorable to immediate germination.

Fragments of stems or seed pods may assist to secure dissemination, by causing the seeds to float in the water currents. It will be seen that the rice fields offer conditions for the wide distribution of the seeds possessed of the characters referred to. The enormous increase of weeds in the fields the second year it is devoted to rice culture is thus partially explained.

Dispersion may not only occur during the time the rice is flooded, but even to a greater extent during the fall and winter from the heavy rains that temporarily flood the fields.

SEEDS INTRODUCED IN RIVER WATER.

The alluvial lands of the State devoted to rice culture are apt to develop a great variety as well as a great number of weeds not previously established there. During the low water of summer and
fall, the river banks become densely populated at many places with thrifty weeds, and seeds mature and fall to the ground in great numbers. The following spring, when heavy rains come, the river gradually climbs the banks, and the lapping waves sweep seeds and fragments of weeds into the current, where some of them may be carried to considerable distances. Local freshets wash many seeds from branches and bayous into the river. The river is frequently on the rise, and therefore carrying its greatest burden of seeds when the time arrives to begin pumping water to cover the rice fields in the early spring. When the water carrying the seeds is passed from the canals into the rice plots, the current being very greatly checked, its carrying powers greatly diminished, the seeds are dropped on the soil and at some time find conditions favorable for development. The number of seeds carried by the river water is very great and there is no doubt the fields may become badly infected from this source with a great variety of weeds; at the same time much is attributed to the water that is really traceable to the oversight of the planter in allowing weeds to mature seeds within the limits of his fields.

Estimates were made at different times of the number and kinds of weed seeds carried by the Mississippi. Water taken from near the surface of the river has been found to contain vast numbers of seeds, amounting to a dozen or more per pint of water. At other times, we have measured and strained several gallons without obtaining a single seed. Water from deeper sampling also contained considerable quantity of weed seeds.

The planters of Southwest Louisiana obtain water for flooding from the bayous and deep wells. Of course in the well water there are no seeds. The bayous being very sluggish, have very little carrying power, and the seeds that find their way into these streams soon sink to the bottom, or floating, are drifted to the shore. Therefore, the imported weeds of this section are not as numerous as in the alluvial lands. There is at present very little money spent in weeding the rice in this section, but several bad weeds have become widely distributed and only the strictest vigilance will prevent them becoming a very great source of annoyance. Some dangerous species have found a foothold along the main canals, from which they may become generally distributed, unless preventive measures are
adopted. In some limited sections the weeds are already quite annoying, as will be seen from the particular species discussed in detail later on.

ADVANTAGES OF SYPHONING WATER OVER THE LEVEE FROM A RESERVOIR.

When the water is pumped from the river to a reservoir and then syphoned over the levee, many seeds will settle to the bottom of the reservoir. The larger the reservoir, and the less current in it, the greater number of seeds deposited in the bottom.

LOCAL SOURCES OF WEEDS.

Many planters who do not give close personal supervision to their plantations, and some who are not diligent in their fight against noxious weeds, pay little or no attention to the banks of ditches or canals that lead the water to the fields, or to areas not actually occupied by the rice. Elevated places in the fields that are not easily flooded are allowed to grow up in weeds and seeds become widely scattered from such places. One of the illustrations given elsewhere was made from a photograph taken in a field cultivated by a gentleman who is considered one of the best planters in the State. It is known to the writer that this gentleman spent a large sum of money for weeding rice, and that he expects to put this same field in rice next year.

Such areas constitute islands, slightly elevated above the surface of flood water, forming ideal conditions for the development of many weeds. Ditch banks are often allowed to grow up in weeds unmolested, and scatter their seeds in the ditches, to be washed wherever the currents may take them.

These areas are generally burned off at some time before the next planting season, with the idea that all the seeds will be destroyed. The efficiency of the method is considered under the head of burning stubble.

(2) ANIMALS AS DISTRIBUTERS OF SEEDS.

Too many planters fail to appreciate the importance of animals as distributors of weed seeds. While many weeds are not eaten by cattle, most of the grasses are, and at times also the coffee weed, indigo, and others, and the seeds pass through the digestive system without having the vitality of the seed impaired. Red rice
is very apt to pass through undigested unless the grains are crushed. Seeds eaten in the uncultivated portions of the fields may be dropped in the level cultivated areas where special effort is made to exterminate weeds of all kinds.

Rice straw often contains many seeds that are not crushed by the mastication of the animal, and the seeds thus become scattered over the fields where the animal is pasturing, or being worked. While the seeds scattered in this way may not be very abundant in any one year, a number of centers of distribution are established where seeds may be matured in considerable numbers the next year, and many centers of distribution established. When cattle are allowed to run on the rice fields, they should not be allowed to run alternately on new land and old, as they will certainly carry many weed seeds and red rice to the new fields.

To a limited extent, cattle may scatter seeds by trampling during muddy weather. Seeds in the mud, clinging to their feet, may be carried to places where no weeds have matured.

Birds may become the distributers of the smaller seeds. Owing to the deficiency of gravel in the rice districts the food of the birds is not perfectly ground, and some of the smaller hard seeds may pass through the digestive system without injury. Such seeds have been found in the excrement of birds that roost in the fields.

Fragments of stems, often carrying seeds, collected by birds, for nest building, are often dropped in the fields, and a focus of infection of a bad weed is established.

(3) WIND AS A DISTRIBUTING AGENT OF WEED SEEDS.

Among the grasses several species produce seeds that are provided with a tuft of hairs which render the seed buoyant enough to float in the air in gentle currents. Such seeds may be very widely distributed during strong winds.

Some of our worst grasses produce heads that are very much after the order of "tumble grasses," the heads being of slender, diffusely branched form, very light, and when such heads are broken from the stem the wind may roll them over the fields, scattering the seeds everywhere they go. There are nearly always some places about the fields where such grasses are allowed to mature seeds, and after the stubble is burned off they go rolling over the fields, carried by every wind. Bull grass (Panicum agrostidiforme) scatters considerably in this way.
(4) THRESHING MACHINES AS DISTRIBUTERS OF WEED SEEDS.

In threshing a weedy crop weed seeds find lodgment in many places about the machine and in the rice left in the various receptacles. In moving the machine these seeds are scattered along the fields and roadsides, or deposited where the next threshing occurs. As the roadsides are frequently supplied with an abundance of water from the leaking levees, favorable conditions are offered for the development of the weeds that we most dread. As it is not the business of any one in particular to destroy these weeds along public highways, we have constantly increasing centers of distribution for weeds of the worst character, and they rapidly spread into the adjoining fields. These remarks are more applicable to the conditions existing in Southwest Louisiana than on the river lands, because the roads in the river section are along the river levees, and occupy the highest part of the plantation, and because the machines are not moved from place to place as they are in the Southwest.

After a weedy crop is threshed, the machine should be thoroughly swept and cleaned before it is moved to another field. This precaution should be especially observed against red rice. It can almost be stated, as a rule, that the weeds that predominate in the flooded places along the roadsides are noxious weeds, and will grow in the rice fields if they become planted there.

DESTRUCTION OF WEEDS.

There is no easy and sure way to insure the destruction of the weed crop, or to prevent the seeds from getting on our ground, but a great deal may be done to hold them within reasonable bounds. We shall note the methods adopted by various planters for fighting weeds.

BURNING STUBBLE.

_Early Burning._—It is a custom with some planters to burn off the stubble as soon after the harvest as possible. A mowing machine is run over the ground, cutting everything as low as possible. After a few days, fire is introduced and allowed to take its course. This method not only kills a great portion of the seeds that may have ripened, but it also kills a great many roots and prevents fur-
ther development. The bare soil will then germinate many seeds that would otherwise have remained dormant in the soil till the following spring. These plants are not likely to mature fruit before frost, when they are killed.

A serious objection to the method is that it injures the land in many ways. It leaves the surface exposed to the hot sunshine during the late summer and fall, which not only bakes the soil, and has a detrimental effect upon its physical condition, but it interferes with the normal process of nitrification. It is well known that shade accelerates, and sunshine retards, the development of the organisms that play so important a part in maintaining the supply of available food. This process is reduced to a minimum or probably stopped altogether while the rice field is flooded, and as the winter temperature reduces the activity of such organisms to a minimum, the only time left for the operation of nature's method of maintaining fertility is from the time the flood water is drawn off till the earth becomes too cool for the active growth of soil bacteria. If, now, this period of recuperation be interfered with by burning, as above indicated, the soil will become depleted much more rapidly.

Another objection to leaving the soil bare is that leaching of the soluble elements will take place to a much greater extent. Where the soil can be plowed after burning, and sown to oats or other winter growing crops, the method is not objectionable. In fact, it is commended where it can be carried out.

Late Burning.—A great many, probably the large majority of the river planters, allow the fields to go unmolested after harvest till late in the fall. A dry time is selected and fire is set to the field of grass, weeds and stubble. Great quantities of seeds are destroyed. This burning is especially destructive to red rice. Grains that are on the stalk, or lying on the top of the soil, are mostly killed by the heat or burned completely.

In the prairie, stubble burning is not so common, the harvest being later, there is not so much aftergrowth to be dealt with, and the stubble can readily be plowed under.

However, there are some objections to ever allowing weeds to mature seeds, if it can be economically prevented. The most of our bad weeds scatter some of their seeds almost as soon as they are ripe, and great quantities of them are shattered before the late burning of the stubble. Some of these seeds will find protection from the
fire. If the soil is dry, it cracks open, and some seeds find lodging in the cracks. If it is rainy, they are covered with soil sufficient to protect them in many instances. Mice and crayfish here and there cover the seeds with the soil taken from their holes. Where the fields are pastured, as they generally are more or less, an immense number of seeds may be trampled into the ground a sufficient distance to protect them from any burning that may follow.

Birds of various kinds scratching in the fields may cover a good number of seeds. Where the soil is rough, seeds will bounce under clods or rough places and be protected from the fire. There are in all fields spots here and there where the fire does not burn well, leaving seeds uninjured, and subsequently during heavy or continued rains these seeds may become scattered widely. The writer has found that in seemingly well burned fields there are clumps of straw or other vegetable matter half decomposed, which have held an excess of moisture, which have not been burned. In these masses it is quite frequent that many seeds may be preserved. The canals are especially apt to be moist or wet in the bottoms, and the fire does not kill all the seeds there. In making examinations of fields that had been burned about as well as they are ever burned, seeds were repeatedly found in all the conditions stated. Repeatedly we selected places where weeds were known to have grown, and searched the surface soil for seeds. In all instances we were able to find seeds that had not been heated sufficiently to impair germination.

Since the coffee weed, or indigo (Sesban macrocarpa), is the most widely distributed of the rice weeds, as well as one of the worst, and since it grows to sufficient size to leave a recognizable stump after the stubble has been burned, and since it has large seeds that are easily recognizable, special observations were made on the efficiency of burning for the destruction of these seeds. In going over the fields and selecting these burnt stumps at random, and making a close examination for seeds in the vicinity of the stumps, we were able to find in every instance a few seeds that were not killed by the fire. It may therefore be said to be practically impossible to destroy all the seeds by burning the stubble. We cannot, therefore, rely upon this method alone. The planters of Southwest Louisiana who allow seeds to mature, thinking burning will
destroy all the weed seeds, will sooner or later find hand weeding a necessity, as does the river planter today. This method, however, of burning is to be commended when the conditions are such as to prevent early plowing. The writer simply wants to emphasize the fact that all seeds cannot be killed in this manner.

PLowing for the Destruction of Weeds.

Some planters burn the stubble in the fall and plow very early in the spring, so as to cover weed seeds and red rice, with the hope of securing the early germination of a good portion of the weeds and red rice, before time to plant the crop. Then just before sowing the seed the land is cultivated to destroy all the germinated plants. If, however, he waits to secure the best results in the destruction of the weeds, he loses by getting his crop in later. It is the desire of the planter to market his crop as early as possible, so as to get the benefit of the higher prices that generally prevail early in the season. If, therefore, he is delayed to accomplish the destruction of the weeds, he loses the benefit of the early price.

Discontinuing Cultivation for the Destruction of Weeds.

In the alluvial lands, as a rule, only two or three successive crops of rice are raised. The soil is then devoted to clean culture or allowed to grow up in weeds for one or two years. After being devoted to two crops of rice the land becomes so badly infested with water weeds and red rice that a third crop is hardly profitable. If now the land be drained and the dry land weeds be allowed to grow, they will almost exterminate the weeds that require wet environments. Of course vast numbers of seeds are matured by these weeds, but they have shaded and crowded the water weeds almost to the point of extermination, and now if the soil be again devoted to rice, the dry land weeds can be held in check by the flooding. In short, weeds are used to fight weeds.

While it looks like extravagance in the extreme to allow such land, rich as it is, to grow up in weeds, some of the best planters advocate this practice. They say the land regains fertility, and the finest rice crop is the first crop after it has been allowed to grow up in weeds. A word of explanation of the increased productiveness of the soil may not be out of place here. Generally the land develops a heavy crop of coffee weed, or indigo (*Sesban*). This plant,
being a member of the leguminous family, has the power to appropriate the nitrogen of the air, as is evidenced by the numerous tubercles often found on the roots, resembling those of the cow pea. They therefore add considerable nitrogen to the soil. Again, as the soil has been drained and shaded during the summer months, normal nitrification in the soil has reached its maximum. If now the land be devoted to rice, flooding stops the process of nitrification for more than half the summer, with the result that the crop the following year finds a less quantity of plant food available. It is very doubtful if the land gains as much by growing a crop of weeds as it would by being devoted to a crop of corn and cow peas.

In Southwest Louisiana, a great deal of land is planted in rice continuously for a number of years, as the weeds can be better controlled by proper flooding. In this section the land is generally devoted to rice till the red rice becomes so abundant that white rice cannot be longer made profitable.

Land is then temporarily abandoned on account of the red rice. No doubt planting the land to cow peas or velvet beans would be vastly more profitable than allowing the land to lie idle for a period.

FLOODING FOR THE DESTRUCTION OF WEEDS.

While the rice plant requires an abundant and a continuous supply of water to attain the best growth, continuous flooding is not essential, and one of the prime objects in flooding the rice as we do is to suppress the weeds. Few of the weeds will germinate and grow in water, and most of them are killed by continued flooding, if they are completely covered. Therefore weeds of slow germination and slow growth give little trouble in the rice fields. The worst weeds germinate rather quickly, and unless the field can be flooded just at the proper time they are enabled to get the bud at the end of the stem above the water, and they are then established. Excessively deep flooding to reach them will then probably do more harm to the rice than it does good in the destruction of weeds.

HAND WEEDING.

In the alluvial land it is the general rule to go over the fields two or three times during the growth of the crop to pull out all weeds by hand. Where the weeds are especially bad, this becomes a tedious and expensive labor. In extreme cases the cost may ex-
ceed six dollars per acre, for the season, but in most cases it is much less than that. The average cost is probably between a dollar and a half and two dollars per acre for hand weeding. The cost to the planter of a crop of weeds is not limited to the amount he has to pay to have them pulled out. They have interfered with the growth of the rice up to the time they are removed, and where the weeds are very bad the space occupied by the piles of pulled weeds is quite considerable.

Some planters claim that the pulling of the weeds serves as a cultivation to the rice, and that after the weeding the rice begins at once to show a more vigorous growth. How much of the increased growth is due to the breaking of the surface soil from pulling the weeds, and how much to the fact that the competitors for plant food have been removed, is hard to say, but the writer is inclined to think the stirring of the soil by pulling the weeds has little to do with the increased growth of the rice.

Hand weeding has not yet become necessary to any considerable extent in Southwest Louisiana. The best planters very wisely go over the fields and pull out such weeds as are discernible, of the varieties that are there recognized as bad weeds.

However, unless greater care is taken to exterminate some weeds that are now getting a good foothold there, hand weeding may become a necessity.

The annual expenditure for the eradication of weeds can be materially reduced if the planters will but give the matter their careful consideration. Hand weeding to a certain extent will probably always be necessary, but the amount of it can be reduced by giving more attention to the prevention of the maturing of seeds on the plantation.

**MOWING YOUNG RICE AND WEEDS AND THEN FLOODING TO DESTROY WEEDS.**

Sometimes when the rice is small and is not far enough in advance of the weeds to permit of flooding so as to cover the weeds, the entire field is mowed, just low enough to not cut off the buds of the rice stalks. Most of the weeds, except the grasses, bear the bud on the summit of the stem, while that of the rice is folded in the leaf, and it is considerably below the summit of the blade, and it is therefore not difficult to cut the bud of the weeds without cut-
ting the bud of the rice. The weeds are retarded in their growth more than the rice, which shoots up new leaves from the uninjured bud, and the field can soon be flooded so as to cover the weeds and kill most of them without injury to the rice. This method, of course, is not effectual with red rice and the grasses.

PASTURING FOR THE DESTRUCTION OF WEEDS.

Pasturing land will diminish the number of weeds if pastured close enough. Many of the weeds that the cattle will not eat will be trampled to death. Keeping the land dry tends to diminish the water weeds. It is suggested that better results would be obtained if the land was plowed some time during the summer and stock taken off so the soil would remain loose, so as to force germination of as many seeds as possible, that they may be destroyed later.

WEEDS DESTROYED BY BIRDS.

The vast throngs of black birds, and other species, that frequent the rice fields are not altogether a nuisance. While they destroy a great deal of rice, they live after the harvest almost entirely upon what they pick up from the fields, and thus destroy a great number of weed seeds and red rice.

RICE WEEDS AND THEIR HABITS.

While it is not possible, nor desirable, to give here all the weeds found in the rice fields, it may be helpful to give the names and the characters of the worst of them. In some instances a weed is known by different names in different parts of the State, and we have attempted to get all the names applied to each plant. Of course there can be but one scientific name, which is given after the common names, and written in italics. In a few instances no common name exists.

RED RICE.

According to the explanation given of the use of the term weed, few will deny red rice the privilege of standing at the head of the list. It is the most widely distributed and most difficult to deal with of all the weeds. Few if any rice fields that have been cultivated one or more years are absolutely free from this pest. It steals into the fields ere we are aware, and sticks there with a persistency that is almost incredible. At one time many planters
thought it spontaneous, or that it resulted from the shattered white rice remaining on the ground all winter and germinating the following year. This latter idea is still entertained by some planters, but the majority of the more observant have abandoned it. There was a time when the northern wheat grower thought the chess in the wheat was produced by the wheat plants that were injured during the winter. The origin and rapid increase of the chess was apparently as mysterious as that of the red rice. The two cases thus far are exactly comparable. Few if any intelligent wheat growers now hold to this idea. While the wheat and the chess are botanically more remote than are the white and red rice, the red rice is a distinct form, and the idea that it comes from the white rice that has remained in the field over winter is rapidly being abandoned. This matter was thoroughly investigated by the Experiment Station and the results published in Bulletin No. 50, 1898.

The red rice grows in China and Japan as well as America. The writer has seen samples of Chinese and Japanese rices that were as badly infested with red rice as we ordinarily find in the Louisiana quality. There are cultivated varieties of rice that have a red grain, but the one that infests our fields is a variety that grows wild like other weeds outside cultivated areas in India. It has probably become distributed to all rice producing countries. Unfortunately it freely mixes with our white rice, and as the rice plant is wind pollenated, crossing may take place at considerable distance from the white. It must be remembered that imported seed may contain red rice. Planters have been prone to think imported seed must of necessity be clear of red rice or it would not be imported. It is not infrequent that imported seed contains as much red as does a good grade of the domestic rice.

Grains on the plant of white that are fertilized with the pollen of the red rice will have a red or pink cuticle, which will mill off in most instances. If, however, the seeds are planted, the red form of the parent stock is apt to show the stronger characters, and some red rice will be obtained. In short, the same rule holds good here that obtains in hybrids among plants and animals in general. Since the red rice is often allowed to grow in the main canals unmolested, there is no doubt in the mind of the writer that the pollen is often carried by the water and occasionally deposited where it
fertilizes the white rice. Pollen-eating insects no doubt frequently carry the pollen on their bodies and often bring about cross fertilization. We have no positive observations on this matter, but since they will cross easily, it is highly probable that these agents, unobserved by the planter, are responsible for much of the red rice where the land was thought to be free from the pest. While the flowers are not frequented to any considerable extent by nectar-seeking insects, pollen-eating insects and beetles are very frequent visitors to the rice flowers. For these reasons the farmer should be as careful about destroying red rice in his canals and about the fields not harvested, as he is with the main crop. All these things must be appreciated by the farmer before the problem will be successfully dealt with. The work of extermination must be directed along two lines, first, to prevent the plant from coming to flower, and, second, to secure the destruction of the seeds already in the ground. The fact that no seeds are allowed to mature one year and there is still an abundance of red rice the next year need not cause discouragement.

Before the seed will germinate three favorable conditions must obtain at the same time: sufficient warmth, moisture and free oxygen. There seems to be good evidence that the seeds may remain buried in the soil for at least a few years without being destroyed, and then germinate when favorable conditions prevail. If we prevent seeds from maturing this year, next year we may plow so as to bring seeds to the surface where they will germinate, that would have otherwise remained encased in the compact clay.

In making an effort to prevent the red rice from maturing seeds, the plants should be destroyed as soon as possible after they can be easily detected, certainly before they have come into full blossom. If any are left till the general harvest, the maturing of the second crop of seeds must be prevented. Large planters who have their fields already badly infested, would probably be unable to pull out the red rice, and must leave it to be cut with the white. There are few, however, who cannot prevent the maturing of the seeds that so often develop on the suckers that shoot up soon after harvest.

For securing the destruction of the seeds already in the soil, no plan can be suggested that has no objectionable features. The plan followed by some of the best planters of plowing the land early
in the spring and allowing it to lie fallow, and again plowing in the
summer, is probably as good as any now practiced, as far as the de-
struction of the seeds is concerned. The seeds that find favorable
conditions for germination in the spring are killed by the second
plowing, which brings other seeds to the surface and secures germi-
nation of the second crop, which will be killed by the frost. How-
ever, two plowings with no crop returns is to be avoided if possible,
with equally good results in destroying the red rice.

The plan suggested by some of planting to some heavy crop
like the velvet beans, or cow peas, would accomplish the destruction
of the first seeds that germinated, but after the soil becomes shaded
it is doubtful if other seeds will germinate. Some system of culti-
vation that involves stirring the soil several times and giving a min-
imum of shade will probably be found to give the best results. Oats
might serve this purpose, as they could be harvested early and be
followed by cow peas.

Allowing the land to grow up in weeds and volunteer red rice,
as some do, is more objectionable in Southwest Louisiana than on the
river. In the alluvial lands the weeds are so abundant and
rank that the red rice is overshadowed and killed out. In the
prairie regions the weeds do not accomplish this. In a favor-
able season a partial crop of red rice is matured, and much of it is
shattered, even when harvested as hay.

If the land lies idle and is not plowed, it should be pastured so
close that no seeds can mature.

Selecting pure seed is of the utmost importance. Where seed
is imported and planted in the midst of areas infested with red rice, it cannot be called pure seed for the second planting, as will
be seen from the above discussion.

We take the liberty of quoting the following extract from an
address delivered by Mr. T. H. Winn, of Jennings, La., one of our
most intelligent and successful rice growers.

"Then how are we to produce better grades of rice? I would
suggest that the first step to be taken is to secure the very choicest
seed to be found in this or any other country. Then to be sure to
sow this seed in clean land; and again, see to it that you keep both
the seed and the land clean. If every farmer in Southwest Lou-
isiana who owns a quarter section of land and cultivates as much as
one hundred acres of the same in rice, would ditch and drain his
rice field so as to plant and properly cultivate fifty acres of this land in cow peas or some other leguminous crop, and the remaining fifty acres in rice, putting the same amount of work on this fifty that he did formerly on the hundred acres, and alternate crops each successive year, I'll venture the assertion that he will then grow more rice and better rice on the fifty acres than he is producing today on the hundred acres. In other words, his net returns from the fifty acres of rice land under the improved method would be greater than the income from the whole hundred acres under the present system. In addition, he would have the hay and food from the fifty acres of cow peas, which if properly harvested, cured and stored away and fed to his mules, his cattle and his hogs, would be worth as much to him as his rice crop, not to mention the fertility imparted to the soil.

"In pursuing this system of farming the planter would not only produce the major portion of his feed at home, and at the same time add immensely to the fertility of his soil, but he would also be dealing a death blow to his arch enemy—red rice.

"Again, because your lands are already foul, that is no reason why you should make them more so by sowing bad seed, but to the contrary, one should sow the very best seed to be obtained, for it is only through the greatest care in the selection of your seed and a continuous rotation of crops that we may hope to eradicate red rice from the soil. Eternal vigilance is the price we must pay for the renovation and regeneration of our foul rice lands.

"If the planters of Louisiana ever expect to get rid of this pest (red rice) we must not only eradicate it from the soil, but we must quit planting it. One is often asked: 'What causes it? Where does it come from? What makes it?' In my opinion God makes it; just as He did the white rice. It is a separate and distinct variety, if not a different species, from the white rice. In physical appearance the plant upon which it grows is very different from that of the white species. In the first place, the red rice does not grow so tall as the white; then the stalks of the red rice grow at an angle of, say, 65 degrees. The stalks never stand perpendicular and erect as does the white rice. Again, the heads are more sprangling and the grain cells distributed more unevenly along the head than is the case with the white rice. The plant is much more vigorous and the grain is not only different in size, shape and color, but pos-
sesses greater vitality. If the conclusion is correct that they are different species, the seed of one will not produce the other, for this would be directly in conflict with the evolution of vegetable life.

"When we contemplate the immense territory to be cultivated in rice in this State and in Texas the next few years, if this mania for canal building is kept up, then nothing but the choicest goods will go, and if we continue our present system of planting, 'Mene, Mene, Tekel, Peres' will be the handwriting on the wall. Othello's occupation will be gone. But by the proper care and selection of our seed rice, rotation of food and leguminous crops, we may convert 'the winter of our discontent' into glorious summer, and all the debts that lower o'er our farms, in the deep bosom of the ocean bury."

**ANALYSIS OF RED RICE.**

An anaylsis of red rice grains, with hulls removed, was made by Mr. R. Glenk, station chemist at Baton Rouge, and is here given. It will be seen that there is scarcely any difference in food value of the red and white rice. From a nutritive standpoint it is as valuable as the white rice.

If this was generally understood, many parties would probably choose to economize by buying it at a price even considerably above what it now commands on the market, in preference to the brewers or lower grades of white. As a stock food it is worth more than it often sells for.

<table>
<thead>
<tr>
<th></th>
<th>Moisture</th>
<th>Ash</th>
<th>Ether extract</th>
<th>Carbohydrates</th>
<th>Crude protein</th>
<th>True protein</th>
<th>Fibre</th>
<th>Total Nitrogen</th>
<th>Alb. Nitrogen</th>
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<tr>
<td>Air dry</td>
<td>13.13</td>
<td>.80</td>
<td>2.20</td>
<td>77.59</td>
<td>7.56</td>
<td>7.31</td>
<td>1.10</td>
<td>1.21</td>
<td>1.17</td>
</tr>
<tr>
<td>Water free</td>
<td>.92</td>
<td>2.53</td>
<td>89.32</td>
<td>8.70</td>
<td>8.42</td>
<td>1.27</td>
<td>1.39</td>
<td>1.34</td>
<td></td>
</tr>
</tbody>
</table>

**AVERAGE ANALYSES OF RED RICE, WHITE RICE AND CORN IN 100 POUNDS.**

<table>
<thead>
<tr>
<th></th>
<th>Carbo-</th>
<th>Ether</th>
<th>Dry.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>hydrates</td>
<td>extract</td>
<td>matter</td>
</tr>
<tr>
<td>Red Rice</td>
<td>7.56</td>
<td>77.59</td>
<td>2.20</td>
</tr>
<tr>
<td>White Rice</td>
<td>8.14</td>
<td>72.01</td>
<td>2.50</td>
</tr>
<tr>
<td>Corn</td>
<td>11.50</td>
<td>78.60</td>
<td>5.60</td>
</tr>
</tbody>
</table>
RED RICE IN JAPAN AND HONDURAS VARIETIES.

The red rice of the alluvial lands where the long grained Hondur- 
as seed is used almost exclusively, seems to be identical with 
that found in Southwest Louisiana, where the short, broad Japan 
seed is used. It is probable that this species has been imported 
with both kinds of seeds.

Among the varieties of rice secured from the Department of 
Agriculture at Washington, one from Siberia was a red grained 
variety, very closely resembling our own, but maturing later.

LARGE INDIGO, STRAIGHT INDIGO, COFFEE WEED, SENNA, LONG 
PODDED SESBAN. (Sesban macrocarpa, Muhl.)

As this plant is most frequently known as large indigo, we 
shall use that name in referring to it.

After red rice, the large indigo is the most extensively distrib-
uted of the rice weeds. It is found more or less abundant in all 
sections of the State. It is the largest and most conspicuous weed 
we have, often growing to a height of fifteen feet, and if not crow-
ded, the stem attains a diameter of two or three inches. The flowers 
are yellowish, with purple spots, and about an inch long. There 
are from fifteen to thirty pairs of leaflets in each leaf. A good 
sized plant will have fifty or more branches, each bearing from 
twenty to forty pods, each of which will contain from twenty to 
forty seeds. A large plant will mature a hundred thousand seeds. 
Where the weeds are thick on the ground, a much smaller per cent. 
of this number will prevail. It will be seen that one plant if al-
lowed to mature a crop of seeds will produce enough plants to keep 
a man busy for some time in destroying them.

Unfortunately for the farmer, the large indigo grows well in 
dry land and wet. It is as bad in the corn as it is in the rice. It 
is not killed by water unless completely submerged.

If the seeds are harvested, many of them remain with the 
threshed rice and are a source of annoyance to the miller, as it is 
impossible to get all of them out. The seeds are possessed of a high 
degree of vitality, and may remain in the soil two or three years, 
and possibly longer, without losing the power to germinate. Fort-
unately it is not as readily distributed as some of the less produc-
tive weeds, or it would be uncontrollable. The seeds do not float 
in the water, but a moderate current may carry them considerable
distances, as quite a number of them are found in the trash and other seeds drifted by the heavy rains. When other food begins to get scarce cows eat seed pods and often void the seeds undigested. It is not infrequent to find these seedlings in the cow stools. The seed pods do not split open freely, and many of the seeds may remain in the pods nearly all winter. Generally most of the pods hang on to the stalks all winter, or till they become whipped into frills by the wind. The non-fibrous portion of the pod decays and is broken away, leaving the stringy or fibrous portion of the pod hanging. In this way seeds are gradually shattered from day to day. This method of dropping the seeds is much more favorable for the preservation of the plant than if they were all dropped at once. Each heavy rain may wash away some of the seeds and lodge them in different parts of the field. Cattle frequently trample the seeds deep into the soil, where they will not germinate till brought near the surface by plowing.

The weeds are conspicuous and cannot escape observation. There is, therefore, less excuse for letting any of them reach maturity. When the plants are pulled up it is necessary to place the roots so they will become dried, as they will continue to grow if dropped back in the water. When this weed is the principal one to be destroyed, it is probably better to cut them with a cane knife than to pull them up, as it can be done much more easily, and few stems will send out any new branches below where they are cut off. It has been the observation very frequently repeated, that the weeds are not cut early enough, many seeds being matured before the stems are cut down.

The illustration produced elsewhere is one of many photographs that might have been secured, showing the weeds cut after many seeds had matured. The stubble has not yet been burned, and many of these pods will be consumed by the fire, more than would be if the weeds were standing. It is therefore better to cut late than not at all.

It is not possible to secure the germination of all the seeds in one year, but by devoting the land to a cultivated crop where the soil is stirred several times during the season, killing seeds that have germinated and bringing others to the surface to secure germination, will accomplish the destruction of the greatest number of seeds. But they must not be allowed to mature a crop of seeds
after the cultivation is completed. These weeds sometimes develop very abundantly after corn is "laid by," and mature an abundant crop of seeds.

As an exterminating measure it would probably pay to go through the corn and cut with a scythe all the weeds that cannot be covered with cow peas. In good land a heavy crop of cow peas will keep most of them down. Cutting the weeds out of the corn might cost more than it would do the corn good, but it would be a good investment in future battles with the weeds.

This weed is rapidly increasing in abundance in Southwest Louisiana, and should receive the careful consideration of the planters throughout that section.

**Curly Indigo, Sensitive Joint Vetch.** (*Aeschynomene Virginica* (L.) B. S. P.)

The "curly indigo" ranks among the very worst rice weeds. It is quite universally distributed over the alluvial districts, and is gaining rapidly in Southwest Louisiana. Although belonging to the same family as the large indigo, it is quite unlike it in many respects as to character and habit of growth. In stead of standing tall and conspicuous like the large indigo, it is generally not more than two or three feet high, and branches more freely. The leaflets are smaller and are somewhat sensitive, closing together when suddenly touched. The flowers are redish yellow, and about a half inch long. There are from six to ten seeds in each pod, and a thousand to three thousand seeds to the plant. It matures earlier than most weeds, and has almost perfect provision for dissemination. The pods are broad, flat and segmented. The pod does not split open, but breaks into as many segments as there are seeds, a portion remaining around each seed. These segments are about square
and will float on the surface of the water, and become very widely distributed. As the pods near maturity, a severe shock, such as would be given by the stroke necessary to cut the stem, is sufficient to break up some of the pods into their respective segments. The portion of the pod surrounding the seed is of a corky nature, and is comparable to a life preserver about the seed. The seeds are floated away on the flood water, or falling on dry land are subsequently trampled into the ground or carried away by the flood water during heavy rains, and may be lodged at a remote portion of the field. In early spring, wherever drifted trash is found, seeds of curly indigo are apt to be abundant.

The accompanying cut, reproduces a photograph that was taken from such a drift, and was not selected as being the most abundant in these seeds that could be found. It was an average sample from the field. In some cases the drift is composed almost entirely of these seeds. As a half cart load of such material may sometimes accumulates in one place, it would be advisable to burn all such trash heaps, instead of scattering them with the plow and turning the seeds under. Quite a number of parties told the writer that they had not observed that these trash piles contained seeds, as they thought they were only fragments of sticks. This weed grows abundantly in many places along the ditches parallel with the railroads. Vast numbers of seeds are matured along these banks, and subsequently washed into the fields further back. The planter should be careful to destroy all growing plants of the curly indigo where either currents or back water can bring the seeds onto the rice lands. When the seeds are harvested they may pass through into the rice and cause some annoyance at the mill.

The planters in Southwest Louisiana should beware of this weed. If it gets started there, it will probably prove to be the worst weed they could introduce. Unlike the large indigo, when the

From photograph of drift trash on rice field. Small quantity spread out. Sharp angle bodies are segments of pods of “curley indigo,” one-half natural size.
stem is cut off, new branches will be sent out from below and soon mature seeds.

TADPOLE GRASS, WIGGLE-TAIL, SPEAR GRASS. (Rhynchospora corniculata. A. Gray.)

The common name is given because of the resemblance of the seed to tadpoles.

This plant is not a grass, but belongs to the sedge family. To one not accustomed to making botanical distinctions, it looks very much like a coarse grass. The stems are from two to four feet high, generally just a little higher than the rice. They frequently occur in rather large clusters, and head out and mature seeds a week or more in advance of the rice. The brownish red color of the heads renders them easily seen. The stem and leaves die at the approach of winter, but the roots live and the shallow plowing practiced in the rice fields does not always kill them unless the roots are left well exposed, or pulled out by the harrow. The plant produces a large number of seeds, some of which are shattered before or during the harvest. The seeds float on the water and may be widely spread in this way. The plants are found in all parts of the State, although in many places it is not abundant enough to make it a serious pest. It grows normally in wet places, and may therefore be reduced by dry crop rotation. It is not very common toward the front of the river plantations, but increases toward the swamp, and the lowest portions of the fields have the-
greatest quantity of it. It is frequently quite abundant just outside the area cultivated, and from such places in many instances the seeds find their way into the fields.

In the prairie regions it is found along nearly all the ponds and little streams, and from these places it is rapidly spreading as the adjoining areas are brought into cultivation in rice, giving favorable conditions for development of the sedge. The seeds frequently go through the mills and into the polished rice. It is therefore regarded by the miller as a bad seed.

Since the only sure way of getting rid of the stools that are already formed is to take them out of the ground, either by plowing and repeated harrowing with a toothed harrow, or pulling them out by hand, it might be well to clean the field of all the old plants during the late fall and winter when other work cannot be done. The stools of the plant are easily recognized in winter, and could be as easily pulled out then as in the spring after the crop is on hand.

BULL GRASS. (Panicum agrostidiforme. Lam.)

Of the grasses proper, bull grass is the worst in rice. Few if any fields of the alluvial lands are free from it, and it is common in the prairie regions. It produces thick, stout stems, 3 to 5 feet high, stools freely and branches profusely, making this one of the most prolific seed bearers of all the grasses. If the stem is cut or broken before the seeds are matured, every joint below the injured place may send out a branch and soon mature seeds. The stems become as large as a man's smallest finger, and a plant that has stooled freely, and come to maturity where not too closely crowded, becomes so firmly rooted in the soil that one man cannot pull up a bunch of it. It is normally a water grass, and it is a very difficult matter to get the start of it sufficiently to hold it in check by flooding.

The seeds are small and float on the surface of the water, thus materially aiding in the wide distribution of the plants that will be produced during the following year. However, as the seeds are light, the fans can easily separate them from the rice, and serious damage is done to the growing crop only. Another feature of the adaptation for distribution is that the panicles are somewhat after the order of the "tumble weeds," and after becoming detached from the stem are rolled considerable distances by the wind, scattering
the seeds as they go, affording a good illustration of how an outside-area may be a constant source of annoyance.

This weed is found along the ditch banks possibly oftener than any other weed, and it would be economy to spend some time to secure its destruction wherever it may be found adjacent to the rice fields, or on the banks of ditches leading the irrigating water to the rice fields.

**Smart Weeds.** (*Polygonum*, especially *P. acre*.)

Smart weeds take an intermediate position in the list of bad rice weeds. They normally live in the water, and in exceptional
instances are the worst weeds on a plantation. They are moderately abundant in most places that are naturally poorly drained. They are apt to mature a crop of seeds after the rice crop is harvested, as they are not eaten by stock or insects, because of the bitter, pungent taste of the leaf and stem. Where the rice is harvested with a sickle, most of the weeds are avoided, and the seeds do not accompany the rice to the mill. Where machines are used for harvesting the rice, the smart weeds are harvested also, and many of the seeds will be sent to the rice mills. They do not bother the better grades of the finished product, but may pass into the brewers or will be in the screenings. As the screenings are used for feed stuff, there is a possible danger from feeding an excessive quantity of these seeds. The writer has not been able to find any experiments in feeding these seeds, but it is probable that the seeds possess to some extent the acrid principle that characterizes the stem and leaves. Screenings containing these seeds should therefore be fed with caution. See also note on dissemination of seeds from feeding.

**TURTLE BACK. (Commelina. Virginica.)**

While these weeds are quite bad in the fields, compared with other weeds, they are possibly not as detrimental to the growing rice as the seeds are to the threshed grain. When the millers are asked what is the worst rice weed, from the millers’ standpoint, most of them will answer that in the river rice the turtle back is
the worst, because it is the hardest to separate. This plant is not abundant in Southwest Louisiana, and it would be well for the planters there to guard against its further spread. The plant resembles a grass, but the leaves are broader than in most grasses, and there is a blue flower in the angle between the leaf and the stem at all of the top joints. Being a water weed, flooding does not kill it out. The stems are rather weak, and seldom stand erect. Some of them find support by resting between the blade and the stem of the rice, and manage to raise their summits into the head of the rice. They have no tendrils, neither do they twine around the stem, but often become well entangled with the head, so that the harvester, even with a sickle, gathers a considerable number of them. The structure of the seed pod is extremely interesting from an economic standpoint. It generally has three compartments, two of which may open after maturity, and drop the bare seeds, one or two from each compartment. The third cell does not split open at all, but with half the wall of each of the other cells, forms a little boat in which the contained seed may float away on the surface of the water. This portion of the seed pod, with the inclosed seed, somewhat resembles the turtle shell, hence the common name "turtle back."

The plant thus provides that if the fruition is not disturbed, two-thirds of the number of seeds matured will be dropped in the vicinity grown, while one-third the number may be carried to new homes whenever the ground is flooded. If the plants are harvested with the rice, the thresher splits the pods not already opened, emptying two of the chambers, while the third sticks close to the inclosed seed. If this seed is not well matured, or the wings are not
broken away, the fans of the thresher will take many of them out, and the mills can take out the remainder. But if the wings are broken by the cylinder of the thresher, or the seeds are extra heavy, they pass into the hullers and it is impossible to get the seeds out of the rice. Of the seeds from the splitting cells of the pod, some are separated by the thresher. The smaller ones and the short ones (when two are in one cell, they are short with one square end) mostly go with the screenings, but the large seeds mostly go with the polished rice.

To one not acquainted with the seed, the sight of them at once suggests that mice have been stooling in the rice. As the plants continue to grow till nearly frost, a good crop of seeds may be matured after the rice is harvested. They are about the last thing in the field to quit growing in the late fall. If the plants are broken from the roots and the stem comes in contact with wet soil, it will take roots at the nodes and continue to grow.

It is apt to mature seeds along the ditches that are not kept well cleaned, or in low, wet places most everywhere. In the late fall the top leaf often breaks from the stem with the pod and folds over it, and the whole thing floats when an opportunity is offered. What seems to be a short folded leaf only, contains a pod with from one to five seeds. In examining the rice fields the last of January, where the stubble had been burned in the fall, the ditch banks held a great many leaves, thus enfolding the seed pods. They had probably been washed in from outside areas, and lodged there.

The stem begins flowering at the ends of the branches, the last leaf partly enveloping the pod, the bud in the axil of the leaf next below then develops, becomes the main stem, produces a flower, and the same process is repeated, until late in the fall. In this way a large quantity of seeds are produced during the season.

**Alligator Head.** (*Diodia teres.*)

This plant gets its common name from the striking resemblance of the fruit to the upper jaw of an alligator. The weed is quite generally distributed over the State, and the seeds are considered among the worst that come to the mills. The growing
plant, however, can hardly be said to be one of the most detrimental to the growing rice, as the weed is not of very rank growth, and seldom attains half the height of the rice. It is most abundant where high places occur in the fields, and if the rice is standing erect at harvest, and the stubble is left high, little of the Alligator Head is harvested. If the rice is harvested by the binder, and the blade for any reason has to be lowered, these plants are cut and carried along in the butts of the bundles, and in this way reach the threshing machine, and the seeds are too heavy to be blown out by the fans. In the mills, the fans and sieves are not able to separate all of these seeds without considerable loss of rice. The seeds are about as thick as a rice grain, and therefore pass into the better grades or head rice.

It produces two seeds to every leaf, between the leaf and the stem. This is not a large number compared to what some of the other weeds produce, but they are better protected and are provided for keeping up their number by the increased vitality of the seeds. At maturity, the seed pod splits into two equal parts, each part enveloping a seed, which it continues to enclose till germination. The surface of the seed pod is covered with fine hairs that are somewhat repellant to water, and the seeds are not readily wet. The seeds float on the surface of the water, but may finally become wet and sink to the bottom. As the seeds are about the color of the soil they are not easily seen and are not apt to be picked up by birds.
These weeds are easily held in check if proper flooding can be secured at the desired time.

As it is a very hardy weed, fallowing will kill it out only when other taller and thriftier weeds are present in abundance to completely overshadow it. Stock grazing these weeds sometimes develop sore lips and gums, from the irritation of the hair-like spines that develop at the nodes of the stem. The weed is of the same character as the "poor Joe," or "poverty weed" of the hill lands.

Another species of the genus is

*Diodia Virginiana.*

which spreads almost flat on the ground or sends up stems obliquely to a height of a foot or more. This weed is exceedingly abundant in most fields in all sections of the State. It is not generally regarded as a very bad weed, but the writer thinks its importance is underestimated. The seeds are surrounded by a thick, soft, corky covering, which renders it light, and the fans are able to take nearly all of them out of the threshed rice.

As soon as the land is drained, it seems to start out from almost everywhere and rapidly matures seeds. Plants that have survived the flooding grow to considerable length, rooting at the nodes.

**Bird's Eye.** (*Scleria—Several species.*)

These plants belong to the sedge family, and look very much like grasses. Most of the planters call them grasses. This is another instance where the seeds are more conspicuous in the threshed rice than the weeds in the field. The seeds are quite spherical, with rough surface generally white, and about the size of a number six shot. Some of the seeds are darker and larger. It seems almost impossible to separate all of them from the head rice. Thorough drainage after harvest will materially aid in destroying these weeds as they are pre-eminently aquatic.

**Morning Glory.** (*Ipomoea tamnifolia.*)

As the morning glory is naturally a dry land plant, it is a matter of some surprise to find it so frequently in the threshed rice. The number of seeds would lead one to think the plant much more abundant in the field than it really is. It climbs and becomes so entangled with the rice that nearly all the fruiting
WINTER CONDITION OF A RICE FIELD.
Large indigo stands out prominently.

LARGE INDIGO WEEDS ON THE LEVEE IN A FIELD.
Taken after a storm, just before harvest. Row of weeds marks cross levee.

LARGE INDIGO (SESBAN)
Cut with cane knife before burning the stubble.
A SERIES OF HIGH PLACES IN THE FIELD, NOT FLOODED.
Grown up in "large indigo" (Sesban) weeds.

RICE READY FOR THE HARVEST.
Large indigo stands high above the rice.
BUILDING LEVEE OF CANAL FOR IRRIGATING RICE IN SOUTHWESTERN LOUISIANA,
BREAKING PRAIRIE SOD FOR RICE, SOUTHWEST LOUISIANA.
TYPICAL RICE FIELD UNDER IRRIGATION, JUST BEFORE RICE BEGINS TO HEAD.
HARVESTING RICE IN SOUTHWESTERN LOUISIANA.
THRESHING RICE IN SOUTHWESTERN LOUISIANA.
SIDE VIEW OF TYPICAL RICE MILL OF SOUTHWESTERN LOUISIANA.
UNLOADING THRESHING MACHINERY FOR RICE CROP IN SOUTHWESTERN LOUISIANA.
PUMPING FROM DEEP WELL FOR IRRIGATING RICE, ACADIA PARISH, LA.
EXTERIOR VIEW OF PUMPS (four 24-in. pipes, four 12-in. pipes, irrigating 18,000 acres of Rice), ACADIA PARISH, LA.
ROTARY PUMPS—INTERIOR VIEW OF A PUMPING STATION.
PUMPS DISCHARGING WATER INTO FLUME LEADING TO CANAL, FOR RICE IRRIGATION.
IRRIGATION CANAL VIEWED FROM PUMPS. RICE FIELDS TO THE LEFT,
PUMPING WATER FROM MISSISSIPPI RIVER, IRRIGATING 400 ACRES OF RICE.
CARRYING WATER OVER THE LEVEE OF THE MISSISSIPPI BY SIPHON.

After it has been raised from the river to a pond at the foot of the levee.
Canal partly filled with Paspalum Fluitans.

Paspalum Fluitans.
Photo-micrograph of section of rice hull. On right is magnification of about 50 times, showing fine saw teeth or spines on margin of hull. On left immature spines highly magnified.
portion is harvested. The seed pods form in large clusters, and, considering the size of the seed, each plant produces quite a large number. They are too heavy to be blown out by the fan in the thresher, but small enough to go through the sieves. From these reasons probably a greater per cent of the seeds pass into the threshed rice than any other weed seed. It may be seen how comparatively few plants in the field may show up a good number of seeds at the mill. The mills can separate most of them, but some of them are apt to pass into the higher grades of rice and cause diminution in the price it would otherwise command. The seeds have no special adaptation for distribution, and the plant should not be very difficult to control. Timely flooding, and a little hand-weeding in the high places, should hold the morning glory in check.

**WATER GRASS. (Paspalum fluitans.)**

This grass grows only in the water or on very wet soil. At present it is abundant only in a few places, and is now giving more trouble in the canals than in the fields. It is of very rank growth, the stems floating in the water and attaining a length of many feet. The stems and bases of the leaves are very spongy in texture, the spaces being filled with air, which renders the stem quite buoyant. The plants are generally attached to the soil at the base, but continue to live if broken away from the first roots. In fact, roots are sent out from every node that may take hold in the soil if they come in contact with it. It starts from the banks and rapidly spreads toward the center of the canals, until the entire mat will reach thirty or forty feet from the bank. In some instances it becomes so abundant as to impede the flow of water to such an extent that it becomes necessary to remove the grass from the main channels by raking it to shore. This has been done by hand. A little ingenuity on the part of some one may result in a rake operated by mules on the levees.

Since the grass does not ripen seed until late summer, it may be much easier to control it than if it seeded early. If the canals are drained as soon as possible after the last water has been drawn on the fields, most of it can be destroyed before seeds have matured. It may be necessary to mow the grass and burn it.

The plant is an annual, and if it is prevented from seeding,
it will soon be exterminated. If the seeds are allowed to mature, they may be washed to the adjoining fields supplied with water from this canal and become a source of trouble there. While this grass has not yet proven to be a bad field weed, there is reason to look with suspicion on it. As pieces broken from the stems will continue to grow, it would be advisable to maintain a boom floating on the surface of the water to catch what pieces are floating before they reach the water gate.

Where it is just getting started, effort should be made to exterminate it at once.

The accompanying picture was taken in July, and the canal is about seventy feet wide, the grass having extended in about fifteen to twenty feet from each bank.

**WATER GRASS.** *(Paspalum virgatum.)*

This grass grows tall and erect in bunches, and is found to some extent in nearly all the rice fields, especially in Southwest Louisiana, where it is native to the prairies. It can be killed by flooding, if covered, and the seeds are nearly all removed, without difficulty, by the mills. It is one of the most common seeds in the screenings. Stock are not very fond of it, and it will mature seeds in pastured fields if there are any other grasses in sufficient quantity to maintain the animals.

**MOSS WEEDS.**

There are several species of small sedges that grow to a height of one to four inches that make quite a dense turf on the fields. These are of little injury to the rice directly, but they make a sod that is difficult to break up so as to get the soil in the best condition for sowing. They make their growth during the fall and winter and early spring. Probably the best way to deal with these weeds is to plow them under as early as possible, giving the sod time to rot before preparing the land to receive the rice. Thorough drainage will help to destroy them, as they are all plants that require a wet soil.

**SEA WEED.** *(Pongatium zeylanicum.)*

During the summer of 1903 quite a good deal of newspaper discussion regarding a so-called new weed, designated as “sea
weed," caused considerable uneasiness in some localities. Upon an investigation it was found that the weed was an imported species, probably brought in with imported seed. The weed has been in the State for a number of years, and is now distributed all over the prairie section. It has attracted much more attention this year than ever before, but there seems to be no more occasion to be alarmed over it than there is regarding some of the weeds that have been in the State all the time. While a few cases are to be found where the crop has been abandoned to this weed, the newspaper reports were very much exaggerated and were not justified by the facts.

The weed is a vigorous grower, has a hollow stem, smooth slick leaves and stem. The flowers are not conspicuous, owing to the fact that the corolla drops off without becoming fully expanded, and only a few of them are to be found on the spike at one time. The seed capsules are borne in dense spikes, terminating the branches. The capsules break around the side and discharge vast numbers of very fine seeds that float on the water till they are thoroughly wet. This is probably their chief dependence for distribution.

The seeds have in all probability been imported with Honduras rice, but the writer has not been able to learn whether the weed is a serious pest in its native home.

MISCELLANEOUS WEEDS.

Besides the weeds mentioned in the foregoing, there are a great many others that are found to some extent, and even abundant in some places. In fact, some individuals have told me, and doubtless others will say that the weed that gives them the most trouble is not included in the above list. If such is the case, it is because the weeds are not generally distributed, or universally bad. It is believed that from the large number of rice fields visited, and from the samples of rice and screenings taken from almost all of the mills of the State, we have secured a fairly accurate opinion of the distribution of the worst weeds. To enumerate and describe all those that are bad would hardly be justifiable. If efforts are directed against the ones described according to the most rational methods, the same methods will serve for whatever others there may be.
AKNOWLEDGMENT.

We are indebted to the many rice planters who have freely contributed to the information herein contained, to the owners and managers of the rice mills of New Orleans, Rayne, Crowley, Jennings, Midland, Gueydan and others for uniform courtesies, and especially for the many samples of rice containing weed seeds and data regarding the same.

We are especially indebted to the Southern Pacific Railroad for its generous interest in these investigations, as manifested in furnishing transportation to the writer over its road throughout the rice belt.
PART III.

THE CHEMICAL COMPOSITION AND FEEDING VALUE OF RICE PRODUCTS.

By C. A. Browne, Jr.

The study of rice products in Louisiana was begun at the Experiment Station in 1887. In Bulletin No. 9 of that year a number of analyses of rice bran and rice polish are reported, and attention is called for the first time to the feeding value of these products. Two years later Prof. B. B. Ross made a very complete study of the chemical composition of all the various products of the rice industry; the results of this work are found in Bulletin No. 24 of the station publications.

Owing to the remarkable increase in the rice industry in Louisiana during the last few years and the corresponding increase in the use of the various rice by-products as feeds for farm animals, a further study of these materials was deemed necessary.

Before taking up the chemical composition and feeding value of the various rice products, a brief description of the structure of the rice kernel and of the commercial process of milling will not be out of place.

STRUCTURE OF THE RICE HULL AND KERNEL.

The rice grain, as it comes from the thresher and as it is sent to the mill, consists of the kernel with its outer hull or husk, the two being easily separated from one another. The hull is tough and fibrous, and impregnated with silica. Examined under the microscope, the hull is seen to consist on the outer surface of
groups of parallel rows of jagged, comb-shaped cells, closely joining one another, with their joints interlapping. Beneath these surface cells is a compact tissue of fibers running lengthwise the hull. A magnificent section from a fragment of rice hull is shown in the accompanying figure (Fig 1); the appearance is so characteristic that the presence of ground rice hulls in adulterated feeds may be easily detected. When the hull is cut in cross section, the surface is seen under the microscope to present a scolloped appearance, as shown in the photomicrograph. These elevated portions overlie the fibro-vascular bundles of the hull, and at intervals are capped with minute spines. These spines are quite transparent, like glass, and are largely composed of silica. The photomicrograph shows these spines, as seen in a longitudinal section of the rice hull. They can be seen on the margin of the divisions of the hull without cutting sections. These jagged edges make the hulls feel rough when rubbed over one's finger. It can readily be seen how an excess of rice hulls in the stomach of an animal would cause extreme irritation to the delicate lining of the wall.

The rice kernel or grain has the general structure of other cereal grains, though differing somewhat in outward appearance. The surface of the rice grain is slightly marked with longitudinal depressions, which give it a fluted appearance; at one end is found the germ containing the plant embryo, not embedded in the grain, but freely exposed. The germ is therefore very easily rubbed off in the process of milling, the little nick at one end of the polished grain marking the place where it was located.
LONGITUDINAL SECTION OF RICE GRAIN
1—Cuticle of Grain.
2—Aleurone or Protein Layer.
3—Starch Cells.
Germ.

TRANSVERSE SECTION OF RICE GRAIN
1—Cuticle of Grain.
2—Aleurone Layer.
3—Starch Cells.
4—Longitudinal Depression in Grain.

On examining under the microscope a thin section cut through the surface of the rice grain, a number of tissues are discovered. There is, first, the outer skin, composed of different layers, as indicated in the drawing. (See illustration, Fig 5 and 6). Beneath this cuticle is found a second tissue, the so-called protein layer, the cells of which are stored with protein and oil. Under the protein layer is the central portion of the grain, quite uniform in structure, the cells being all filled with starch. The starch grains of rice are spheroidal in shape and are composed of many polyhedral granules. The grains present a very characteristic appearance, when seen under the microscope, shown in Figure 4.
Highly magnified view of section cut across the long axis of rice grain. Cell layers correspond to lettering of cut on right.

Longitudinal section of rice grain, magnified about 900 times.

cw—Cuticle layer.
c—Layer showing green coloring matter in young grain, starch, etc., later becomes partially absorbed.
s—Several layers of cylindrical cells containing some starch.
x—Layers not well defined.
o—Layers of cells along which the hull separates from the grain in milling.
Al—Aleurone layer, rich in proteins, much of which is ground off in the bran and polish.
sx—Starch cells which continue to center of grain.

Starch grains of rice highly magnified.

MILLING PROCESSES.

To understand the manner in which the various rice products are obtained, the following description of the milling process is given, this being taken in part from Bulletin No. 24.
The rice is threshed in the straw by a thresher similar to the one used to thresh other small grains. It is now rough rice and is sold in this condition to the millers. The rough rice is first screened to remove all foreign particles and then passed to the milling stones where the outer husk is removed. Leaving the stones the material passes into horizontal screens, and through shakers and fans, where the hulls, chaff, broken and whole kernels are mechanically separated.

The next process in the treatment of the whole kernels is the decorticating process. This was formerly done by pounding the grain with large wooden pestles, weighing about 400 pounds, in large mortars also made of wood and holding from four to six bushels. Of late years the mortar and pounder have gone out of use, a small machine called the "huller" having been substituted. The huller, which resembles a large sausage machine in outward appearance, consists of a short horizontal cast iron cylinder fitted with ribs on the interior surface. A shaft, also provided with ribs, revolves inside this cylinder. The rice enters through a funnel at one end and, passing through the machine, the friction against the ribs removes the outer cuticle and much of the gluten layer of the grain, together with the germ. The material next passes through screens and fans, where the bran or meal is removed from the clean grain. The latter is now ready for the final process—polishing, which is necessary to give the grain the pearly lustre so much desired. This is effected by rotating the rice in cylinders of wood and wire gauze whose surface is covered with pieces of moose hide or sheepskin, tanned and worked to a high degree of softness. In the polishing the powdery film of gluten and starch cells, visible on the grain after removing the bran, is rubbed off, and the fine flour thus obtained constitutes rice polish. From the polishers the rice goes to the separating screens, with meshes of different size, where it is separated into its appropriate grades.

YIELD OF PRODUCTS.

Dr. S. A. Knapp, in his "Report on Rice Culture" (Bulletin 22, U. S. Dept. Agriculture, Division of Botany), gives the following results from two rice mills; the figures show pounds of products per barrel of 162 pounds:
No. 1, or head rice (unbroken grains) .......... 91.32
No. 2, or broken rice ... 15.30      59.82
Brewers' rice, very broken, 6.28
Bran .................................. 20.00
Polish ................................. 8.00
Hulls ................................ 21.10

<table>
<thead>
<tr>
<th>GRADE</th>
<th>Mill 1,200 barrels daily capacity</th>
<th>Mill 200 barrels daily capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 1, or head rice (unbroken grains) .......... 91.32</td>
<td>60.00</td>
<td></td>
</tr>
<tr>
<td>No. 2, or broken rice ... 15.30</td>
<td>59.82</td>
<td>30.00</td>
</tr>
<tr>
<td>Brewers' rice, very broken, 6.28</td>
<td>3.78</td>
<td>10.00</td>
</tr>
<tr>
<td>Bran .................................. 20.00</td>
<td>40.00</td>
<td>25.00</td>
</tr>
<tr>
<td>Polish ................................. 8.00</td>
<td>46.00</td>
<td>5.00</td>
</tr>
<tr>
<td>Hulls ................................ 21.10</td>
<td>42.40</td>
<td>32.00</td>
</tr>
</tbody>
</table>

162.00 | 162.00 | 162.00 | 162.00

ANALYSES OF RICE PRODUCTS.

Very complete analyses of the various products of the Louisiana rice industry were made in 1889 by Prof. B. B. Ross. The results of his work are given in the following table, which is taken from Bulletin No. 24.

ANALYSES OF RICE PRODUCTS. (Ross.)

<table>
<thead>
<tr>
<th>SAMPLE</th>
<th>Water</th>
<th>Ash</th>
<th>Fat</th>
<th>Carbohydrates</th>
<th>Crude Protein</th>
<th>Crude Fiber</th>
<th>Carbohydrates</th>
<th>Total Nitrogen</th>
<th>Total Ash</th>
<th>Total Protein</th>
<th>True Protein</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Rough rice</td>
<td>10.95</td>
<td>5.45</td>
<td>2.53</td>
<td>9.38</td>
<td>7.44</td>
<td>64.30</td>
<td>1.19</td>
<td>1.134</td>
<td>7.09</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Rice from the stones</td>
<td>12.12</td>
<td>2.35</td>
<td>1.05</td>
<td>3.03</td>
<td>8.09</td>
<td>72.11</td>
<td>1.29</td>
<td>1.295</td>
<td>8.09</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Pounded rice</td>
<td>12.42</td>
<td>2.38</td>
<td>2.50</td>
<td>2.55</td>
<td>8.14</td>
<td>72.01</td>
<td>1.30</td>
<td>1.374</td>
<td>7.96</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Bran</td>
<td>10.67</td>
<td>1.00</td>
<td>0.97</td>
<td>10.95</td>
<td>11.29</td>
<td>46.02</td>
<td>1.806</td>
<td>1.708</td>
<td>16.67</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Rice from cooling floor</td>
<td>12.75</td>
<td>0.82</td>
<td>1.05</td>
<td>0.72</td>
<td>7.74</td>
<td>76.92</td>
<td>1.29</td>
<td>1.304</td>
<td>16.77</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Polish</td>
<td>10.63</td>
<td>5.45</td>
<td>7.02</td>
<td>2.53</td>
<td>10.94</td>
<td>63.34</td>
<td>1.75</td>
<td>1.786</td>
<td>10.85</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Clean rice</td>
<td>12.85</td>
<td>0.73</td>
<td>0.82</td>
<td>0.47</td>
<td>7.82</td>
<td>78.05</td>
<td>1.30</td>
<td>1.394</td>
<td>17.17</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Hulls</td>
<td>8.27</td>
<td>13.85</td>
<td>0.35</td>
<td>18.15</td>
<td>3.83</td>
<td>34.99</td>
<td>4.72</td>
<td>5.09</td>
<td>10.35</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Straw</td>
<td>8.97</td>
<td>10.97</td>
<td>1.87</td>
<td>32.25</td>
<td>4.72</td>
<td>32.21</td>
<td>7.56</td>
<td>7.56</td>
<td>4.73</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Analyses of various rice products from Louisiana rice mills, made during the past year at the Sugar Experiment Station, by Browne and Chiquelin, are also given:

ANALYSES OF RICE PRODUCTS. (Browne and Chiquelin.)

<table>
<thead>
<tr>
<th>SAMPLE</th>
<th>Water</th>
<th>Ash</th>
<th>Fat</th>
<th>Protein</th>
<th>Crude Fiber</th>
<th>Carbohydrates</th>
<th>Total Nitrogen</th>
<th>Total Ash</th>
<th>Total Protein</th>
<th>True Protein</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice straw</td>
<td>10.84</td>
<td>3.37</td>
<td>14.21</td>
<td>2.31</td>
<td>33.31</td>
<td>15.04</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rice hulls</td>
<td>8.87</td>
<td>4.97</td>
<td>14.29</td>
<td>2.60</td>
<td>41.89</td>
<td>17.94</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rice bran (per cent. hulls, 25 per cent. grits)</td>
<td>9.84</td>
<td>9.08</td>
<td>18.80</td>
<td>9.63</td>
<td>54.82</td>
<td>18.20</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rice bran (per cent. hulls, 25 per cent. grits)</td>
<td>10.01</td>
<td>9.08</td>
<td>18.80</td>
<td>9.63</td>
<td>54.82</td>
<td>18.20</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rice polish (8 per cent. grits)</td>
<td>10.74</td>
<td>6.85</td>
<td>2.95</td>
<td>8.53</td>
<td>1.80</td>
<td>33.14</td>
<td>6.60</td>
<td>77.55</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Samples from rice mills at Crowley, La., hulls and grits not determined.
Varying amounts of hulls and grits are found in the commercial bran and polish, so that these products never possess a fixed composition.

Very complete analyses of products from the South Carolina rice mills have been made by C. C. McDonnell of the South Carolina Agricultural Experiment Station. (Bulletin No. 59, 1901.)

The utilization of rice straw and rice hulls as stock for paper-making has been proposed. Rice straw and hulls are largely composed of cellulose, lignin, and pentosans or gum. The lignin and pentosans (mostly xylan with a little araban), are largely removed in the preparation of paper pulp by digesting with alkalies, leaving an impure cellulose. This cellulose may be further purified by bleaching. The percentage of bleached pulp (dried) obtained from rice straw and rice hulls is: Straw, 44.21 per cent, and hulls 43.09 per cent. The ash constituents of the hulls and straw were almost completely removed, leaving a pulp well adapted for paper stock.

THE FEEDING VALUE OF RICE PRODUCTS.

The rice feeds, as they are sold in Louisiana, may be divided into four general classes—rice hulls, rice meal, rice polish and commercial rice bran.

1. Rice Hulls, which are sold either in the coarse condition or ground. In the latter form they are marketed usually as “husk meal” or “star bran.” Considerable quantities of this product are exported to Germany. As a stock food they have absolutely no feeding value, and are, in fact, injurious, as will be shown.

2. The Rice Meal.—This is the pure bran, and properly speaking, should be so designated. It is the most nutritious of the rice feeds, containing the most protein and fat.

3. The Rice Polish.—This contains less fat and protein than the meal, but a higher percentage of starch. In addition to its use as a cattle food, rice polish has been employed to some extent as a stuffing material in the manufacture of sausage. A considerable part of the polish made in this country is exported to Germany, where it is used in large quantities for manufacturing buttons. Paraffin, and also powdered talc, have been employed in connection with the polishing of rice. The fear of a possible
contamination with such polishing agents, and the occasional finding in the polish of fragments of wire, broken off from the screens and brushes, have produced in some instances a prejudice against the use of rice polish as a feeding material.

4. Commercial Rice Bran.—What is usually sold under the name of rice bran in Louisiana, is a mixture of the pure bran with varying amounts of hulls, the quantity of the latter being sometimes as high as 70 per cent.

RICE HULLS AND THEIR FEEDING VALUE.

An inspection of the analyses of rice hulls given in preceding tables shows that these have but a low percentage of protein and fat, and that the percentage of woody matter is high. In addition to that the tissues of the hull are heavily impregnated with insoluble silica (12.15 per cent), which renders the work of digestion very hard. But a greater objection to rice hulls for feeding purposes is the element of danger which attends their use. The hull of the rice is not only itself very coarse and rough, but the hard silicified fibers, which make it up, are exceedingly harsh and sharp (See Fig. 1 above), so that when the hulls are eaten in any quantity an intense irritation is provoked in the delicate membranes which line the stomach and intestinal tract.

An interesting case illustrating the danger resulting from feeding rice hulls recently came to light in Stamford, Texas. Swenson Bros., large feeders of cattle, attempted to use rice hulls to supply part of the roughage, and immediately began to be troubled with their animals vomiting. A considerable correspondence took place between these feeders and Dr. Stubbs in regard to the matter. The following summary of the case is given: Swenson Bros., finding that the vomiting did not cease, sent on samples of the vomit and excreta from the sick animals. Dr. Dalrymple, veterinarian of the Experiment Station, made an examination of these, and reported as follows:

Veterinary Department, State Experiment Station, Baton Rouge, La., March 24, 1903.

Dr. Wm. C. Stubbs, New Orleans, La.:

My Dear Sir—The specimens of feces and vomitus were received this morning, both of which I examined. I noticed that
some of the rice hulls in the vomitus were still stiff and pointed, although they had been in this moist material, and which is still very moist, ever since it came from the stomach. In the dried specimen of feces they were, of course, as hard, I should say, as before they were partaken of by the animal. There appeared to be a great quantity of the hulls intact, which would indicate that they had escaped mastication, which condition shows up well in the feces, where one would think they ought to have been in much finer division after having undergone a second mastication. I took some of the hulls between my finger and thumb, pressing lengthwise on the hull, and the ends pricked almost like a needle. Of course, when first swallowed, the hulls would be much more irritating to the delicate stomach walls. Taking the history of the case, as given by Swenson Bros., and if you cannot suggest any chemical irritant in the mass of food material, as a whole, I believe the most feasible diagnosis would be, as stated in my previous communication, gastric irritation produced mechanically by the hard, fibrous and pointed condition of the hulls, due to their being swallowed in that condition, and not sufficiently reduced and softened to prevent their irritating effect upon the delicate nerve filaments in the mucous membrane in the gastric walls. Very respectfully,

W. H. DALRYMPLE.

Swenson Bros. reported that several bulls died during the feeding of rice hulls. In dissecting one of these the paunch was found distended with rice hulls, although none had been eaten in two weeks. In cases where hulls were omitted from the feed the vomiting of the animals ceased.

THE ADULTERATION OF RICE BRAN WITH RICE HULLS.

The experience of Swenson Bros., just recorded, is of especial value as illustrating the dangerous effects of feeding rice hulls; yet these hulls are constantly being fed throughout the South, in many cases probably without its being known. The hulls, which are separated first of all in the process of milling, are frequently ground up and then incorporated with rice bran, or else sold as a filler to other parties, who, no doubt, employ them in the manufacture of the various mixtures now sold everywhere as commercial stock feeds. Our feeders cannot be cautioned too strongly.
against these brands of mixed feeds, as all sorts of refuse and miller's waste frequently enter into their composition. The best plan is always to buy pure unmixed feeds, and when mixing is to be done, do it yourself.

The practice of mixing hulls and rice meal, which is really the most nutritious portion of the rice for feeding, should therefore be discouraged. Even as a matter of economy, aside from all other objections, feeds adulterated with hulls should not be purchased. Although the direct cost per ton of the adulterated feed may seem less, the feeder is really paying proportionately much more for the amount of nutriment actually received than he would pay if the pure feed had been bought. It should be stated, however, in this connection, that it has been found impossible thus far in the milling of rice to manufacture a bran or meal absolutely free from hulls. Small quantities of the latter work their way into the bran unavoidably, and this seems to be particularly true of the more modern processes of milling, where "hulling" machines are used instead of the old "pounders."

It is highly desirable that some standard be established for rice bran that purchasers may be protected against an unscrupulous adulteration of the product with hulls. A maximum percentage should be set for the quantity of hulls considered unavoidable in the milling process, and all brans exceeding this maximum should be regarded as adulterated. The amount of hulls that may work their way into the bran seems to vary somewhat with the quality of the rice; in the opinion of some rice millers, 10 per cent of hulls would be a very safe maximum to allow. Samples of good rice bran by the new process, analyzed at the Louisiana Station, were found to contain only about 5 per cent hulls, so that 10 per cent would seem to be a liberal allowance.

Judging from the results of reliable analyses, rice bran should contain at least 12 per cent protein and 12 per cent fat, though an excessive amount of grits or broken rice might reduce these figures. In fixing a standard more stress should be laid, therefore, upon the maximum of fiber and ash. Rice bran exceeding 10 per cent fiber or 9 per cent ash should be regarded with suspicion. These limits are suggested, however, only tentatively, as the analyses of many samples from different mills is necessary before a standard can be fixed.
The analyses of a number of adulterated rice brans, analyzed at the Audubon Park Experiment Station, are given in the following table:

**ANALYSES OF ADULTERATED RICE BRANS.**

<table>
<thead>
<tr>
<th>SAMPLE</th>
<th>Moisture</th>
<th>Fat</th>
<th>Ash</th>
<th>Protein</th>
<th>Fiber</th>
<th>Carbohydrates</th>
<th>Per cent. hulls</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>8.70</td>
<td>11.00</td>
<td>14.39</td>
<td>9.13</td>
<td>20.84</td>
<td>35.94</td>
<td>36.1</td>
</tr>
<tr>
<td>2</td>
<td>9.82</td>
<td>4.58</td>
<td>14.29</td>
<td>6.32</td>
<td>31.36</td>
<td>33.63</td>
<td>71.2</td>
</tr>
<tr>
<td>3</td>
<td>10.04</td>
<td>10.60</td>
<td>9.27</td>
<td>10.00</td>
<td>17.49</td>
<td>42.60</td>
<td>25.0</td>
</tr>
<tr>
<td>4</td>
<td>9.14</td>
<td>11.52</td>
<td>7.89</td>
<td>11.14</td>
<td>13.38</td>
<td>46.93</td>
<td>11.3</td>
</tr>
<tr>
<td>5</td>
<td>8.34</td>
<td>13.50</td>
<td>11.36</td>
<td>11.98</td>
<td>11.67</td>
<td>43.25</td>
<td>5.6</td>
</tr>
<tr>
<td>6</td>
<td>9.65</td>
<td>10.38</td>
<td>11.38</td>
<td>9.34</td>
<td>14.41</td>
<td>44.84</td>
<td>14.7</td>
</tr>
<tr>
<td>7</td>
<td>13.32</td>
<td>10.12</td>
<td>17.45</td>
<td></td>
<td></td>
<td></td>
<td>25.0</td>
</tr>
</tbody>
</table>

The formula employed for calculating adulteration is—

\[
\text{Per cent hulls} = 3.33 \times (\text{per cent fiber} - 10)
\]

The above formula assumes 40 per cent fiber for pure hulls and 10 per cent fiber for pure bran.

Calculations of adulteration from the increase in percentage of ash are not always trustworthy, as the amount of ash seems to vary in different products, being dependent upon location (upland or lowland), and also upon the degree of irrigation. The adulteration with hulls calculated from the diminution in fat or protein content of the bran would be erroneous in case a large amount of rice grits were present.

Various simple methods are in use among feeders for the detection of hulls in rice bran. If the hulls are not too finely ground, they may be separated together with the grits, by passing the bran through a fine sieve. Stirring the bran up in a glass of water is a method sometimes employed, the amount of floating material being taken as an index of the extent of adulteration, but this is not very reliable as the hulls have a greater tendency to sink than to float. Determination of fiber by chemical analysis is the only reliable means of detecting adulterations with hulls.
GRITS IN RICE FEEDS.

Reference has been made to the presence of grits or broken grains of rice in rice bran and rice polish. In some cases 25 per cent of the feed consists of grits, the varying amounts of these in the rice feeds naturally causes a fluctuation in the composition, a large quantity of grits causing an increase in starch and a decrease in protein and fat. While the grits have a high feeding value, and are not particularly detrimental to the animal, as is the case with rice hulls, it must be noted that many of them pass through the animal undigested. These fragments of rice are very hard to break up and are not easily affected by the digestive juices of the animal. Nearly 10 per cent of the dry matter in the excrement of an animal fed with polish consisted of undigested grits. If these grits could be ground up, or if they could be removed during milling, the digestibility of the feed would be increased. Information has been received that it is even poor economy for the miller to allow the grits to escape into his feeds; that he can sell the grits as brewers' rice for $40 a ton, whereas rice polish brings him but $20, and rice bran considerably less.

RANCIDITY OF RICE FEEDS.

Frequent complaints have been reported in connection with the use of rice feeds, as to their being unpalatable. In some of our own experiments at Baton Rouge, Prof. Dodson reports that animals would not eat rice bran well at first, but had to be coax ed by first mixing in a little cotton seed meal. Reports from the North Carolina Experiment Station, and elsewhere, also show that rice bran is not always relished, it being so distasteful at times that animals will not eat it unless driven by hunger. Lack of palatability in a feed is, of course, a serious drawback to its use; we have, accordingly, made at the Experiment Station an investigation as to the causes of the distaste which animals sometimes show to the various rice feeds. Our experiments show that the trouble consists in a breaking up of the rice oil, which is so abundant in these feeds (over 14 per cent. in pure bran) into free fatty acids, the latter giving the feed a very rancid taste. In some cases we found the rice oil to be nearly 90 per cent. free acid, this amounting to from 8 to 12 per cent. free acid in the feeds themselves. Fresh bran
shows only a very low degree of rancidity, but on standing in a sack for some weeks the free acid was found to increase very rapidly. In large bulks this development of rancidity seems to be attended by the feed heating and caking. The cause of this decomposition of the rice oil was traced to a ferment or enzyme, lipase, which occurs naturally in the rice, as well as in many other seeds of plants, and has the property of splitting up the vegetable oil into glycerine and free fatty acids. This decomposition does not occur except during germination, or when the seeds are crushed. By subjecting the bran to a heat of 200 degrees Fahrenheit this ferment is destroyed.

The results of some experiments upon the rancidity of oil in rice products is given below. The effect of heating rice bran as a means of preventing rancidity is also shown:

<table>
<thead>
<tr>
<th>Per cent. Free Fatty Acids in Oil.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil from very rancid rice bran</td>
</tr>
<tr>
<td>Oil from rancid polish</td>
</tr>
<tr>
<td>Oil from raw rice</td>
</tr>
<tr>
<td>Oil from fresh bran, 6 hours after milling</td>
</tr>
<tr>
<td>Oil from above bran, 1 month old, unheated</td>
</tr>
<tr>
<td>Oil from above bran, 1 month old, heated</td>
</tr>
</tbody>
</table>

The unheated bran turned very rancid; this change went on very slowly in the heated sample, and the slight increase observed was due probably to the natural oxidation which all oils and fats undergo on exposure to the air. If our millers could subject their bran as soon as it is made to a dry heat of 200 degrees Fahrenheit, or even higher, as is done sometimes in the kiln drying of various feeds, and then press the material into cake form, we believe all dangers of rancidity would be removed. A similar process is employed in the preparation of cotton seed and linseed cake, and these feeds, so far as known, are not affected with rancidity. Feeds pressed into cake form are also most conveniently adapted to transportation.

EXTRACTION AND UTILIZATION OF RICE OIL.

Another means of preventing rancidity in rice bran consists in removing a part of the oil. The percentage of oil in rice bran is very high, being double that found in wheat or corn bran. This
large percentage of oil is considerably in excess of that required for general feeding purposes, so that an extraction of a considerable part of the oil from rice bran would remove not only the danger of rancidity, but increase the feeding value of the product, it being a well known fact that excess of fat in a feed decreases the digestibility of the protein and other constituents. The rice oil thus removed would have a considerable commercial value, so that the process of extraction would be a source of profit, rather than an item of expense. Complaints as to the laxative effects of rice bran when fed to animals in large amounts, are, no doubt, due to the excess of rice oil, and this difficulty would also be obviated by reducing the amount of oil in rice bran down to two or three per cent.

The Experiment Station at Audubon Park is at present conducting a series of co-operative experiments with an oil company upon the extraction and utilization of rice oil, studying particularly the question as to what extent the character of the rice bran is thus improved.

DIGESTION EXPERIMENTS WITH RICE BRAN AND RICE POLISH.

In these experiments three steers were used, the care of the feeding details being under the supervision of Prof. W. R. Dodson at Baton Rouge. Results are reported for only two of the steers, as one of the animals did not eat well during the experiment, besides manifesting other irregularities. The animals were fed in each experiment unmixed rations. While the feeding of pure bran or of pure polish, without roughage, to stock would never be advisable, it was done in the experiments for the reason that a more accurate knowledge of the digestibility of certain constituents of the rice feeds could be secured, than where a mixed ration was fed. The digestibility of mixed rations, containing rice bran or meal, will be the object of future experiments.

EXPERIMENT WITH RICE BRAN.

The rice bran used in the experiment was purchased as a pure article, but was found on analysis to contain about 16 per cent. of hulls; 25 per cent. of grits were also present. The steers manifested a dislike to the feed at first, due probably to the fact that it was rancid. By coaxing the animals with a little cotton seed meal
mixed with the bran, this dislike was somewhat, though not entirely, overcome.

On January 26, the feeding of the bran began; a little cotton-seed meal and hay were also given. On February 2 the animals were eating fairly well and the hay and cotton seed meal were dropped. February 5 the steers were put in the stalls, where they were kept for twelve days; they were fed twice daily, at 6 a.m. and 6 p.m. During the last six days of the period the feces from each animal were collected at regular intervals and an aliquot sample drawn for analysis. At the end of the experiment the daily samples were thoroughly mixed and a sample from this composite was sealed up in a jar, after addition of a little preservative. Samples of the bran were also taken, a small portion being drawn at each feeding.

All samples were sent to the Experiment Station laboratory at Audubon Park, where the analyses were made.

**COMPOSITION OF RICE BRAN—EXPERIMENT 1.**

<table>
<thead>
<tr>
<th></th>
<th>Steer Bob.</th>
<th>Steer Buck.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Per cent.</td>
<td>Per cent.</td>
</tr>
<tr>
<td>Moisture</td>
<td>9.96</td>
<td>9.84</td>
</tr>
<tr>
<td>Fat</td>
<td>9.88</td>
<td>9.91</td>
</tr>
<tr>
<td>Protein</td>
<td>9.88</td>
<td>9.88</td>
</tr>
<tr>
<td>Ash</td>
<td>11.23</td>
<td>11.35</td>
</tr>
<tr>
<td>Fiber</td>
<td>14.30</td>
<td>14.76</td>
</tr>
<tr>
<td>Carbohydrates (Nitrogen free extract)</td>
<td>44.75</td>
<td>44.26</td>
</tr>
<tr>
<td></td>
<td>100.00</td>
<td>100.00</td>
</tr>
</tbody>
</table>

**COMPOSITION OF FECES—EXPERIMENT 1.**

<table>
<thead>
<tr>
<th></th>
<th>Steer Bob.</th>
<th>Steer Buck.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Per cent.</td>
<td>Per cent.</td>
</tr>
<tr>
<td>Air dry matter</td>
<td>27.30</td>
<td>28.95</td>
</tr>
</tbody>
</table>

**PERCENTAGE COMPOSITION OF AIR DRY FECES.**

<table>
<thead>
<tr>
<th></th>
<th>Steer Bob.</th>
<th>Steer Buck.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fat</td>
<td>11.09</td>
<td>11.56</td>
</tr>
</tbody>
</table>
### TABLE I.

#### STEER BOB.

<table>
<thead>
<tr>
<th></th>
<th>Total amount</th>
<th>Dry matter</th>
<th>Fat</th>
<th>Protein</th>
<th>Ash</th>
<th>Fiber</th>
<th>Carbohydrates (Nitrogen free extract)</th>
<th>Albuminoids</th>
<th>Pentosans</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice bran fed six days</td>
<td>1309.0</td>
<td>1178.6</td>
<td>129.3</td>
<td>129.3</td>
<td>146.5</td>
<td>187.2</td>
<td>585.8</td>
<td>117.8</td>
<td>117.1</td>
</tr>
<tr>
<td>Feces, six days</td>
<td>1809.0</td>
<td>474.8</td>
<td>54.9</td>
<td>42.6</td>
<td>99.6</td>
<td>161.3</td>
<td>116.6</td>
<td>37.7</td>
<td>70.8</td>
</tr>
<tr>
<td>Digested</td>
<td>703.8</td>
<td>74.4</td>
<td>86.7</td>
<td>46.9</td>
<td>25.9</td>
<td>469.2</td>
<td>80.1</td>
<td>46.3</td>
<td></td>
</tr>
<tr>
<td>Per cent. digested</td>
<td>59.7</td>
<td>57.5</td>
<td>67.0</td>
<td>32.0</td>
<td>13.8</td>
<td>80.1</td>
<td>68.8</td>
<td>39.5</td>
<td></td>
</tr>
</tbody>
</table>

#### STEER BUCK.

<table>
<thead>
<tr>
<th></th>
<th>Total amount</th>
<th>Dry matter</th>
<th>Fat</th>
<th>Protein</th>
<th>Ash</th>
<th>Fiber</th>
<th>Carbohydrate (N.)</th>
<th>Albuminoids</th>
<th>Pentosans</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice bran fed six days</td>
<td>1796.5</td>
<td>1619.7</td>
<td>178.0</td>
<td>177.5</td>
<td>146.5</td>
<td>187.2</td>
<td>585.2</td>
<td>116.7</td>
<td>160.8</td>
</tr>
<tr>
<td>Feces, six days</td>
<td>2550.0</td>
<td>709.4</td>
<td>85.4</td>
<td>66.9</td>
<td>134.6</td>
<td>231.6</td>
<td>190.9</td>
<td>64.6</td>
<td>116.6</td>
</tr>
<tr>
<td>Digested</td>
<td>910.3</td>
<td>92.6</td>
<td>110.6</td>
<td>69.3</td>
<td>33.6</td>
<td>604.2</td>
<td>97.1</td>
<td>44.2</td>
<td></td>
</tr>
<tr>
<td>Per cent. digested</td>
<td>56.2</td>
<td>52.0</td>
<td>62.3</td>
<td>34.0</td>
<td>12.7</td>
<td>76.0</td>
<td>60.0</td>
<td>27.4</td>
<td></td>
</tr>
<tr>
<td>Av. 2 steers, pct. dig.</td>
<td>58.0</td>
<td>54.8</td>
<td>64.7</td>
<td>33.0</td>
<td>13.3</td>
<td>78.1</td>
<td>64.4</td>
<td>33.5</td>
<td></td>
</tr>
</tbody>
</table>

The animals lost a little in weight during the experiment with rice bran, as is shown from the following record:

Steer Bob. Steer Buck.

Weight at beginning of experiment... 1,280 lbs. 1,440 lbs.
Weight at close of experiment........ 1,250 lbs. 1,430 lbs.

### EXPERIMENT WITH RICE POLISH.

The rice polish used in the experiment was a good quality of the commercial article. It was comparatively free from hulls, but contained about 23 per cent. of grits or broken grains. The feed
was slightly rancid, but the animals seemed on the whole to relish it better than the bran.

The steers were first fed on the polish March 6, when they were still running in the pasture. March 7 they were taken up, and not put on grass again, but could graze a little in the lot. Some cotton seed meal was added to the polish till March 10. On March 11 they were put in the stalls and allowed nothing to eat but the rice polish, receiving five pounds at each feed, night and morning, for twelve days. Collections of samples of feed and feces were made during the last six days, as in the previous experiment.

**COMPOSITION OF THE POLISH—EXPERIMENT 2.**

<table>
<thead>
<tr>
<th></th>
<th>Steer Bob.</th>
<th>Steer Buck</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture</td>
<td>11.19</td>
<td>11.83</td>
</tr>
<tr>
<td>Fat</td>
<td>5.67</td>
<td>5.92</td>
</tr>
<tr>
<td>Protein</td>
<td>11.13</td>
<td>11.06</td>
</tr>
<tr>
<td>Ash</td>
<td>3.52</td>
<td>3.46</td>
</tr>
<tr>
<td>Fiber</td>
<td>3.88</td>
<td>3.76</td>
</tr>
<tr>
<td>Carbohydrates (Nitrogen free extract)</td>
<td>64.61</td>
<td>63.97</td>
</tr>
<tr>
<td></td>
<td>100.00</td>
<td>100.00</td>
</tr>
</tbody>
</table>

**COMPOSITION OF FECES—EXPERIMENT 2.**

<table>
<thead>
<tr>
<th></th>
<th>Steer Bob.</th>
<th>Steer Buck</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air dry matter</td>
<td>27.30</td>
<td>26.27</td>
</tr>
</tbody>
</table>

**PERCENTAGE COMPOSITION OF AIR DRY FECES.**

<table>
<thead>
<tr>
<th></th>
<th>Steer Bob.</th>
<th>Steer Buck</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture</td>
<td>3.80</td>
<td>3.20</td>
</tr>
<tr>
<td>Fat</td>
<td>6.63</td>
<td>12.78</td>
</tr>
<tr>
<td>Protein</td>
<td>24.00</td>
<td>23.63</td>
</tr>
<tr>
<td>Ash</td>
<td>15.79</td>
<td>14.08</td>
</tr>
<tr>
<td>Fiber</td>
<td>18.88</td>
<td>18.70</td>
</tr>
<tr>
<td>Carbohydrates (Nitrogen free extract)</td>
<td>30.90</td>
<td>27.61</td>
</tr>
<tr>
<td></td>
<td>100.00</td>
<td>100.00</td>
</tr>
</tbody>
</table>

Albuminoids                     23.25 | 22.56
Starch                          5.78  | 1.73
Pentosans                       9.57  | 10.86
The coefficients of digestibility of the rice polish, calculated from the above analyses, are given in the following tables:

### TABLE II.

#### STEER BOB.

<table>
<thead>
<tr>
<th>Total Amount,</th>
<th>960</th>
<th>852.6</th>
<th>54.4</th>
<th>106.8</th>
<th>33.8</th>
<th>38.2</th>
<th>620.3</th>
<th>105.6</th>
<th>29.5</th>
<th>526.3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry matter,</td>
<td>574</td>
<td>160.7</td>
<td>10.4</td>
<td>37.6</td>
<td>24.7</td>
<td>29.6</td>
<td>48.4</td>
<td>36.4</td>
<td>15.0</td>
<td>9.1</td>
</tr>
<tr>
<td>Pat, ounces</td>
<td>701.9</td>
<td>44.0</td>
<td>69.2</td>
<td>9.1</td>
<td>8.6</td>
<td>571.9</td>
<td>69.2</td>
<td>14.5</td>
<td>517.2</td>
<td></td>
</tr>
<tr>
<td>Protein, ounces</td>
<td>82.3</td>
<td>80.9</td>
<td>64.8</td>
<td>26.9</td>
<td>22.5</td>
<td>92.2</td>
<td>65.5</td>
<td>49.2</td>
<td>98.2</td>
<td></td>
</tr>
</tbody>
</table>

**Rice polish fed 6 days**

**Feces, 6 days**

**Digested**

**Per cent. digested**

---

#### STEER BUCK.

<table>
<thead>
<tr>
<th>Total Amount,</th>
<th>960</th>
<th>846.4</th>
<th>56.8</th>
<th>106.2</th>
<th>33.2</th>
<th>36.1</th>
<th>614.1</th>
<th>104.4</th>
<th>29.5</th>
<th>526.3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry matter,</td>
<td>576</td>
<td>146.5</td>
<td>19.3</td>
<td>35.8</td>
<td>21.3</td>
<td>28.3</td>
<td>41.8</td>
<td>34.1</td>
<td>16.4</td>
<td>2.6</td>
</tr>
<tr>
<td>Pat, ounces</td>
<td>699.9</td>
<td>37.5</td>
<td>70.4</td>
<td>11.9</td>
<td>7.8</td>
<td>572.3</td>
<td>70.3</td>
<td>13.1</td>
<td>523.7</td>
<td></td>
</tr>
<tr>
<td>Protein, ounces</td>
<td>82.7</td>
<td>66.0</td>
<td>66.3</td>
<td>35.8</td>
<td>21.6</td>
<td>93.2</td>
<td>67.3</td>
<td>44.4</td>
<td>99.5</td>
<td></td>
</tr>
</tbody>
</table>

**Rice polish fed 6 days**

**Feces, 6 days**

**Digested**

**Percent. digested**

**Av. 2 steers, pct. dig.**

---

The animals lost again in weight during the feeding with rice polish, but this loss was due largely to the fact that the animals were drinking a great deal less water at the close of the experiment.

Steer Bob. Steer Buck.

**Weight at beginning of experiment...** 1,240 lbs. 1,445 lbs.

**Weight at close of experiment...** 1,220 lbs. 1,400 lbs.

At the beginning of the experiment the steers were drinking from 40 to 45 pounds of water per day, and at the close only from 18 to 20 pounds.

**EXPERIMENTS ELSEWHERE UPON RICE FEEDS.**

The results of a few experiments performed elsewhere upon the digestibility of rice bran and rice meal is given below:

### TABLE III.

<table>
<thead>
<tr>
<th>Authority</th>
<th>Rice Bran</th>
<th>Rice Meal.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emery, N. C. Station, Bull. 160...</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Lindsey, Mass. Station Rep. 1898, p. 135...</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>German Reports...</td>
<td>1</td>
<td>3</td>
</tr>
</tbody>
</table>

**AUTHORITY.**

**DIGESTION COEFFICIENTS.**

<table>
<thead>
<tr>
<th>Authority</th>
<th>Rice Bran</th>
<th>Rice Meal.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emery, N. C. Station, Bull. 160...</td>
<td>64.7</td>
<td>63.0</td>
</tr>
<tr>
<td>Lindsey, Mass. Station Rep. 1898, p. 135...</td>
<td>74.0</td>
<td>62.0</td>
</tr>
<tr>
<td>German Reports...</td>
<td>75.0</td>
<td>63.0</td>
</tr>
</tbody>
</table>
DISCUSSION OF RESULTS UPON DIGESTIBILITY OF RICE BRAN AND RICE POLISH.

DIGESTIBILITY OF DRY MATTER.

Comparing the bran with the polish we note from Tables I. and II. that the percentage of dry matter digested from the latter is about 25 per cent. greater. The high percentage of hulls in the bran (about 16 per cent.) explains this fact, the large amount of insoluble silicious matter in the hulls rendering them practically indigestible. Eliminating the mineral matter and calculating the digestive coefficients to organic matter alone, we obtain the following results:

<table>
<thead>
<tr>
<th></th>
<th>Rice Bran</th>
<th>Rice Polish</th>
</tr>
</thead>
<tbody>
<tr>
<td>Per cent. of organic matter digested—Bob...</td>
<td>63.6</td>
<td>84.6</td>
</tr>
<tr>
<td>Per cent. of organic matter digested—Buck...</td>
<td>59.4</td>
<td>84.6</td>
</tr>
<tr>
<td>Average</td>
<td>61.5</td>
<td>84.6</td>
</tr>
</tbody>
</table>

This still shows a difference of 23 per cent. in favor of the polish. The dry matter of the polish containing about 30 per cent. more starch than that of the bran would naturally have a greater digestibility.

The feces of the animals fed on bran was made up to a large extent of undigested hulls very little broken or reduced during the process of mastication and digestion.

DIGESTIBILITY OF RICE OIL.

The steers were able to digest a much higher percentage of fat from the polish than from the bran. This may have been due to the fact that the animals received in the polish experiments only about one-third the quantity of fat given during the feeding with bran and were thus able to digest a greater percentage from the rations. The fat in the bran was also much more rancid than that in the polish, and this may have affected its digestibility to some extent.
Free Fatty Acids.

Rice oil from bran ........................................... 83.5 per cent.
Rice oil from polish .......................................... 47.5 per cent.

The excess of the hulls in the bran may also have lessened the digestibility of the fat.

Individuality of the animal seemed to play a considerable part in the digestion of the fat. With the polish the steer Bob was able to digest 15 per cent. more of the fat than Buck. In the case of the latter animal about 13 per cent. of the dry feces consisted of undigested fat.

It was found in the determination of fat in the feces that the customary extraction with ether, according to the method of the Association of Agricultural Chemists, did not effect in every case a complete removal of the fat. It was only after digesting the feces with pepsin solution, to remove the excess of albuminoid products, and then filtering off and drying the residue, that a satisfactory extraction could be made.

**PER CENT FAT IN AIR DRY FECES.**

<table>
<thead>
<tr>
<th>Method of Analysis</th>
<th>Bran</th>
<th>Polish</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steer Bob—</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ordinary method, 20 hours extraction</td>
<td>11.09</td>
<td>6.19</td>
</tr>
<tr>
<td>Pepsin method, 20 hours extraction</td>
<td>11.12</td>
<td>6.63</td>
</tr>
<tr>
<td>Steer Buck—</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ordinary method, 20 hours extraction</td>
<td>9.80</td>
<td>8.87</td>
</tr>
<tr>
<td>Ordinary method, 24 hours extraction</td>
<td>—</td>
<td>8.94</td>
</tr>
<tr>
<td>Ordinary method, 32 hours extraction</td>
<td>—</td>
<td>10.00</td>
</tr>
<tr>
<td>Pepsin method, 20 hours extraction</td>
<td>11.56</td>
<td>12.78</td>
</tr>
</tbody>
</table>

The greater amount of fat obtained after digesting the feces with pepsin is very marked for the steer Buck. Beger (Chemiker Zeitung, 1902, 26, No. 11) has called attention to the necessity of employing the pepsin method in determining fat in various materials, and the same necessity would appear to exist in the analysis of some kinds of feces. The feces of the animals were very glutinous and several per cent. of proteid matter was removed by the pepsin treatment. A mechanical occlusion of fat by albuminoid matter is the probable explanation of the difficulty experienced in making a direct extraction with ether.
The chemical composition of rice oil, and the changes which it undergoes through digestion, were studied to some extent. The following table shows a few of the chemical and physical constants of the fat obtained from rice bran and of that extracted from the feces of the steers fed upon the same:

<table>
<thead>
<tr>
<th></th>
<th>Fat from Rice Bran.</th>
<th>Fat from Feces.</th>
</tr>
</thead>
<tbody>
<tr>
<td>99° Specific gravity</td>
<td>0.8907</td>
<td></td>
</tr>
<tr>
<td>Melting point</td>
<td>24°C.</td>
<td>58°C.</td>
</tr>
<tr>
<td>but not perfectly</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Melted until 47°C.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acid number</td>
<td>166.2</td>
<td>144.2</td>
</tr>
<tr>
<td>Saponification number</td>
<td>193.5</td>
<td>176.0</td>
</tr>
<tr>
<td>Ether number</td>
<td>27.3</td>
<td>31.8</td>
</tr>
<tr>
<td>Iodine number</td>
<td>91.65</td>
<td>27.08</td>
</tr>
<tr>
<td>Volatile acid number</td>
<td>1.1</td>
<td></td>
</tr>
<tr>
<td>(2.5 gm.) Mean</td>
<td></td>
<td></td>
</tr>
<tr>
<td>molecular weight of</td>
<td>289.3</td>
<td>320.2</td>
</tr>
<tr>
<td>insoluble fatty acids</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Melting point of fatty</td>
<td></td>
<td></td>
</tr>
<tr>
<td>acids</td>
<td>36°C.</td>
<td>60°C.</td>
</tr>
</tbody>
</table>

The rice fat in winter weather consisted of a semi-solid pasty mass, but in summer had melted to a clear brownish colored oil with a deposit of solid crystallized fats. The fat from the feces was firm and solid.

The results show that rice fat is not a simple substance, but a mixture of different fatty bodies, some of which are liquid, containing unsaturated compounds, similar to olein or oleic acid, while others are solid; the fatty acids occurring in rice oil vary also in complexity, some of them being of low and others of high molecular weight.

A comparison of the figures for the rice oil and the oil from the feces shows very marked differences; without entering into a detailed interpretation of these, the results show that the liquid portion of the fat and the compounds of lowest molecular weight are the most easily assimilated. The fat from the feces, compared with that from the bran, has over 60 per cent, less of the unsaturated or liquid constituents and a much greater percentage of the fats of high molecular weight, which, owing to the resistance they offer to emulsification, have escaped assimilation. The molecular weight of stearic acid, the highest fat in the animal body, is 284;
solid fatty acids of greater molecular weight than this are assimilated in the animal probably only to a very limited extent.

**Digestibility of Protein.**

Comparing the rice bran with the polish there appears to be but little difference between the digestion coefficients of protein. The results also agree very closely with the values, determined by other investigations, for rice bran and rice meal, as shown in Table III. Compared, however, with the results obtained by an artificial digestion of the rice bran and polish with pepsin solutions, the digestion coefficients of protein in Tables I. and II. are exceedingly low.

**Table IV.**

**Artificial Digestion of Rice Bran and Rice Polish.**

<table>
<thead>
<tr>
<th></th>
<th>Rice Bran</th>
<th>Rice Polish</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein in original feed</td>
<td>9.88</td>
<td>11.13</td>
</tr>
<tr>
<td>Protein in residue after digesting with pepsin solution 48 hours</td>
<td>1.63</td>
<td>1.09</td>
</tr>
<tr>
<td>Protein dissolved by pepsin</td>
<td>8.25</td>
<td>10.04</td>
</tr>
<tr>
<td>Percentage protein dissolved by pepsin</td>
<td>83.5</td>
<td>90.2</td>
</tr>
<tr>
<td>Average digestion coefficient of protein</td>
<td>64.7</td>
<td>65.6</td>
</tr>
<tr>
<td>Excess of protein digested by pepsin</td>
<td>18.8</td>
<td>24.6</td>
</tr>
</tbody>
</table>

The above results would indicate either an imperfect digestion of the protein of the feed on the part of the steers, or the presence in the feces of proteid matter, sluffed off from the walls of the intestines during digestion. Such substances resulting from the wear and tear on the digestive organs are usually termed "metabolic" products.

The following experiments were made by artificial digestion with pepsin solution, to determine whether any digestible proteid matter was present in the feces of the steers fed on rice bran and polish:
Protein in undried feces...

Bran Experiment.
Bob. Buck.

per cent. per cent per cent. per cent.

2.38 2.63 5.60 5.86

Protein in undried feces after
digestion with pepsin 48

hours ............... 1.36 1.28 3.11 3.39

Protein removed by pepsin... 1.02 1.35 2.49 2.47

Per cent of protein in feces
digestible by pepsin........ 43.53 51.33 44.46 42.15

The results show a surprisingly large amount of digestible protein in the feces of the steers. This may come, as has been indicated, either from the feed or from the animal body; more probably it comes from both. While there is no satisfactory method, as yet, for differentiating between these sources of the digestible protein left in the feces, it is very evident that the digestive coefficients of protein, as commonly determined are much too low and that some correction should be made.

If we recalculate the digestion coefficients of protein in the experiments by correcting for the digestible protein in the feces, the following results are obtained:

Bran Experiment. Polish Experiment.


Oz. Oz. Oz. Oz.

Protein in feed 6 days..... 129.3 177.5 106.8 106.2

Protein in feces, 6 days after
deducting protein soluble
in pepsin sol........... 24.5 32.6 17.9 19.5

Digestible protein ......... 104.8 144.9 88.9 86.7

Percentage digestible of pro-
tein .................... 81.1 81.6 83.2 81.1

The above corrected coefficients for digestible protein are nearly 20 per cent higher than those given in tables I and II, but are still somewhat lower than the values found by artificial digestion in Table IV. The excretion by the animal of metabolic nitrogenous compounds, insoluble in pepsin, such as nuclein, no doubt accounts for the lower results.
It is still a question whether the method of an artificial digestion does not give more accurate results for the actual digestibility of protein in a ration, than an experiment with an animal. While it is not a test under perfectly natural conditions, the method can be perfectly controlled, and is not open to the many sources of error that are encountered in experiments with animals.

**DIGESTIBILITY OF FIBER AND CARBOHYDRATES.**

Among the carbohydrates of feeding materials are included a number of bodies, the principal ones being the *sugars, starch*, and the *gums*, or *pentosans*, these latter accompanying the fiber, together with the various bodies of a woody nature grouped together under the name *lignin*. The sugars and starch of a ration are very completely digested, the pentosans, fiber, and lignin bodies only imperfectly so.

The rice bran, as was stated, contained over 16 per cent rice hulls, which, owing to their woody nature, are rich in fiber, pentosans and lignin; the rice polish was comparatively free from hulls, but contained instead a large quantity of starch. These facts readily explain the greater digestibility of the carbohydrates in the polish. The fiber and pentosans are both less digestible in the bran, due to the fact already explained that the large amount of silica in the hulls decreases their digestibility.

The varying quantities of grits, or broken grains of rice in the bran and polish causes, naturally, a variation in the amounts of carbohydrates present and influences also to some extent the digestibility of the same. The statement has been made by some authorities that the sugar and starch of a ration are completely digested; this statement requires some modification, for while it may be true of materials fed in a fine condition, it is by no means the case when animals are fed whole grain, or grain only roughly ground. In the feces of the steers, both in the bran and in the polish experiment, there were found many undigested grits, these varying in size from microscopic particles, to whole rice grains. The feces, after reducing the grits in a mortar, all gave strong starch reactions with iodine. In the case of the polish it was calculated from the amount of starch in the feces of one of the animals that about 7 per cent of the grits in the feed escaped digestion. The digestion
coefficients of the starch in the polish experiment are given in Table II.

COMPARISON OF RICE BRAN AND POLISH WITH OTHER CEREAL FEEDS.

The percentage of digestible nutrients in the rice bran and polish, as calculated from the tables of composition and digestibility previously given, appears below. The composition of a few other cereal feeds is also given for comparison. Digestible fiber is included in the carbohydrates:

<table>
<thead>
<tr>
<th>PRODUCT</th>
<th>DIGESTIBLE.</th>
<th>Total Indigestible</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Protein—Per</td>
<td>Fat—Per Cent</td>
</tr>
<tr>
<td>Rice Polish</td>
<td>7.26</td>
<td>4.36</td>
</tr>
<tr>
<td>Rice Meal</td>
<td>8.80</td>
<td>10.50</td>
</tr>
<tr>
<td>Rice Bran (16 per cent hulls)</td>
<td>6.37</td>
<td>5.43</td>
</tr>
<tr>
<td>Rice Straw</td>
<td>1.56</td>
<td>0.28</td>
</tr>
<tr>
<td>Rice Hulls</td>
<td>0.20</td>
<td>0.23</td>
</tr>
</tbody>
</table>

COMPARISON OF DIFFERENT RICE PRODUCTS IN DIGESTIBILITY.

In the following tables the percentages of digestible ingredients and indigestible matter are given for the different rice products, which are arranged in the order of their digestibility. The figures for Rice Meal and Hulls are estimates based upon the experiments with the bran and polish. The figures for Rice Straw are taken from tables by Dietrich & König:

PERCENTAGE OF DIGESTIBLE NUTRIENTS.

<table>
<thead>
<tr>
<th></th>
<th>Protein</th>
<th>Fat</th>
<th>Carbohydrate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice bran, (16 per cent hulls)</td>
<td>6.4</td>
<td>5.4</td>
<td>36.9</td>
</tr>
<tr>
<td>Rice polish</td>
<td></td>
<td>7.3</td>
<td>4.4</td>
</tr>
<tr>
<td>Rice meal (i.e., pure rice bran free from hulls), calculated</td>
<td>8.8</td>
<td>10.5</td>
<td>42.0</td>
</tr>
<tr>
<td>Wheat bran</td>
<td></td>
<td>12.2</td>
<td>2.7</td>
</tr>
<tr>
<td>Wheat middlings</td>
<td></td>
<td>12.8</td>
<td>3.4</td>
</tr>
<tr>
<td>Corn bran</td>
<td></td>
<td>7.4</td>
<td>4.6</td>
</tr>
<tr>
<td>Rye bran</td>
<td></td>
<td>11.5</td>
<td>2.0</td>
</tr>
<tr>
<td>Oat shorts</td>
<td></td>
<td>12.5</td>
<td>2.8</td>
</tr>
</tbody>
</table>

Rice meal or rice polish contains considerably less digestible
protein than any of the other cereal feeds, with the exception of corn bran. The distinguishing characteristics of rice bran when pure, is the large amount of fat, the percentage of this being over twice that found in any other cereal bran.

THE FEEDING OF RICE PRODUCTS TO FARM ANIMALS.

The following remarks in regard to the feeding of rice products apply for the most part to the pure bran or rice meal, this being the principal by-product of the milling industry. Rice polish is produced in much less quantity, and at its present high price it is a question whether it is an economical feed for general purposes. It contains less protein and fat than the meal, and there are other cheaper materials, as molasses, which can supply any deficiency our rations may have in carbohydrates, without paying $20 or more per ton for the polish.

Pure rice bran or meal, while not belonging to the higher concentrates, such as cotton seed or linseed meal, which have a high protein content, is excellently adapted as an adjunct to those more concentrated feeds, and in compounding any ration the Southern feeder will find it especially useful.

*Rice Bran for Horses or Mules*—Rice bran has been fed with considerable success to horses and mules in Louisiana and elsewhere in the South.

A few examples of a mixed ration for horses or mules, introducing rice meal, are given below. Such a ration should contain coarse fodder, such as hay, in addition to the concentrates. The general practice is to use the coarse and concentrated feed in about equal proportions. The following rations ought to meet the needs of an ordinary farm mule, weighing 1,200 pounds, and doing a heavy amount of work:

Ration No. 1—15 pounds crabgrass hay, 
8 pounds corn, 
8 pounds rice meal, 
1½ pounds cotton seed meal.

If leguminous hays are available, these may be used instead of cotton seed meal to supply protein.

Ration No. 2—15 pounds alfalfa hay, 
8 pounds rice meal, 
2 pounds corn,
8 pounds molasses.

Ration No. 3—15 pounds cow pea hay,
8 pounds rice meal,
8 pounds corn.

The amounts of digestible protein in the above rations approximate 2½ pounds, the amounts of digestible fat and carbohydrates about 15 pounds.

These values exceed somewhat the usual practice of American feeders, but are no greater than the standards accepted in France and Germany, and certainly none too large for plantation mules, which are usually very heavily worked.

The rations given are, of course, only examples, and can be varied in any number of different ways to suit the convenience of the feeder.

**Rice Bran for Cows**—Comparative experiments at the North Carolina Experiment Station (Bulletin No. 169) in feeding rice bran and wheat bran to dairy cows have demonstrated that rice bran alone, with corn silage as a source of roughage, is inferior to wheat bran, inasmuch as cows lost both weight and milk on the rice ration. Owing to the deficiency of rice bran in protein, it is difficult to make a properly balanced ration for milch cows with this feed alone in connection with some kinds of roughage. Experiments at the above named station (Bulletin No. 169) show, however, that if this deficiency in protein be made up by adding a little cotton seed meal to the ration, there is no difference in the feeding value of rice bran and wheat bran, provided the animals relish the feed equally well, which is not always the case. The distaste which farm animals show at times to rice bran was found in our own experiments to be due to a rancid condition of the feed. Henry states (Feeds and Feeding, page 144) that “rancid rice meal has a bad influence on milk and butter and is apt to disturb the digestion of the cow.” The causes of rancidity in rice products and possible remedies therefor have already been dwelt upon.

**Rice Bran for Pigs**—Rice bran and also rice polish have been used very successfully in Louisiana for feeding and fattening pigs. Experiments by Connor at the South Carolina Agricultural Experiment Station (Bulletin No. 55) show that rice meal fed with skim milk to pigs has a feeding value equal to, if not greater, than that of corn meal. Similar results have been reported by Lindsay, Hol-
land and Billings, at the Massachusetts Hatch Experiment Station (9th Annual Report, 1897, page 126).

Rice bran, owing to its deficiency in protein, should not be fed alone to growing pigs, but with some adjunct such as skim milk or meat scraps.

**FERTILIZING VALUE OF THE RICE FEEDS.**

An important point in connection with the purchase of feeding materials, is the amount of fertilizing matter which they contain in the form of nitrogen, potash and phosphoric acid. These ingredients are to a large extent all recovered in the manure of the animals, and they therefore contribute in an indirect way to the maintenance of soil fertility. In the following table is given the percentage of different rice products in nitrogen, phosphoric acid and potash, according to analyses by C. C. McDonnell, of the South Carolina Experiment Station, together with the relative commercial value of these per ton of product (Louisiana prices). A few other feeds are also given for comparison:

<table>
<thead>
<tr>
<th>Nitrogen</th>
<th>Phos. Acid</th>
<th>Potash</th>
<th>Commercial Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice straw</td>
<td>.48</td>
<td>.10</td>
<td>1.28</td>
</tr>
<tr>
<td>Rice hulls</td>
<td>.30</td>
<td>.09</td>
<td>.22</td>
</tr>
<tr>
<td>Rice bran or flour</td>
<td>2.13</td>
<td>3.90</td>
<td>1.50</td>
</tr>
<tr>
<td>Rice polish</td>
<td>1.90</td>
<td>2.50</td>
<td>.94</td>
</tr>
<tr>
<td>Wheat bran</td>
<td>2.67</td>
<td>2.89</td>
<td>1.61</td>
</tr>
<tr>
<td>Wheat middlings</td>
<td>2.63</td>
<td>.95</td>
<td>.63</td>
</tr>
<tr>
<td>Rye bran</td>
<td>2.32</td>
<td>2.28</td>
<td>1.40</td>
</tr>
<tr>
<td>Corn meal</td>
<td>1.58</td>
<td>.63</td>
<td>.40</td>
</tr>
<tr>
<td>Cotton seed meal</td>
<td>6.64</td>
<td>2.68</td>
<td>1.79</td>
</tr>
</tbody>
</table>

In the following table the percentage of digestible nutriments in some of our common feeding materials are given. These figures have been compiled from various sources and will no doubt be found useful in the compounding of rations for farm animals.

**DIGESTIBLE NUTRIENTS IN COMMON FEEDSTUFFS.**

<table>
<thead>
<tr>
<th>Name of Feed</th>
<th>Protein</th>
<th>Fat</th>
<th>Carbohydrates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cow pea vine hay</td>
<td>10.8</td>
<td>1.1</td>
<td>38.6</td>
</tr>
</tbody>
</table>
Alfalfa hay (Lucerne) .......... 11.0 1.2 39.6
White clover hay ............. 11.5 1.5 42.2
Red clover hay .............. 6.8 1.7 35.8
Sorghum (green) ........... 0.6 0.4 12.2
Corn fodder ................. 2.5 1.2 34.6
Corn stover (without ears) ... 1.7 0.7 32.4
Crab grass hay ............. 2.2 0.6 42.8
Johnson grass hay .......... 3.4 1.2 39.8
Oat hay .................. 4.3 1.5 46.4
Oat straw .................. 1.2 0.8 38.6
Wheat straw .............. 0.4 0.4 36.3
Rice straw ............... 1.5 0.3 31.0
Corn silage ............. 0.9 0.7 11.3
Corn, flint grain ........ 8.0 4.3 66.2
Corn, dent grain ........ 7.8 4.3 66.7
Corn and cob meal ... 4.4 2.9 60.0
Corn cobs .............. 0.4 0.3 52.5
Oats .................. 9.2 4.2 47.3
Wheat bran ............. 12.2 2.7 39.2
Wheat middlings ........ 12.8 3.4 53.0
Rice bran (free from hulls) .... 8.8 10.5 42.0
Rice polish ............. 7.3 4.4 60.7
Cotton seed meal ........ 37.2 12.2 16.9
Cotton seed hulls ........ 0.3 1.7 33.1
Centrifugal molasses (sugar cane) 2.5 .... 70.0

ACKNOWLEDGMENTS.

In the preparation of the foregoing works upon Rice Feeding Stuffs the writer desires to express his indebtedness to Dr. W. C. Stubbs and Prof. W. R. Dodson, the latter having had charge of the feeding experiments and having also prepared microscopic cuts of the rice hull and grain. We also acknowledge courtesies extended by Dr. W. H. Dalrymple. For samples of the various rice by-products, we are greatly indebted to Mr. Henry Kahn, president of the National Rice Milling Company. In the work of analysis very valuable assistance was rendered by Mr. George Chiquelin.