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RICE IN THE AMERICAS

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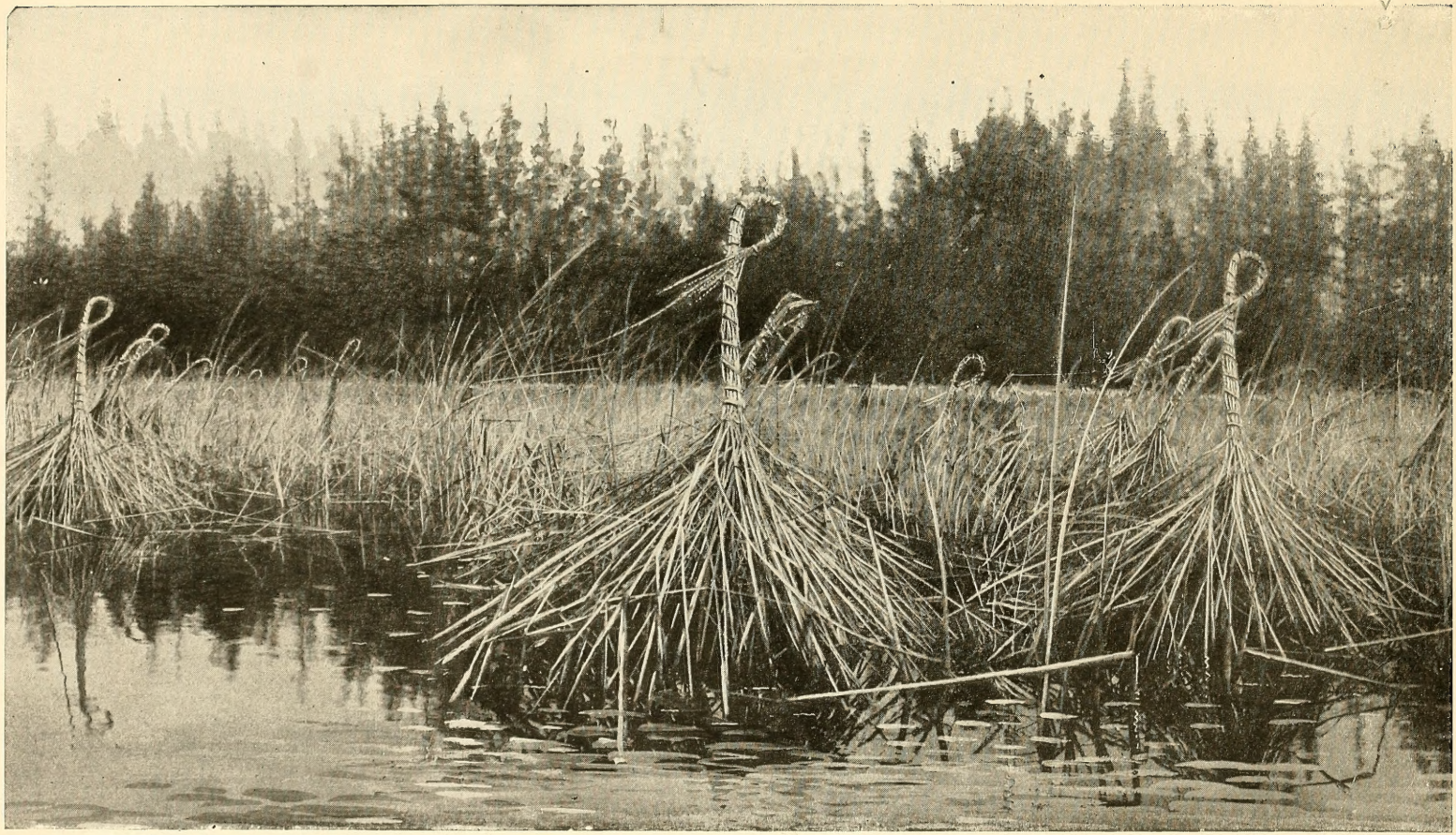
RICE IN THE AMERICAS

PERHAPS the greatest event in the history of man's gradual evolution from the lower orders of animal forms to his present status occurred at the psychological moment when, doubtless through sheer accident, he discovered that the application of fire to his food made it more palatable. It may have been a piece of raw flesh inadvertently dropped into the hot coals of the fire whose warmth gave him the agreeable sensation he desired, or it may have been some accidentally roasted nuts that first gave him the idea; at any rate, he discovered that the roasted food tasted better than the raw, and that was all that was necessary. With that discovery the art of cookery was born. That cooked food is also better adapted to his nourishment is a matter that subsequent ages of experiment and observation may or may not have established. The inducement that led *homo sapiens* to cook the things he ate was that the process made them more delectable to his more or less discriminating palate, a fact that also led to continued experiment to add to his supply of edibles.

Among the various natural food products that were thus improved from a gustatory viewpoint were the cereals. It was because cooking in various ways improved the taste of grains of wheat, oats, barley, millet, maize, and rice that these cereals eventually became the most generally used and widely distributed of foods. Among these perhaps the most important, if we consider the numerical proportion of people who make it their chief diet, is rice, which is said to be the principal food of nearly one-third of the human race.

Just when rice first came into use as an important food staple is not known, nor has its place of origin been satisfactorily determined, for its use and culture antedate our written records. That it was cultivated and formed one of the chief food products of China as early as 2,800 years B. C. is pretty well established. A ceremonial ordinance promulgated at that time by the Emperor Chin-nung provided that the rice seed used in the ceremony must be sown by the Emperor himself, the four other cereals—presumably of less importance—could be sown by other members of the royal family. This being the earliest

By Edward Albes, of Pan American Union staff.



Courtesy of the Bureau of American Ethnology.

WILD RICE TIED IN BUNCHES OR SHEAVES.

A short time before grain is matured the Indian women of the wild-rice regions go to the fields in their canoes and tie the stalks in small bunches or sheaves, as shown in the above photograph. This is done for the purpose of saving the grain from the many kinds of birds which consume it with avidity when left unprotected, and also to protect the grain from the beating rains and wind. The grain is also more easily gathered when the stalks are thus tied in bundles, by the process of gathering outlined in the text.

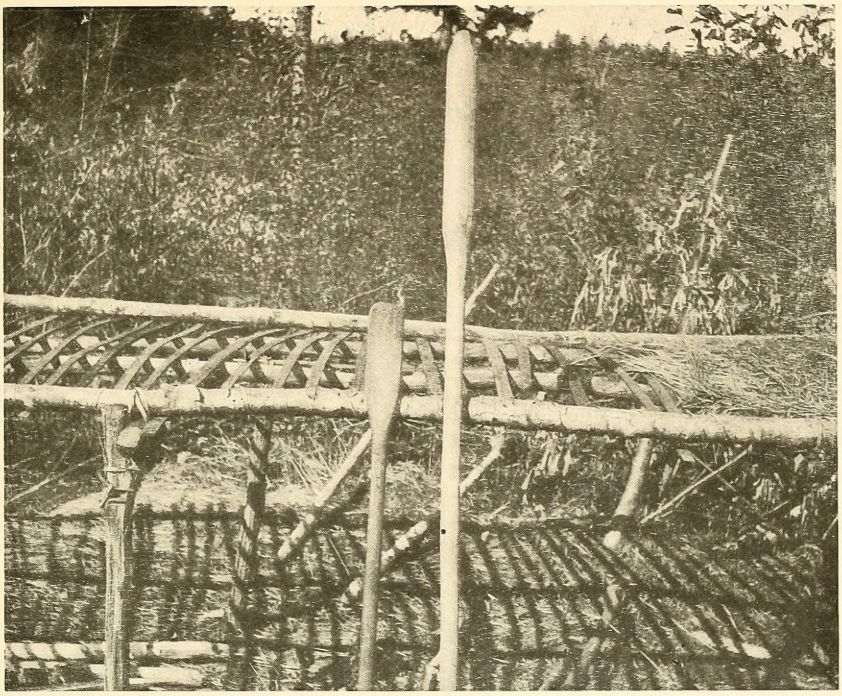
reliable account of the cultivation of rice, Alphonse de Condolle, in his "Origin of Cultivated Plants," gives China as its probable place of origin, notwithstanding the fact that it is also indigenous in some parts of India and in the northern or tropical section of Australia.

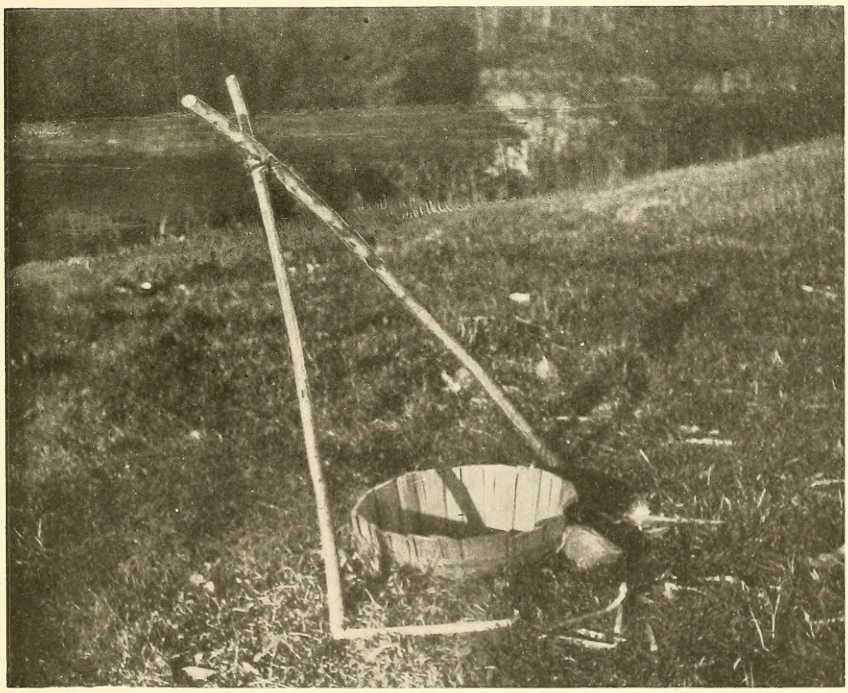
While this is doubtless true as to the generally known cultivated species of rice botanically known as *Oryza sativa*, there is another genus, *Zizania aquatica*, commonly called "wild rice," which is indigenous to North America, where it grows abundantly in many regions east of the Rocky Mountains from latitude 50° north down to the Gulf of Mexico on the south. The same species is reported to have been found native in eastern Siberia, and plentifully in eastern China and in Japan. According to some Brazilian authorities it is also found in that country.

This wild rice was, and still is in some sections, an important element in the domestic economy of various Indian tribes of the North American continent. The name given it by the Algonquian Indians was *mano'min*, meaning "good fruit," and one of the important tribes of the Algonquian linguistic stock took its name, "Menomini," from the plant. Its use as a food, methods of gathering, harvesting, thrashing, preservation, and final preparation for consumption among the various Indian tribes have been exhaustively studied by Dr Albert Ernest Jenks, and the results of his investigations published in an extended memoir entitled "The Wild Rice Gatherers of the Upper Lakes," in the Nineteenth Annual Report of the Bureau of American Ethnology. The following descriptions are taken from this work:

The genus *Zizania* comprises two species, and is well characterized by the unisexual spikelets in an androgynous panicle, each having two glumes, and the males having two stamens. The plant ordinarily grows from 5 to 10 feet high, with a thick, spongy stem and an abundance of long, broad leaves. The chief mark of distinction between the two species is that the *miliacea* bears its male and female flowers intermixed on its fruit head, while the *aquatica* bears its female flowers near the top, where the cylindrical panicle, from 1 to 2 feet long, is quite appressed, and its male flowers on the more widely spread lower branches of the panicle. The glumes or husks of the female or fertile flowers are about an inch long and are armed with an awn or beard usually of about the same length as the husk, but at times twice its length. The grain, which is inclosed within the glumes, is a slender. cylindrical kernel, varying in length from almost half an inch to nearly an inch, and is of dark-slate color when ripe. The plant is an annual, and grows in either fresh or brackish waters from a bed of mud alluvium.

Wild rice is one of the most beautiful aquatic single-stem plants in America. The grain is shed into the water when it ripens in the





Courtesy of the Bureau of American Ethnology.

CONTRIVANCE OF THE INDIANS FOR PREPARING WILD RICE.

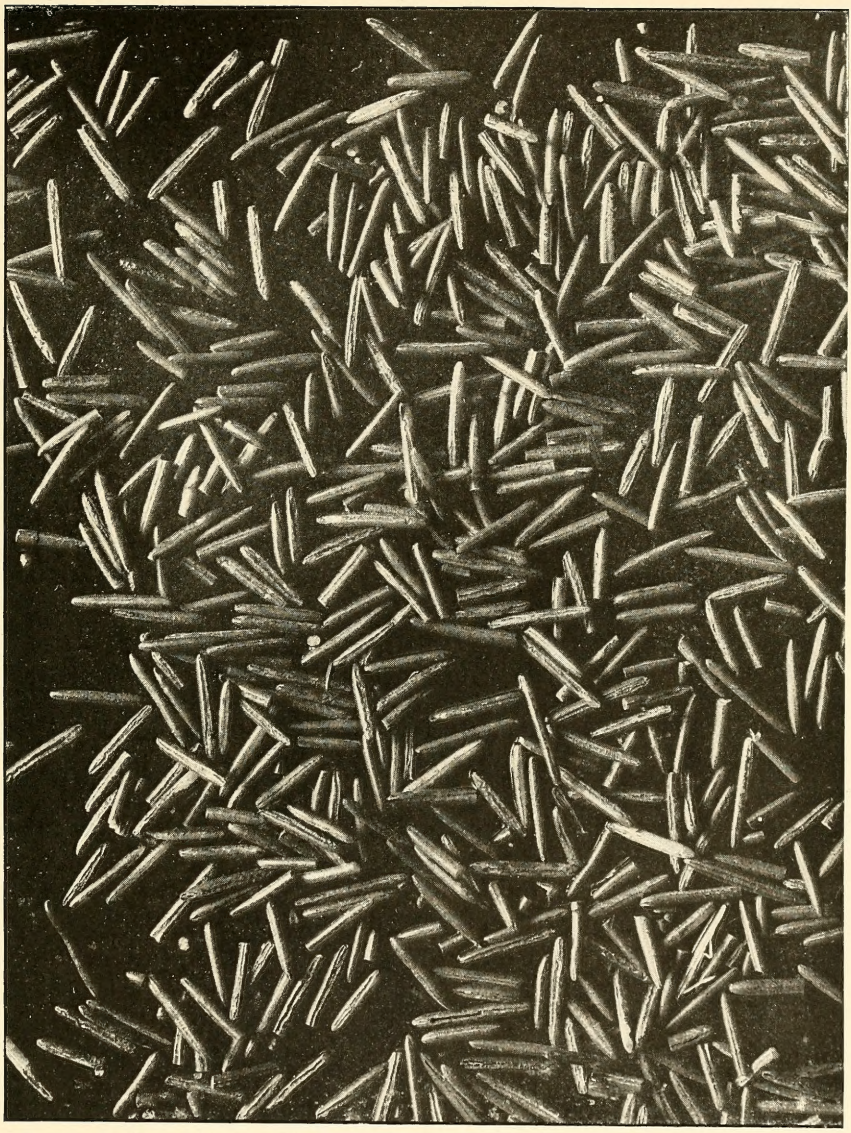
Upper: Section of drying rack used by various Indian tribes of the wild-rice country to cure the grain after its collection from the fields. A scaffolding of small poles is erected to a height of about 3 feet; this is covered with thin cedar slabs, upon which the grain is spread, and a slow fire is kept burning underneath until the kernels have become thoroughly dried. Lower: A stave-lined thrashing hole for treading out the grain. A hole about 2 feet in diameter and 18 inches deep is dug in the earth and lined with handmade staves on the sides, the bottom being covered with a block of wood. The husk-covered rice grains as they come from the stalk are placed into the hole until it is nearly full, when the Indian steps in and treads on the grain until the husks are loosened and separated from the kernels. The poles are stuck into the earth merely to serve as an aid to balance the thrasher.

autumn, and lies in the soft ooze of alluvial mud at the bottom of a lake or river until spring, when it germinates and grows rapidly to the surface. The old stalks die down below the surface of the water before the time arrives for the new ones to appear, so the inference has been that they all come from the same root; but the plant is an annual, growing from new seed each year. Early in June the shoot appears at the surface of the water and at once begins to prepare its fruit head. The plant blossoms late in June, and by September the seeds are mature. The fruit heads are mostly of a pale-green color tinged with yellow, but at maturity they generally acquire a cast of purple. Rice beds have been described as resembling fields of wheat, of canebrake, and of maize. At maturity the stalks range from 2 to 12 feet in height above the water, and they also vary much in thickness. Their total length depends largely on the depth of the water in which they grow, as well as on the fertility of the soil.

By the middle of July the stalks are generally about 8 feet high. At that time from the center of each stalk a long slender shoot grows to the height of about 4 feet above the topmost leaf. This shoot bears the fruit head. The stalk grows an inch or more in diameter, and to the height of 10 or 12 feet above water. It grows to this, its greatest height, in water about 1 foot in depth, but it will grow and mature in water as much as 8 feet in depth, in which case it rises about 4 feet above the surface. The roots are so strong and matted that they will support the weight of a man walking upon the mass in shallow water.

The grain is matured by the latter part of August or in September. Shortly before that time the Indian women often go to these wild rice fields in their canoes and tie the standing stalks into small bunches. When the grain is sufficiently mature, two persons, generally women, go together into the fields to garner the seed. The stalks are usually so close together in the harvest field that it is impossible to use a paddle, so the canoe is pushed along by a pole. As the harvesters pass slowly through the rice, standing 4 or 5 feet above the water, one of the women reaches out and, by means of a stick bent in the shape of a sickle or hook, pulls a quantity of the stalks down over the side of the canoe. Then with another stick held in her free hand she beats the fruit heads, thus knocking the grain into the bottom of the canoe whereon a blanket is usually spread to catch it. In this way the grain on both sides of the path is gathered. When one end of the canoe is full, the laborers exchange implements, and the other end of the canoe is filled on the return trip to the shore. The grain is then taken out, dried or cured, its tenacious hull is thrashed off, and, after being winnowed, it is stored away for future use.

As to the nutritive qualities of wild rice, Dr. Jenks states that an analysis shows "that wild rice is more nutritious than the other native



Courtesy of the Bureau of American Ethnology.

WILD-RICE KERNELS AFTER THRASHING AND WINNOWING.

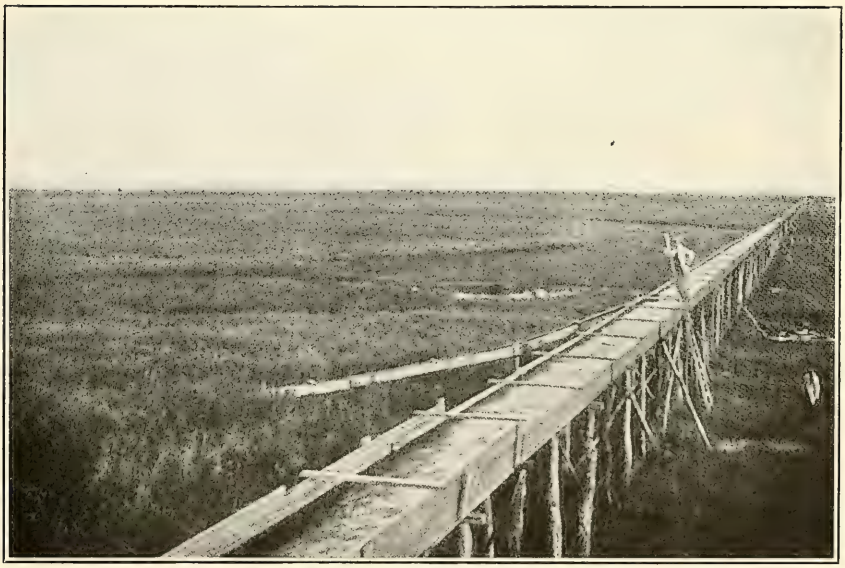
The edible part of wild rice is a slender cylindrical kernel, varying in length from half an inch to nearly an inch, and is of a dark slate color when ripe. As a food it is very nutritious, perhaps even more so than the cultivated species which forms such an important element in the world's domestic economy. It is said to be richer in carbohydrates, the fat and heat producing units, than any of the commonly used cereals. Among many of the northern tribes of Indians in the United States and Canada it has been a favorite food for many centuries, being prepared for consumption in many ways. Dr. Jenks writes of it in this connection: "When it is cooked like oatmeal twice as much boiling water is used. The grain cooked in this manner may be warmed over, and its flavor and wholesomeness in no way impaired. In cooking it swells probably a little less than commercial rice, but a coffee-cup full, measured before cooking, will furnish a meal for two Indians, or sufficient breakfast food for 8 or 10 persons. The grain is especially wholesome as a breakfast food served with sugar and cream; and when treated in any way with wild game, whether as a dressing, in soups, or stews, or as a side dish dressed with the juices of the game, it is at its best and is delicious and wholesome."

foods to which the wild rice producing Indians had access—viz, maize, green corn, corn meal, white hominy, strawberries, whortleberries, sturgeon, brook trout, and dried beef. It also shows that it is more nutritious than any of our common cereals, as oats, barley, wheat, rye, cultivated rice, and maize."

This kind of rice, therefore, indigenous to North America, and utilized by the Indians long before the advent of the white man, has been a staple food for centuries. Having thus briefly disposed of the wild relative of *Oriza sativa,* we may now take up the cultivated and better known species.

The culture of this species is alluded to in the Talmud, and there is evidence that it was grown in the valley of the Euphrates and in Syria before 400 B. C. It was taken into Persia from India, and later into Spain by the Arabs. Thence its culture was introduced into Italy about 1468 A. D. The Spaniards are also responsible for its introduction into Peru and other sections of Spanish America during the early colonial period, but the exact date has not been definitely determined. Padre Calancha, in his "Cronica Moralizada," published in 1639, mentions rice as among the products of the Zana district in Peru, but it was not until the latter part of the seventeenth century that it was grown to an appreciable extent.

The first introduction of rice culture in the Americas seems really to have been in Brazil. Numerous references in the works of the older Brazilian writers, as well as casual mention of rice fields in official records, would indicate that this cereal was cultivated in certain sections of the country even in the sixteenth century. For instance, in his "Memorias para a Historia da Capitania de São Vicente," Frei Gaspar Madre de Deus, referring to the sugar factories which were in operation in São Vicente during the years 1550–1557, writes: "The ordinary price of an arroba of refined sugar was 400 reis; and rice in the husk sold for 50 reis the alqueire, according to the books and writers of that time; also according to these, everyone was occupied in raising these two products." Again, in a survey of Sesmaria Husayhy, situated on the right bank of the Ribeira River near its mouth, made in 1631, a dividing line between these lands and those of Antonio Serão "passed close to a small coffee plantation and farther on through the middle of a rice field." In 1692 a Capt. Martin Garcia Lumbria, in order to favor the gold mining industry of the region, arbitrarily fixed the price of two food products, mandioca and rice, at such a low figure that in an official statement issued the next year we read: "The farmers so reduced the plantations of rice and mandioca as to have only enough to sustain their own families." From all of which we may infer that the cultivation of rice had become an established industry in Brazil by the middle of



RICE CULTURE IN BRAZIL.

Top: An irrigated rice field near the Moreira Cesar station on the Central Railway of Brazil, State of São Paulo, about midway between Rio de Janeiro and the city of São Paulo. It was here that rice culture by means of scientific irrigation was introduced into Brazil by Mr. Welman Bradford, an American expert employed by São Paulo in 1907 to teach modern methods of cultivation and harvesting in that State. Bottom: Conveying water for irrigating certain sections of rice lands in Brazil by means of elevated sluices. The introduction of modern devices has increased the production of rice in that country to such an extent that importation has grown less each year, so that now very little is imported.

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the seventeenth century and was doubtless started as early as the sixteenth.

In the United States, according to the late Dr. Seaman A. Knapp, of the United States Department of Agriculture, rice is said to have been cultivated in Virginia by Sir William Berkley as early as 1647. He states, however, that no particulars are given, except that from a half bushel of seed planted the product was 16 bushels. Dr. Knapp also quotes another account, taken from Ramsay's History of South Carolina, which states that "An English or Dutch ship, homeward bound from Madagascar, was driven by stress of weather to seek shelter in the harbor of Charleston, and the captain seized the opportunity to visit an old acquaintance, the landgrave and governor of the Province, Thomas Smith, whom he had already met in Madagascar. Smith expressed the desire to experiment with the growing of rice upon a low, moist patch of ground in his garden, similar to the ground upon which he had seen rice growing in Madagascar, whereupon the captain presented him with a small bag of rice seed which happened to be among the ship's stores. The seed was planted in a garden in Longitude Lane, Charleston, the spot being still pointed out." This event is said to have occurred in 1694.

From the time of its introduction until about 1880 the greatest rice producing areas were in the States of South Carolina, North Carolina, and Georgia, while limited amounts were also grown in Florida, Alabama, Mississippi, and Louisiana. In recent years the industry has received its greatest development in Louisiana, Texas, and Arkansas, and these three States now produce about 95 per cent of the entire product of the United States. The reasons for this remarkable progress in rice culture in these States are to be found in the peculiar soil conditions and the enormous acreage adapted to irrigation, conditions which will be more particularly noted hereafter in dealing with the methods of producing the cereal.

The rice plant is an annual which belongs, as its botanical name *Oryza sativa* would indicate, to the natural family of grasses. It is extensively cultivated in India, China, Japan, Malaysia, Brazil, Peru, the southern section of the United States, Italy, and Spain. It is also cultivated to a less extent in the countries of Central America, in Argentina, Ecuador, Colombia, Venezuela, and the Guianas. The plant varies in height from 1 to 6 feet, and there are many hundreds of cultivated varieties. These differ in the size, shape, and color of the grain produced as well as in the relative proportion of food constituents and flavor. A botanical catalogue enumerates 161 varieties found in Ceylon alone, while in China, Japan, and India, where the cereal has been cultivated for so many centuries and where care has been taken to improve varieties by seed selection, no less than 1,400 varieties are said to exist. It requires for ripening a

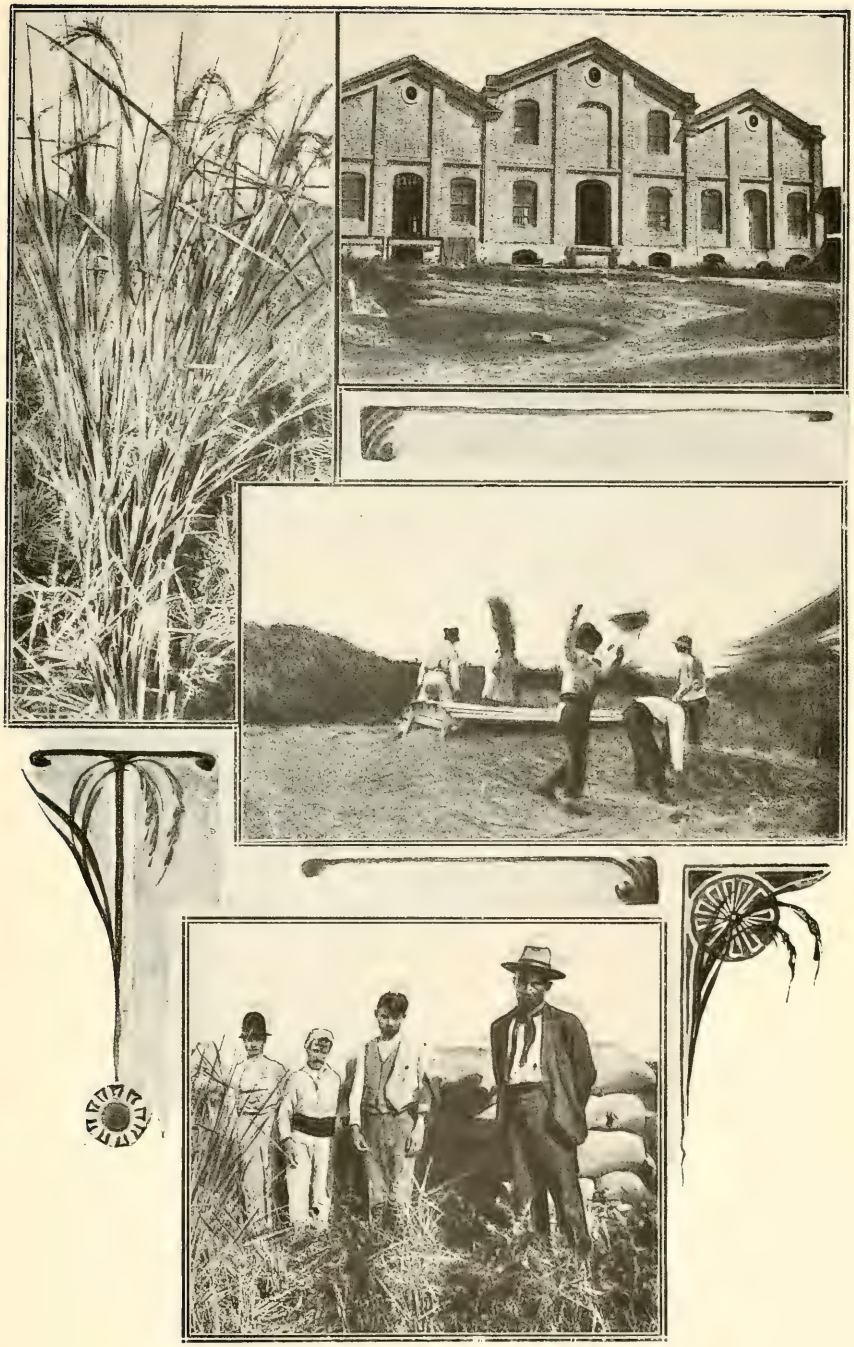
AN IRRIGATED RICE FIELD IN MEXICO.

Rice is one of the staple products of certain sections of Mexico. The States of Colima and Guerrero lead in point of production, but important rice plantations are also found in the municipalities of Teapa and Jalpa, in the State of Tabasco. The sections where the cereal has been most successfully produced lie between the parallels of 17° and 19° north latitude. The States of Michoacan and Puebla also produce considerable quantities. The annual production of the country, prior to the disturbed political conditions, amounted to about 1,200,000 bushels.

temperature of from 60° to 80° F., and in general can be grown successfully and in large quantities only on irrigable lands. Upland rice, while still grown in some places, is an uncertain crop that requires laborious cultivation, so that in comparison with the irrigated varieties of the lowlands its production is in negligible quantities.

Rice is the characteristic grain crop of the plains in the monsoon area of the tropical and subtropical parts of southeastern Asia. The varieties which are most abundantly produced demand not only a high summer temperature but also must be grown in fields capable of being flooded at certain stages of the plant's growth. It is these conditions which are offered in the great river deltas and low-lying areas near the seashore subject to inundation during the summer rains. The fields in which rice is grown are embanked to retain the water as long as required and are either naturally very level or made so artificially. Where the rains or overflow of the rivers are not sufficient to inundate the fields, the necessary water must be furnished by irrigation. The physical characteristics and climatic conditions needed for the successful growth of the rice plant are to be found in many of the tropical and subtropical sections of the Americas, but the most extensive areas suitable for its production on a large scale are found in the Gulf States of the United States, especially in Louisiana and Texas; in the vast reaches of level lands in Brazil; in the Pacific coast sections of Peru and Ecuador; in the northern lowlands of Colombia, Venezuela, and the Guianas; and in the extensive and fertile plains of northern Argentina.

To discuss the many interesting features of rice culture in detail is far beyond the scope of this sketch. Only a few of the most general factors that enter into the successful production of the plant can be touched. Those interested in such details as the precise character of soils, selection of seeds, plowing and preparation of the land, methods of planting, fertilizing, irrigation problems, thrashing, milling, etc., details which differ widely in the various countries of production, are referred to recent publications of the agricultural departments of such countries. In the Americas, for instance, among such publications may be mentioned the various bulletins prepared for the United States Department of Agriculture by the late Dr. Seaman A. Knapp, whose investigations in regard to rice culture extended over a period of perhaps 20 years and included a comprehensive and detailed study of the industry in China and Japan; in Brazil an excellent and comprehensive work on the subject by Dr. L. Granato, entitled "O Arroz," was published under the auspices of the "Ministerio da Agricultura, Industria e Commercio" in 1914. In this scholarly production may be found a complete survey of the rice industry, including every phase from the most primitive methods to the most modern, from the preparation of the soil to the



THE RICE INDUSTRY IN ARGENTINA.

Top: Left, an Argentine rice plant; right, a rice mill at Aguillares, Tucuman. Center: Thrashing rice in an Argentine field. Bottom: Sacks of rough rice, or "paddy," ready for transportation to the mill.

finished product of the best modern mills. In Peru the "Boletin del Ministerio de Fomento," published in August, 1916, gives an interesting sketch of the industry in that country, including its historical features as well as its present status, and embracing statistics in regard to acreage, production, etc., of the various plantations to be found in the Republic.

In general terms it may be stated that the best soil for rice is a medium loam, containing about 50 per cent of clay. This allows the presence of sufficient humus for the highest fertility without decreasing too much the compact nature of the soil. The alluvial lands along the banks of rivers in tropical and subtropical countries, where they can be drained, are well adapted to rice cultivation. Occasionally such lands are too sandy. The rich drift soils of the Louisiana and Texas prairies in the United States are wonderfully adapted to the growth of rice. These soils are underlain with clay, which retains the water as long as desired, while the sand is exceedingly fine. They also have about the right proportion of potash, phosphoric acid, and other essential mineral elements, with humus, to make them lastingly productive. It would seem that the best rice lands must be thus underlain by a semi-impervious subsoil in order that the land may be drained at the time of the harvest, and thus permit the use of modern harvesting machinery.

In some localities tidal deltas of rivers have been found to furnish excellent rice lands. Much of the rice formerly grown in South Carolina and Georgia in the United States was produced on such areas. A body of land along some river and sufficiently remote from the sea to be free from actual salt water is selected with reference to the feasibility of being flooded from the river at high tide and of being drained at low tide. Lands such as these are also found in Louisiana and are being extensively utilized for rice growing. In some places marshes are found on what may be termed "high land" and, where they can be easily drained and again flooded from near-by streams, form excellent rice plantations.

The rice growers of the United States have been remarkably successful in the cultivation of this cereal, and it may not be amiss to give a brief outline of their methods as described by Dr. Knapp in a bulletin published in 1910. 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 half an acre. The entire surface of the 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 small.

Courtesy of the Bureau of Plant Industry, United States Department of Agriculture.

THE RICE INDUSTRY IN SOUTH CAROLINA.

Upper: Typical rice field, showing the irrigating canal. Lower: Hauling the cut rice from the field to the thrasher.

Whether small or large, the fields must 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 up on 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 the 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 its temperature. A great body of water descending rapidly from the mountains to the sea is several degrees colder than water under ordinary flow. Such water admitted to the field retards the growth and is a positive injury to the crop. In periods of continued drought the salt water of the sea frequently ascends the rivers a considerable distance; and, while slightly brackish water is not injurious, very salt water is destructive to rice.

The tract of land selected and inclosed is then cut up by smaller canals into subfields of suitable size, a small levee being thrown up on the borders of each. The entire tract is usually level, but in case of 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 have ready access to the entire circuit of the tract, while still smaller boats can pass along the subcanals to the several fields. The subcanals are usually from 6 to 10 feet wide and should be about as deep as the main canal.

Rice lands are usually plowed a short time before planting time, and 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. Deep plowing is recommended by leading rice experts. 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; it is therefore evident that deep cultivation places more food within reach of the plant. If the soil is well drained deep plowing will be found profitable. 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 furrows for any considerable time it will bake and can not be brought into that fine tilth so necessary to the best seed conditions. 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

MODERN METHODS OF HARVESTING RICE.

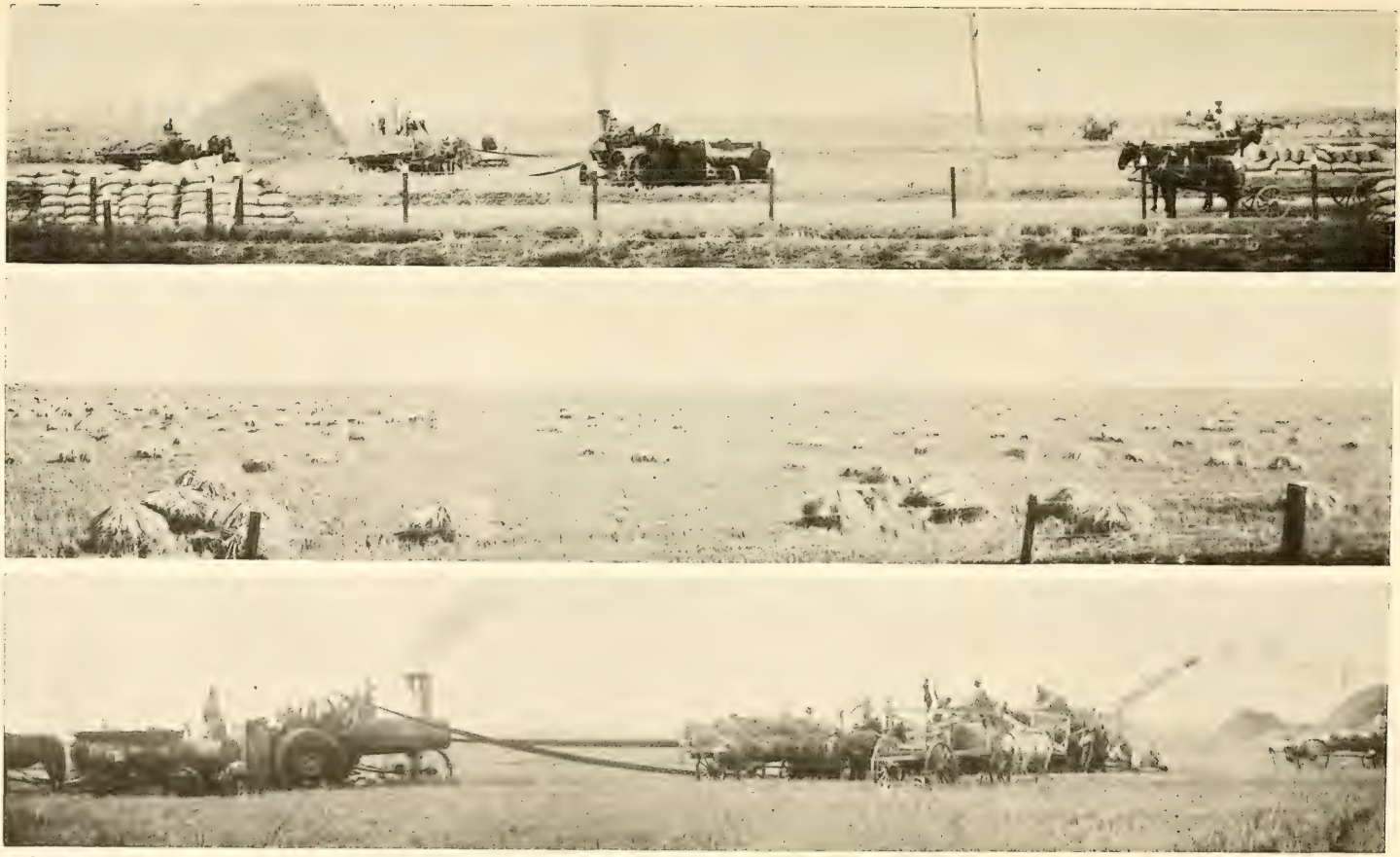
About the year 1885 some farmers from the northeastern section of the United States settled in the level prairie region of southwestern Louisiana, which extends from the parish of St. Mary along the Gulf coast to Texas. Finding rice to be a very profitable crop, they at once began to adapt the agricultural machinery to whose use they had become accustomed in the wheat-growing States whence they came to the cultivation and harvesting of this cereal. The gang plow, disk harrow, drill for planting, and broadcast seeder were all easily adjusted to the new use. Large fields, containing from 40 to 80 acres in one plot, became common, and by use of this modern machinery the cost of production of rice was very materially reduced. The same conditions in regard to level and easily irrigated lands with an impervious subsoil are to be found in Brazil, and since about 1907 great strides have been made in adopting modern methods similar to those used in the United States. The upper picture shows a harvesting scene in Louisiana; the lower a similar scene in Brazil.

compact, and conserve the moisture for germinating the grain, rendering it unnecessary to flood for "sprouting."

The amount of rice sown per acre varies in different sections and with different methods of sewing, from 1 to 3 bushels per acre being used. In the United States three different methods of treating the seed are followed. Some planters let on just enough water to saturate the ground immediately after sowing and harrowing and at once draw off any surplus water. This insures germination of the seed. Others sow and trust to there being enough moisture in the land to germinate the seed. This is sometimes uncertain and rarely produces the best results. A few planters sprout the seed before planting by placing bags of seed rice in water, but this is sure to prove a failure if the soil is very dry when planting. The seed is usually planted with a drill. It is thus more equally distributed and the quantity used per acre is exact, while the seeds will be planted at a uniform depth and the earth packed over them by the drill roller. Broadcast sowing is the method still in vogue in many places, but is found much less efficient for many reasons.

Except where water is necessary for germination of the seed, flooding is not practiced until the rice is 6 to 8 inches high. If rains are abundant enough to keep the soil moist, flooding is not begun until the plants are 8 inches high. At the time they have reached that height a sufficient depth of water can be allowed on the field to prevent scalding. If the growing crop thoroughly shades the land, just enough water to keep the soil saturated suffices. To be safe, however, for all portions of the field, the water should stand from 3 to 6 inches deep, and to avoid stagnation should be renewed by a continuous inflow and outflow. 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 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. Where the lands are sufficiently level and have good drainage, the tillering of rice can be greatly facilitated by keeping the soil saturated with water but not allowing enough to cover the surface. In this way the crop is frequently nearly double what it would be if allowed to grow dry until tall enough to flood or if flooded before fully tillered. Rice should be cut when the straw has barely commenced to yellow. If the cutting is delayed till the straw shows yellow to the top, the grain is reduced in quality and quantity and the straw is less valuable. There is also a considerable loss by shelling in handling in the field.

In the United States reaping machines are generally used in the prairie districts of Louisiana and Texas, but in other rice-producing sections such machines can be used only to a limited extent. The principal obstacle to the use of large and heavy machinery is that



Courtesy of the Bureau of Plant Industry, United States Department of Agriculture.

LOUISIANA RICE FIELDS.

Modern reaping machines are extensively used in harvesting the grain in the prairie districts of Louisiana, Texas, Arkansas, and California. A single field often contains 80 acres of rice. The top and bottom pictures show the great steam thrashers at work in the field; the center picture shows the rice gathered in shocks for the purpose of curing the straw and hardening the grain.

the ground is not sufficiently dry and firm at harvest time, while often the field is too small to permit of its use. Where the use of reaping machines is impracticable, the sickle is used in harvesting the rice crop. 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, bound in small bundles, and then shocked on dry ground, the bundles being carefully braced against each other so as to resist wind or storm. The rice is left in the shock until the straw is cured and the kernels have become hard. When the weather is dry, 10 or 12 days after cutting is sufficient for completely curing the grain.

After the grain is cured it is thrashed. The primitive methods of "flailing," "treading out," etc., have been abandoned in the progressive rice-producing countries and the steam thrasher has come into general use. After coming from the thrasher the rice must be thoroughly dried before being sacked. At this stage it is known as "paddy" or "rough rice," consisting of the grain proper with its closely fitting cuticle roughly inclosed by the stiff, hard husk. It is now ready to be milled. 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 from 12 to 25 per cent of the weight of the paddy, depending upon the variety and condition.

The improved modern 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. The product goes over horizontal screens and blowers, which separate the light chaff from the whole or broken kernels. 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, which notwithstanding their weight seldom break the kernels. 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; thence to the fine-chaff fan, where the chaff is blown out. The rice then goes to the cooling bins, where it remains for 8 or 9 hours, and then passes to the brush screens where the smallest rice and the little flour left pass down one side and the larger rice grains down the other.

The grain is now ready for the polishing process. This is necessary to give it its pearly luster. It is effected by friction against the rice of moose hide or sheepskin, tanned and worked to a high degree of softness, loosely tacked about a revolving cylinder of wood and wire gauze. From the polishers the rice goes to the separating screens,

Courtesy of the Bureau of Plant Industry, United States Department of Agriculture.

RICE GRAINS IN THREE STAGES OF PREPARATION.

Left: The kernels in the husk, known as "paddy." Center: The kernels after the husk is removed, but before they have undergone the polishing process. Right: Highly polished kernels of rice. Highly polished rice is conceded by all authorities to be less wholesome and nutritious than the unpolished, although the former is more popular and higher in price. According to some investigators the constant use of highly polished rice as almost an exclusive diet is largely responsible for the tropical disease known as beriberi. Experiments conducted in Japan, China, and the Philippine Islands seem to bear out this theory. When beans, lentils, or other edibles containing phosphorus are eaten with the rice, however, no ill effects were noted even when the polished rice was a part of the diet. Unpolished rice, on the other hand, even when the chief article of diet, had no ill effects. In the polishing process the outer layers of the rice grain, which contain phosphorous pentoxide, are removed, and it seems that this ingredient is necessary to make rice wholesome. In the Philippine Islands the use of rice containing less than four-tenths of 1 per cent of phosphorous pentoxide is forbidden by executive order.

composed of different sizes of gauze, where it is divided into its appropriate grades. It is then barreled and is ready for the market.

As a food rice is nutritious and very easily digested. Boiled rice for instance, is said to be digestible in one hour. As to its food value in comparison with wheat flour analyses show that 100 pounds of cleaned rice contains 87.7 pounds of nutrients, consisting of 8 pounds of protein, 0.3 pound fat, 79 pounds of carbohydrates, and 0.4 pound of ash; 100 pounds of wheat flour contain 87.2 pounds of nutrients, consisting of 10.8 pounds protein, 1.1 pounds fat, 74.8 pounds carbohydrates, and 0.4 pound ash. The deficiency of albuminoids and fats can easily be supplied from the milk or meat gravies with which it is usually eaten, or from leguminous vegetables such as peas, beans, etc.

The popularity of rice as one of the staple articles of diet in the countries comprising the Pan American Union is attested by their annual imports of the cereal. When it is remembered that rice is grown to a greater or less extent in almost all of them, the following statistics as to the imports of the countries enumerated are somewhat surprising. Only the values of the imports are given, and these, with the exceptions noted, are for the year 1915; statements as to quantities are omitted because unavailable in some instances, while in others varying weights and measures were used. Argentina, $1,972,426; Bolivia (1913), $175,699; Brazil, $529,861; Chile, $1,106,187; Colombia, $800,697; Costa Rica, $108,649; Cuba, $8,304,579; Dominican Republic, $908,876; Ecuador (not segregated in report); Guatemala, $34,129; Haiti (1,773,252 pounds imported, value not given); Honduras, $112,627; Mexico (1912–13), $40,677; Nicaragua, $145,550; Panama (1914), $350,903; Paraguay (1914), $92,676; Peru, $603,700; Salvador (not segregated in report); United States, $6,093,611; Uruguay, $440,000; Venezuela, $621,797. It will be seen, therefore, that with three countries omitted the annual imports of rice in Pan America amount to a total value of about $22,442,644.

As to the production of the cereal in the Americas, it may be said that it is increasing rapidly in several of the countries where modern methods of cultivation, harvesting, and milling have been introduced. In the United States a remarkable increase was shown last year. The production of 1915 had broken the record with a total of 28,947,000 bushels, exceeding that of any previous year by over 3,000,000 bushels, but when the statistics for the year 1916 were recently completed it was found that the crop had reached a total of 41,982,000 bushels. The country's rice imports for the year ending June 30, 1916, amounted to the value of $6,093,611, while its exports of the cereal amounted to $4,942,373. It may be safely assumed,

therefore, that the industry has reached the point in the United States where production will very nearly equal actual consumption.

In point of production as well as in the matter of improved methods and extent of area devoted to rice culture, Brazil may be ranked second among the American rice-producing countries. Largely because of the intelligent efforts of the Ministerio da Agricultura, Industria e Commercio, the rice industry has grown wonderfully in that Republic within the last six or seven years. Extensive areas are being cultivated under modern systems of irrigation and with modern implements and agricultural machinery. The most marked development has taken place in the States of Minas Geraes, São Paulo, Rio Grande do Sul, Rio de Janeiro, and Santa Catharina. In these five States the production for the year 1911 was placed by Dr. Granato at a total of 556,982,700 litros, or about 15,823,372 bushels. While later statistics are not yet available to the writer, it may be safely assumed that the figures for 1916 will show a tremendous increase. In this connection it may be of interest to note that in a recent consular report from Rio de Janeiro, relative to the establishment of a new line of steamers from Japan to Brazil, appears the following paragraph:

> It is stated that the first steamer, of 6,000 tons register, will leave Japan next February, and in addition to special cargo will bring 900 emigrants. According to arrangements which it is said have been made, Japan is to send every year, beginning next February, 5,000 immigrants to be employed in accordance with the regulations of the national authorities in the cultivation of rice, beans, potatoes, onions, and coffee.

Just what effect the importation of Japanese laborers, many of whom are experienced growers of the cereal, will have on the rice industry remains to be seen. If they are to be colonized or given employment in the rice-growing areas, the effect will doubtless be a great increase in the area cultivated and in the amount of annual production. With millions of acres of level land traversed by many rivers of varying size that minimize the difficulties of irrigation, with a well-adapted soil and an almost ideal climate, there is almost no limit to the successful production of rice in Brazil, and the day is probably not far distant when it will form one of the country's most important exports.

Argentina has also recently turned its attention to the development of the rice industry. Two or three years ago a Japanese expert was employed by the Argentine Government to make a general survey of the country in regard to locating the sections best adapted to rice culture, to conduct experiments and to teach the best methods of cultivation, and to improve generally the status of the industry. At present the development is greatest perhaps in the Provinces of Tucuman, Corrientes, Salta, and Jujuy, and in the Territory of Misiones. The production of the country has increased from 5,250,300 kilos (about 11,550,660 pounds) in 1911 to over 12,000,000 kilos (about 26,400,000

pounds) in 1916. The Ministry of Agriculture is actively cooperating with the rice growers and is stimulating the industry in every way possible. At its instance, selected varieties of seed have been imported from China, Japan, Italy, and Spain in order that systematic experiment may determine the varieties best suited to the needs of the Argentine growers; it has acted as an intermediary between the mill owners and growers in order to secure satisfactory terms and arrangements for preparing the product for the markets; and largely because of its activities the great Banco de la Nación stands ready to lend financial assistance to both millers and growers.

In Peru the rice industry dates back for several centuries, but it is only during the past few years that the people have begun to realize its possibilities and to appreciate that it may be made a very important factor in their national life. Ancient methods of planting and cultivation are being discarded and modern appliances are rapidly being brought into use, while modern rice mills are also being established. The annual production for the past several years has been from 70,000,000 to 100,000,000 pounds, and through the efforts of the Ministerio de Fomento is increasing.

Mexico, the Central American countries, Ecuador, Colombia, Venezuela, and the island Republics of Cuba, Dominican Republic, and Haiti all produce rice for domestic consumption, but accurate statistics are not available. That they do not produce as much as they should is evidenced by the import statistics heretofore given. In view of the fact that rice is a cheap, wholesome, palatable, and very nutritious food, it is remarkable that so little attention has been given to its production in some of the countries that are blessed with suitable lands, proper soils, and ideal climates. It is to be hoped that the people of these countries may be more fully aroused to the great importance of this industry and that they will produce at least sufficient quantities to meet the demands of domestic consumption.