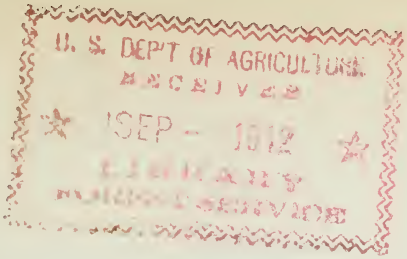

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A PRELIMINARY REPORT ON RICE GROWING IN THE SACRAMENTO VALLEY.

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A PRELIMINARY REPORT ON RICE GROWING IN THE SACRAMENTO VALLEY.

INTRODUCTION.

In the Sacramento Valley of California there are large tracts of land that 30 years ago produced profitable crops of wheat and barley which are now not yielding crops of either grain in paying quantities. These tracts were first used for grazing cattle, but were afterwards converted into extensive grain ranches, which to-day might be as remunerative in yield as in the earlier days if maintenance of soil fertility had been valued as an asset. Under improved methods of farming, however, a large part of this area, depleted as it is in plant food, will still produce grain in quantity and of good quality at a profit. While crop rotation, diversified farming, and intensive culture will play conspicuous parts in the improvement of the agriculture of this valley, irrigation will play a more important part in the development of its agricultural possibilities, for through the intelligent use of water it is possible to obtain the full capacity of the crops now grown and also profitable returns from crops which are not now cultivated in this valley.

Among the crops requiring water rice is worthy of a trial, but its successful cultivation is so dependent upon water that it should never be planted where the supply is not sufficient to submerge the land to the depth of at least 3 inches from the middle of June to the middle of September. If there is water enough during this period for a continuous submergence, the greatest obstacle to the production of the crop is removed. There is no crop grown in California at present that requires as much water as rice.

CONDITIONS UNDER WHICH VARIETY TESTS OF RICES WERE MADE.

In the spring of 1909 the Office of Grain Investigations of the Bureau of Plant Industry inaugurated tests to determine the adaptability of rice to the climate and soil of the Sacramento Valley. These tests were made on the black adobe soil lying on the east side of Butte Creek, approximately 9 miles west of Biggs, Cal. (Pl. I,

fig. 1.) This soil is of a close, compact structure. When wet it has an exceedingly tenacious and puttylike consistency. During the dry season it breaks at the surface into blocks with deep fissures between them. These blocks upon long exposure are divided and subdivided by smaller fissures until the surface may become a loose, shallow mass of small pieces of the size of peas. In this condition the soil absorbs water readily, which is given up slowly under evaporation. The subsoil, which lies at a depth of approximately 3 feet, is very impervious, though water penetrated it to a depth of 6 inches before the plats were drained. The surface of the plats was nearly level, with just enough slope for good drainage into the narrow sloughs, which are features of the topography of this area of black adobe that may be used for conveying water for both drainage and irrigation.

Grain had been grown exclusively upon this land, though it was not under cultivation during the year preceding the tests. The land was plowed in the autumn. The rains of the winter months reduced the clods and left the surface of the soil in a condition that required less work and expense to secure a good seed bed than would have been possible if the entire preparation for planting had been postponed until spring.

The seed of each variety was planted with a drill to the depth of 1½ to 2 inches at the rate of 80 pounds per acre. On account of a lack of moisture in the soil at the time of planting, it became necessary to apply water to germinate the seed. This irrigation is not likely to be required when the planting is done immediately after the late spring rains or before the end of the rainy season. It would not be advisable to plant early except on well-drained land that had been plowed in the autumn.

In the first irrigation the water was retained long enough to wet the surface of the soil thoroughly. The second application of water was made when the plants were approximately 3 inches high, which was sooner than would have been necessary if the soil had not become too compact on the surface when the plats were drained. From this period water was applied every 7 to 10 days to keep the soil moist. After the plants had tillered well the land was submerged to a depth of 3 to 5 inches. This submergence was continuous until the grain reached the hard-dough stage. At this stage of maturity the plats were drained for harvest. All varieties were allowed at least 10 days in the shock before they were thrashed.

From the date of planting until October 1 there was less than 1 inch of rain. During the same period the average daily range of temperature varied from 29° in May to 38° in August, with the greatest range occurring in July, August, and September.

FIG. 1.—A GENERAL VIEW OF THE RICE PLATS ON BLACK ADOBE SOIL IN THE SACRAMENTO VALLEY OF CALIFORNIA.

FIG. 2.—A PLAT OF THE LENCINO VARIETY OF RICE (G. I. NO. 1583) IN FLOWER. DURING THIS PERIOD THE LAND IS SUBMERGED.

FIG. 1.—A PLAT OF THE WATARIBUNE VARIETY OF RICE (G. I. NO. 1561) IN "BOOT." DURING THIS PERIOD THE LAND IS SUBMERGED.

FIG. 2.—A PLAT OF THE HONDURAS VARIETY OF RICE (G. I. NO. 1643) AT FULL MATURITY.

TABLE I.—*Results of variety tests of rices*[1] *grown upon one-tenth acre plats on black adobe soil in the Sacramento Valley of California in 1910.*

G. I. No.	Date planted.	Date land was submerged.	Date of maturity.	Days to maturity.	Height of plant, including head.	Length of heads.	Heads per plant.	Yield per acre.[2]
					Inches.	*Inches.*		*Bushels.*
1533	Apr. 12	June 25	Oct. 22	193	38	7.0	6–12	71.5
1561[3]	Apr. 13	...do.....	...do.....	192	36	7.5	7–21	154.0
1562	...do.....	...do.....	Oct. 1	171	40	7.5	7–10	131.3
1563	...do.....	...do.....	Sept. 29	165	40	7.0	6–14	122.4
1582	...do.....	...do.....	Sept. 2	142	31	7.0	8–22	42.8
1583[3]	...do.....	...do.....	...do.....	142	33	7.0	8–15	47.1
1585	...do.....	...do.....	...do.....	142	31	6.5	8–22	58.0
1597	Apr. 12	...do.....	Sept. 7	148	28	6.5	5–14	71.3
1599	Apr. 13	...do.....	Sept. 2	142	33	7.0	8–15	23.1
1600	...do.....	...do.....	Sept. 30	170	38	7.0	6–11	94.6
1602	...do.....	...do.....	Sept. 25	165	36	7.0	9–20	77.7
1642[3]	Apr. 12	...do.....	Oct. 22	193	29	7.0	10–27	124.0
1643[3]	...do.....	...do.....	...do.....	193	38	7.5	6–12	63.3

[1] These rices, on account of the quality of their grain, were selected for planting in 1910 from 300 varieties which were grown here in 1909 on plats consisting of only 4 rows a rod each in length and 7 inches apart. The yields from the rices in 1909 were relatively much higher than in 1910, when the plantings were made on a larger scale. Estimated upon the actual yield from plats one-half acre in size, the Wataribune (G. I. No. 1561) and Shinriki (G. I. No. 1642) varieties in 1910 yielded 113.7 and 137.2 bushels per acre, respectively.

[2] Estimated upon the actual yields from one-tenth acre plats.

[3] See illustrations.

In this valley these rices require a longer time to mature and they produce smaller plants than when grown on the plains of the Gulf coast, but they exhibit a greater capacity for tillering, with resultant larger yields.

The short-grain rices appear to be better suited to this climate than the long-grain varieties. (Pl. I, fig. 2.) They ripen more uniformly, though slowly, tend to shatter less, and produce larger yields. There is less sun-cracking of the grain in these varieties after ripening than in the long-grain rices, which will result, of course, in a larger percentage of head rice when milled.

The number of days for maturing the crop may be greatly lessened by stimulating the growth at the time the plants begin to "boot" by increasing the depth of water (Pl. II, fig. 1), with a gradual lowering of it during this period, and by giving another impetus to growth by suddenly increasing the depth of water just as the heads appear. This last depth of water should be maintained until the heads begin to turn down, when the land should be drained for harvest. A shorter season and earlier planting seem desirable in order that the crop may escape the effect of the increasing humidity in September and October, which appears to lengthen the period of ripening.

The Honduras (Pl. II, fig. 2) and Shinriki (Pl. III) varieties (G. I. Nos. 1643 and 1642) are the leading commercial rices of the United States. In this test these varieties have exceeded the maximum yields produced on experimental plats in Louisiana and Texas. Of the two rices, the Shinriki, which is a small-grain variety, is better adapted to the Sacramento Valley.

The Wataribune (G. I. No. 1561) (Pl. IV), the Oiran (G. I. No. 1562), and the Shinriki (G. I. No. 1642) varieties produce good yields, but on account of the long period which they require for maturity they may never become the leading rices of this valley, because the late planting of them might result in the loss of a crop. For this reason early-maturing varieties of good quality, though producing less per acre, might be more remunerative. The other varieties included in Table I are introductions from foreign countries that will be described and discussed in a later publication.

SUGGESTIONS AS TO METHODS OF CULTURE.

In selecting land for rice it is very important to know whether the subsoil possesses the mechanical characters for retaining water, for in the irrigation of this crop a continuous submergence of the land for several weeks is required. Such a condition is not possible unless the subsoil is sufficiently impervious to water, or unless, by tidal irrigation, the depth of water upon the land may be maintained continuously when needed, regardless of the nature of the underlying stratum of soil. On land that can not be flowed by the tides the cost of submergence and the time required in the submergence depend upon the depth of the soil. A soil with a depth of 20 inches is preferable to a deeper one, because less water will be used and less time consumed in flowing the land. However, heavy clay soils of great depth that can be well prepared and drained may be used advantageously for the crop, but comparatively shallow soils must be underlain by an impervious subsoil or so located as to be subject to tidal overflow. These details of irrigation, an item of great expense in the production of rice, must be considered to secure maximum returns.

Soil of a compact nature seems well adapted to rice. Clays, for this reason, if they are not too deficient in organic matter and can be effectively drained, are preferred to other soils, because they dry out more readily at the surface and become solid after the removal of the water, making the fields accessible at harvest much sooner than would be possible on the more open soils. The culture of rice, however, is not confined to clay soils, for wherever water can be economically handled by irrigation and drainage loamy and even sandy soils will produce good crops.

When not contrary to good farm management and the nature of the soil will permit it, land for rice should be plowed in the late autumn and well drained. With good drainage at this time the alkali which has accumulated just below the surface will be washed out by the winter rains. Furthermore, the action of the weather during the dormant period will have the effect of pulverizing the

A PLAT OF THE SHINRIKI VARIETY OF RICE (G. I. NO. 1642) AT FULL MATURITY. THIS VARIETY REQUIRES A LONG SEASON AND SHOULD NOT BE PLANTED LATER THAN APRIL 15 IN THE SACRAMENTO VALLEY.

A TENTH-ACRE PLAT OF THE WATARIBUNE VARIETY OF RICE (G. I. NO. 1561) DRAINED FOR HARVEST. THIS VARIETY REQUIRES A LONG SEASON AND SHOULD NOT BE PLANTED LATER THAN APRIL 15 IN THE SACRAMENTO VALLEY.

soil and making possible a good seed bed at a minimum cost. If plowing is postponed until spring, the land should not be left in furrow, but should be harrowed at once and not allowed to dry out before planting. High germination and vigorous growth of the young plants are dependent upon a good seed bed. The importance of its preparation can not be emphasized too strongly.

The seed may be drilled or broadcasted. Large, heavy, flinty seed, uniform in size and free from sun cracks, should be used. The cracking of the grain by the sun occurs when the plants are allowed to stand too long after ripening or when the heads of rice are exposed in the shock. In thrashing and in cleaning by a fanning mill, grains are often cracked, but this may be easily prevented by the proper adjustment of the machinery. This imperfection in the seed is not easily detected, because the husk which envelops the kernel remains attached when the grain is thrashed. Sun-cracked and machine-cracked seed will not produce vigorous plants.

The seed should not be sown deeper than 1½ inches. In a well-prepared seed bed a less depth is desirable if the proper conditions of moisture exist. On a cloddy seed bed greater depth is required in order that all seed may be covered. A drill should be used to get a uniform depth and distribution of seed, for these conditions insure an even stand, which is an advantage in controlling weeds. In broadcasting seed there is always danger of getting a very uneven stand, due to difficulties in covering. Poor seeding reveals itself again at harvest when the rice does not ripen uniformly, which always means a loss, whether the field is cut when ripe or when portions of it are immature. This loss may come from the shattering of grain from the mature plants or from the low marketable product caused by small and poorly formed kernels.

The rate of seeding will vary according to the variety of rice, the vitality of the seed, the character of the seed bed, and the method of seeding. With the small-grain rices, which, as a rule, tiller heavily, the quantity of seed that should be sown per acre should be less than with the large-grain rices that do not tiller so strongly. Too thin seeding, however, induces excessive tillering, which invariably results in irregular ripening and low-grade rice. The sowing of seed of good vitality in a well-prepared seed bed will always give better results than the sowing of seed of low vitality in a poorly prepared seed bed. A smaller quantity of seed is used when drilled than when broadcasted.

Rice should be sown late enough to escape the extreme cold weather of spring, but early enough to mature before the autumnal rains. Sowing in April usually will be safe, as the crop will seldom be exposed to low temperatures.

Level tracts of land with sufficient slope for effective drainage, if they possess the required characters of soil and subsoil, are admirably suited for rice. In the use of such lands for this crop the field should be inclosed by strong embankments and so subdivided that each subfield shall have a surface level enough to hold the irrigation water at a rather uniform depth and yet with the necessary slope for good drainage. These conditions are obtainable by constructing the field levees on contour lines at distances which during submergence will hold the water at a depth of approximately 5 inches on the lower side and 3 inches on the upper side of each subfield. These levees should be just high enough to prevent the water from overflowing into the subfields below and broad enough to allow all kinds of machinery used in the cultivation of rice to pass over them easily and without damage to them. The planting of the field levees, which is made possible by their construction, will leave no uncultivated strips of land in the field for the growth of weeds, and though the rice upon them may not be equal in every respect to the main crop, the results obtained in the control of weeds alone will justify the practice. Such levees are permanent, and with little money and time can be kept in excellent condition.

The successful cultivation of rice is dependent upon an abundant and always available supply of water. This does not mean, however, that the land upon which the crop is grown must be submerged during the entire season. Under the favorable conditions of a good seed bed, water need not be applied for germination. However, the soil should never be allowed to dry out. This will require frequent irrigation.

After the plants have tillered well, the land should be submerged for a week to as great a depth as the levees will allow. At the end of this time the water may be lowered in the subfields to approximately 1½ inches and kept at this stage until the plants begin to "boot," when the water should be applied again to the maximum depth for a few days. (Pl. II, fig. 1.) After most of the heads have appeared, the water should be applied for a third time to its maximum depth and maintained without fluctuation until the heads are well turned down. (Pl. III.) At this stage of growth the fields should be rapidly drained.

With effective drainage (Pl. IV) the ground will be dry and firm enough within two weeks to support the weight of the harvesting machinery. Rapid drainage of the fields at this time is imperative if the crop is to be harvested at the least expense in labor and loss of grain. It can be easily obtained through open ditches, varying in depth from 2 to 4 feet, if properly located and kept free of weeds and other obstructions. Even with increased power the self-binder can not do efficient work on wet ground, and the delay in harvesting

on account of a boggy field invariably results in reduced yields from the shattering of the grain. Besides facilitating the field operations at harvest, thorough drainage is needed for other purposes. With a crop that requires water so constantly and abundantly as rice there is always danger of the soil becoming water-logged unless provisions are made for removing the surplus water. A well-aerated soil is just as essential for rice as for any other crop if maximum yields are to be maintained. To prevent alkali from accumulating in dangerous quantities and for the control of aquatic weeds a good drainage system is a necessity and makes possible the rotation of crops, which must be practiced if the fertility of the soil is to be conserved.

The rice crop is valued not so much for the yield in bushels as for the yield in pounds of head rice, or whole grains, which it will produce when milled. It is therefore important that all parts of the field should mature simultaneously and that there should be no delay in harvesting, for a lack of uniformity in ripening produces too many chalky grains that do not mill well, and the long exposure of ripe grains to the sun produces cracked kernels that break readily in the process of milling.

The milling quality of rice is further increased by prompt and careful shocking. As soon as the grain is harvested the sheaves should be put into round shocks. These shocks must be strongly built to withstand the wind and well capped to protect the grain from rain and sun. During dry weather the process of curing requires at least two weeks. This period is considerably prolonged during rainy weather. Under no circumstances should the grain be thrashed until the kernel is hard and the straw thoroughly dry. After thrashing, the quality of the grain may be seriously affected by exposure to rain and sun. For this reason thrashed rice should be stored at once under a good cover.

SUMMARY.

Clay soil with an impervious subsoil, if it lies in level tracts and can be well drained, is well adapted to rice.

Shallow soils are preferable to deep soils, because less water will be required to submerge them.

For rice there should be an abundant and always available supply of water.

To prepare a good seed bed on black adobe soil it is better to plow in autumn than in spring.

Sow with a drill.

Plant in April if the land is dry and firm enough to support teams and implements.

Do not allow the soil to bake.

Keep the necessary moisture in the soil by frequent irrigation.

Keep the land submerged from the time the plants have tillered well until the heads turn down.

Provide for thorough drainage.

Build shocks to protect the grain from sun and rain.

Keep the rice in shocks at least 10 days before thrashing it.

CONCLUSIONS.

The results from a two-year test of 300 varieties of rices on black adobe soil near Biggs, Cal., indicate the possibility of rice culture in the Sacramento Valley. The successful introduction of this crop is dependent upon an abundant supply of water, which must always be available during the growing season. The soil area adapted to rice in this valley is sufficiently large to produce many times the 55,000,000 pounds of cleaned rice which are consumed each year on the Pacific coast. How much of this area has sufficient available water for proper irrigation is uncertain, though for a good portion of it there is apparently an abundant supply. Increase in the rice acreage should therefore be made with care.

Approved:

JAMES WILSON,
Secretary of Agriculture.

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