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INFORMATION BASIC TO ADJUSTMENTS IN RICE PRODUCTION IN TEXAS

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The war resulted in a large increase in both the demand for and in the price of United States rice. Texas growers have responded by expanding the harvested acreage from 291,000 in 1940 to 396,000 in 1943. A similar expansion was reported for the nation as a whole.

The present favorable position of United States rice in the world market is largely due to the fact that the most important rice producing and exporting countries of the world have been over-run by the Japanese and consequently the large quantities of rice usually obtained from these sources must now be obtained elsewhere. When peace is restored throughout the world, the countries that were large exporters of rice before the war can be expected to compete again for world rice markets.

Prospects are that United States rice will be less in demand when the Asiatic crop comes back on the world market. This suggests that Texas farmers will need to adjust their production methods to meet lower prices if they are to continue production at or near present levels and at the same time realize a profit.

The purpose of this Bulletin is to assist farmers in determining the adjustments to be made. It deals with production and production requirements, with the effect of changes in production practices, and in turn with the probable effect of these changes on earnings.

Basic information obtained by means of a detailed survey of 66 rice growers is used in a budget analysis to estimate the effect on income of such factors as size of farm, variations in price, type of lease, variations in yield, systems of farming, and method of harvesting. Thus the direction which adjustments should take in order to obtain maximum returns are indicated. Attention is directed to the following conclusions:

1. An annual rice crop of 400 acres is more profitable than either an average-sized crop of 282 acres or a small 180-acre crop.

2. Larger earnings were obtained by tenant farmers under cash rent than under share-crop rent.

3. A yield of about 10 barrels per acre pays the expenses of making a rice crop but leaves the operator nothing for his labor and management. Yields must be kept above this level to insure profitable production.

4. The "rice-cattle" system of farming is more profitable than the "rice" system but requires considerably more capital.

5. Land values were high relative to cash rental rates and it was more profitable to lease for cash than to own land used for rice and beef cattle production.

6. Farm earnings are increased by combine harvesting and artificial drying as compared to the old method of binding and threshing. Combining reduces harvesting costs and results in less waste in harvesting.

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Division of Farm and Ranch Economics

Texas has ranked second among rice producing states for the past several years and had more than one-fourth of the nation's rice acreage in 1943. Rice production in Texas is confined to that part of the Coastal Prairie situated between the Sabine and Guadalupe Rivers. (Sub-areas 18b and 18c, Bulletin 544, A Description of the Agriculture and Type-of-Farming Areas in Texas, page 68.)

Rice was grown in Texas to a small extent without irrigation, perhaps as early as 1863, but the crop did not become of commercial importance until the advent of irrigation more than 30 years later in the locality of Beaumont, Texas.[1] Rapid expansion followed and a total of 303,000 acres was harvested in 1913. (See Table 1.) The 1913 crop was the largest harvested in the state prior to 1941.

The war resulted in a large increase in the demand for rice and a rapid rise in price. In Texas the average seasonal price received by farmers for rough rice was $2.80 per barrel for the 1939 crop, $3.03 in 1940, $5.25 in 1941, $5.69 in 1942, and $6.84 in 1943. In response to wartime demand, Texas growers expanded rice production from 291,000 acres harvested in 1940 to a record of 396,000 acres in 1943. This increase of 36 percent was in line with the expansion in rice production reported for the nation as a whole.

The present favorable economic position of rice in the United States is due largely to the fact that the most important rice producing and exporting countries of the world have been over-run by the Japanese, and consequently the large quantities of rice usually obtained from these sources must now be obtained elsewhere. This suggests that the end of fighting in Europe will not change the supply situation for rice, that the demand may even increase; but when peace is restored throughout the world the countries that were large exporters of rice before the war may be expected to compete again for world rice markets.

Most of the nations which consume large quantities of rice are relatively low income countries and buy rice on a price basis with little regard for quality. Rice grown in Burma, Siam, Indo-China, and other large exporting countries is usually of the cheap, low quality types. Consequently the southern United States rice, which is largely of high quality, long-grained types, will be less in

[1]Fertilizers for Rice in Texas, E. B. Reynolds and R. H. Wyche, Texas Agr. Exp. Sta. Bul. 398, June 1929.

Table 1. Acreage harvested, yield per acre, total production, price per bushel, and total farm value of rice in Texas, 1904-1944

Year	Harvested acreage 1,000	Yield per acre Bushels[2]	Total production 1,000 bushels	Estimated price per bu., Dec. 1 Dollars	Total farm value[1] $1,000
1904	234	35.5	8,314	.66	5,487
1905	214	31.0	6,649	1.00	6,649
1906	234	36.0	8,429	.90	7,586
1907	284	32.0	9,088	.85	7,725
1908	265	34.5	9,143	.83	7,588
1909	291	34.0	9,894	.78	7,717
1910	265	33.0	8,738	.68	5,942
1911	238	34.3	8,174	.80	6,539
1912	266	35.5	9,429	.94	8,863
1913	303	32.0	9,696	.86	8,339
1914	240	33.8	8,102	.92	7,454
1915	260	30.5	7,930	.89	7,058
1916	235	45.0	10,575	.86	9,095
1917	230	30.0	6,210	2.00	12,429
1918	245	32.0	7,840	1.97	15,445
1919	218	32.0	6,998	2.80	19,594
1920	281	34.0	9,554	1.25	11,942
1921	166	36.1	5,993	1.01	6,053
1922	191	31.2	5,959	.90	5,363
1923	145	40.0	5,800	1.15	6,670
1924	151	40.0	6,040	1.25	7,550
1925	156	39.8	6,209	1.49	9,251
1926	169	40.5	6,844	1.10	7,528
1927	165	48.2	7,953	.86	6,840
1928	162	50.1	8,116	.88	7,142
1929	144	48.8	7,027	1.03	7,238
1930	192	53.6	10,291	.79	8,130
1931	205	51.7	10,598	.61	6,465
1932	186	49.0	9,114	.40	3,646
1933	148	49.6	7,341	.81	5,946
1934	148	49.8	7,370	.83[3]	6,117
1935	167	52.0	8,684	.76	6,600
1936	204	52.0	10,608	.87	9,229
1937	250	52.0	13,000	.71	9,230
1938	268	51.0	13,668	.69	9,431
1939	269	56.4	15,172	.78	11,834
1940	291	57.2	16,645	.84	13,982
1941	305	38.0	11,590	1.46	16,921
1942	370	43.0	15,910	1.70	27,047
1943	396	43.0	16,684	1.90[4]	38,372
1944	392	49.0	19,208	.....	.....

[1]Value = Production × Price.
[2]Standard weight for rough rice is 45 pounds per bushel.
[3]Prices prior to 1934 as of Dec. 1. Prices for 1934 and following years are seasonal average prices.
[4]Preliminary.

demand when the Asiatic rice crop comes back on the world market. When that time comes, the present large production of rice in the United States will likely be more than sufficient for available markets.

It is impossible to forecast accurately the postwar outlook for rice because of the many factors involved. Indications, however, are that farmers will need to adjust their production methods to meet lower prices if they are to continue production at or near present levels and at the same time realize a profit.

The information contained in this report should be helpful to growers in determining the adjustments to be made. It deals with production and pro-

duction requirements, with the effect of changes in production practices, and in turn with the probable effect of these changes on farm income.

This study is based on data obtained in 1941 from 66 representative rice growers in Wharton, Matagorda, and Colorado Counties. This survey included: an inventory of the farm business, land use, crop and livestock organization, production and disposal, amounts and costs of hired labor, details concerning farm power, and input requirements for rice and beef cattle production. Rice yields were obtained for the period 1931-40, inclusive, on farms representative of the common soil situations in the area.

Following harvest of the 1943 crop, data were obtained from 44 growers relative to the use of combines for rice harvest. Data were also secured from 15 operators of rice drying plants. This was done in cooperation with the Division of Agricultural Engineering.

DESCRIPTION OF AREA

Topographic, Soils, and Native Vegetation

The topography of the area is generally smooth. The elevation increases about one foot per mile inland from the Gulf of Mexico. This gradual slope provides the surface drainage necessary for rice production and at the same time permits irrigation with a minimum number of levees.

Rice can be grown successfully on all Coast Prairie soils to which water can be made available except on alluvium, marshland, and loose sands. A subsoil that is slowly permeable to water prevents rapid under drainage and facilitates holding water on the land during the period the crop is flooded.

For the purpose of this report the soils commonly utilized for rice production may be divided into two groups: (1) Dark-colored heavy soils and (2) light-colored sandy soils. The dark-colored heavy soils are chiefly of the Lake Charles series which occupy the main body of the smooth flat prairie. These soils usually have slow surface drainage, are deep and fertile, and have a heavy subsoil slowly permeable to water. Though very hard when dry, the soil material pulverizes readily when tilled in a slightly moist condition.[2] Crowley clay is of local importance for rice in the eastern part of the area. Lake Charles and Crowley soils are well suited to growing rice, and due to their greater natural fertility can be used for this crop more intensely than the light-colored sandy soils. Some areas of heavy soils of the Edna series occur in close association with the dark-colored heavy soils, but are less suited for rice owing to very slow drainage, both from the surface and internally, lower productive capacity, and dense compact physical character causing difficult cultivation. It has been estimated that 75 percent of the Texas rice acreage is grown on dark-colored heavy soils.

The principal light-colored sandy soils utilized for rice production are of the Hockley-Katy group and occur mainly in the upper or interior portion

[2]The Soils of Texas, W. T. Carter, Texas Agr. Exp. Sta. Bul. 431, July 1931.

of the area. However, small bodies of these soils are found throughout all portions of the Coast Prairie. The sandy topsoil grades abruptly into clay subsoils that are so dense that water passes through the material very slowly. Although the surface is undulating in places, rice production is confined to the nearly flat soils. Here drainage is usually slow. Soils of the Hockley-Katy series are low in organic matter and natural fertility.

The area consists mostly of open prairies except along stream bottoms which are usually heavily wooded. Originally the Coast Prairie was covered with a heavy growth of grass, consisting mainly of coarse bunch grasses, largely of species of Andropogon, Panicum, Paspalum, Sporobolus, and others of similar character. Many native grass pastures have been so heavily grazed as to reduce the stands, and on a large number of these Bermuda, Dallis, and carpet grasses have been introduced, providing pasturage of increased value.[3] Bermuda grass is commonly found in most rice farm pastures.

Irrigation Water

Rice is grown entirely under irrigation in Texas. Both surface and underground water are utilized. Irrigation water is taken from the lower courses of the Sabine, Neches, Trinity, Brazos, Colorado, and Lavaca Rivers and from other Coastal streams and from wells. Water is pumped from the streams and flows through canals to the fields. Canal companies provide a large part of the water used to irrigate rice. These companies operate large pumping plants in connection with a system of canals and furnish water at a fixed rate per acre. Some small, privately-owned plants furnish water for a relatively small rice acreage. Well irrigation has been used, largely in Wharton, Jackson, Harris, and Waller Counties, to grow about 40,000 acres of rice.

A high percentage of the land in the area is adapted to rice production. Water, however, is the limiting factor. In 1943 it was estimated that water resources were sufficient for an annual rice crop of 476,000 acres.[4] This would be 80,000 acres more rice than was reported for 1943. No increase was considered feasible for those portions of the area supplied with water pumped from the Neches and Sabine Rivers without further development of water facilities. It was considered possible to increase the rice acreage along the Colorado and Brazos Rivers. In the latter case, use could be made of water stored in the Possum Kingdom Reservoir. An estimated 50,000 acres of rice could be developed in Victoria and Calhoun Counties by installing pumping equipment and canals to utilize water from the Guadalupe River.

"The amount of water required for irrigating rice depends on several factors: (1) The individual user of water, (2) the nature of the soil, and (3) the amount and distribution of rainfall. More water is required in years of light rainfall than in years of heavy rainfall. In general, however, about 24 inches of water is used in an average season in the rice-growing region of Texas."[5]

[3]**Pasture Improvement in the Gulf Coast Prairie of Texas, R. H. Stansel, E. B. Reynolds, and J. H. Jones, Texas Agr. Exp. Sta. Bul. 570, Jan. 1939.**

[4]**Unpublished report of the State Water Utilization Technician of the Bureau of Agricultural Economics.**

[5]**Fertilizers for Rice in Texas, E. B. Reynolds and R. H. Wyche, Texas Agr. Exp. Sta. Bul. 398, June 1929.**

Climate

A long growing season with fairly high seasonal temperatures is favorable to rice production. The average annual rainfall at Beaumont was 54.89 inches as shown in Table 2. Rainfall becomes lighter to the west and southwest as indicated by the average yearly precipitation of 46.74 inches recorded at Angleton. Heavy rainfall and high humidity during the growing season are favorable from the standpoint of rice irrigation but heavy rainfall during the harvest season, August through November, adds greatly to weather damage. Another weather hazard is the occasional hurricane which blows in from the Gulf of Mexico during some harvest seasons. Such storms may cause heavy damage to rice in the shock and also may cause severe lodging of unharvested rice.

The area has an average frost-free period of approximately 270 days. Late-maturing varieties have ample time to ripen.

Table 2. Average monthly and annual rainfall at Beaumont and Angleton in Coastal Prairie Area, 31-year period, 1914-1944, inclusive

Station	Average precipitation, inches												
	Monthly												Annual
	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	
Beaumont.	4.74	3.70	3.85	3.98	5.66	4.57	5.63	5.19	4.42	3.44	4.17	5.52	54.89
Angleton..	3.54	2.88	3.26	2.94	3.77	3.85	5.28	4.22	4.91	3.77	3.69	4.65	46.74

LAND TENURE AND LEASE ARRANGEMENTS

Land usually remains idle for a period ranging from two to four years after a crop of rice. This practice results in extensive use of land resources and in relatively large units of land being associated with rice production. Use of this type of rotation has led to a combination of beef cattle and rice farming with cattle utilizing the grazing on the lands not in rice. The rapidity with which grasses become re-established following a rice crop greatly facilitates this combination. Although rice and beef cattle use the same land in rotation, these enterprises may or may not be under the management of the same operator.

Rice farmers included in the survey operated a total of 71,397 acres. Sixty-nine percent of the acreage was rented for cash, 13 percent was share-rented, and 18 percent was owned.

A relatively large proportion of land in the Coastal Prairie is owned by non-residents. It is most common for non-resident-owned rice and grazing land to be leased on a long-time basis by canal companies, by rice farmers, or by individuals primarily interested in ranching. Farm organization is influenced by land tenure to the extent that tenure affects the control of grazing resources, especially during years rice land is not in cultivation. It frequently occurs that ranchmen lease part of their holdings each year to rice growers but retain

all grazing rights during years the land is not planted to rice. In some instances the ranchman reserves the right to graze rice stubble and to utilize the straw. The rice farmer usually pays cash rent for the acreage in rice under this type of arrangement. In 1940 the most common cash rental rate was $3 per acre. During 1943 and 1944 cash rentals for land seeded to rice varied from $3 to $5 per acre. Growers who farm with this arrangement do not maintain beef herds unless they own or lease other land for grazing. The cost of a grazing lease varies but an annual rental of 50 to 60 cents per acre was common during the period 1940-1943.

Canal or water companies generally own or have long-time leases on a considerable proportion of the rice land served by their respective system of canals. Such land is rented out largely by these companies to individual growers on a share basis. The most common type of share-rental agreement provides that the water company furnish the land, water, and seed and receive one-half of the rice crop as rent. With a share lease of this kind the tenant does not have the grazing rights during years between rice crops. Such growers do not maintain a beef cattle enterprise unless they control additional grazing land. In general, farmers whose tenure includes the use of pasture associated with the rice-pasture rotation maintain beef cattle.

Very few rice growers own all the land operated. Even so, nearly 76 percent of those who combined beef cattle with rice production owned a part of the acreage operated as compared to only 24 percent of those who did not maintain beef herds.

SYSTEMS OF FARMING ASSOCIATED WITH RICE PRODUCTION

The previous discussion suggests that rice growers tend to follow two general systems of farming, namely: (1) Specialized rice production, and (2) a combination of rice and beef production. In the first case rice is the only important source of income and is herein called the "rice system". Both rice and beef cattle are major enterprises with the second type of farm organization which is designated as the "rice-cattle system". Average land and livestock organization of farms in each of the common systems is shown in Table 3.

There was little difference in the average rice acreage for the two systems of farming. Differences in the area in pasture and in the number of beef cows maintained were the most significant distinctions between the land and livestock organization of the two groups. The rice system farms averaged only 72 acres in pasture and 4 beef cows as compared to 1,666 acres of pasture and 208 beef cows for rice-cattle farms. About one-third of the latter group raised feed crops (corn and sorghums), which were utilized largely as feed for beef cattle. Only 4 rice system farmers reported feed crops and the acreages were small.

Horse stock consisted mostly of saddle animals used in looking after cattle and in riding over rice fields. Differences in the average number of horses and mules associated with the two systems of farming largely reflect the use made of saddle animals in connection with the cattle enterprise.

Table 3. Average land and livestock organization for the principal systems of farming—1940

Items	Rice system	Rice-cattle system
	Number	Number
Number of farms	37	29
Land organization:		
Acres in rice	282.5	290.6
Acres in feed crops	1.7	33.1
Acres in pasture	72.4	1665.8
Acres in farmstead	2.3	8.5
Total acres operated	358.9	1999.0
Livestock organization:		
Beef cows per farm	4	208
Horses and mules per farm	.6	6.6
Dairy cows per farm	.9	1.7
Hogs for meat	.2	.6
Chicken hens per farm	13	59

In general, beef cattle is the only important livestock enterprise maintained in connection with rice production. The dairy cows, hogs, and chickens maintained are kept primarily for home use. In a few instances surplus eggs and dairy products are sold. On the average, farmers who combine rice and beef cattle also keep more of the other classes of livestock than do rice system farmers.

Some rice system farmers who have a small acreage of grass land prefer to rent out such land rather than bother with a few beef cows. As shown in Table 4, only 8 rice system farmers kept beef cows. These herds averaged 19 cows each as compared to 208 cows per rice-cattle farm. Rice system farmers with beef cows usually own a small acreage of pasture.

All rice-cattle farmers kept saddle horses, and in a few cases work animals were maintained for feed hauling and other work associated with the cattle enterprise. These farmers averaged 6.6 horses and mules compared with 2 saddle horses per farm for the 13 rice system farmers having horse stock.

Of the 37 rice system farms, 30 percent maintained dairy cows, 11 percent had meat hogs, and 35 percent kept chickens. The same classes of livestock were maintained on 41 percent, 24 percent, and 66 percent, respectively, of the rice-cattle farms.

The rice system of farming is characterized by tenant operators who rent land for a single year. They pay cash rent or a share of the crop. Often such leases do not include the use of any buildings and as a result relatively few of these growers live on the farm. Furthermore, the land farmed one year may be several miles from the land farmed the next year.

Twenty-six, or 70 percent, of the rice system farmers included in the study rented all the land operated and all but one of these lived in town. Residence on the farm was associated with ownership of land as 9 of the 11 rice system farmers who owned a part or all of the land operated lived on the farm. Of those who resided on the farm, all had one or more milk cows, all but one kept

Table 4. Residence of operator, farmers reporting livestock, average number of livestock per farm reporting, and tenure of rice and pasture land

Items	Rice system farms		Rice-cattle system farms	
	Number	Percent	Number	Percent
Number of farms	37	100	29	100
Farmers with residence on farm	10	27	19	65.5
Farmers with residence in town	27	73	10	34.5
Number of farmers maintaining:				
Beef cows	8	21.6	29	100
Horses and mules	13	35.1	29	100
Dairy cows	11	29.7	12	41.4
Meat hogs	4	10.8	7	24.1
Chicken hens	13	35.1	19	65.5
Average number per farm reporting:				
Beef cows	19	.....	208	.....
Horses and mules	2	.....	6.6	.....
Dairy cows	2.9	.....	4	.....
Meat hogs	1.5	.....	2.4	.....
Chicken hens	36	.....	90	.....
Farmers owning all land operated (1940)	2	5.4	1	3.4
Farmers owning part of land operated	9	24.3	22	75.9
Average acres in rice: Total	282.5	100	290.6	100
Owned	19.8	7	30	10.3
Cash lease	113.7	40.3	143.2	49.3
Share lease	149.0	52.7	117.4	40.4
Average acres in pasture: Total	72.4	100	1665.8	100
Owned	55.8	77.1	317.5	19
Cash lease	16.6	22.9	1348.3	81

chickens, and three had meat hogs. In contrast, only one of the 27 rice system farmers who lived in town had a milk cow, four kept chickens, and one had hogs.

Compared to rice system farmers, a much larger percentage of rice-cattle operators owned land. Twenty-three, or nearly 80 percent, of the rice-cattle farmers own at least part of the acreage operated. Others who combine a cattle enterprise with rice growing had a cash lease on pasture land.

Approximately two-thirds of the rice-cattle farmers lived on the farm and those who lived in town usually kept a hired hand on the farm to care for the beef herd. With the exception of beef cattle and horse stock, livestock were limited almost entirely to operators with farm residence.

The rice system of farming has the disadvantage of depending on a single crop for the farm income. Wide variations in income are likely to occur because of variations both in the yield and in the price of rice. Farmers using this system are more mobile than those who combine rice and beef cattle in their farming operations. For this reason the rice system is popular with tenants who are not permanently located. Such a system requires the minimum investment in improvements, equipment, and livestock.

The rice-cattle system is more diversified than the rice system because beef cattle as well as rice is a major source of income. As a result, farm income is less affected by fluctuations in the yield and price of rice than is the case with the rice system. The more diversified system provides better distribu-

tion of income throughout the year which in turn reduces the need for credit. Maintaining beef cattle requires a greater number of skills on the part of the operator than does a system that includes only rice production.

Combining a beef cattle enterprise with rice farming necessitates the control of a greater amount of land and a large increase in the investment in livestock as compared to specialized rice production. Rice-cattle farms also have more investment in improvements and equipment than do rice farms.

NORMAL PRODUCTION AND PRODUCTION REQUIREMENTS OF RICE

A consideration of the normal production and production requirements is important to an understanding of the problems of rice farming. Data include normal yields, requirements of seed and materials, kind of equipment used, and hours of man labor and tractor work.

Production

Rice yields were obtained from growers in Wharton County who farmed dark heavy land and from farmers in Colorado and Wharton Counties on light sandy soils. These data were for the period 1931-40, inclusive, and are summarized in Table 5. For comparison, the yields reported by the Division of Agricultural Statistics, Bureau of Agricultural Economics, for the state as a whole are also shown.

The 10-year average yield on dark heavy soils was 13.66 barrels per acre. Yields varied from approximately 12 barrels in 1936 to more than 15 barrels in 1940. At the same time, year-to-year variations on light sandy soils ranged from an average of 11.56 barrels per acre in 1933 to 16.82 barrels in 1939. The 10-year average for these soils was 14.34 barrels per acre. The higher

Table 5. Average rice yields on selected farms by soil groups and estimated state average yields, 1931-1940, inclusive

Year	Yields of rough rice in barrels per acre		
	Dark heavy soils	Light sandy soils	State average[1]
1931	13.59	14.45	14.36
1932	12.47	13.35	13.61
1933	13.72	11.56	13.78
1934	15.09	13.45	13.83
1935	13.42	13.11	14.44
1936	12.03	14.93	14.44
1937	13.35	16.33	14.44
1938	14.14	14.00	14.17
1939	13.59	16.82	15.67
1940	15.15	15.38	15.89
10-year average	13.66	14.34	14.58

[1]Rice yields as reported by the Division of Agr. Statis., Bur. Agr. Econ., reduced from bushels to a per barrel basis. A barrel of rice equals 3.6 bushels or 162 pounds.

yield indicated for sandy soil is partly due to a greater proportion of new land being included on the sandy land farms for which yields were obtained. It was also significant that rice was not seeded as frequently on sandy land as on dark heavy land.

It was generally considered that the dark heavy soils were more productive than were light sandy soils. Yields are good on sandy land for the first few rice crops but a relatively long idle period is necessary between crops if yields are to be maintained.

Normal Requirements of Seed and Materials

The usual quantities of seed, twine, and other materials used in rice production are shown in Table 6. Normal seeding rates vary from about one-half barrel per acre for growers using drills to three-fourths barrel for growers using end-gate seeders. An average of approximately one-fourth of the planting seed was purchased. Normally about 4 pounds of binder twine are used per acre. The number of sacks purchased varied according to yields.

Canal companies supply irrigation water for the greater part of the Texas rice acreage. Before the crop is started the grower contracts for this service at a flat rate per acre irrigated. In 1940 the usual rate was $9 per acre. Recently, some companies have charged extra for flushing and in some cases an extra charge was made for the acreage planted to late-maturing varieties.

Table 6. Normal requirements of seed and materials

Items	Rice production
Number of farms in sample	66
Seed per acre:	
Planted with end-gate seeder (lbs.)	120
Planted with drill (lbs.)	85
Proportion of seed purchased (%)	26
Binder twine used per acre (lbs.)	4.2
Sacks purchased per acre (No.)	13
Sack twine used per acre (lbs.)	.13
Usual per acre cost of irrigation water supplied by Canal Company (dollars)	9.00

Usual Practices in the Production of Rice

Forty-two percent of the growers planted two varieties and 37 percent planted three varieties of rice. In all cases the two or more varieties seeded had different maturity dates. By growing two or more varieties having different maturity dates, the operator can spread harvesting operations over a much longer period than is possible when one variety is grown. This practice greatly increases the acreage that can be harvested with a single set of equipment.

Rice Varieties

Early varieties most extensively seeded were Early Prolific, Zenith, Edith, and Lady Wright. Early Prolific and Zenith are medium- and the other two are long-grain types. Farmers reported Blue Rose, Nira, and Fortuna as the most commonly grown varieties of medium-late maturity. Of these, Blue Rose is a medium- and Nira and Fortuna are long-grain types. Rexoro, a long slender-grain type, was the only late-maturing rice grown extensively. No short-grained rice was grown on the farms studied. More recently Texas Patna has become an important late-maturing variety.

Cultural practices are similar for all varieties. Medium-late and late-maturing varieties, however, require a longer period of flooding than do those that mature early in the season. Under certain conditions, Blue Rose and Early Prolific require additional drainings because of susceptibility to "straight-head."

Usual Field Operations

In most cases it is necessary to clean out old ditches and do some drainage work in preparation for a rice crop. Seed-bed preparation normally consists of plowing, harrowing, and disking. Floating is also important in the locality around Beaumont. On sandy soils a 5- or 6-foot one-way is commonly used for plowing, but on the heavy soils a 3- or 4-bottom moldboard plow is used. Plowing is done during the fall or winter. Four to six weeks after plowing sandy land is disked and later harrowed. Heavy soils are harrowed first and then disked. A large proportion of the farmers use an 8- to 10-foot tandem

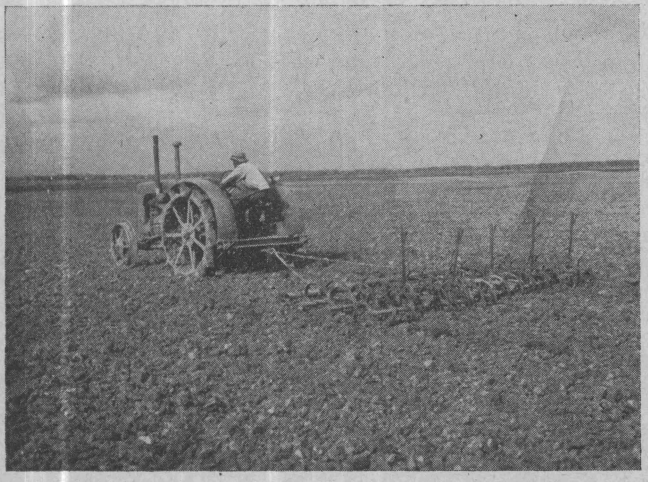

Fig. 1. Preparing the seed-bed for rice. The common type of tractor pulling a 5-section spring-tooth harrow.

for disking but some 18- to 20-foot single disks are used. About 50 percent of the growers farming heavy land harrow the seed-bed a second time after disking. Both spring-tooth and heavy spike-tooth harrows are used.

Levees are built or rebuilt previous to seeding and are sometimes reworked after seeding. Usually it is not necessary to re-run lines for levees on lands that previously have been cropped to rice.

Rice land seeded by drilling is not usually flushed after seeding as is the case when seed are broadcast. Drilling is the common practice on sandy lands as flushing causes the soil to crust. It is also the common practice on the dark heavy lands which are irrigated from wells and on a majority of farms in the locality of Beaumont. On the other dark heavy lands served by a canal company, the seed are usually broadcasted with an end-gate seeder. A large part of the rice crop is normally planted between March 25 and May 1.

Generally one irrigation is given about four weeks after the plants emerge, the time depending on the amount of rainfall. Water is held on the crop a few days and drained off and the surface permitted to dry one or two times. Thereafter water is applied and held on the land for the remainder of the season. Rice fields are drained to permit them to dry before harvesting.

Harvesting of early-maturing varieties of rice usually commences about August 10, but later varieties are not ready to cut until the last half of September or the first two weeks in October. Prior to 1941 practically all rice was cut with a binder and shocked by hand. After curing in the shock for ten days to two weeks, the grain was threshed with stationary threshers and trucked to the mill or warehouse in sacks. Peak requirements for labor in rice production occur during the critical and comparatively short optimum harvest period. Harvest labor has been expensive and difficult to obtain during the war period. To meet this problem farmers have shifted as rapidly as possible to the use of combine harvesters and to the artificial drying of rice. By so doing they have not only reduced the need for labor but also have avoided some of the losses normally resulting from weather damage and from shattering. Indications are that this method of harvesting will completely replace the old method as rapidly as the necessary machines and materials are available.

Labor and Power Requirements for Rice Production

The labor and power required previous to harvest varies with differences in soil and type of irrigation, but these factors have little effect on harvesting operations. On the other hand, labor and power requirements during harvest are greatly affected by the method of harvesting. Consequently, labor and power needs prior to harvest are discussed separately from the requirements for harvesting operations.

Preharvest Requirements

The farms for which crop practices were obtained are grouped according to general soil type and to source of water for irrigation. The normal preharvest

labor and power used by each group are shown in Table 7. In general, labor and power requirements were lower on light sandy soils than on heavy soils. The practice of flat breaking heavy land with a moldboard plow requires more time than does one-waying of sandy soils. The heavy soils are also more difficult to pulverize and require more harrowing and disking than does sandy land. A drilled crop does not usually need to be flushed to insure germination.

Table 7. Labor and power required per acre for preharvest operations in growing rice

Operations	Canal irrigation[1]				Well irrigation[2]					
	Heavy soils		Light sandy soils		Heavy soils			Light sandy soils		
	Hours per acre									
	Man	Tractor	Man	Tractor	Man	Tractor	Pump engine	Man	Tractor	Pump engine
Seed-bed preparation:										
Plow: Flat break	.92	.92	.....	.....	.92	.92	.....	.....	.....	.....
One-way	.....	.....	.63	.63	.....	.....	.....	.63	.63	.....
Harrow	.38	.38	.24	.24	.38	.38	.....	.24	.24	.....
Disk	.40	.40	.34	.34	.40	.40	.....	.34	.34	.....
Build levees & drain ditches	.70	.35	.70	.35	.70	.35	.....	.70	.35	.....
Plant:										
Drill	.....	.....	.21	.21	.29	.29	.....	.21	.21	.....
Drill levees	.....	.....	.08	.08	.07	.07	.....	.08	.08	.....
Sow, end-gate seeder	.26	.13	.....	.....	.....	.....	.....	.....	.....	.....
Harrow after seeding	.22	.22	.....	.....	.....	.....	.....	.....	.....	.....
Irrigate and drain	5.90	.....	5.20	.....	10.10	.....	5.30	10.00	.....	5.00
Total preharvest	8.78	2.40	7.40	1.85	12.86	2.41	5.30	12.20	1.85	5.00

[1]Surface water furnished by a water company at a fixed charge per acre of rice.
[2]Underground water pumped from a well or wells located on the farm. Farmers using well irrigation do not pay the per acre charge for water that is incurred in the case of canal irrigation.

Preharvest requirements for crops irrigated with surface water obtained from a canal system include a total of 8.78 hours of man labor and 2.4 hours of tractor work per acre of rice on heavy land as compared to 7.4 and 1.85 hours, respectively, of man and tractor work with light sandy soil. Both labor and power requirements are somewhat greater on farms using well irrigation. Additional power is needed to operate a pump, approximating 5 hours per acre of rice. The operation of pump and pump motor also requires extra labor. Per acre requirements with well irrigation include 12.86 hours of man labor and 2.41 hours of tractor work on heavy soils. For sandy soils 12.20 and 1.85 hours, respectively, of man and tractor work are required.

Harvesting is the critical operation in rice production. Peak labor requirements occur during the comparatively short optimum harvest period. It is important that rice be harvested as soon as possible after maturity in order to minimize the hazards of inclement weather and losses to birds.

Harvesting Requirements With Binders and Threshers

A crew of 7 men and 1 tractor can cut and shock an average of 16 acres of rice in a 10-hour day. A crew of 24 men and 11 horse-drawn bundle wagons can thresh an average of 3.1 acres per hour. A crew of 28 men and 5 tractors

Table 8. Labor and power required for harvesting rice by binding and threshing

Operations	Unit crew				Hours per acre			
	Man	Horse	Tractor	Truck	Man	Horse	Tractor	Truck
Bind	2	.....	1	.....	1.26	.....	.63	.....
Shock	5	.....	.....	.....	3.15	.....	.....	.....
Thresh:								
Using tractor wagons	28	.....	5	.....	8.12	.....	1.45	.....
Using horse-drawn bundle wagons	24	22	1	.....	7.68	7.04	.32	.....
Haul to market	3	.....	.....	1	1.20	.....	.....	.40
Harvest total:								
With tractor wagons	.....	.....	.....	.....	13.73	.....	2.08	.40
With bundle wagons	.....	.....	.....	.....	13.29	7.04	.95	.40

is common when tractor-drawn wagons are used to haul bundles to the thresher. The rate of performance by this type of crew is 3.4 acres per hour. The labor and power requirements for the binder-thresher method of rice harvest are shown in Table 8. With this method more than 13 hours of labor and .40 hour of truck work were required to harvest an acre of rice and deliver the grain to a warehouse or mill. Tractor work varied from .95 hour per acre when horse-drawn bundle wagons were used during threshing to 2.08 hours with tractor wagons.

Each grower plans to thresh as soon as practical after the crop is put in the shock in order to reduce the risk of weather damage. The greater part of the laborers used for shocking and threshing are employed only as needed for these

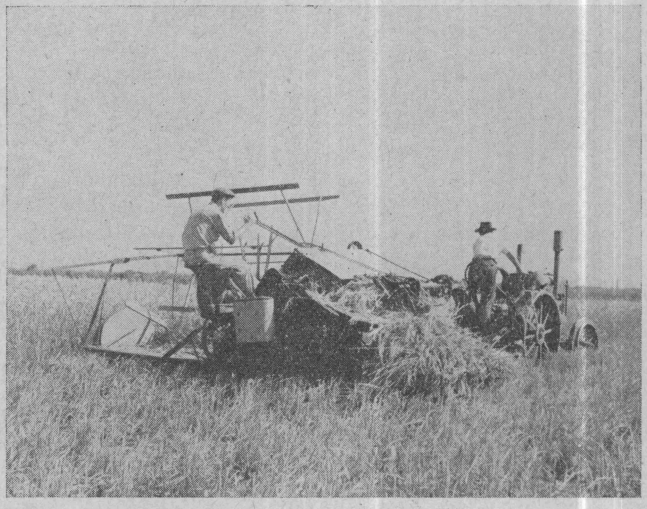

Fig. 2. Binding is the first harvesting operation when rice is bound, shocked, and threshed. (Photograph furnished by Texas Agricultural Extension Service.)

operations. Timely harvesting of the crop is dependent on an ample supply of man-power and is greatly affected by major changes in the number of available workers.

Harvesting and threshing are being replaced as rapidly as possible by combining and artificial drying. The use of combines reduces manpower requirements and is a necessary step to complete the mechanization of rice production.

Combine Harvesting

Combines used to harvest rice may be grouped in two general classes. First is the self-propelled type of which the 14-foot cut is the most common size; second is the smaller pull-type machine equipped with an auxiliary engine. In the latter case the common rice farm tractor is used to pull the combine. The combine is tended by the man who drives the tractor. Machines of this type used for rice harvesting in 1943 were either the 6-foot or the 7-foot cut.

Combined rice is largely handled in bulk but some is sacked. For bulk handling, wagons or carts are used to transport rice from the combine to the edge of the field or to the nearest road. Here it is transferred to a truck and taken to the drier. The transfer of rice from wagon to truck is accomplished by the use of augers driven from the power take-off of the tractor which pulls the wagon, or by means of other special loading equipment. It is sometimes possible to effect a saving by unloading rice from the combine tank directly into the trucks. It is necessary for growers to truck rough rice to a car, mill, or warehouse after drying when driers are not located on the railroad.

Rice growers find it very much to their advantage to work together and pool their equipment and labor when harvesting with combines. Two, three, or

Fig. 3. Harvesting is accomplished with one operation when rice is combined. In 1943 growers using 14-foot self-propelled combines used about 20 percent of the labor needed to harvest by binding, shocking, and threshing.

Table 9. Labor and power required for rice harvesting and drying, using 14-foot, self-propelled combines, and handling in bulk

Operations	Unit crew				Hours per acre			
	Man	Tractor	Truck	Combine	Man	Tractor	Truck	Combine
Combine	2			2	.56			.56
Haul out of field	2	2			.56	.56		
Haul, field to drier	2		2		.56		.56	
Drying	2–3				.65			
Haul, drier to market	1		1		.32		.32	
Total, harvesting and drying					2.65	.56	.88	.56

more combines are frequently operated together in a field as a part of a single harvesting crew. The advantages of timeliness and efficiency in the use of tractors, trucks, and manpower are apparent and this practice greatly simplifies the problem of drying and handling the rice of different growers at the drier. It is possible for two or three farmers owning combines to harvest their entire acreage with the regular labor force normally maintained throughout the year.

The labor and farm power required for rice harvesting and drying, assuming the use of a 14-foot, self-propelled combine, and handling in bulk, are shown in Table 9. A field crew of 6 men operating two self-propelled combines, two trucks, and two tractors pulling bulk wagons harvested an average of 27 acres per day, and delivered the rough rice to the drier. One additional truck was required to haul dried rice to market. Handled in this way rice was harvested, dried, and delivered to market with an average of 2.65 man hours per acre. This was less than one-fourth the labor required for binding, shocking, and threshing.

Fig. 4. Combined rice is usually handled in bulk. Wagons or carts are used to transport rice from the combine to the edge of the field or to the nearest road. Here the grain is transferred to a truck by means of tractor-driven augers and then taken to the drier.

Two of the 6- or 7-foot pull-type combines were usually operated together in the same field. When handling the grain in bulk, most growers used two men with tractors and bulk wagons to move the grain from the combines to a truck. The distance from the field to the drier determined whether one or two trucks were needed for hauling to the drier. A majority of those with pull-type combines used one truck for two machines. Handled in this way, a field crew of 5 men with two combines, four tractors, and one truck harvested an average of 18.4 acres of rice per day and hauled it to the driers. As shown in Table 10, an average of 3.09 man hours were required per acre to combine, dry, and deliver the crop to market.

Table 10. Labor and power required for rice harvesting and drying, using 6- and 7-foot pull-type combines and handling in bulk

Operations	Unit crew				Hours per acre			
	Man	Tractor	Truck	Combine	Man	Tractor	Truck	Combine
Combine	2	2	.....	2	.83	.83	.....	.83
Haul out of field	2	2	.....	.....	.83	.83	.....	.....
Haul, field to drier	1	.....	1	.....	.46	.....	.46	.....
Drying	2–3	.....	.....	.....	.65	.....	.....	.....
Haul, drier to market	1	.....	1	.....	.32	.....	.32	.....
Total, harvesting and drying	.....	.....	.....	.....	3.09	1.66	.78	.83

Rather than handle in bulk, some operators of pull-type machines sack rice at the combine. One man drives the tractor and operates the combine and a second person sacks the rice and sews the sacks. Two men are also used to truck sacked grain to the drier. The most common field crew for handling sacked rice consists of 4 men operating 2 pull-type combines, 2 men hauling from the combine to the truck, and 2 men trucking to the drier. This crew of 8 men can be reduced to 5 when the grain is handled in bulk.

As shown in Table 11, an average of approximately 4.5 hours of labor was used per acre to harvest and dry sacked rice. This was 1.4 hours more man labor per acre than was needed to handle bulk rice with the same size and type of combine. Special wagon and truck beds are not necessary when rice is sacked but the cost of sacks is more than the added expense incurred for bulk handling.

Table 11. Labor and power required for rice harvesting and drying, using 6- and 7-foot pull-type combines and handling in sacks

Operations	Unit crew				Hours per acre			
	Man	Tractor	Truck	Combine	Man	Tractor	Truck	Combine
Combine	4	2	.....	2	1.66	.83	.....	.83
Haul out of field	2	1	.....	.....	.94	.47	.....	.....
Haul, field to drier	2	.....	1	.....	.92	.....	.46	.....
Drying	2–3	.....	.....	.....	.65	.....	.....	.....
Haul, drier to market	1	.....	1	.....	.32	.....	.32	.....
Total, harvesting and drying	.....	.....	.....	.....	4.49	1.30	.78	.83

Artificial Drying of Rice

To insure safe storage combined rice normally must be dried. Artificial drying and bulk storage are essential to complete mechanization of rice harvesting. The capacity of the drying plants in use during 1944 was estimated to be about 40 percent of the 1944 crop.

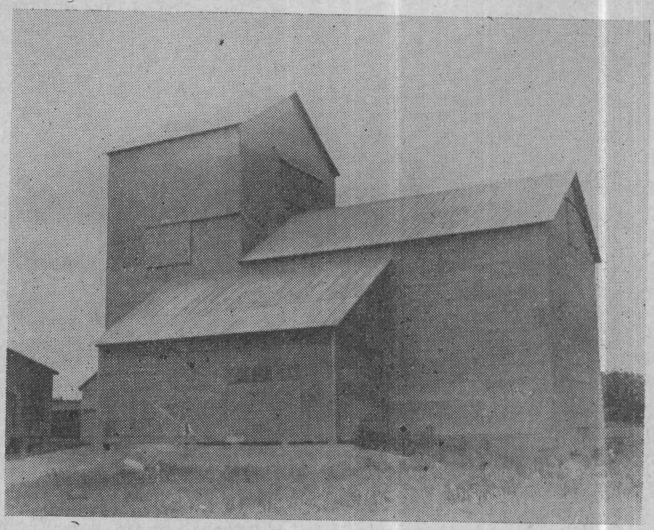

Fig. 5. Mechanical rice drying plant. Combined rice normally must be dried to insure safe storage. A large part of the rice artificially dried in Texas is custom dried.

Rough rice of high moisture content can be successfully dried with mechanical driers if the proper procedure is followed.[6] Current methods used in drying rice differ from those used in drying other grains. Lower temperatures are used and the rice is usually given a series of successive dryings between which there are periods of rest, during which the moisture content in the kernels tends to become equalized.

The total hours of daily operation of the drying plant caused more variation in the labor requirements than did the size of the drying unit. In most instances 2 or 3 men made up the drying crew. These men were more highly skilled than the average hired laborer. According to data obtained in 1943, an average of .65 hour of man labor is required per acre to dry rice. This was based on an average yield of 13.55 barrels per acre.

Drying plants operated during 1943 had an average capacity of 43,000 barrels per season, an amount which is about equal to the production from 10 or 12 farms of average size. Operators of privately owned plants usually did as

[6]Harvesting and Drying Rough Rice in Texas, A. C. Magee and W. E. McCune, Texas Agr. Exp. Sta. Progress Report 880, Feb. 1944.

much drying for their neighbors as facilities permitted. Consequently, a large part of the rice artificially dried on farms was custom dried. Present indications are that a large proportion of growers will depend on custom drying in the future.

PRODUCTION AND PRODUCTION REQUIREMENTS OF BEEF CATTLE ON RICE FARMS

Beef production is the only livestock enterprise of major importance carried on in connection with rice farming. The Coastal Prairie Area is adapted to cattle raising and supports the most dense population of range cattle (one animal unit per 8 acres of range) of any important grazing area in the state.

Abundant rainfall, a warm humid climate, and poor drainage provide breeding places for many types of animal parasites. Flies and mosquitoes abound. Fresh water snails, secondary host of the liver fluke, which is one of the most common and most injurious internal parasites of cattle in the Coastal Prairie, are often abundant in and adjacent to the small ponds commonly in pastures. In order to do well, cattle must have a high degree of resistance to these and other parasites.

As a whole, the cattle found in the area are of lower grade than animals of the western range areas and are of mixed breeding with a large percentage having Brahman blood. Purebred bulls of Brahman, Hereford, and Shorthorn breeds have been used to improve the hardy native cattle.

Herds of breeding cows rather than stocker and feeder steers predominate in the Coastal Prairie Area. The common practice is to sell slaughter calves at 6 to 8 months of age. Rice growers included in the survey sold their calves at an average liveweight of 336 pounds.

As shown in Table 12, the 29 rice-cattle farms maintained an average of 208 beef cows from which a 66 percent calf crop was obtained. Total average calf production amounted to 258 pounds liveweight per mother cow, of which 75 percent was marketed and the remainder kept for herd replacement. Death losses of breeding cows averaged 4 percent annually. An average of 12.5 percent of the cow herd was marketed in 1940.

The winter maintenance of cattle is a problem since the prairie grasses become less nutritious after frost and rot rather than cure during the winter. Sudden periods of freezing weather with strong north winds occur occasionally during the winter months. These cold periods are especially severe when accompanied by rain that freezes as it falls and covers the ground and vegetation with a thin coat of ice. During these storms many cattle on the open prairie may die from exposure and lack of feed. During the winter it is a common practice to move cattle from the open prairie to wooded areas along streams where fairly good protection from sudden northers is found.

Cattle have access to some form of grazing practically the entire year. Under favorable conditions very little supplemental feeding is done during the winter, but with unfavorable conditions it may be necessary to feed the entire breeding

Table 12. Average production and normal requirements of beef cattle on rice farms

Items	Rice-cattle system farms
Number of farms	29
Cows per farm	208
Percent calf crop	66
Calf production per cow (lbs.)	258
Calf production marketed per cow (lbs.)	194
Normal production requirements per cow:	
Feed:	
Concentrates:	
Corn (lbs.)	35
Cottonseed meal or cake (lbs.)	35
Rice mill feed (lbs.)	5
Roughage:	
Sorghum hay or bundles or the equivalent as silage (lbs.)	120
Johnson grass hay (lbs.)	20
Prairie hay (lbs.)	10
Rice straw (lbs.)	60
Minerals:	
Bone meal (lbs.)	2.3
Salt (lbs.)	2.7
Pasture:	
Native (days)	284
Rice fields and straw stacks (days)	52
Man labor (hours)	7.5
Miscellaneous cash costs (dollars)	.26

herd. In general, a low level of nutrition is maintained during the winter. Light rather than heavy feeding is the rule since breeding animals are fed primarily to avoid death losses. The most common practice for the farms studied was to feed 50 percent of the cow herd for a period of 50 to 75 days. Thin cows and cows with calves received most of the supplemental feed. It was also common practice to feed the bulls.

Feeding practices varied greatly from farm to farm. In some cases only roughage is fed, in other cases concentrates are fed to supplement native pastures, and in still other cases both concentrates and roughage are fed. A high proportion of those interviewed used cottonseed meal or cake, either alone or in combination with corn or rice mill feeds. Farmers who raise corn feed most of it to cattle but those who grow no corn depend largely on cottonseed meal or cake and rice mill feeds for concentrates. The normal feed requirements per mother cow kept during the year are shown in Table 12 and consist of 75 pounds of concentrates and approximately 200 pounds of hay, bundles and straw, or the equivalent in silage. Rice straw included in these figures was usually baled and did not include straw utilized by cattle which had free access to straw stacks after harvest.

Since it was the usual practice to feed only about 50 percent of the cow herd, the animals that were fed received an average of 2 to 3 pounds of concentrates and 5 to 8 pounds of roughage daily during the feeding period in addition to whatever pasture was available.

More than half of the operators pastured rice fields after harvest and obtained about 100 days grazing for their cattle from second growth rice and from straw stacks. For the entire group of 29 farms, grazing of rice fields averaged 52 days per cow.

Sixteen of the 29 herds received salt and about 20 percent of the cattle was given bone meal. Bone meal was fed to compensate for the low phosphouous content of the pasture grasses and to prevent the disease known as creeps. Rice-cattle farmers spent 7 1/2 hours per mother cow looking after the beef herd. Stock dip, medicine, vaccine, and other miscellaneous cash costs averaged 26 cents per cow.

About one-third of the rice-cattle farmers raised the grain and roughages fed to the beef herd during the winter and the remainder depended on purchased feeds. Feed production on rice farms is hindered by the fact that feed crops require labor and power when farmers are busy with the rice crop and also because most rice growers are equipped to grow broadcast crops only. The difficulties encountered in curing and storing roughages discouraged their production. Trench silos have been used to some extent but this method of feed storage has not been satisfactory in many cases. Unless placed on a well-drained location, the silo becomes partially filled with water, making it difficult to handle the ensilage at feeding time.

FARM POWER

Farm power is a very important consideration with an enterprise as highly mechanized as is rice production. Rice farming entails much heavy field work that is accomplished through the use of large grain type tractors. Various kinds of power units are used for pumping on farms on which well irrigation is practiced. The introduction of combine harvesters has added to the amount and variety of power needed. A large majority of the growers have pick-up trucks and many are equipped with one and one-half ton farm trucks. A discussion of power costs and related questions follows.

Cost of Tractor Work

The number of tractors used per farm varied with the acreage of rice but at least two tractors were considered necessary. Detailed information concerning farm power was obtained for 65 farms on which there was a total of 171 tractors. These farms averaged 283.6 acres in rice, or 108 acres per tractor. The requirements for tractor operation per farm and per tractor together with operating costs as of 1940 are shown in Table 13.

Growers estimated an average depreciated value of $682 per tractor, or a total per farm value of $1,794. Gasoline was the predominating fuel, but small amounts of kerosene and other tractor fuels were used in some cases. Lubricating oil was changed at regular intervals and oil was added between changes when necessary. On the average, approximately 2,900 gallons of fuel, 50 gallons of lubricating oil, and 50 pounds of grease were used per tractor to accomplish 700 hours of work. Total costs amounted to a little more than $250 per tractor for fuel, oil, and grease. This was about $2.35 per acre of rice.

Table 13. Cost of tractor work per farm, per tractor, and per day, 1940

Items	Per farm		Per tractor	
Acres in rice	283.6		108	
Number of tractors	2.63		1	
Average value of tractors	$1,794		$682	
Hours tractor work	1,850		700	
	Amount	Value dollars	Amount	Value dollars
Fuel:				
Gasoline (gallons)	6,960	541.67	2,646	205.90
Other (gallons)	663	42.74	252	16.24
Oil (gallons)	128	69.78	49	26.53
Grease (pounds)	129	15.96	49	6.06
Total cost fuel, oil and grease	.....	670.15	.....	254.73
Other costs:				
Labor repairing tractors	.....	50.10	.....	19.02
Repairs	.....	247.08	.....	93.92
Interest	.....	107.64	.....	40.92
Depreciation	.....	365.38	.....	138.89
Taxes	.....	18.47	.....	7.02
Total other costs	.....	788.67	.....	299.77
Total, all costs	.....	1,458.82	.....	554.50
Total cost per 10-hour day's work	.....	.....	.....	7.92

Farmers overhaul their own tractors and replace broken and worn parts That work in rice fields is hard on equipment is indicated by the fact that repair parts averaged $93.92 per tractor. Costs other than fuel, oil, and grease amounted to nearly $300 per tractor, and the total of all costs averaged $7.92 per 10-hour day of tractor work.

Power Costs for Pumping

Data were obtained from 15 farmers relative to the requirements and costs of power used in pumping irrigation water from wells. Gas engines, Diesel engines, and electric motors were used for this purpose.

As shown in Table 14, the per acre power cost of pumping water in 1940 averaged $5.22 for eight farms with gas engines, $4.15 for four farms using Diesel engines, and $7.79 for three farms with electric motors. Gas engines and electric motors had the advantage of low average investment as compared to Diesel power. On the other hand, per acre fuel costs averaged relatively low for those farms using Diesels.

Cost of Combine Work

Self-propelled combines used during 1943 were equipped with an 85-horsepower gasoline engine which provided power to operate the combine thresher, and also to propel the machine in the field. The data obtained on the operation of 22 combines of this type are summarized in column one of Table 15. An average of 614 acres of rice was combined at a cost of $188.50 per combine

Table 14. Power costs of pumping water with well irrigation of rice, 1940

Items	Gas engines		Diesel engines		Electric motors	
Number of farms	8		4		3	
Acres in rice per farm	128.9		306.0		156.8	
Number wells per farm	1.12		2		1	
Acres rice watered per well	114.6		153.0		156.8	
Average value of power unit (dollars)	267.00		1,665.00		250.00	
	Amount	Cost dollars	Amount	Cost dollars	Amount	Cost dollars
Fuel per well:						
Gasoline (gallons)	1,532	124.85				
Distillate & kerosene (gallons)	5,467	323.56				
Diesel fuel (gallons)			8,445	319.05		
Electricity						1,186.83
Oil (gallons)	101	45.09	90	41.43		
Grease (pounds)	18	2.36	8	.93		
Total cost fuel, oil, and grease		495.86		361.41		1,186.83
Other costs per well:						
Repairs		30.61		75.00		3.67
Interest		16.02		99.90		15.00
Depreciation		55.19		99.13		16.67
Total other costs		101.82		274.03		35.34
Total all costs per well		597.68		635.44		1,222.17
Total costs per acre irrigated		5.22		4.15		7.79

Table 15. Cost of combine work, 1943

Items	With 14-foot self-propelled combine		With 6- or 7-foot pull-type combine[1]	
Number of combines	22		36	
Value per combine	$3,720		$1,154	
Acres harvested per combine	614		303	
Hours work per combine	326		255	
	Amount	Cost dollars	Amount	Cost dollars
Used with combine and combine engine:				
Gasoline (gallons)	1,223	154.05	401	53.02
Oil (gallons)	17	12.19	13	8.14
Grease (pounds)	215	22.26	73	7.13
Total cost fuel, oil, and grease for combine engine		188.50		68.29
Other costs associated with combining:				
Labor repairing combine		32.50		54.50
Combine repairs		269.41		74.44
Interest per combine		223.20		69.24
Depreciation per combine		711.53		318.38
Tractor power to pull combine				201.96
Total other costs		1,236.64		718.52
Total cost of combine work		1,425.14		786.81
Cost per hour		4.37		3.09
Cost per acre		2.32		2.60

[1]These combines were equipped with auxiliary engines.

for fuel, oil, and grease, or a per acre cost of about 31 cents. This, however, amounted to less than 15 percent of the total cost of combine work. Repairs, interest, and depreciation made up nearly 85 percent of this cost. The total cost of operating a self-propelled combine averaged $4.37 per hour, or $2.32 per acre.

Self-propelled combines are a relatively new development in the farm machinery field. It is expected that interest on investment, repairs, and depreciation will decrease as improvements are made and as quantity production of these machines is attained. Some progress has already been made toward reducing initial costs.

The per hour and per acre costs for 6- or 7-foot pull-type combines were $3.09 and $2.60, respectively. The cost of fuel, oil, and grease for operating the engine plus the cost of tractor power necessary to pull the machine was considerably greater than similar costs with self-propelled equipment.

The pull-type machines were of lighter construction and were more subject to breakdowns than self-propelled combines. The smaller machines required about 65 percent more repair labor as compared with the self-propelled combines. This is an important consideration when purchasing a combine as it is important that loss of time due to breakdowns be kept to a minimum during the critical harvest period.

The importance of timeliness in performing field work makes it desirable that farmers own all the power and equipment used in rice farming. It is especially important that harvesting be done at the optimum time in order to reduce the losses from weather and other causes. For this reason, growers with a relatively small rice acreage who harvest by the old method of binding and threshing, own a thresher rather than resort to the use of custom threshing even though they need the machine only a few days during the season.

Power and equipment costs were high in many instances where land resources were far short of the acreage necessary to utilize the available power and equipment to capacity. These growers may reduce costs by increasing their operations to the optimum acreage to allow use of power and equipment at near capacity level.

OPTIMUM RICE ACREAGE

The relatively short period of time during which a field of rice must be harvested if losses are to be avoided is the main consideration in determining the optimum rice acreage that can be harvested with one set of harvesting equipment. Early rice may be ready for harvest by August 10, but late-maturing varieties do not usually ripen until about October 10 to 15. The optimum harvest period is very short if the entire crop consists of a single variety but growers usually avoid this difficulty by seeding early-, midseason-, and late-maturing varieties. In computing optimum rice acreages, it is assumed that such practices are followed.

The acreage that can be handled satisfactorily per season with a threshing machine provides the basis for an optimum rice acreage on farms that bind, shock, and thresh the crop. With combine harvesting the optimum size crop is based on the seasonal capacity of the common combine units. It was customary for two or more farmers to work together when rice was combine-harvested. The optimum acreages for combining were calculated on the basis of this practice.

The optimum acreages shown in Table 16 are based on the usual rates of performance with common types of harvesting equipment and upon an estimated optimum length of harvesting period of 27 days in case of binding and threshing and 30 days for combining.

Calculated in this way, 400 acres is the optimum rice acreage for farms equipped with binders and threshers. The optimum acreage capacity of 14-foot self-propelled and 6- or 7-foot pull-type combines are calculated to be 400 and 200 acres, respectively.

Table 16. Optimum rice acreages for different sizes and types of harvesting equipment

Items	Acres of rice
Farms harvesting with:	
Binders and thresher	400
14-foot self-propelled combine	400
6- or 7-foot pull-type combine	200

OVERHEAD FARM EXPENSE

The investment in land, improvements, machinery, and equipment, and the depreciation and repair expense connected with these items are factors to be considered in planning the operation of a rice farm. The amount of the investment, rates of depreciation, and repair expense were computed from data secured from the farms studied and are adaptable to other farms in the area.

Land and Improvements

Grower estimates of the value of land without improvements varied from $15 to $30 per acre in 1940. On the average, however, the estimated value was approximately $20 per acre.

Improvements on the farms studied included such items as housing for laborers, barns, stock sheds, corrals, machine shops, tractor sheds, garages, fencing, and water systems. The average estimated depreciated value of improvements (without residence) on the farms studied were as follows:

Rice system farms:	
Well irrigation	$ 4,550
Canal irrigation	800

Rice-cattle system farms:	
Well irrigation	5,900
Canal irrigation	2,950

The annual estimated rate of depreciation was 5.8 percent of the depreciated value of improvements for rice system farms and 6.8 percent for rice-cattle system units. Due to climatic conditions, fences depreciate more rapidly than do other farm improvements. Because of the greater amount of fencing, rice-cattle farms had a higher rate of depreciation for improvements than did rice system farms.

Normal repairs amounted to 5 percent of the depreciated value of improvements.

Machinery and Equipment

A large amount of expensive equipment is used by rice growers. The depreciated value of farm equipment in 1941 varied from an average of about $4,500 for rice system farms to $5,600 for rice-cattle units. These amounts are approximately 50 percent of the cost new.

The average cost of new tractors used by farmers was $1,385. Tractor repairs for the year amounted to 7 percent of the cost new and depreciation was estimated at 10 percent of the purchase price. The tractors included in the survey were used an average of 70 days per year.

Pick-up trucks were used by the majority of rice producers and had an estimated life of between 4 and 5 years. The average cost new of a pick-up was $765. Annual cost of repairs and tires averaged 9 percent of the cost new and depreciation 22.5 percent. Pick-up trucks were run an average of 16,000 miles per year.

Fifty percent of the rice system farmers and 60 percent of rice-cattle system operators owned farm trucks that were driven an average of 8,000 miles per year. The one and one-half ton size predominated and the cost new averaged $955. Yearly depreciation was estimated at 17 percent and repair and tire costs were 7 percent of the cost new.

The average grower who harvested rice by binding and threshing was equipped with two binders and a thresher. The cost new of this equipment was:

Binder, per machine	$ 425
Thresher	1,400

Binders were estimated to depreciate annually at the rate of 12 percent of the cost new and threshers at 7 percent. Based on first costs, binder repairs per year amounted to 16 percent and thresher repairs to 3.5 percent.

Numerous other machinery such as plows, disks, harrows, drills or seeders, graders, levee pushes, and wagons are standard equipment on rice farms. Most growers are equipped to make the major part of their machinery repairs. Rice-cattle system farmers have additional equipment incident to feed production and the beef enterprise. The costs new of other equipment were as follows:

Rice system farms	$ 2,500
Rice-cattle system farms	3,875

The estimated annual rate of depreciation of other machinery and equipment amounted to 9 percent of the cost new, while annual repairs were 8.5 percent.

The average cost of a new self-propelled combine during 1943 was $3,750. Operators also spent an average of $290 making changes to better adapt these machines to rice field conditions. Combines included in the study harvested more than 600 acres of rice per machine in 1943, or more than double the acreage of the average grower. Under these conditions depreciation was estimated at 17 percent of the cost new and repairs at 7 percent. It was expected that combines of this type would give 10 to 12 years of service if used to harvest no more than the average grower's own rice crop. It must be remembered that rice growers had used combines for only one or two crops and their estimates of depreciation were based on expectations rather than on experiences covering the life of the combine.

There are indications that self-propelled combines will be less expensive in the future. During 1944 a limited number of 12-foot self-propelled machines were available to rice growers at prices ranging from $3,300 to $3,350 per machine.

Pull-type combines were purchased new at an average cost of $1,270 per machine and owners incurred costs of $210 per combine adapting these machines to rice harvesting. In 1943 pull-type machines on the farms studied cut an average of 300 acres. Under these conditions, growers estimated the life of the pull-type combine in use during 1943 to be 5 years. Repairs for these combines amounted to 5 percent of the cost new.

INFLUENCE OF CERTAIN FACTORS ON INCOME AS A BASIS FOR PLANNING FARM ADJUSTMENTS

The reader's attention has been called to some adjustments that have been taking place in rice production and in farming methods during the war period. It has also been pointed out that when the Asiatic crop comes back on the world market there will be need for increased efficiency if production is to be maintained at a profitable level.

This suggests that successful farm operation depends on well-made plans for the future. The records of past performance, however, play an important part, that of providing dependable information on what can be expected from the farm under conditions similar to those of the recent past. Estimates of the effects of newly adopted technical methods must be taken into account. Furthermore, prospects for change in price relationships must be considered. Recorded facts have significance only as they help us to anticipate future developments. Thus the whole process of farm business planning must be forward looking. The relative advantage of each alternative needs to be considered. This type of farm planning is termed budgeting.

Basic information pertaining to production and production requirements

Table 17. Prices of items purchased and products sold

Commodity	Unit	1940 prices	1943 prices
		Dollars	Dollars
Items purchased:			
Wages without board:			
Previous to harvest	Hour	.20	.50
During harvest	Hour	.25	.60
Rice seed	Barrel	3.50	8.00
Binder twine	Pound	.10	.12
Sack twine	Pound	.50	1.00
Sacks	Hundred	11.00	23.00
Feed:			
Cottonseed meal	Ton	30.00	53.00
Corn	Bushel	.45	1.18
Rice bran	Ton	14.00	32.00
Cane hay	Ton	10.00	20.00
Prairie hay	Ton	8.00	15.00
Johnson grass hay	Ton	8.00	15.00
Bone meal	Cwt.	2.25	4.00
Salt	Cwt.	.85	.85
Tractor operation:			
Gasoline (less tax)	Gallon	.08	.10
Kerosene	Gallon	.06	.07
Lube oil	Gallon	.60	.60
Grease	Pound	.12	.12
Truck and pick-up operation:			
Gasoline	Gallon	.15	.16
Lube oil	Gallon	.75	.75
Grease	Pound	.12	.12
Combine operation:			
Gasoline (less tax)	Gallon	.11	.12
Lube oil	Gallon	.75	.75
Grease	Pound	.12	.12
Contract trucking	Barrel	.08	.16
Irrigation water	Acre	9.00	10.00
Drying rough rice	Barrel	.20	.50
Cash land rent:			
Land in rice	Acre	3.00	5.00
Pasture land	Acre	.50	.60
Products sold:			
Rice	Barrel	3.03	6.84
Calves	Cwt.	7.75	12.30
Cows	Cwt.	5.50	8.75

has been presented in the preceding section. This information is herein used in a budget analysis to closely approximate the effect on income of such factors as size of farm, variations in prices, types of lease, variations in yield, systems of farming, and method of harvesting. Because of the amount of detail, all budgets are shown in summary form.

In these budgets typical crop and livestock organizations are used and canal irrigation is assumed in each case. The 10-year average yield reported for the state and average labor and power requirements with dark heavy soils are used for rice and normal feed and labor requirements and production are assumed for livestock. Average values are used in calculating the farm investment. The operating costs of tractors, pick-up type trucks, and one and one-half ton trucks are based on average figures as are also the amounts of seed and other materials used, depreciation rates and repairs on improvements and equipment, prices of products sold, and materials and services purchased. Interest on investment is calculated at 5 percent for real estate and 6 percent for all other. In all budgets it is assumed that, in addition to the labor of the operator, 86 days of family labor are also available. This was the average

amount contributed by the operator's family in 1940. Any labor required above that furnished by the operator and his family is assumed to be hired. Except when otherwise indicated, it is assumed that rice is harvested by binding and threshing and that rough rice is delivered to the warehouse or market in sacks.

Growers supplied a large part of the price data shown in Table 17. In addition to that obtained from farmers, price information was also secured from feed dealers, implement dealers, warehouse operators, and others who supply materials and services to rice growers. Two price situations are used to indicate the probable effect of wide variations in price relationships on income. Prices prevailing in 1940 are used to represent relatively low or prewar prices and those experienced in 1943 to reflect relatively high or wartime prices.

Influence of Size of Farm and Variations in Prices on Earnings

The 37 rice system farms studied averaged 282 acres seeded to rice. The rice crop on the 19 farms of less than average size ranged from 80 to 272 acres and averaged 180 acres. The average rice acreage for the remaining farms approximated the optimum for farms harvesting with binders and threshers, or about 400 acres.

The influence of size of farm on income is herein illustrated by comparing the estimated earnings of a small rice system farm, one of average size, and another of optimum size. The typical situation in which rice system farmers

Table 18. Budget summaries for rice system farms of three sizes, 1940 and 1943 prices

Items	1940 price situation			1943 price situation		
	Small size	Average size	Optimum size	Small size	Average size	Optimum size
	Acres	Acres	Acres	Acres	Acres	Acres
Land organization:						
Acres in rice	180	282	400	180	282	400
Total acres operated	180	282	400	180	282	400
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
Operator's farm investment: Total	3,691	4,495	5,192	3,691	4,495	5,192
Farm expenses: Total	4,795	7,517	10,729	7,031	11,309	16,266
Crop expense	2,489	3,797	5,371	3,422	5,164	7,229
Machinery and equipment	1,077	1,650	2,318	1,186	1,818	2,556
Hired labor	659	1,188	1,800	1,493	2,881	4,371
Rent	540	846	1,200	900	1,410	2,000
Taxes	30	36	40	30	36	40
Total sales	8,042	12,340	17,201	18,153	27,856	38,831
Products used in home						
Gross farm income	8,042	12,340	17,201	18,153	27,856	38,831
Total farm expenses	4,795	7,517	10,729	7,031	11,309	16,266
Unpaid family labor	172	172	172	430	430	430
Depreciation	907	1,042	1,181	907	1,042	1,181
Total deductions	5,874	8,731	12,083	8,367	12,781	17,877
Returns to capital and operator's labor	2,168	3,609	5,119	9,786	15,075	20,954
Interest on investment[1]	221	270	312	221	270	312
Labor and management wage	1,947	3,339	4,807	9,565	14,805	20,642

[1]6 per cent of investment in machinery and equipment.

lease all land operated for cash, live in town, and maintain no livestock is assumed. Budget summaries for the three units of different size are shown in Table 18.

The farm investment of the cash tenant is comprised entirely of machinery and equipment. The investment for the small unit was $3,691. Such a unit would require two tractors, a thresher, a pick-up type of truck, and a large part of the other equipment needed on the larger farms. Farms of this size are not usually equipped with a farm truck and the practice is to hire grain trucked to warehouse or market. Nevertheless the investment in machinery and equipment was $205 per acre of rice as compared to $159 and $130, respectively, for the average size and the optimum size crop.

Three tractors, a pick-up type truck, a farm truck, two binders, and a thresher would be included in the equipment found on most farms of average size. A fourth tractor was added to the equipment inventory in preparing the budget for the optimum size farm.

At 1940 prices, estimated sales are $8,042 for the small unit, $12,340 for the average size unit, and $17,201 for the large unit. These differences are due entirely to the larger amount of rice sold from the larger farms since the same yield per acre is used in all cases.

The estimated total expense for a 400-acre rice crop ($11,199 in 1940) is considerably greater than for a 282-acre crop ($7,635) or a 180-acre crop ($4,795). Many of the expense items such as water, land rent, seed, binder twine, sacks, and tractor fuel are directly in proportion to the acreage of rice.

The hired labor expense per acre of rice, however, is highest for the optimum size farm and lowest for the small size farm. The operator of a small rice farm can do a relatively large proportion of the preharvest work himself and thus effect some saving in hired labor.

Total deductions include family labor and the decrease in inventory in addition to cash expenses. Unpaid family labor, contributed largely by school age boys, is commonly used when available to supplement the labor force. The average number of days of unpaid family labor reported for the farms studied was converted to man-equivalent days and valued at current wage rates without board. The decrease in inventory represents normal depreciation on machinery and equipment.

The return to capital and operator's labor (obtained by subtracting the total deductions from gross farm income) is the amount left as joint payment for the operator's labor and management and for the use of the capital invested in the farm business. Calculated on the basis of 1940 prices, the returns to capital and operator's labor for the small, the average, and the optimum rice farms were $2,168, $3,609, and $5,119, respectively. This return is sometimes called net farm income. Assuming that 6 percent of the farm investment (which includes only machinery and equipment in these cases) is adequate compensation for its use, the remainder is the amount received by the operator for his labor and managerial ability.

At 1940 prices, the estimated labor and management wage for an optimum

size farm is $4,807, or more than double the $1,947 estimated for the 180-acre farm. Compared with the average size farm, there is a difference of $1,468 in favor of the optimum. In general, farm earnings increase with size of farm under price relationships that prevailed during 1940.

Expanding operations to approximate the optimum acreage is one alternative of growers operating small or average size farms. This adjustment entails the use of additional machinery and an increase in total operating expenses. Increasing the size of farm will permit such farmers to make more complete use of their operating capital and has the benefit of increased efficiency which is reflected in earnings.

The size of farm may be increased by land purchase or by renting additional cropland. Generally speaking, rice growers would use the latter method. In either case he competes with other growers for land already developed or to be developed. Although there is still some undeveloped land in the area that is within reach of available sources of irrigation water, opportunities for enlarging individual rice farms in this way are limited. Consequently an increase in size for a large number of farms would necessitate that numerous small units be combined into fewer farms of larger size. Management will, no doubt, play an important part in deciding which farmers are able to make changes in size of farms. The more successful operators will be in the best position to obtain control of the land necessary to adjust the size of farm upward.

The advantages of larger size tends to be greater during periods of relatively high farm prices and to be less during periods of relatively low prices. As the general price level rises, the prices of various materials and services used in production such as cash rent, water charges, fuel and oil for tractors and trucks, repairs, and taxes tend to rise less rapidly than the price of rice. Because of this lag a period of rapidly rising prices is favorable to the grower. In 1943 the price of rough rice was more than double the 1940 price. During the period of 1940 to 1943, inclusive, rice prices increased more rapidly than did production costs. This resulted in a price situation in 1943 which was very favorable to rice production.

As shown in Table 18, a labor and management wage of $4,807 is estimated for an optimum sized rice system farm with 1940 prices. Assuming the same level of production in 1943, estimated earnings for this acreage are $20,642. In this case an increase of approximately 125 percent in the price of rough rice resulted in an estimated increase of more than 300 percent in the labor and management wage of the operator. Estimated earnings for small sized and averaged sized rice farms show a similar rate of increase between these two years.

Rice is among the basic commodities which have been assured support prices at 90 percent of parity for two full crop years following the end of the war. The present parity price for rice is about $5 per barrel. Assuming no change in the prices of the cost factors in the parity formula, a support price of about $4.50 per barrel can be expected for this two-year transition period.[7] Assuming

[7]Louisiana Rural Economist, November 1944, p. 2.

no change in the law, the parity price will be lowered and the support price will be decreased accordingly as prices paid by farmers decrease.

The price of cost items also tends to go down more slowly than do rice prices during a period of price decline. This is an important factor to be considered and emphasizes the importance of efficient operation in event the price of rice declines during the period following World War II.

Effect of Type of Lease on Earnings

A very high proportion of the land seeded to rice on the cooperating farms is leased. Two types of leases are in common use, namely: cash lease and share lease. In the first case the grower pays a stipulated amount of cash per acre for the use of the land devoted to rice. The grower owns the machinery used in making the crop and furnishes labor, planting seed, irrigation water, and bears all other expenses for materials and services required to produce and market the crop. Three dollars per acre was the usual cash rental rate for land seeded to rice at the time the study was made. The rental rate tends to remain the same from year to year except in case of extreme variations in the price of rice. In 1943, $5 per acre was a common cash rental for rice land, notwithstanding some growers were renting at a lower rate. Generally speaking, adjustments in the cash rental rate tend to lag somewhat behind changes in rice prices.

The most common share rental agreement provides that the landlord furnish the land, the water, and the planting seed, and receive one-half of the crop as rent. The grower is responsible for all other costs of operation. The landlord pays his share of any storage and selling costs.

A comparison of estimated earnings for an optimum rice acreage leased for cash and on the share basis is shown in Table 19. Rice, of course, would be the only source of income. All rice sales are credited to the operator in each instance. In the case of share rent operations the value of the landlord's share of the crop was entered as expense to the grower.

At 1940 prices the total farm expenses, assuming share rent, was estimated to be $13,890 as compared with a total of $10,729 assuming cash rent. Since the landlord furnishes irrigation water and seed and pays a share of the storage and selling charges, growers with share leases have much lower operating expenses than do operators with cash leases. This advantage is more than offset, however, by the difference in rent paid to the landlord.

The estimated labor and management wage of a cash rent operator was $4,807 at 1940 prices or more than double the $2,116 for a share rent operator. At 1943 prices the labor and management wage for these same situations would be $20,642 and $9,482, respectively.

The landlord shares the risk of making the crop by furnishing the land, water, and seed, and to this extent insures the grower against loss in case of crop failure. The operator, however, pays a very high price for such insurance.

Less operating capital is required to finance a rice crop with a share lease than when land is rented for cash. For this reason share leases are attractive

Table 19. Budget summaries involving two common types of lease arrangement, 1940 and 1943 prices

Items	1940 price situation		1943 price situation	
	Rice land rented for share of crop	Rice land rented for cash	Rice land rented for share of crop	Rice land rented for cash
Land organization:				
Acres in rice	400	400	400	400
Total acres operated	400	400	400	400
	Dollars	Dollars	Dollars	Dollars
Operator's farm investment: Total	5,192	5,192	5,192	5,192
Farm expenses: Total	13,890	10,729	28,486	16,266
Crop expenses	897	5,371	1,574	7,299
Machinery and equipment	2,318	2,318	2,556	2,556
Hired labor	1,800	1,800	4,371	4,371
Rent	8,835	1,200	19,945	2,000
Taxes	40	40	40	40
Total sales	17,671	17,201	39,891	38,831
Products used in home				
Gross farm income	17,671	17,201	39,891	38,831
Total farm expenses	13,890	10,729	28,486	16,266
Unpaid family labor	172	172	430	430
Depreciation	1,181	1,181	1,181	1,181
Total deductions	15,243	12,083	30,097	17,877
Returns to capital and operator's labor	2,428	5,119	9,794	20,954
Interest on investment[1]	312	312	312	312
Labor and management wage	2,116	4,807	9,482	20,642

[1]6 per cent of investment in machinery and equipment.

to growers who lack operating capital and are not financially able to withstand a heavy loss because of crop failure or low yields. With either 1940 or 1943 price relationships, it would be very much to the advantage of growers to borrow the additional capital necessary to pay cash rent rather than to lease the land on the usual crop share basis.

Relationship of Yields to Income

The highly specialized nature of rice farming tends to maximize the effect of variations in yield on income. Data in Table 5 indicate that average yields vary significantly from year to year. Yield data for individual farms show even greater variation. For example, the rice yields obtained in 1940 on the 66 farms included in this study averaged 15.9 barrels per acre. Yields on individual farms, however, ranged from 10 barrels to 23.7 barrels per acre. Variations in yield resulted in proportionately greater variations in earnings.

Estimated earnings for an optimum size rice system farm, assuming the average yield and the highest and the lowest yields obtained on cooperating farms in 1940, are shown in Table 20. In all cases 1940 price levels and the leasing of land for cash are assumed.

Only minor variations in total expenses result from variations in yield. Water charges, cash rent, machinery expenses, seed, labor, and taxes make up a large part of the total cost of producing rice, and these expenses are incurred regard-

Table 20. Budget summaries for different yields of rice, 1940 prices

Items	1940 price situation		
	10-barrel per acre yield	15.9-barrel per acre yield	23.7-barrel per acre yield
	Acres	Acres	Acres
Land organization:			
Acres in rice	400	400	400
Total acres operated	400	400	400
	Dollars	Dollars	Dollars
Operator's farm investment: Total	5,192	5,192	5,192
Farm expenses: Total	10,173	10,889	11,836
Crop expenses	4,815	5,531	6,478
Machinery and equipment	2,318	2,318	2,318
Hired labor	1,800	1,800	1,800
Rent	1,200	1,200	1,200
Taxes	40	40	40
Total sales	11,650	18,801	28,255
Products used in home			
Gross farm income	11,650	18,801	28,255
Total farm expenses	10,173	10,889	11,836
Unpaid family labor	172	172	172
Depreciation	1,181	1,181	1,181
Total deductions	11,526	12,242	13,189
Returns to capital and operator's labor	124	6,559	15,066
Interest on investment	312	312	312
Labor and management wage	—188	6,247	14,754

less of the yield obtained. Items such as storage and marketing costs and the expense of hauling grain to warehouse or market are the principal expenses directly associated with yields. The latter items are a small part of the total costs. Total cash expenses for the 10-barrel crop are $10,173 as compared to $10,889 in the case of the 15.9-barrel yield and $11,836 with a 23.7-barrel yield.

In general, a yield of approximately 10 barrels per acre is necessary to break even on a rice crop at 1940 prices. Such a yield (see column 1) would pay all expenses of making the crop but would not leave the operator anything for his labor or management and would lack $188 of returning 6 percent interest on the investment in machinery and equipment.

Although variations in yields have little effect on total costs, they do affect per unit costs and this in turn results in wide variations in earnings. As shown in Table 20, an average yield of 15.9 barrels would be accompanied by a labor and management wage of $6,247 as compared with a return of $14,754 from the highest yield of 23.7 barrels. The latter yield is 49 percent above the average while the earnings are 136 percent greater.

Unit costs can be kept low by maintaining yields at a high level. Yields drop rapidly on land seeded continuiusly to rice. This difficulty has been partially overcome by using the common rice-grass rotation. This rotation involves one year of rice with two to four years of grass. The rotation tends to be shorter on the heavy dark soils than on the light sandy soils.

During a period of favorable rice prices there is always the urge to reduce the length of time rice land is in pasture and to seed a crop after one or two

years of grazing. As commonly practiced, such a procedure invariably results in lower yields than is obtained with a longer rest period. With present methods, a four- to five-year rice-pasture rotation is necessary if yields are to be maintained at a profitable level on old rice land. In some cases an even longer rotation is needed.

Generally speaking, land suitable for rice is abundant relative to available sources of irrigation water. As a result, rice farmers have been extravagant in their use of land. Since land was plentiful the simplest procedure has been to allow nature three or four years to recondition the soil after each rice crop. Thorough drainage, plowing or other cultivation to aerate the soil, and seeding to promote an early grass cover are practices that hasten the reconditioning of the soil for a subsequent rice crop.

Another means of maintaining yields is through the use of commercial fertilizer. The most extensive use of fertilizer has been in the territory around Beaumont and in the locality of Katy. To date very little fertilizer has been used on rice in the western part of the area.

Tests conducted by the Agricultural Experiment Substation at Beaumont indicate that it is profitable to apply fertilizer to rice in that part of the area. The results as a whole show that a good practice on the principal rice soils of the area is to apply a combination of fertilizer carrying 20 pounds of nitrogen and 20 pounds of phosphoric acid per acre. Such a combination would be supplied in 100 pounds each of sulphate of ammonia and 20 percent superphosphate and should be applied with the seed at planting time.[8] At 1940 prices, this amount of fertilizer cost $3.45 per acre. An increase in production of about 1 1/2 barrels per acre was necessary to pay this added cost.

Still another means of maintaining yields is through improvement in varieties. New varieties are being developed and tested continuously at the Beaumont Substation. The results are available to all farmers and should be helpful in keeping them informed as to high yielding and better adapted varieties.

Systems of Farming as Related to Income

It has been shown that the rice system and the rice-cattle systems are the types of farm organization commonly used by rice growers. Rice is the only important source of farm income from the rice system as contrasted with the rice-cattle system where both rice and beef cattle are major enterprises. The budget summaries in Table 21 show the estimated income for each system of farming.

A cash lease arrangement was selected as typical of each system of farming. In 1940 land seeded to rice was rented for $3 per acre and grass land for 50 cents per acre (see Table 17), but in 1943 the corresponding rental rates were $5 and 60 cents per acre, respectively. In the budget summaries shown in Table 21, rice is the only crop grown in either system of farming. An optimum size rice crop of 400 acres is used in each instance. In the case of the rice-

[8]Texas Agr. Exp. Sta. Bul. 602, Fertilizers for Rice in Texas.

Table 21. Budget summaries of rice system and rice-cattle system farms, 1940 and 1943 prices

Items	1940 price situation		1943 price situation	
	Rice system	Rice-cattle system	Rice system	Rice-cattle system
	Acres	Acres	Acres	Acres
Land organization:				
Acres in rice	400	400	400	400
Acres in pasture	.....	1,690	.....	1,690
Acres in farmstead	.....	10	.....	10
Total acres operated	400	2,100	400	2,100
	Number	Number	Number	Number
Livestock organization:				
Beef cows	.....	210	.....	210
Horses and mules	.....	7	.....	7
Dairy cows	.....	2	.....	2
Chickens	.....	90	.....	90
	Dollars	Dollars	Dollars	Dollars
Operator's farm investment: Total	5,192	15,839	5,192	21,264
Land	.....	.....	.....	.....
Improvements (excl. residence)	.....	.....	.....	.....
Machinery and equipment	5,192	5,894	5,192	5,894
Livestock	.....	9,945	.....	15,370
Farm sales: Total	17,201	21,597	38,831	45,782
Rice	17,201	17,201	38,831	38,831
Beef cattle	.....	4,260	.....	6,765
Other	.....	136	.....	186
Farm expenses: Total	10,729	12,662	16,266	19,207
Improvements (excl. residence)	.....	.....	.....	.....
Crop expenses	5,371	5,371	7,299	7,299
Machinery and equipment	2,318	2,353	2,556	2,591
Hired labor	1,800	1,948	4,371	4,741
Rent	1,200	2,050	2,000	3,020
Livestock expense	.....	791	.....	1,407
Taxes	40	149	40	149
Total sales	17,201	21,597	38,831	45,782
Products used in the home	.....	149	.....	188
Gross farm income	17,201	21,746	38,831	45,970
Total farm expenses	10,729	12,662	16,266	19,207
Unpaid family labor	172	172	430	430
Depreciation	1,181	1,251	1,181	1,251
Total deductions	12,082	14,085	17,877	20,888
Returns to capital and operator's labor	5,119	7,661	20,954	25,082
Interest on investment[1]	312	950	312	1,156
Labor and management wage	4,807	6,711	20,642	23,926

[1]Real estate at 5 percent, other investments at 6 percent.

cattle system, it is assumed that the grazing resources associated with rice production are utilized by the grower. Approximately 76 percent of the land included in the study is suitable for rice production. On this basis a farm unit totalling approximately 2,100 acres would provide for a 400-acre rice crop each year with the usual rotation of one year in rice and three years in grass. The 1,690 acres of pasture land would provide grazing for 210 beef cows. A typical livestock organization for such a farm would include 7 horses, 2 dairy cows, and 90 chickens in addition to the above mentioned beef cows. Dairy and poultry products are produced primarily for home use.

The rice system is attractive to growers with limited capital. An average value of the machinery and equipment needed to handle a 400-acre rice crop is $5,200. An additional investment in livestock of about $10,000 at 1940 prices and $15,000 at 1943 prices is required for the rice-cattle system.

The advantage of combining the rice and beef cattle enterprises is partially offset by a larger cash rental and the expenses incurred in connection with the beef enterprise. The estimated labor and management wage for the rice-cattle system is, however, $1,900 above that estimated for the rice system at prices that prevailed during 1940. At 1943 prices the difference is nearly $3,300 in favor of the rice-cattle system. Compared with a rice farm, the rice-cattle system is more diversified, gives a greater return to labor and management, and provides a somewhat better distribution of income during the year. Furthermore, income on rice-cattle farms is less affected by crop failure or by fluctuations in the price of rice.

Effect of Tenure on Income of Rice-Cattle Farms

Much of the land utilized for rice production is owned by non-residents and by individuals not engaged in agriculture. Many landowners are chiefly concerned with developing the mineral resources. The owner frequently obtains a greater return from mineral leases than from crop and grazing rentals. The possibility of mineral development tends to keep the price of land above its value for agricultural production. Rental rates for agricultural uses on the other hand are fairly closely related to the returns obtained from rice and beef cattle.

An indication of the influence of tenure on income may be obtained by comparing the estimated earnings from cash tenant-operated and owner-operated rice-cattle units. In the first situation, 1,700 acres of pasture and 400 acres of rice land are rented for cash as in the case described above under "Systems of Farming as Related to Income." The operator-owned farm is assumed to be identical in size and in crop and livestock organization to the above. Here again, 1940 and 1943 price relationships are used. A summary of the analysis is shown in Table 22.

The average value of rice land (without improvements) in 1940 was estimated by cooperating farmers to be $20 per acre. Recent studies of the trend of land prices during World War II indicate considerable increase in the selling price of land used for rice production. Based on these studies, a value of $30 per acre without improvements is assumed for 1943.

The capital outlay for machinery and equipment and for livestock is assumed to be the same regardless of type of tenure. The real estate investment of the owner-operator is approximately $45,000 at 1940 prices and nearly $66,000 at 1943 prices. Of course, tenant farmers have no real estate investment. Farm sales and gross farm income are the same for both owner and tenant. Repairs and upkeep on improvements and real estate taxes are expenses of the owner not incurred by the tenant. These items, however, are more than offset by the cash rent paid by the tenant.

Calculated on the basis of 1940 prices, the returns to capital and operator's labor for the owner-operated and the tenant-operated farm are $8,899 and $7,661, respectively. After interest is deducted for the investment in farm

Table 22. Budget summaries of owner-operated and cash tenant-operated rice-cattle farms, 1940 and 1943 prices

Items	1940 price situation		1943 price situation	
	Owner-operated	Cash tenant-operated	Owner-operated	Cash tenant-operated
	Acres	Acres	Acres	Acres
Land organization:				
Acres in rice	400	400	400	400
Acres in pasture	1,690	1,690	1,690	1,690
Acres in farmstead	10	10	10	10
Total acres operated	2,100	2,100	2,100	2,100
	Number	Number	Number	Number
Livestock organization:				
Beef cows	210	210	210	210
Horses and mules	7	7	7	7
Dairy cows	2	2	2	2
Chickens	90	90	90	90
	Dollars	Dollars	Dollars	Dollars
Operator's farm investment: Total	60,789	15,839	87,214	21,264
Land	42,000	.....	63,000	.....
Improvements (excl. residence)	2,950	.....	2,950	.....
Machinery and equipment	5,894	5,894	5,894	5,894
Livestock	9,945	9,945	15,370	15,370
Farm sales: Total	21,597	21,597	45,782	45,782
Rice	17,201	17,201	38,831	38,831
Beef cattle	4,260	4,260	6,765	6,765
Other	136	136	186	186
Farm expenses: Total	11,233	12,662	16,908	19,207
Improvements (excl. residence)	201	.....	301	.....
Crop expenses	5,371	5,371	7,299	7,299
Machinery and equipment	2,353	2,353	2,591	2,591
Hired labor	1,948	1,948	4,741	4,741
Rent	.....	2,050	.....	3,020
Livestock expense	791	791	1,407	1,407
Taxes	569	149	569	149
Total sales	21,597	21,597	45,782	45,782
Products used in the home	149	149	188	188
Gross farm income	21,746	21,746	45,970	45,970
Total farm expenses	11,233	12,662	16,908	19,207
Unpaid family labor	172	172	430	430
Depreciation	1,453	1,251	1,453	1,251
Total deductions	12,849	14,085	18,791	20,888
Returns to capital and operator's labor	8,899	7,661	27,179	25,082
Interest on investment[1]	3,227	950	4,603	1,156
Labor and management wage	5,672	6,711	22,576	23,926

[1]Real estate at 5 percent, other investments at 6 percent.

real estate at 5 percent and for all other farm investments at 6 percent, the owner-operator has an estimated labor and management wage of $5,672 compared with $6,711 in the case of the cash tenant.

This analysis indicates that the rice-cattle system is profitable for both owner-operators and cash tenants under the conditions assumed. It also indicates that at rates prevailing during 1940, land prices are high relative to cash rent and that it is more profitable to lease for cash than to own land used exclusively for rice-cattle production. The labor and management wage of an owner-operator and a cash tenant would have been approximately the same had an interest rate of 2.75 percent been deducted for the investment in land and improvements. Earnings in 1940 would have returned 5 percent interest on a land value of approximately $12 per acre and at the same time

would have provided the owner-operator the same labor and management wage as was obtained by the cash tenant-operator.

At 1943 prices the estimated labor and management wage was $22,576 and $23,926, respectively, for the owner-operator and for the cash tenant. This was a difference of $1,350 in favor of renting for cash. In other words, it was more profitable in 1943 for rice-cattle farmers to lease rice land for $5 per acre and pasture land for 60 cents per acre than to buy the land at $30 per acre. The labor and management wage of the owner-operator and the cash tenant would have been the same had an interest rate of 3.2 percent instead of 5 percent been deducted for the investment in real estate. It would also have been the same with interest at 5 percent and land at $20 per acre.

Relationship of Method of Harvesting to Income

The peak demand for labor in rice production occurs at harvest time. The importance of labor in the cost of harvesting has created a great deal of interest in labor saving practices. A significant development during the war period has been the substitution of combine harvesting and artificial drying of rice for binding and threshing.

The use of rice combines and rice driers is not an entirely new practice in Texas. As early as 1929 a few large combines were brought in from the wheat belt. In 1930 a drier was installed and operated at Nome, Texas, but its lack of capacity and bulk storage facilities limited its use. Combine harvesting did not gain favor at that time and the reasons are apparent. First, the combines were not well designed for rice harvesting. Second, with the combine method the grain must be artificially dried, a practice about which very little was known at that time. Third, cheap farm labor was available in abundance. The present combines and driers are, however, satisfactorily reducing labor and power requirements.

Combine operators generally agree that less grain is lost in the field when rice is combined than when cut with a binder and threshed. The growers contacted estimated that combining reduced the waste in harvesting by an average of 1.5 barrels per acre. They point out that losses due to lodging and to adverse weather are reduced and less grain is lost by shattering and by bird damage.

The results of an appraisal of the effect of combine harvesting on income assuming the prewar price situation of 1940 and wartime price relationships such as existed during 1943 are shown in Table 23. A rice system unit of optimum size operating under a cash lease is also assumed. It is estimated that two of the 6- or 7-foot pull-type combines or one 12- or 14-foot self-propelled combine is needed to harvest the optimum crop of 400 acres. It is assumed that combined rice would be handled in bulk and that grain harvested by the old method would be sacked. Since no prices for drying in 1940 are available, it was estimated that 20 cents per barrel was a reasonable charge for rice drying at that price level. Estimated earnings are shown for harvesting by the old method of binding and threshing and with both self-propelled and pull-type combines.

Table 23. Budget summaries for different methods of harvesting rice, 1940 and 1943 prices

Items	1940 price situation			1943 price situation		
	Method of harvesting					
	Binder and thresher	12-14-foot self-propelled combine	6-7-foot pull-type combine	Binder and thresher	12-14-foot self-propelled combine	6-7-foot pull-type combine
Land organization:						
Acres in rice	400	400	400	400	400	400
Total acres operated	400	400	400	400	400	400
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
Operator's farm investment: Total	5,192	6,109	5,714	5,192	6,109	5,714
Land						
Improvements (excl. residence)						
Machinery and equipment	5,192	6,109	5,714	5,192	6,109	5,714
Livestock						
Farm expenses: Total	10,729	9,885	9,967	16,266	14,963	15,140
Improvements (excl. residence)						
Crop expenses	5,371	5,482	5,482	7,299	8,546	8,546
Machinery and equipment	2,318	2,456	2,513	2,556	2,650	2,769
Hired labor	1,800	702	727	4,371	1,722	1,780
Rent	1,200	1,200	1,200	2,000	2,000	2,000
Livestock expenses						
Taxes	40	45	45	40	45	
Total sales	17,201	19,159	19,159	38,831	43,249	43,249
Products used in the home						
Gross farm income	17,201	19,159	19,159	38,831	43,249	43,249
Total farm expenses	10,729	9,885	9,967	16,266	14,963	15,140
Unpaid family labor	172	172	172	430	430	430
Depreciation	1,181	1,741	1,768	1,181	1,741	1,768
Total deductions	12,083	11,798	11,907	17,877	17,134	17,338
Returns to capital and operator's labor	5,119	7,359	7,252	20,954	26,115	25,911
Interest on investment[1]	312	367	343	312	367	343
Labor and management wage	4,807	6,992	6,909	20,642	25,748	25,568

[1]Real estate at 5 percent, other investments at 6 percent.

Compared to binding and threshing, combine harvesting entails an increase in the equipment investment of from $500 to $900, depending on the type of combine used. The cost of operating binders and threshers is eliminated with combine harvesting but drying charges and operation of the combine are added cost items. Combine operators save the cost of sacks by handling rice in bulk. The greatest saving in expense, however, resulting from combine harvesting is the reduction in cost of harvesting labor. For each type of combine, this saving is approximately $1,100 at 1940 prices and $2,600 at 1943 prices. Total farm expenses are estimated to be approximately $750 to $850 less at 1940 prices and $1,125 to $1,300 less at 1943 prices, depending on the type of combine used.

At 1940 prices the estimated returns to the operator's labor and management are $6,992 and $6,909, respectively, when self-propelled and pull-type combines are used compared with $4,807 for harvesting by binding and threshing. The difference is even more striking at prices prevailing in 1943 when harvesting labor was very expensive. At 1943 prices the difference in the estimated return to labor and management is approximately $5,000 in favor of combine

harvesting. Combining gives the farmer better control of harvesting operations by making him less dependent on seasonal labor.

A large part of the increase in earnings resulting from the use of combines is due to the elimination of a large part of the waste normally accompanying binding and threshing. Any delay in the harvesting of mature rice tends to increase the waste. Losses are likely to occur in both production and in quality when ripe grain remains uncut or when bundles remain in the shock for long periods. Combine harvesting is not delayed as long following heavy rains as is binding or threshing. It is not feasible to bind rice while water stands in the field and a good job of threshing cannot be done with wet bundles. When rice heads are dry, however, the crop can be combined even though water may be standing in the field. This is a great advantage during harvest seasons when frequent rains delay binding and threshing.

Rice that is combined is safe from hurricane or other weather damage as soon as it reaches the drier. On the other hand a crop that is cut with a binder is subject to this type of damage for a period of 10 days to two weeks while curing in the shock previous to threshing. The likelihood of heavy loss due to a hurricane is reduced to the extent that combining shortens the time required to get ripened grain under cover.

Many of the combines now in use were not designed for rice harvesting, and the expense incurred by growers in converting them for use in rice fields added materially to the investment. As machinery manufacturers adapt harvesting equipment to the needs of the rice farmer, it is expected that such costs will be eliminated and that in general the machines will give better service.

CONCLUSIONS

The estimated effect on income of certain alternatives open to rice farmers indicates the direction which adjustments should take in order to obtain maximum returns. A brief appraisal of alternative adjustments as indicated by this study follows:

1. In general, farm income increases with size of farm. Increasing the size of farm is a profitable alternative for farmers growing less than the optimum sized rice crop of 400 acres.

2. Larger earnings were obtained by tenant farmers who paid cash rent than by those paying share rent. In case of crop failure, the share tenant is partially insured against loss because the landlord shares the risk by furnishing land, water, and seed. The risk taken by the landlord is not, however, in proportion to the normal amount of rent received.

3. A yield of about 10 barrels per acre would pay the expenses incurred in making a rice crop but would leave the operator nothing for his labor and management. Yields must be maintained above this level to insure profitable production. Yields are adversely affected by shortening the interval between rice crops. As commonly practiced, it is necessary that rice land be in pasture for 3 or 4 years between rice crops if profitable yields are to be obtained. Re-

conditioning of rice land may be speeded up by thorough drainage, aerating the soil, and seeding to obtain an early stand of grass after each rice crop. In some parts of the area the use of commercial fertilizer has been profitable. Production is also increased by planting high yielding varieties.

4. The rice-cattle system is more profitable than is the rice system. With the former type of organization there was a somewhat better distribution of income throughout the year and earnings are less affected by crop failure or fluctuations in the price of rice. The change from a rice system to a rice-cattle type of organization would result in a large increase in the total investment. It is also necessary that the operator obtain control of grazing land in addition to the acreage seeded to rice.

5. Land values are high relative to cash rental rates. It is more profitable to lease for cash than to own land.

6. Farm earnings are increased by combine harvesting and artificial drying as compared to the old method of binding and threshing. Harvesting costs are reduced as well as are losses due to lodging, shattering, adverse weather, and birds.