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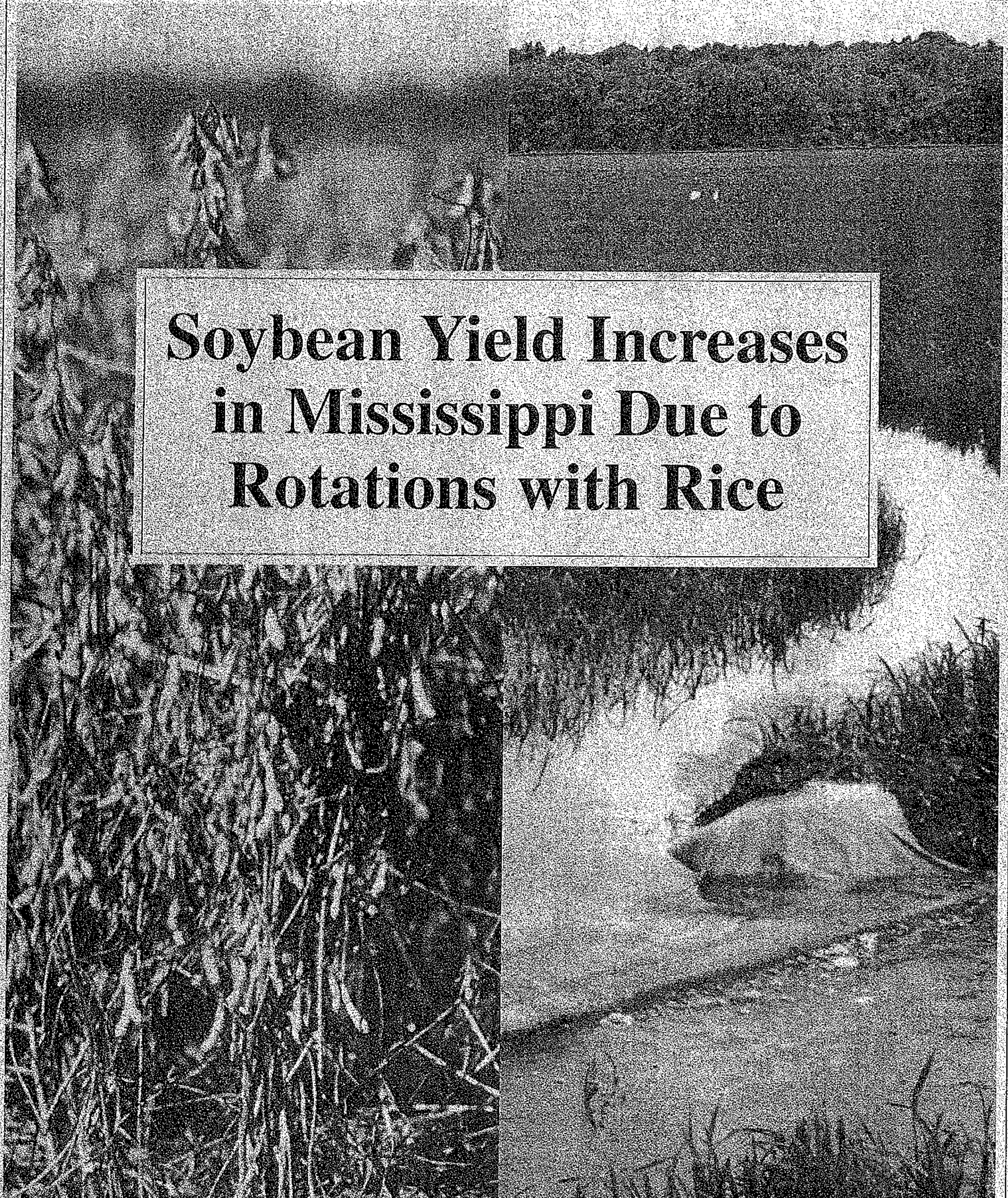

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# Soybean Yield Increases in Mississippi Due to Rotations With Rice


## Abstract

A field experiment was conducted over 8 years, 1983-1990, at the Delta Branch Experiment Station, Stoneville, MS, on a Sharkey clay (very-fine, montmorillonitic, nonacid, thermic, Vertic Haplaquepts) to evaluate the influence of various rice-soybean rotational patterns on soybean yield in subsequent years. Most rice (*Oryza sativa* L.) in the Mississippi Delta is grown in some rotation with soybeans [*Glycine max* (L.) Merr.]. Soybeans grown behind 1 or 2 years of rice averaged 27.7 bu/acre, which was a 9.3 bu/acre increase over continuous soybeans and a 6.4 bu/acre increase over the long- term Mississippi state average of 21.3 bu/acre. The 2:2, 1:1, and 3:1 (rice:soybean) rotational sequences resulted in the highest returns of \$93, \$74, and \$52/acre/yr, respectively, above specified costs during the last 4 years, with the 2:2 being significantly higher than the 3:1. Soil nutrient status did not change appreciably during the 8 years. Soil pH increased in every rotation system where rice was grown after the fourth year.


## Introduction

The response of crops and soils to various cropping systems has been of interest to researchers since the 1700's (15). Because yield maintenance is so important to soybean production (4), strict attention must be paid to this aspect of crop rotation. Crop rotations have been successful in reducing incidences of diseases and weeds (1, 3, 4, 5, 9). However, benefits of crop rotation on soybean yields have varied.

Barker et al. (2) reported that monocropped soybeans yielded higher than soybeans in a soybean- wheat-cotton or soybean-wheat-corn rotation.

Wesley et al. (16) evaluated four cropping systems: monocrop soybeans, wheat-soybeans doublecrop, and 2-year rotations of corn/wheat-soybeans and sorghum/wheat-soybeans in irrigated and nonirrigated environments. Data from their studies indicated yields of soybeans from the monocrop system exceeded yields from the doublecrop systems in both the irrigated and nonirrigated environments.

Hinkle (6) showed soybean yield increases following 2 years of cotton. Peterson and Varvel (7) found that soybeans grown in continuous monoculture produced lower seed yield, less dry matter, and smaller seeds than soybeans grown in rotation. Sanford et al. (11) reported soybean-wheat doublecrop systems were more profitable than monocrop soybeans even though the doublecrop production costs were nearly twice those of monocrop soybeans.

The effect of rotations on soybean yield was intensively explored in a 214-farm survey (4). All farmers interviewed who used rotations said that yields were somewhat higher on rotated than on nonrotated fields. Rotations with a specific crop, such as cotton (*Gossypium hirsutum* L.) or rice, had no apparent advantage in terms of soybean yields.

The influence of crop rotations on soil productivity has been reported by many researchers (2, 10, 14, 17). Spurgeon and Grissom (13) reported that organic matter content of soils increased when a sod crop was used in different cropping systems; however, this was the only significant change for several rotation sequences. Snipes et al. (12) found that in a 4-year rice-cotton rotation, rotating with rice did not result in an increase in subsequent seed cotton yield. The appreciable amount of rice straw at the end of the growing seasons failed to improve soil organic matter content. Rice stubble returned to the soil has the potential to increase soil organic matter content; however, percent organic matter at either the 6-inch or 12-inch depth was not affected by any system evaluated.

Diversification of income can be considered an additional benefit of crop rotation. Producers can reduce the risk associated with producing one particular commodity by increasing the number of commodities produced per farm unit.

This study was conducted to include rice and soybeans because of their adaptability to the clay soils of the Mississippi Delta. Rotational sequences of rice and soybeans currently in use in the Mississippi Delta are: 2 years rice:2 years soybeans, 1 year rice:1 year 1 soybeans, 1 year rice: 2 years soybeans, or a rotational sequence based on expected economic returns. Ideally, a rotational system should be devised to maximize profitability.

The objective of this research was to determine the effect of various rice-soybean rotational systems on soybean yield and economic returns.

## Materials and Methods

A field experiment was initiated in 1983 at the Delta Branch Experiment Station, Stoneville, MS, on a Sharkey clay. The area had been planted to monocrop soybeans for at least 10 years. Seven crop sequences were chosen to evaluate the utility of rice for improving soybean yield. The seven treatments were (1) continuous rice, (2) continuous soybeans, (3) 1 year rice:1 year soybeans, (4) 2 years rice:1 year soybeans, (5) 3 years rice:1 year soybeans, (6) 1 year rice:2 years soybeans, and (7) 2 years rice:2 years soybeans.

Treatment plots were 60 feet wide by 100 feet long, and each treatment was replicated four times in a randomized complete block design. Individual plots were surrounded by double levees 10 feet wide by 2 feet high each year rice was grown. Plots were at least 20 feet apart on all sides to prevent seepage from plot-to-plot.

Overflow water from rice plots was channeled through individual ditches to keep it away from soybean plots. General recommended crop production practices were used for each crop sequence.

Rice [cv. Starbonnet (1983-1986) and Newbonnet (1987-1990)] was drill-seeded in mid-April to early May each year at a seeding rate of 90 lb/acre. Rice cultivars were changed in 1987 because of unavailability of Starbonnet seed. When necessary, rice was flood-irrigated to obtain a uniform stand. Nitrogen at a rate of 120 lb/acre (1983-1986) for Starbonnet and 150 lb/acre (1987-1990) for Newbonnet was applied as urea. One-half the total rate was applied to dry soil prior to permanent flooding and the other half was applied at midseason when internode elongation was one-half inch or less.

Weeds were controlled with tank-mix applications of propanil (N-[3,4-dichlorophenyl] propanamide) + thiobencarb (2-[4-chlorophenyl)methyl]diethyl carbamothioate) or bifenox (methyl5-[2,4-dichloro phenoxy]-2-nitrobenzoate) applied postemergence prior to flooding. Escaping grass weeds were controlled after the permanent flood was established with either molinate (s-ethyl hexahydro-1H-azepine-1-carbothioate) or fenoxaprop ((±)-2-[4-[(6-chloro-2-benzoxazolyl)oxy]phenoxy]propanoic acid). A 2-inch to 4-inch permanent flood was established using well water in late May or early June when rice was 6 inches to 8 inches tall.

In the spring each year, soil samples were taken from the top 6 inches from each plot and analyzed by the Mississippi Cooperative Extension Service Soil Testing Laboratory at Mississippi State University.

Soybeans (cv. Centennial) were planted in rows spaced 40 inches apart in mid-May to early June at a seeding rate of 50 lb/acre. Soybeans were not irrigated in any year. Weed control was maintained with tank-mix broadcast applications of metolachlor [2-chloro-N-(2-ethyl-6-methylphenyl)-N-6-methoxy-1-methylethyl) acetamide] + metribuzin [4-amino- 6-(1,1-dimethylethyl)-3-(methylthio)-1,2,4-triazin-5-(4H)-one] applied preemergence; or with trifluralin [2,6-dinitro-N,N-dipropyl-4-(trifluoromethyl) benzenamine] + metribuzin preplant applied as a tank-mix and incorporated using a spring-tined harrow. Escaping grass weeds were controlled with fluazifop ((±)-2-[4-[[5-trifluoromethyl)-2-pyridinyl]oxy]phenoxy]-propanoic acid) or sethoxydim (2-[1-(ethoxyimino)butyl]-5-[2-(ethylthio)-propyl]-3-hydroxy-2- cyclohexen-1-one) applied postemergence, and escaping broadleaf weeds were controlled with acifluorfen (5-[2-chloro-4-(trifluoromethyl)phenoxy]-2-nitrobenzoic acid) applied postemergence.

All data were analyzed statistically and means were separated at the 5% level according to Fisher's Protected Least Significant Difference (LSD) test.

It is difficult to determine the economic value of a crop sequence by comparing yields of different crops. Therefore, the yields of rice and soybeans were indexed using dollar values. The gross values of rice and soybeans were determined as the product of the crop yield times an 8-year seasonal average price paid to producers in Mississippi from 1983 through 1990 (Table 4). Net returns above specific costs were determined by subtracting an 8-year average cost per acre for each crop from the gross value of each crop.

## Results and Discussion

### *Crop Yields*

Soybean and rice yields are presented in Tables 1 and 2. During the 8 years of this experiment, soybeans occurred 17 times in the various rotations following rice (Table 1). Eight of these occurrences resulted in significant soybean yield increases over the continuous soybean system. When grown in the 1:1 system, soybean yields increased two out of the four times this rotation occurred (7.3 bu/acre in 1986, and 7.2 bu/acre in 1988). In the 2:1 (9.8 bu/acre average increase) and 3:1 (11.9 bu/acre average increase) systems, soybean yields were always significantly higher than the control. No yield increases were measured for soybeans in the 1:2 rotation. Soybean yield increases occurred two out of four times in the 2:2 system (11.1 bu/acre in 1985 and 11.7 bu/acre in 1990). No pattern of continuous soybean yield increases was noted in the 8 years of the experiment (Table 1).

Rice yields also benefited from these rotations. After year one, rice occurred 18 times in various soybean rotations, with rotational rice yields increased over the continuous rice system in eight of those occurrences (Table 2). After year one, where rice was grown in all plots except the continuous soybeans, rice yields increased in the 1:1 rotation two out of three times this rotation occurred (20.4 bu/acre in 1985 and 42.4 bu/acre in 1987), one out of five in the 2:1 system (29.6 bu/acre in 1986), one out of five in the 3:1 system (43.4 bu/acre in 1987), one out of two in the 1:2 rotation (46.1 bu/acre in 1986), and two out of three in the 2:2 system (56.7 bu/acre in 1987 and 46.3 bu/acre in 1988). Rice yields decreased after the third year of continuous rice and never yielded as high as in the first year (Table 2).

## *Costs and Returns*

Table 3 presents estimates of the prices received and costs used in this study. These values do not include management fees, land costs, or general farm overhead.

When dollar values accumulated over the entire 8 years of the experiment and production costs were considered, all rotations out-performed continuous rice and continuous soybeans (Table 4). During the last 4 years of the experiment, all rotational sequences and continuous soybeans provided higher net returns than continuous rice; however, only the 2:2 (rice:soybeans), 1:1, and continuous soybeans resulted in increased net returns compared to the 8-year average. The 2:2, 1:1, and 3:1 rotations provided significantly higher net returns than continuous soybeans. The 2:2, 1:1, and 3:1 rotational systems resulted in the highest net returns of $93, $74, and $52/acre/year, respectively, above specified costs during the last 4 years. The net return from the 2:2 system was significantly greater than that from the 3:1 system.

Table 5 presents 8-year average yields and costs and net returns of continuous soybeans and soybeans produced in the 1:1 and 2:1 rotations with rice. Average yields of soybeans from the rotations exceeded those from the continuous soybean system by 9.3 bu/acre (27.7 vs 18.4 bu/acre). Average net returns for soybeans following 1 or 2 years of rice were $65.30/acre, while average net return to continuous soybeans was only $8.29/acre.

## *Soil Nutrient Status*

Percent organic matter was not increased by any system. Failure of rice straw to substantially increase organic matter supports earlier findings (12). Soil pH increased in every system where rice was grown after the fourth year when

**Table 1. Influence of a rice-soybean rotation on soybean yield on Sharkey clay at the Delta Branch Experiment Station, Stoneville, MS, 1983-1990.**

| Treatment description | Soybean yield | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
| | bu/acre | | | | | | | |
| 1:1 Rice-Soybeans | | 26.8 | | 15.4 | | 37.3 | | 25.4 |
| 2:1 Rice-Soybeans | | | 39.1 | | 40.1 | | | |
| 3:1 Rice-Soybeans | | | | 16.7 | | | | 33.1 |
| 1:2 Rice-Soybeans | | 24.8 | 35.4 | 11.2 | | 32.7 | | 20.8 |
| 2:2 Rice-Soybeans | | | 40.5 | 12.1 | | | 27.0 | 29.4 |
| Continuous Soybeans | 13.9 | 19.1 | 29.4 | 8.1 | 4.3 | 30.1 | 24.35 | 17.7 |
| [a]LSD (0.05) = 8.75 | | | | | | | | |
| CV (%) 33 | | | | | | | | |
| [b]LSD (0.05) | NS | NS | 8.5 | 4.7 | NS | 4.6 | NS | 9.8 |
| CV (%) | 0 | 21.7 | 14.6 | 22.5 | 48.0 | 8.2 | 15.6 | 25.2 |

[a]For comparison of any two means across years of continuous soybeans.
[b]For comparison of any two means within a single year.

**Table 2. Influence of rice-soybean rotation on rice yield on Sharkey clay at the Delta Branch Experiment Sta tion, Stoneville, MS, 1983-1990.**

| Treatment description | Rice yield | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
| | bu/acre | | | | | | | |
| 1:1 Rice-Soybeans | 126.4 | | 160.2 | | 141.2 | | 124.6 | |
| 2:1 Rice-Soybeans | 139.5 | 148.1 | | 123.1 | 125.9 | | 126.6 | 95.2 |
| 3:1 Rice-Soybeans | 137.8 | 146.1 | 139.0 | | 142.2 | 118.0 | 116.6 | |
| 1:2 Rice-Soybeans | 134.0 | | | 139.6 | | | 134.6 | |
| 2:2 Rice-Soybeans | 141.5 | 143.4 | | | 155.5 | 138.4 | | |
| Continuous Rice | 138.1 | 150.9 | 139.8 | 93.5 | 98.8 | 92.1 | 113.0 | 89.9 |
| [a]LSD (0.05) = 22.9 | | | | | | | | |
| CV (%) 13.6 | | | | | | | | |
| [b]LSD (0.05) | NS | NS | 19.2 | 12.5 | 29.7 | 39.4 | NS | NS |
| CV (%) | 9.6 | 6.9 | 7.6 | 6.1 | 13.1 | 19.6 | 14.6 | 21.3 |

[a]For comparison of any two means across years of continuous rice.
[b]For comparison of any two means within a single year.

**Table 3. Specified costs and price received for rice and soybean grown in Mississippi. Mississippi Agricultural and Forestry Experiment Station and Mississippi Cooperative Extension Service, 1983-1990.**

| Item | Crop year | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 8-yr avg. |
| | $/acre | | | | | | | | |
| **Rice** | | | | | | | | | |
| Direct | 320 | 308 | 279 | 270 | 320 | 304 | 299 | 306 | 301 |
| Total | 389 | 372 | 361 | 351 | 416 | 370 | 368 | 387 | 377 |
| Price received per bushel[a] | 4.29 | 4.00 | 3.20 | 1.76 | 3.55 | 3.16 | 3.89 | 2.93 | 3.29 |
| **Soybeans** | | | | | | | | | |
| Direct | 81 | 71 | 70 | 76 | 70 | 65 | 70 | 80 | 73 |
| Total | 116 | 102 | 103 | 108 | 99 | 95 | 100 | 113 | 105 |
| Price received per bushel[a] | 7.85 | 6.07 | 5.16 | 4.93 | 5.84 | 7.47 | 5.90 | 5.84 | 6.13 |

[a]Price received per bushel of rice and soybean. National Agric. Statistics Service Annual Report to Mississippi.

compared to the continuous soybean system (Table 6). Prior to the fifth year of production, a trend for pH increase was started and 57% of the treatments had higher pH values than the continuous soybean system. Urea, an acid-forming fertilizer, was applied at 260 lb/acre in 1983 through 1986, and at 326 lb/acre thereafter. Tisdale et al. (15) showed that it would take, on average, 252 lb/acre/yr of $CaCO_3$ equivalent to neutralize the acid formed by this urea application. Mississippi Delta water is very high in calcium carbonate and thus acts as a liming agent, driving soil pH higher.

Mississippi recommendations are to use ammonium sulfate when soil pH rises because it is the most acid-forming source of fertilizer available for rice production and will help bring down soil pH. Pettiet Agricultural Services estimates that 30 acre-inches of well water supply between 1 and 1.2 tons of lime equivalent to the soil[1]. Earlier reports (8, 12) indicated that pH reductions were related to plots where the greatest amount of N fertilizer was applied; however, the increase in pH values shown in our results seem to have resulted from repeated irrigation with water high in calcium carbonate.

Exchangeable calcium ($Ca^{2}$+) content of the soil fluctuated with time in this experiment. In the majority of years, no differences in $Ca^{2}$+ occurred. Continuous rice had higher $Ca^{2}$+ in only 1 year when compared to continuous soybeans (data not presented). Sharkey clay has a high CEC (40 meq/100 g) with relatively high calcium levels (>4,000 ppm). Reported $Ca^{2}$+ does not reflect the total calcium found in the soil as free calcium and because of such a high $Ca^{2}$+ content, shifts are hard to detect.

Year-to-year increases in exchangeable $Mg^{2}$+ occurred regardless of cropping sequence (data not presented). In the last 3 years of the experiment, K+ levels were higher in continuous soybeans than in continuous rice. One explanation for the elevated P content in soils in 1989 and 1990 was that there was a solubilization of Fe-reducing P compounds, thus causing an increase in soil-test P in the continuous rice plots in the last 4 years compared to continuous soybeans (Table 7). Zinc levels fluctuated from year-to-year with no apparent pattern evident for the various cropping systems (data not presented).

[1]Personal communication with Dr. Joe Pettiet, Pettiet Soil Testing Laboratory, Leland, MS.

**Table 4. Net returns above specified costs from an 8-year rice:soybean rotation on Sharkey clay at the Delta Branch Experiment Station, Stoneville, MS, (1983-1990).**

| Treatment description | Net returns above specified costs[a] | | |
|---|---|---|---|
| | 8-yr avg | Last 4-yr avg | Difference |
| | ($/acre) | | |
| 1 Rice: 1 Soybeans | 66.75 a | 74.15 ab | + 7.40 |
| 2 Rice: 1 Soybeans | 63.75 a | 38.69 cd | –25.06 |
| 3 Rice: 1 Soybeans | 58.25 a | 51.96 bc | – 6.29 |
| 1 Rice: 2 Soybeans | 56.87 b | 37.16 cd | –19.71 |
| 2 Rice: 2 Soybeans | 83.5 a | 93.11 a | + 9.61 |
| Cont. Soybeans | 7.88 c | 12.55 d | + 4.67 |
| Cont. Rice | 0.15 c | -52.59 e | –52.44 |

[a]Means followed by the same letter do not significantly differ (Duncan's MRT, P=0.05).

**Table 5. Yield, net returns, and costs for continuous soybean compared to those from soybean following one or two years of rice, Delta Branch Experiment Station, Stoneville, MS, 1983 to 1990.**

| Treatment description | Average[a] yield | Gross[b] value | Average production cost | Net return |
|---|---|---|---|---|
| | bu/acre | $/acre | | |
| Continuous soybeans | 18.4 | 112.79 | 104.5 | 8.29 |
| Soybeans behind 1 or 2 years of rice | 27.7 | 169.80 | 104.5 | 65.30 |

[a]Average yield represents the 8-year average for the specified crop sequence.

[b]Gross value determined as the product of yield and a seasonal average price of $6.13/bu.

**Table 6. Influence of an 8-year rice-soybean rotation on soil pH and percent organic matter at the Delta Branch Experiment Station, Stoneville, MS, 1983-1990.**

| Treatment Description | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|
| | Soil pH | | | | | | | |
| Continuous Rice | 6.70 | 6.83 | 6.90 | 7.05 | 7.53 | 7.88 | 7.60 | 7.70 |
| Continuous Soybeans | 6.23 | 6.25 | 6.25 | 6.35 | 5.83 | 4.67 | 6.55 | 6.63 |
| 1:1 Rice-Soybeans | 6.48 | 6.58 | 6.53 | 6.53 | 7.18 | 7.35 | 7.25 | 7.30 |
| 2:1 Rice-Soybeans | 6.65 | 6.85 | 6.78 | 6.73 | 7.55 | 7.60 | 7.45 | 7.70 |
| 3:1 Rice-Soybeans | 6.73 | 6.75 | 6.73 | 7.38 | 7.45 | 7.83 | 7.70 | 7.48 |
| 1:2 Rice-Soybeans | 6.58 | 6.78 | 6.40 | 6.48 | 7.15 | 7.08 | 7.18 | 7.23 |
| 2:2 Rice-Soybeans | 6.70 | 6.55 | 6.65 | 6.48 | 7.20 | 7.38 | 7.25 | 7.43 |
| LSD (0.05)[a] | 0.32 | 0.36 | 0.3 | 0.32 | 1.03 | 0.46 | 0.25 | 0.28 |
| CV, % | 3.22 | 3.60 | 3.09 | 3.17 | 9.70 | 2.89 | 2.26 | 2.53 |
| | Organic Matter (%) | | | | | | | |
| Continuous Rice | 2.14 | 2.15 | 2.26 | 2.54 | 2.54 | 2.34 | 2.31 | 2.23 |
| Continuous Soybeans | 2.02 | 2.17 | 2.15 | 1.97 | 1.99 | 2.35 | 1.97 | 1.89 |
| 1:1 Rice-Soybeans | 2.33 | 2.28 | 2.32 | 2.25 | 2.29 | 2.29 | 1.97 | 2.29 |
| 2:1 Rice-Soybeans | 2.04 | 2.28 | 2.08 | 2.02 | 2.20 | 2.36 | 2.08 | 2.11 |
| 3:1 Rice-Soybeans | 1.96 | 2.03 | 1.99 | 2.13 | 2.20 | 2.15 | 1.98 | 1.90 |
| 1:2 Rice-Soybeans | 2.05 | 2.34 | 2.25 | 2.26 | 2.21 | 2.34 | 2.03 | 2.35 |
| 2:2 Rice-Soybeans | 2.11 | 2.29 | 2.25 | 1.93 | 2.07 | 2.32 | 2.08 | 2.19 |
| LSD (0.05)[a] | NS | NS | NS | 0.47 | 0.48 | NS | NS | NS |
| CV, % | 19.62 | 17.14 | 16.16 | 14.57 | 14.70 | 13.67 | 14.91 | 17.0 |

[a]For comparison of any two means within a column and soil parameter.

**Table 7. Influence of an 8-year rice-soybean rotation on exchangeable potassium and phosphorous in the soil at the Delta Branch Experiment Station, Stoneville, MS, 1983-1990.**

| Treatment Description | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|
| | Potassium (K+) (ppm) | | | | | | | |
| Continuous Rice | 255 | 242 | 297 | 271 | 230 | 218 | 265 | 264 |
| Continuous Soybeans | 261 | 252 | 282 | 271 | 261 | 260 | 306 | 330 |
| 1:1 Rice-Soybeans | 262 | 242 | 279 | 257 | 234 | 224 | 283 | 297 |
| 2:1 Rice-Soybeans | 232 | 224 | 271 | 233 | 226 | 221 | 267 | 277 |
| 3:1 Rice-Soybeans | 245 | 238 | 286 | 255 | 242 | 215 | 266 | 275 |
| 1:2 Rice-Soybeans | 253 | 250 | 287 | 267 | 237 | 245 | 280 | 308 |
| 2:2 Rice-Soybeans | 257 | 250 | 300 | 269 | 235 | 225 | 293 | 325 |
| LSD (0.05)[a] | 46 | 50 | 38 | 50 | 33 | 37 | 33 | 56 |
| CV, % | 6.13 | 6.98 | 4.4 | 6.49 | 4.64 | 5.44 | 3.97 | 6.30 |
| | Phosphorus (P) (ppm) | | | | | | | |
| Continuous Rice | 37 | 37 | 49 | 41 | 47 | 45 | 59 | 64 |
| Continuous Soybeans | 38 | 41 | 44 | 41 | 34 | 34 | 46 | 41 |
| 1:1 Rice-Soybeans | 33 | 36 | 37 | 29 | 39 | 39 | 55 | 43 |
| 2:1 Rice-Soybeans | 31 | 36 | 34 | 25 | 42 | 44 | 53 | 54 |
| 3:3 Rice-Soybeans | 39 | 39 | 43 | 35 | 45 | 42 | 58 | 62 |
| 1:2 Rice-Soybeans | 38 | 44 | 45 | 32 | 38 | 41 | 50 | 45 |
| 2:2 Rice-Soybeans | 39 | 36 | 45 | 34 | 39 | 40 | 61 | 63 |
| LSD (0.05)[a] | 11 | 12 | 12 | 12 | 8 | 11 | 12 | 22 |
| CV, % | 9.81 | 10.4 | 9.4 | 4.70 | 6.65 | 9.19 | 7.14 | 13.94 |

[a]For comparison of any two means within a column and soil parameter.

## Summary

When soybeans were grown behind 1 or 2 years of rice, the average soybean yield increased 9.3 bu/acre compared to continuous soybeans (Table 5) resulting in a $57.01 increased net return. The rotations that resulted in the highest returns above specified costs during the last 4 years were the 2:2 and 1:1 rotation, with a 3:1 being equal to the 1:1. Each of these rotational systems returned a higher dollar value than either continuous soybeans or continuous rice. These data clearly indicate that rice makes a valuable rotational crop with soybeans and the returns far exceed those for either crop grown in continuous monoculture.

The appreciable amount of rice straw incorporated into the soil at the end of the growing season did not increase organic matter content over the term of the experiment. Soil pH increased in every system where rice was grown after the fourth year when compared to continuous soybeans. Exchangeable $Ca^{2}$+ and $Mg^{2}$+ fluctuated with time in this experiment.

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