

## RICE CULTURE IN THE UNITED STATES.\*

By DR. S. A. KNAPP.

Rice forms the principal food of one-half the population of the earth. It is more widely and generally used as a food material than any other cereal. Where dense populations are dependent for food upon an annual crop, and the climate permits its cultivation, rice has been selected as the staple food. The luxuriant growth of leguminous plants (beans, peas, etc.) at all seasons in tropical climates provides the nitrogenous food elements necessary to supplement rice. A combination of rice and legumes is a much cheaper complete food ration than wheat and meat and can be produced on a much smaller area.

Rice is an annual plant belonging to the natural family of the grasses. There is an immense number of varieties of cultivated rice, differing in length of the season required for maturing, and in character, yield, and quality. Their divergence not only extends to size, shape, and color of the grain, but to the relative proportion of food constituents and the consequent flavor. South Carolina and Japan rices are rich in fats, and hence are ranked high in flavor and nutrition among rice-eating nations. A botanical catalogue enumerates 161 varieties found in Ceylon alone, while in Japan, China, and India, where its cultivation has gone on for centuries, and where great care is usually taken in the improvement of the crop by the selection of the seed, no less than 1,400 varieties are said to exist.

The two principal varieties of lowland rice cultivated in the Atlantic States are the "gold seed," so called from the golden-yellow color of its husk when ripe, and the "white rice," the original rice introduced into this country in 1694, which has a cream-colored husk and resembles the rice commonly grown in China.

The gold-seed rice, justly famous for the quality and large yield of the grain, stands, in the estimation of the market, among the first rices in the world. Along the Atlantic coast it has practically superseded the white rice which was generally cultivated in the earlier periods of the industry. The two varieties of gold-seed appear to differ little except that one has a slightly larger grain than the other. White rice is valued for its early maturity.

The principal variety hitherto planted in Louisiana is the Honduras, so named from the country which furnishes the seed. The grain is similar in general appearance and character to that of the Carolina rice, but the kernel is slightly larger and the straw stiffer.

The Kiushu or Japan rice, now in process of introduction, has a short and thick kernel, and a thin hull; the percentage of bran and polish is small; the straw is still green when the grain is ripe; the yield is very large.

**Lowland and Upland Rice.**—While rice is chiefly grown on the lands that are low, level, and easily irrigated, there are varieties which can be grown on fertile uplands without irrigation. In the interior districts of India, China, and Japan upland rice is grown to a considerable extent, and experiments have demonstrated that it can be grown over large areas in the United States; but the crop is uncertain, and, in yield and quality, considerably inferior to lowland rice produced by irrigation.

Rice production in the United States is limited to the South Atlantic and Gulf States, where, in some sections, it is the principal cereal product. For nearly one hundred and ninety years after the production of rice into the United States, South Carolina and Georgia produced the principal portion, while North Carolina, Florida, Alabama, Mississippi and Louisiana grew only a limited amount. Within the last ten years Louisiana and Texas have increased the area devoted to rice to such an extent that they now furnish nearly three-fourths of all the product of the country.

For fifteen years prior to 1861 the annual production of rice in North Carolina, South Carolina, and Georgia had averaged more than 105,000,000 pounds of cleaned rice. Of this South Carolina produced more than three-fourths. But the industry in these States was wrecked by the war, and changed labor conditions, lack of necessary capital, and other causes have since prevented its full restoration. From 1866 to 1880, inclusive, the annual production of the three States averaged a little less than 41,000,000 pounds, of which South Carolina produced more than one-half. Since 1880 the average annual production has been, in round numbers, 46,000,000 pounds of cleaned rice, of which North Carolina produced 5,500,000, South Carolina 27,000,000, and Georgia 13,500,000 pounds.

Coincident with the breaking out of the civil war began the development of the rice industry in Louisiana. For a number of years the product was small, but during the seventies the industry began to assume large proportions, averaging nearly 30,000,000 pounds for the decade and exceeding 51,000,000 in 1880. In 1885 the production of Louisiana reached 100,000,000 pounds, and in 1892 182,000,000 pounds; but these were years of exceptionally large crops. The average crop of the State since 1880 has been, in round numbers, 86,000,000 pounds of cleaned rice.

The great development of the rice industry in Louisiana since 1884 has resulted from the opening up of a prairie region in the southwestern part of the State, and the development of a system of irrigation and culture which made possible the use of harvesting machinery similar to that used in the wheat fields of the Northwest, thereby greatly lessening the cost of production. In 1896, however, a new difficulty began to be felt. The varieties of rice which yielded best and were otherwise most satisfactory from a cultural standpoint under the new system proved inferior commercially because the percentage of grains broken in the process of milling was very large, and the proportion of "head rice," made up of the unbroken grains, was low. As the Japanese rices possess superior milling qualities, yielding a high percentage of head rice, it was desirable that they should be experimented with in this country. With this idea in view, the Department of Agriculture, in the spring of 1899, imported from Japan about 10 tons of Kiushu

rice, which was distributed to experimenters in southwestern Louisiana, and elsewhere in the rice belt.

In rice culture the size of the fields depends on circumstances, chief among which are the slope of the land and the character of the soil as regards drainage. Fields range in size from 60 to 80 acres on the level prairies of southwestern Louisiana down to 1 or 2 acres along the banks of the Mississippi River. In oriental countries fields seldom contain more than a half acre. The entire surface of each field should be nearly at the same level so that the irrigation water will stand at about the same depth. Hence, where the slope of the surface is considerable, the fields must be made small. Fields must also be laid off in such a manner as to admit of effective drainage.

In coast-marsh and river-bottom culture a canal is excavated on the outer rim of the tract selected, completely inclosing it. The excavated dirt is thrown upon the outer bank to form a levee. The canal must be of sufficient capacity for irrigation and drainage. The levee must be sufficient not only to inclose the flooding water, but to protect the fields from encroachment of the river at all seasons. When practicable the rice lands are flooded from the river, and find drainage by a canal or subsidiary stream that enters the river at a lower level. The embankment must be sufficient to protect the rice against either freshets or salt water. Freshets are injurious to growing rice, not only because of the volume of water, but by reason of the temperature. A great body of water descending rapidly from the mountains to the sea is several degrees colder than water under the ordinary flow. Any large amount of this cold water admitted to the field not only retards the growth but is a positive injury to the crop. In periods of continued drought the salt water of the sea frequently ascends the river a considerable distance. Slightly brackish water is not injurious to rice, but salt water is destructive.

The tract of land selected and inclosed is then cut up by smaller canals into fields or subfields of suitable size, a small levee being thrown up on the borders of each. The entire tract is usually level, but if there should be any inequality care must be taken that the surface of each subfield be level. The main canal is 10 to 30 feet wide, about 4 feet deep, and connects with the river by flood gates. Through these canals boats of considerable tonnage have ready access to the entire circuit of the tract, while smaller boats can pass along the subcanals to the several fields. The subcanals are usually from 6 to 10 feet in width and should be nearly as deep as the main canal.

During the flooding period the ditches and canals become more or less filled with mud which flows into them with the water. As soon after harvest as possible the ditch banks should be cleared of foul grasses, weeds, or brush, and the ditches cleaned. The levees should be examined to see if they are in repair.

The entirely different method employed in the prairie regions of southwestern Louisiana and adjacent Texas will be described further on.

The time of plowing differs with different lands and circumstances, but in general it may be said that for wet culture plowing is done in the spring shortly before planting time. In the South Atlantic States, however, the land is often plowed or dug over with a hoe early in the winter. In some parts of southern Louisiana the land is so low and wet and the soil so stiff as to necessitate plowing in the water.

Some planters advocate shallow plowing for rice, because it appears to thrive best in compact earth. Even if this be granted, it does not prove the superiority of shallow over deep plowing. It has been demonstrated that the better the soil and the more thoroughly it is pulverized the better the crop. The roots of annual cultivated plants do not feed much below the plow line, so that it becomes evident that deep cultivation places more food within the reach of the plant. If pulverizing the earth deeply be a disadvantage, by reason of the too great porosity of the soil at seeding time, it can be easily remedied by the use of a heavy roller subsequently. If the soil is well drained deep plowing will be found profitable. Deep plowing just before planting sometimes brings too much alkali to the surface. The remedy for this is to plow a little deeper than the previous plowing just after harvest. The alkali will then be washed out before the spring plowing. The plow should be followed in a short time by the disk harrow and then by the smoothing harrow. If the land is allowed to remain in the furrow for any considerable time it will bake and can not be brought into that fine tilth so necessary to the best seed conditions. This is particularly true of rice land. If the best results are desired it will be advisable to follow the harrow with a heavy roller. The roller will crush the lumps, make the soil more compact, and conserve the moisture for germinating the grain, rendering it unnecessary to flood for "sprouting."

For dry culture the land is prepared very much as it is for a crop of oats.

Perfect drainage is one of the most important considerations in rice farming, because upon it depends the proper condition of the soil for planting. It may appear unimportant that a water plant like rice should have aerated and finely pulverized soil for the seed bed, but such is the case. Thorough cultivation seems to be as beneficial to rice as to wheat. Complete and rapid drainage at harvest always insures the saving of the crop under the best conditions and reduces the expense of the harvest.

Thorough drainage is even more essential for rice than for wheat, because irrigation brings the alkali to the surface to an extent that finally becomes detrimental to the rice plant. Alkali sometimes accumulates in the soil just below the depth of the usual furrow to such an extent that any plowing is dangerous to the crop. Experience has shown that there is but one effective way of disposing of these salts, and that is by thorough drainage and deep plowing. As the water drains away the excess of soluble salts is carried off. Now if the ditches are no deeper than the ordinary furrow it is evident that only the surface of the soil can be cleared. Either tiling must be employed or there must be plenty of open ditches, the main ones at least 3 feet deep.

Too great care can not be exercised in selecting rice for seed. It is indispensable that the seed should be free from red rice, grass, and weed seeds, uniform in

quality and size of kernel, well filled, flinty, and free from sun cracks. Uniformity of kernel is more essential in rice than in other cereals, because of the polishing process.

The best time to sow rice differs in different sections and varies somewhat with varying conditions in the same section. It may be sown between the middle of March and the middle of May, but in most cases it should be sown by April 20 for best results. Sowing should take place as soon as possible after spring plowing. Care must be taken to plant the several fields at different periods, so that harvest will not be too crowded.

The amount of rice sown per acre varies, in different sections and with different methods of sowing, from 1 to 3 bushels per acre.

Three different methods of treating the seed are followed. Some let on just enough water to saturate the ground immediately after sowing and harrowing and at once draw off any surplus water. This insures the germination of the seed. Others sow and trust to there being sufficient moisture in the land to germinate the seed. This is sometimes uncertain and rarely produces the best results. A few sprout the seed before planting by placing bags of rice in water. This is sure to be a failure if the soil is very dry when the seed is sown. In case of planting in dry soil without following with water saturation, rolling the land after seeding and harrowing has been found beneficial.

The rice should be planted with a drill. It will be more equally distributed and the quantity used to the acre will be exact. The seeds will be planted at a uniform depth and the earth packed over them by the drill roller. It also prevents the birds from taking the seeds. The roller should precede the drill. If it follows the drill the feet of the horses, mules, or oxen drawing the roller will press some of the planted rice 4 or 5 inches deeper into the earth than the general average. Furthermore, the lumps of earth will prevent the uniform operation of the drill. In rice farming too much emphasis can not be placed upon the importance of thoroughly pulverizing the soil to a considerable depth; leveling with a harrow as perfectly as possible; crushing all the lumps and packing the surface to conserve the moisture; and planting the seed at a uniform depth.

**Broadcast Sowing.**—Broadcast sowing of rice is the method most in vogue in many localities, but it should be discontinued; the seed is never scattered with uniformity; some grains remain upon the surface and the remainder is buried by the harrow and the tramp of the team to depths varying from 1 to 6 inches. Rice sown broadcast does not germinate with any uniformity. Some seeds are taken by the birds, some are too near the surface and lack moisture to germinate, while others are buried too deep. In some instances the variation in the germination of the rice in the same field has been as much as eight weeks. Then at the harvest when the main portion is ready for the reaper, quite an amount of the rice is still immature. The product commands a very low price in the market, because the merchantable grain must sell at the price of the low grade. It requires much more care to produce a strictly first-class quality of rice than is found necessary in the production of any other cereal, and nearly every fall prime offerings are the exception.

Flooding is the most important distinctive feature of rice culture as compared with the culture of cereals generally. When it is considered that rice can be grown successfully without any irrigation whatever or with continuous irrigation from the time of sowing till nearly ripe, the wide scope there is for variation in practice will be realized.

Except where water is necessary for germinating the seed, flooding is not practised until the rice is 6 to 8 inches high. If showers are abundant enough to keep the soil moist it is better to delay flooding till the rice is 8 inches high, as there is considerable danger of scalding the rice when very young. At 8 inches high a sufficient depth of water can be allowed on the field to prevent scalding. The depth of water that should be maintained from the first flooding until it is withdrawn for the harvest depends upon other conditions. If the growing crop thoroughly shades the land, just water enough to keep the soil saturated will answer. To be safe, however, for all portions of the field, it should stand 3 to 6 inches deep, and, to avoid stagnation, it should be renewed by a continuous inflow and outflow. In case the stand of rice is thin the water should be deeper. A flow of water through the field aids in keeping the body of the water cool and in preventing the growth of injurious plants that thrive in the stagnant water. The water should stand at uniform depth all over the field. Unequal depths of water will cause the crop to ripen at different times.

In South Carolina under the usual method the water is let on as soon as the seed is covered, and remains on four to six days, till the grain is well sprouted. It is then withdrawn. As soon as the blade is up a few inches the water is sometimes put on for a few days and again withdrawn. The first water is locally called the "sprout water." After the rice has two leaves the so-called "stretch water," or "long-point flow," is put on. At first it is allowed to be deep enough to cover the rice completely—generally from 10 to 12 inches—then it is gradually drawn down to about 6 inches, where it is held twenty to thirty days. It is then withdrawn and the field allowed to dry. When the field is sufficiently dry the rice is hoed thoroughly, all grass and "volunteer" rice being carefully removed. After hoeing it remains without irrigation until jointing commences, when it is slightly hoed, care being used to prevent injury to the plants, and the water is then turned on again. During the time water is held on the rice it is changed at least every week to avoid becoming stagnant. When this occurs rice is liable to be troubled with the water weevil. This "lay-by flow," or final irrigation, continues until about eight days before the harvest, when the water is drawn off for the field to dry.

## FERTILIZING.

Rice is not a great impoverisher of the soil, especially if the straw and chaff are regularly returned to it.

It has been claimed that the flooding of the rice fields restores to the soil as much nutritive material as

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the rice crop removes. Where lands are flooded from rivers like the Mississippi or the Nile, which carry a large amount of silt, this may be true. It is not the case where flooding is done with pure water. The continued fertility of the rice field can only be maintained by restoring to the soil annually a portion of what the crop removes. Whether this can be more economically done by the use of commercial fertilizers and plowing under the rice straw, or by fallowing occasionally and using some renovating crop as a green manure is an economic question to be determined by each planter according to the conditions presented. Repeated trials of commercial fertilizers have almost invariably shown gains in the quality and quantity of the crop more

thrashing ought to keep in the bin without heating.

The primitive methods of "failing," "treading out," etc., have largely given place to the use of the steam thrasher. At the commencement of the thrashing examination should be made to see that there is no avoidable breakage of the grain. If the rice is damp when delivered from the machine, it should be spread upon a floor and dried before sacking, so as to be in the best condition for the market, for color of grain affects the value.

#### YIELD OF RICE.

The yield of rice varies with conditions of soil and climate and methods of culture. The commercial

thence to the fine-chaff fan, where the fine chaff is blown out. On account of the heat generated by the heavy frictional process through which it has just passed, the rice next goes to the cooling bins. It remains here for eight or nine hours, and then passes to the brush screens, whence the smallest rice and what little flour is left pass down on one side and the larger rice down the other.

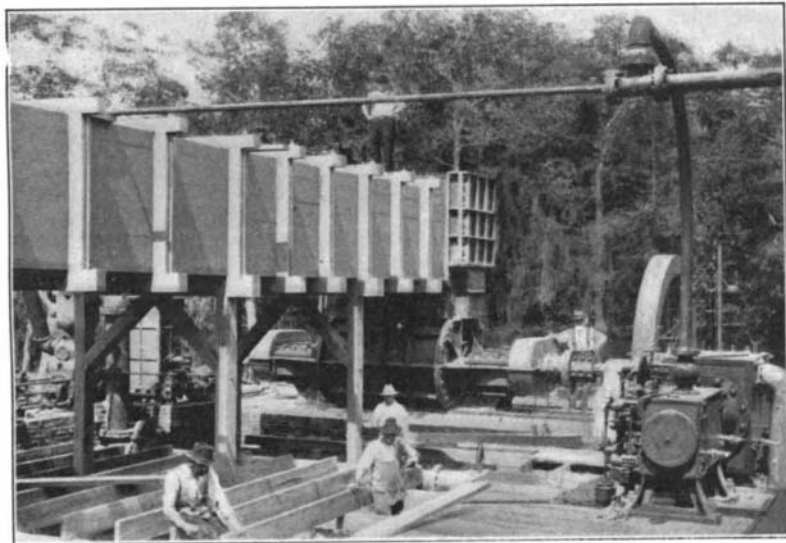
The grain is now clean and ready for the last process—polishing. This is necessary to give the rice its pearly luster, and it makes all the difference imaginable in its appearance. The polishing is effected by friction against the rice of pieces of moose hide or sheepskin, tanned and worked to a wonderful degree of softness, loosely tacked around a revolving double cylinder of wood and wire gauze. From the polishers the rice goes to the separating screens, composed of different sizes of gauze, where it is divided into its appropriate grades. It is then barreled and is ready for market.

In mills more recently erected the foregoing process has been modified by substituting the "huller" for the mortar and pounder. The huller is a short, cast-iron, horizontal tube with interior ribs and a funnel at one end to admit the rice. Within this tube revolves a shaft with ribs. These ribs are so adjusted that the revolution of the shaft creates the friction necessary to remove the cuticle. The rice passes out of the huller at the end opposite the funnel. It resembles externally a large sausage machine. It requires six hullers for each set of burs. The automatic sacker and weigher is used instead of barreling, sacks being preferred for shipping the cleaned rice.

With the above modification of the milling processes considerable reduction has been made in the cost of the mill. Mills of a daily capacity of 60,000 pounds of cleaned rice can now be constructed at a total cost of \$10,000 to \$15,000.

#### RICE CULTIVATION IN SOUTHWESTERN LOUISIANA AND SOUTHEASTERN TEXAS.

In 1884 and 1885 a few farmers from the Northwestern prairie States settled on the great Southern prairie which extends along the coast from the parish of St. Mary in Louisiana to the Texas line—about 140 miles. Finding that rice, which had been grown for many years for home consumption, but by oriental methods, was well suited to the conditions of agriculture here, they commenced immediately to adapt the agricultural machinery to which they had been accustomed to the rice industry. The gang plow, disk harrow, drill, and broadcast seeder were readily adjusted, but the twine binder encountered a number of serious obstacles. However, by the close of 1886 the principal difficulties had been overcome. Wherever prairies were found sufficiently level, with an intersecting creek which could be used to flood them, they were surrounded by a small levee thrown up by a road grader or by a plow with a strong wing attached to the moldboard extending it 4 or 5 feet. These levees were usually 12 to 24 inches high, and the interior ditch was 12 to 18 inches deep and 4 to 5 feet wide. Very few interior ditches were made for drainage. The land was so level that fields of 40 or 80 acres were common. Large crops were produced. The prairies were practically free from injurious grasses, and the creek or river water was soft and bore no damaging seeds to the fields. The rice fields were handled like the bonanza wheat farms of Dakota, and fortunes were made. Levees were cheaply constructed; little attention was paid to drainage, more than to remove the surface water; shocking, stacking, and thrashing were done in a very careless manner; the main object being, apparently, to plant a large acreage and secure a certain number of bushels, regardless of quality. Ultimate failure was certain, but it was hastened by drought. A succession of dry years followed. The creeks failed, and reservoirs were found to be expensive and unreliable.



PUMPING STATION.

than sufficient to cover the cost. Summer fallowing, where it can be practised, is, in addition to its renovating effect, a substantial aid in destroying noxious grasses and red rice.

There is very little exact information on the subject of fertilizers for rice. In Japan and other oriental countries a large proportion of the rice lands is thoroughly fertilized in the fall with straw, leaves, rice hulls, fish, and night soil. The fields are planted to wheat or vetches for the winter crop, followed the next spring by rice without additional manures.

#### HARVESTING.

Reaping machines are generally used in the prairie district of Louisiana and Texas.

Where the use of reaping machines is impracticable, the sickle is the implement commonly used in harvesting rice. The rice is cut at 6 to 12 inches from the ground, and the cut grain is laid upon the stubble to keep it off the wet soil and to allow the air to circulate about it. After a day's curing the grain is removed from the field, care being taken not to bind it while wet with dew or rain. The smaller the bundles the better will be the cure.

Care in shocking is also important. Thirty per cent of the crop may be lost by improper shocking. The following directions will aid: First, shock on dry ground; second, brace the bundles carefully against each other, so as to resist wind or storm; third, let the shock be longest east and west and cap carefully with bundles, allowing the heads of the capping bundles to fall on the north side of the shock to avoid the sun. Exposure of the heads to sun and storm is a large factor in producing sun-cracked and chalky kernels, which reduce the milling value. Slow curing

standard weight of "rough rice" is 45 pounds to the bushel. The product is usually put up in sacks or barrels of 162 pounds each.

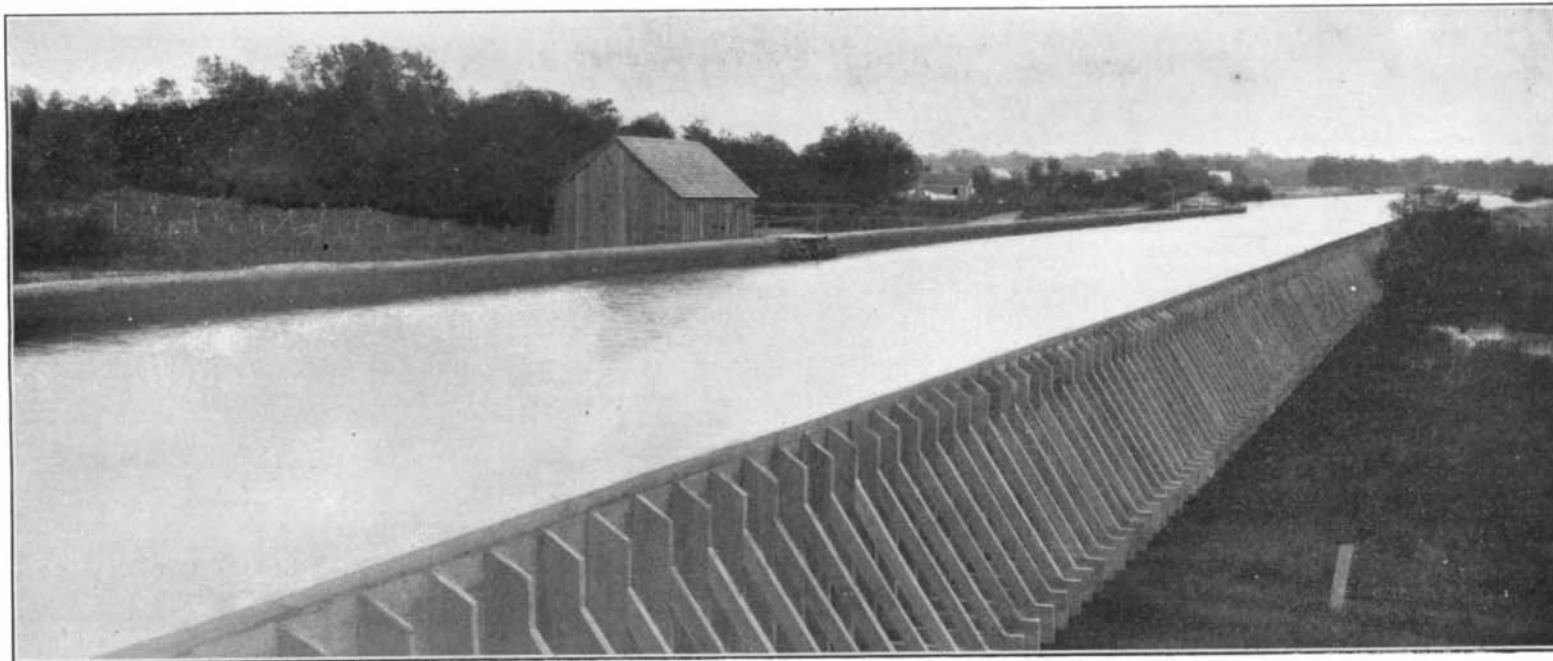
In South Carolina and Georgia the average yield is given as 8 to 12 barrels. Good lands properly managed will give a considerably larger yield.

The yield in southwestern Louisiana is said by good authority to range from 8 to 18 barrels per acre.

In a report made by planters to the Savannah Rice Association, January 28, 1882, the average yield to the acre is placed at 30 bushels, and the annual cost of cultivation, including the interest on the land, at \$35 per acre. In a report made by prominent rice planters to the House Committee on Ways and Means in January, 1897, the average yield to the acre is placed at 32 bushels, and the cost of production is fixed at \$24. If we take the latter estimate, the cost to the planter in the Atlantic States of raising 100 pounds of rough rice is \$1.66, or \$2.69 per sack of 162 pounds. Of course this is only an average, the cost being much less in some instances and in others much greater.

The rice as it comes from the thrasher is known as "paddy" or "rough rice." It consists of the grain proper with its close-fitting cuticle roughly inclosed by the somewhat stiff, hard husk. The object of milling is to produce cleaned rice by removing the husk and cuticle and polishing the surface of the grain. The hulls or chaff constitute about 20 per cent of the weight of the paddy.

The improved processes of milling rice are quite complicated. The paddy is first screened to remove trash and foreign particles. The hulls, or chaff, are removed by rapidly revolving "milling stones" set about two-thirds of the length of a rice grain apart.



FLUME FOR FLOODING RICE FIELDS.

in the shade produces the toughness of kernel necessary to withstand the milling processes. In the shock every head should be shaded and sheltered from storm as much as possible. The rice should be left in the shock till the straw is cured and the kernel hard.

Whether stacking rice from the shock is a benefit depends upon the condition of the grain and straw at the time of stacking and how the stacking is done. If too much heat is generated, stacking is an injury. It is, moreover, of less importance with rice than with wheat. Judging from the practice in other countries, rice well cured in the shock and aired after

The product goes over horizontal screens and blowers, which separate the light chaff and the whole and broken kernels. The grain is now of a mixed yellow and white color. To remove the outer skin the grain is put in huge mortars holding from 4 to 6 bushels each and pounded with pestles weighing 350 to 400 pounds. Strange to say, the heavy weight of the pestles breaks very little grain.

When sufficiently decorticated, the contents of the mortars, consisting now of flour, fine chaff, and clean rice of a dull, filmy, creamy color, are removed to the flour screens, where the flour is sifted out; and

The soil and climatic conditions in southeastern Texas are almost precisely like those in southwestern Louisiana. Rice culture in this section requires no separate treatment. What is applicable to the one applies also to the other. There is a belt of prairie well suited to rice extending from the Sabine River west for 100 miles or more along the coast. Within a few years large farms have been opened and devoted to this cereal with excellent returns.

To provide a reliable supply of water, pumping plants for raising water from the streams were gradually put in. The elevation of the prairies above the



streams varies from 6 to 38 feet. the larger portion being from 15 to 25 feet. At first, farms along the streams and lakes were irrigated; gradually large surface canals were constructed.

Irrigating canals were started in a small way in Acadia Parish, La., in 1890. In 1894 a canal 40 feet wide was built for 15 miles with 10 miles of laterals. This was followed by the Crowley Canal, which is now 35 feet wide and 8 miles in length, and has 10 miles of lateral lines. The Riverdale Canal was the next, and now has several miles in operation. These enterprises have grown steadily until there are now 9 canals in Acadia Parish, with an approximate length of 115 miles. There are about 25 irrigating canals in Acadia, Calcasieu, Cameron, and Vermilion parishes, with a total length of over 400 miles of mains and probably twice that extent of laterals, built at a total cost of about \$1,500,000. In nearly every township there are one or more ridges slightly above the surrounding land. On these surface canals are built from 20 to 150 feet in width, according to the area to be watered. The sides of the canal are raised from 4 to 5 feet with plows and scrapers or with grading machinery. Grading machines work very well, as the soil is a loam or a clay loam free from stones. Side gates are inserted in the embankment as frequently as necessary. Laterals are run from the main canal to accommodate remote farms. Powerful pumping plants are erected on the bank of the river at the head of the surface canal. These canals, where well constructed and operated, prove entirely successful and make the rice crop a practical certainty over a large section of country. They range in irrigating capacity from 1,000 to 30,000 acres. The usual water rent charged the planter by the canal company is 324 pounds of rough rice per acre watered.

Scarcely had the surface canals been accepted as a success when southwestern Louisiana was startled by the announcement that there were strata of gravel at 125 to 200 feet under the surface of the entire section, containing an unlimited supply of water, which would, of its own pressure, come so near the surface that it could be readily pumped. This was received with considerable incredulity at first, but repeated tests have proved that there is a bed of gravel nearly 50 feet in thickness underlying this section of Louisiana, which carries a large amount of soft water with sufficient pressure to bring it nearly to the surface. Pipes of 2, 3, 4, 6 and 8-inch size have been sunk to the gravel and pumped continuously for months without diminution of the supply. The water is soft, at a constant temperature of about 70 deg., and absolutely free from injurious seeds or minerals. Such is the facility with which these wells are made that a 6-inch tube has been put down to the full depth required—200 feet—in fourteen hours. Thus far it has been found that a 2-inch pipe will furnish sufficient water to flood 10 acres of rice and a 6-inch pipe will flood 80 to 90 acres. Any number of wells may be made, and even if no more than 20 or 30 feet apart, one does not diminish the amount of water obtained from another. It is probable that such wells will become common for the irrigation of other crops than rice.

A 6-inch well will furnish a constant stream for a 4 to 5 inch pump. A system of such wells may be put down 30 to 40 feet apart and each one will act independently and furnish as much water as if it stood alone. Such a combination of wells may be united just below water level and all be run by one engine and pump. Water rises naturally in these wells to within 20 feet of the surface, and a number of flowing wells have been secured. The lift is not greater than from rivers, lakes, or bayous into canals. Eight 4-inch wells united at the top can be run by one 16-inch pump and a 50-horsepower engine, and will flood 1,000 acres of rice.

The total cost of an irrigating plant sufficient for flooding 200 acres is from \$1,500 to \$2,500. It requires about seventy days' pumping for the rice season.

The operations of harvesting and thrashing the rice crop in southwestern Louisiana are performed largely with the McCormick self-binder and the steam thrasher. The use of the former is favored by the size of the fields, and by the character of the soil. The use of the latter is a cheap, rapid, and effective method of separating the rice from the straw. Without the use of such machines the large cultural operations of this section would be impossible.

The outlook for the further extension of the industry is very promising. According to the best estimates there are about 10,000,000 acres of land in the five States bordering the Gulf of Mexico well suited to rice cultivation. The amount which can be successfully irrigated by present methods, using the available surface and artesian flows, does not exceed 3,000,000 acres. The balance of the land could probably be brought into cultivation were it necessary, but the cost would, perhaps, be prohibitive at present prices. Three million acres is a conservative estimate of the amount which can be successfully irrigated. The best results require rotation of crops; consequently only one-half of that amount, or 1,500,000 acres, would be in rice at one time. At an average yield of 10 barrels (of 162 pounds) per acre, 1,500,000 acres of rice would produce nearly 2,500,000,000 pounds of cleaned rice, nearly six times the amount of our present consumption. There is no satisfactory reason why the United States should not grow and mill all of its own rice and become an exporter.

The employment of machinery in the rice fields of the Southwest similar to that used in the great wheat fields of California and the Dakotas is revolutionizing the methods of cultivation and greatly reducing the cost. The American rice grower, employing higher-priced labor than any other rice grower of the world, will ultimately be able to market his crop at the least cost and the greatest profit. If, in addition, the same relative improvement can be secured in the rice itself, if varieties which yield from 80 to 90 per cent of head rice in the finished product can be successfully introduced, American rice growers will be able to command the highest prices for their product in the markets of the world. In view of the success in this direction of the Kiushu rice experimentally introduced by the Department of Agriculture, more than a hundred tons of this rice have been ordered from Japan by Louisiana planters for the season of 1900.

#### MECHANICAL MANUFACTURE OF BOTTLES.

THE manufacture of glassware is one of the industries most detrimental to the health of the workmen employed in it. Despite the precautions that may be taken, the extremely high temperature of the furnaces (about 2,192 degs. F.) causes a considerable disengagement of heat by radiation and conductivity, while, on the other hand, the glass in a fused state is at a temperature of from 1,292 to 1,472 degs. F., and it is hence impossible to prevent radiation and conduction from occurring. Under such conditions the temperature of the atmosphere of the rooms in the vicinity of the furnaces varies between 104 and 122 degs., and whatever be the lightness of their clothing, the workmen are in a constant state of perspiration. The inconveniences and ailments that such abnormal temperature may involve can readily be perceived. Moreover, the reflection of light and heat from the glass when fused is extremely fatiguing to the sight and, in the long run, causes a special disease in the workmen. Besides, this continual stay in a superheated atmosphere leads the glass founders to indulge to excess in drinking which adds its disastrous effects to those injurious ones that are a natural consequence of the nature of the work.

Again, the blowing of the glass also is accompanied with serious inconveniences, especially for workmen engaged in the manufacture of bottles. The rough turning is very fatiguing. The workman has to give the mass of glass, which is often quite heavy, a rapid rotary motion lasting for hours, since one man with his two helpers makes at least 600 bottles per day of from 10 to 12 hours work. Since each bottle weighs about 19 or 20 ounces, it will be seen that the amount of work done is very considerable; and, if we reflect that it has to be performed in an atmosphere of from

The reason that M. Boucher has reached so satisfactory a result is that he has endeavored to so combine his mechanisms as to make them perform as far as possible the various manual operations involved in the manufacture of bottles. Human blowing, moreover, is replaced by compressed air, which, according to the periods of the manufacture, is used under two different pressures.

The machine consists of a rectangular cast iron frame, at each end of which is fixed a support carrying the different pieces employed in the manufacture of the bottle. A number of these may be easily exchanged according to the models to be manufactured, such, for example, as the molds used for forming the collar, the measuring mold for the reception of the proper quantity of molten glass, the intermediate molds in which the rough model is successively blown, and, finally, the finishing mold in which the internal form is exactly that of the bottle or other object to be manufactured.

Fig. 1 shows the machine at the moment at which the series of operations is to be begun. The measuring mold, A, is formed of two parts that may be separated or brought together at will by means of bevel gearing, a. At the lower part is the collar mold, B, in the interior of which slides a mandrel having the internal dimensions of the neck of the bottle, so as slightly to perforate the entrance of the neck. The molten glass, taken from the furnace by means of an iron rod, is poured into the measuring mold previously heated to a temperature of from 1,112 to 1,292 degs. F. The molder, seated in front of his machine, then applies the compressor, C, to the upper end of the mold and, pressing upon a pedal, causes air compressed to about 10 pounds to the square inch to enter above the glass, which is as yet extremely hot and almost liquid. This latter descends to the lower mold, into

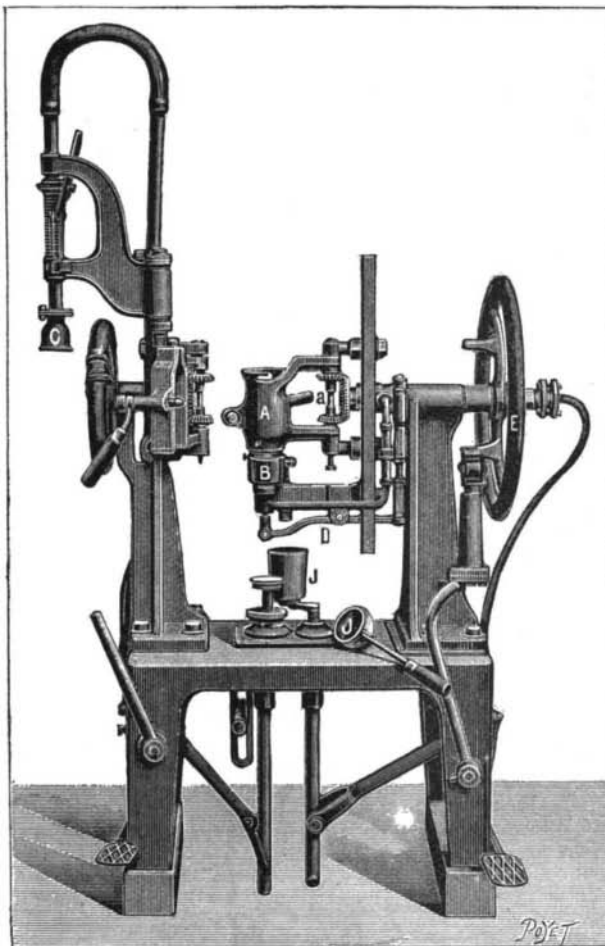


FIG. 1.—THE BOUCHER MACHINE FOR THE MANUFACTURE OF BOTTLES READY FOR THE RECEPTION OF THE MOLTEN GLASS.

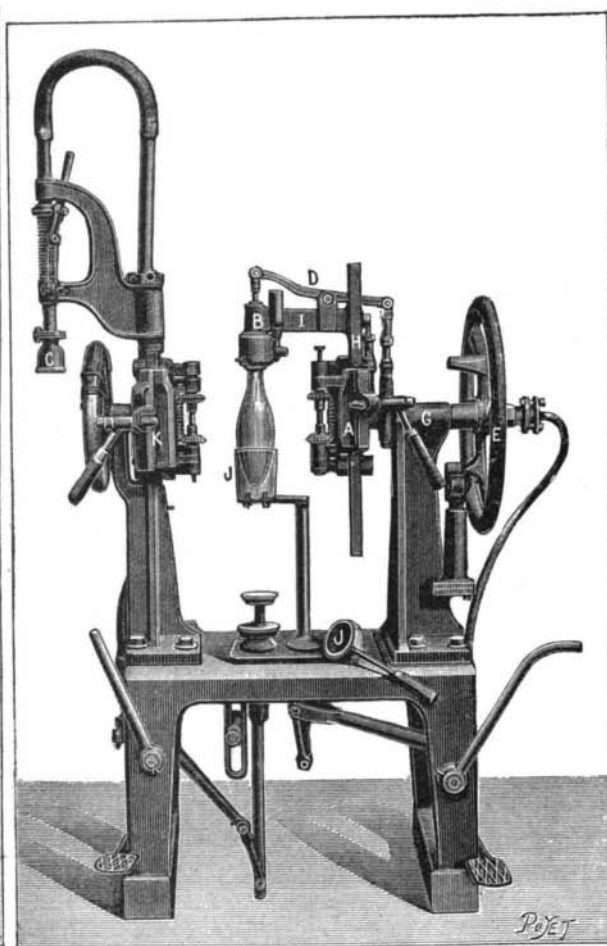


FIG. 2.—BOUCHER BOTTLE MACHINE AS IT APPEARS IN OPERATION.

104 to 122 degs. F., we can appreciate what fatigue must result therefrom to those upon whom it devolves.

Blowing by pipe into the fused glass rapidly involves the burning of the tissues of the throat and cheeks, and soon leads to a rupture thereof. Such work frequently causes pulmonary phthisis, or at least often affects the respiratory tracts. Finally, and this is not the least danger, the transmission of contagious diseases to the workmen by the pipe is unfortunately very frequent, a bad state of the tissues of the mouth greatly facilitating such transmission and rendering it still more dangerous.

Under such circumstances the fact that glass blowers never grow to be old and are obliged to abandon their trade at the age of about forty at the most is easily explainable.

Inflammation of the lungs, phthisis, weakening of the muscles, anæmia and blindness are, in fact, the terrible afflictions that attack them, and which they can escape only exceptionally. So, for some time past, and with a philanthropic end in view (and at the same time, an economical one, since glass makers are pretty well paid), an endeavor has been made to manufacture glass mechanically and especially to do away with blowing, which is so dangerous to the workmen.

Although numerous systems have been proposed, the practical results obtained up to the present time have not come up to the expectations of their inventors.

M. Boucher, a master glassmaker of Cognac, has recently devised a process of manufacture that seems as if it ought to give satisfaction both to proprietors and workmen, since it not only does away with the danger attending the operation of blowing and partially with that due to the reflection from the fused glass, but also permits of a more economical and rapid production. The Société d'Encouragement à l'Industrie Nationale, moreover, has recognized the value of this process by awarding its inventor a gold medal.

which the mandrel is gently introduced by means of an eccentric that acts upon a lever, D. The neck is thus molded perfectly. By means of a handwheel, E, the workman immediately inverts the two molds and opens the measuring one. As the mass of glass is suspended by the neck (Fig. 2) it elongates freely. This causes in the fluid mass a sort of spontaneous reheating that gives the glass a luster. When the rough-shaped bottle is sufficiently elongated, the workman introduces it successively into the intermediate molds, J, and introducing air through the neck at a pressure of about 3.5 pounds to the square inch, gradually increases the volume of the mass. This compressed air is led through the pipe, F, and passages arranged in the arms, G H I (Fig. 2). The glass then being placed in the finishing mold, K, another compression causes it to assume the exact form thereof by forcing it against the walls. The bottle, now finished, is left in the mold for a couple of seconds, after which it is removed and carried by an apprentice to the annealing furnace. This machine, the operation of which is very simple, permits of manufacturing all kinds of bottles, flasks, bowls and other objects, especially those having a neck of small size.

With two machines, two operatives and one boy for carrying the molten glass can manufacture 3,600 bottles in 24 hours, say 1,800 bottles per machine, at a cost of 40 cents per hundred, against 70 cents by the old method; whence a saving of 30 cents per hundred. Moreover, the product obtained is of very excellent quality, since the glass is more regularly distributed and the intermediate molds permit of regulating the thickness of it. As regards strength, the results of tests made in one of the largest bottle works in Spain show that the bottles manufactured with the Boucher machine have a resistance of 338 pounds to the square

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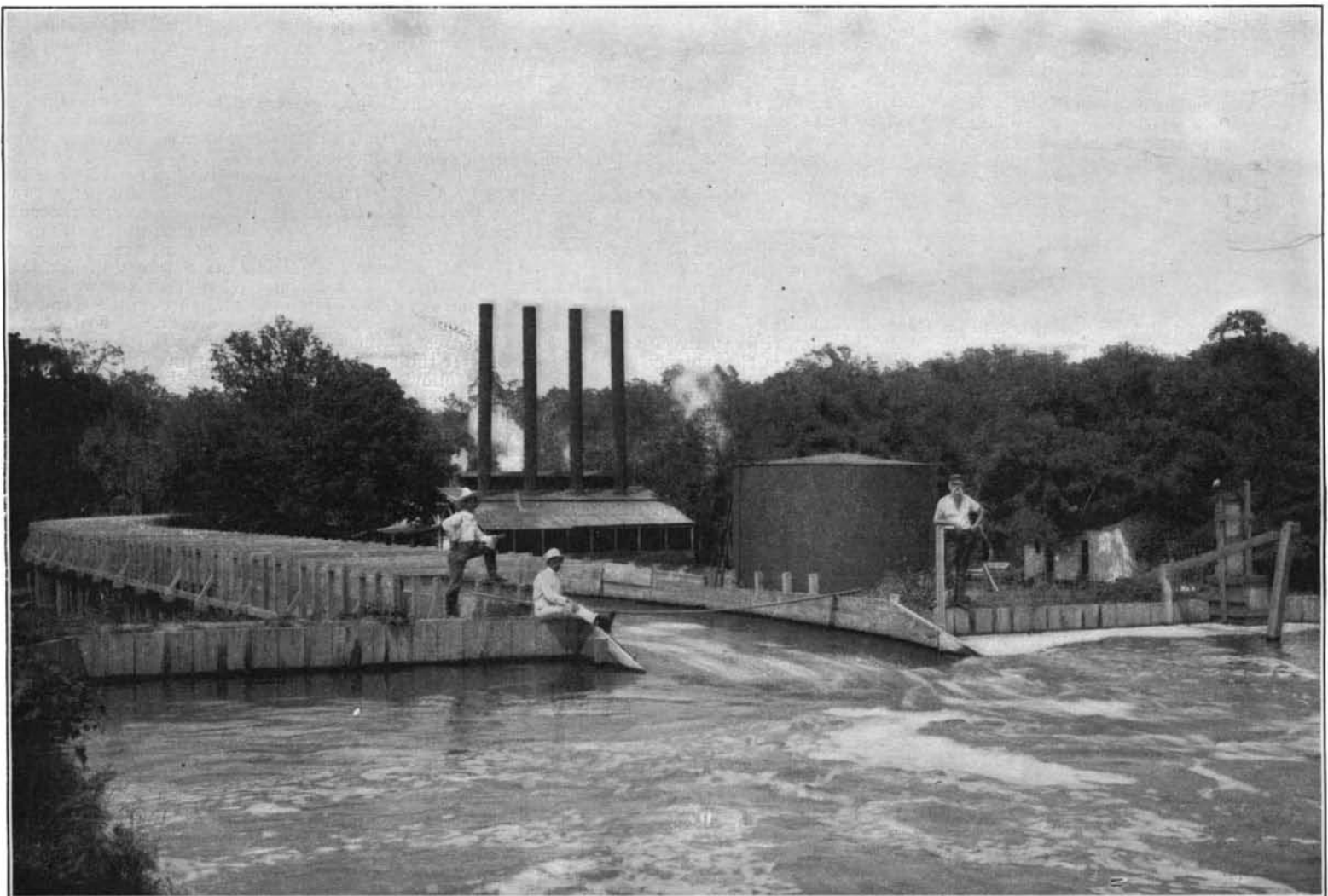
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