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On the Cover

Relaying small, stunted, low value crawfish from overcrowded, food-deficient production ponds to a rice field was shown to encourage further growth, thus increasing market value.

Designated trapping lanes were constructed in the rice field to accommodate the crawfish harvest and comprised approximately 15% of the field area; lower proportions allocated to lane area may be acceptable for commercial sized fields.

Crawfish of minimal market size more than doubled in weight after relaying and a large portion of the reharvested crawfish were in the most valuable size category. Average recovery was 95% of the total weight stocked.

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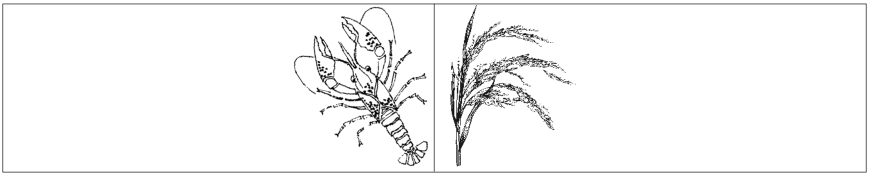

Relaying: An Intercropping Approach to the Co-Culture of Crawfish and Rice

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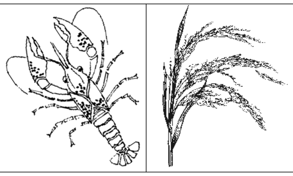


Introduction

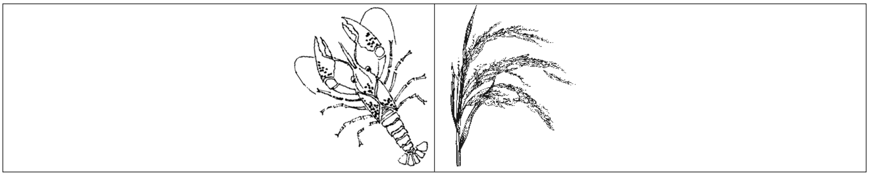
Louisiana is the international leader in freshwater crawfish production, and crawfish aquaculture (*Procambarus* spp.) is an important industry to the state. Approximately 50 million pounds of crawfish are harvested annually from culture ponds (LCES 1991, 1992, 1993, 1994, 1995). Additional crawfish are harvested from a natural fishery. The natural harvest can be extremely variable from year to year, ranging from near zero to well over the total harvested from farm ponds. Crawfish are usually graded into 3 or 4 size categories, and the larger sizes bring the highest prices (McClain and Romaire 1995a). Only a small percentage (<28%) of Louisiana's farmed crawfish production falls in the largest, most valuable size category. The highest percentage of marketable crawfish falls in the smallest size category, where prices can be one-fourth to one-fifth the price for the largest crawfish (Landreneau 1995). Some crawfish often remain unharvested due to low, or no, market potential. This is exacerbated in years when harvest from the natural fishery is high. Lack of satisfactory marketing opportunities for small crawfish can be economically devastating to many producers.

Excessive production of small, low-value crawfish has often been cited as a critical problem (Avault et al. 1975, Huner and Romaire 1979, Romaire and Lutz 1989) and remains one of the most important problems facing the Louisiana crawfish industry today (McClain and Romaire 1995a). This problem usually occurs late in the season (April - June) due to overpopulation and the early depletion of vegetative food resources. Established forages (mainly rice, *Oryza sativa*) serve as the primary input that drives a vegetative detrital food-web (Avault and Brunson 1990). When forage depletion occurs in ponds with high crawfish populations, the result is a cessation of crawfish growth, often resulting in "stunting" at an undesirable size (de la Bretonne and Romaire 1989). This puts many producers at an economic disadvantage because stunting frequently occurs before a significant amount of the annual harvest has been removed. Costly supplemental feeding has been tried with little or no biological or economical benefits. No management practice has been instrumental in predictably correcting the problem of stunting once it has occurred.

There are currently more than 100,000 acres devoted to crawfish production in Louisiana and over 500,000 acres devoted to rice production (LCES 1995). Much of the crawfish production area is in rice-dominated parishes. Because of common resource requirements for both commodities, many producers of crawfish also cultivate rice; in fact, crawfish culture is frequently used by rice producers in crop-rotational practices. In a double-cropping rice and crawfish system, a crawfish crop is produced in the same field following the rice harvest. Rice is planted in early spring and harvested in mid- to late summer. Following harvest, the rice stubble is managed for regrowth (ratooning), and after the ponds are flooded in autumn, the ratoon crop and residual straw from the rice harvest provide substrate for the detrital system. The integration of rice and crawfish culture in this manner is a logical combination that makes efficient use of resources.

There is usually an overlap in crawfish and rice seasons during spring, and it is common to have newly established rice fields on the same farm or nearby when crawfish growth ceases in forage-depleted crawfish ponds. This provides an opportunity to utilize the vegetative growth phase of rice production as a valuable resource for obtaining additional growth of crawfish to increase their market value, perhaps while preserving acceptable rice yields. Transferring, or “relaying,” small, low-value crawfish from “poor” production ponds into newly established rice fields, where there is an existing, more favorable environment for growth, and reharvesting them (prior to the rice harvest) at a larger, more valuable size may have favorable economic impacts on farming systems that are already integrated. The process of relaying may be particularly applicable in rice fields that are intended for use in double-cropping. With double-cropping, mature crawfish are usually stocked (seeded) at low rates in rice fields during early summer to provide broodstock for the subsequent crawfish season (de la Bretonne and Romaire 1989). Modifying this procedure to use sub-marketable crawfish in lieu of broodstock should have similar results since the remaining crawfish left in the field from a relay-reharvest operation would serve as brooders for the subsequent fall-winter-spring crawfish season.

This study was designed to examine the biological and economical efficacy of relaying crawfish into a growing rice crop in an intercropping manner. Intercropping refers to the simultaneous culture of two crops in the same field. Early findings of this study were reported by McClain et al. (1993). A series of experiments was then conducted to examine several aspects of this new concept. The principal objectives were to evaluate the potential for increasing crawfish size by relaying and to determine the effect of stocking density on percentage of recovery and size-at-harvest of crawfish retrieved prior to rice harvest. Also examined was the impact of the intercropping practice on rice yield. As additional sub-objectives, preplanting condition and an alternate crawfish harvest method were assessed for their effects on crawfish and rice yields.



Experimental Methods and Procedures

Field testing of intercropping crawfish and rice was conducted at the Rice Research Station, Crowley, Louisiana, between 1991 and 1995 in small (0.4 - 1.0 acre) earthen impoundments. Fields were managed to simulate rice-crawfish systems typical of the south-central region of Louisiana where much of the state's rice and crawfish are produced. The soil (pH, 5.4; organic content, 1.34%) was a Crowley silt loam. Well water (pH, 7.7; total alkalinity, 270 mg/L; and total hardness, 195 mg/L as $CaCO_3$) was supplied to each field via irrigation canals.

Rice was planted in early spring following standard practices (Bollich et al. 1987). Mars, a medium-grain variety commonly planted for grain and crawfish forage, was planted three of the five years. When Mars seed became unavailable, a closely related variety, Orion, was planted. Rice was planted in well tilled seedbeds following a 9-month fallow period (except where another preplanting condition was used as a treatment factor). Table 1 presents pertinent annual variables of the study.

Annual fertilizer applications were similar and averaged 132, 34, and 34 lb/A of N, P_2O_5, and K_2O, respectively. Phosphorus and potassium were applied in one application annually and incorporated prior to planting, except when applied after rice emergence in stale seedbed plantings. Part of the nitrogen requirement was applied with the phosphorus and potassium, and the remainder was applied prior to the permanent flood. To minimize the impact of weeds on yield variables for this study, herbicides (propanil + bentazon, 3 + 0.5 lb ai/A) were applied to the rice at about the 4-leaf stage, well in advance of crawfish stocking. No insecticide or fungicide was used in this study. For control of the rice water weevil (*Lissorhoptrus oryzophilus*),

Table 1. Annual experimental conditions for intercropping trials in which crawfish were relayed into a rice crop, and crawfish and rice yields were subsequently achieved. Rice Research Station, Crowley, LA

Annual Variables	1991	1992	1993	1994	1995
Rice Variety	Mars	Mars	Mars	Orion	Orion
Rice Planted	April 4	March 23	April 15	April 5	April 19
Previous Field Condition[1]	Fallow	Fallow or Flooded	Fallow or Flooded	Fallow	Fallow
Fertilizer N-P-K (lb/A)	124-45-45	126-48-48	125-24-24	136-24-24	148-30-30
Crawfish Stocking Rates (lb/A)[1]	500 or 1,000	1,000	500 or 750	250 or 750	250 or 750
Mean Size at Stocking (g)	15.1	14.0	13.5	11.9	13.5
% Immature at Stocking	56.0	42.5	50.0	78.4	80.0
Crawfish Relayed	May 22-29	May 11-20	June 1-7	May 16-25	May 24-June 2
Crawfish Harvested	June 26-July 17	June 22-July 10	July 19-August 6	July 11-29	July 5-August 4
Crawfish Harvest Method[1]	Trap	Trap	Trap	Trap or Net	Trap or Net
Total Trap-sets (No./A)	480	608	640	512	512
Rice Harvested	August 5	July 31	August 17	August 15	August 19

[1] Experimental variables used as treatment factors.

fields were drained (Quisenberry et al. 1992) for a period of about 5 days prior to permanent flood and subsequent introduction of crawfish.

Approximately 30 days after rice emergence, fields receiving crawfish were stocked with red swamp crawfish (*Procambarus clarkii*) purchased from nearby commercial producers. Other fields (controls) did not receive crawfish and were managed for rice production alone. Small or stunted crawfish were sought for this study and were easily obtained. Initial mean crawfish size ranged from 12 to 15 g (Table 1) and, on average, 39% (range 20% - 58%) were sexually mature. Crawfish were purchased daily and stocked within 1 to 2 hours after purchase. All stocking was completed within 5 days. The main component of this study evaluated crawfish yields and size-at-harvest when small crawfish were stocked into growing rice crops at four stocking rates (250, 500, 750, or 1,000 lb/A) and reharvested prior to rice maturity. Treatments were replicated in three to four field plots annually, and each stocking rate was implemented for 2 years.

Crawfish mortality due to handling and stress of the relay process was estimated each year. Enclosures were used to contain representative samples of crawfish for 1 week after stocking to fully assess stress-related death loss. Six cylindrical wire-mesh enclosures (5.4 ft^2 end area) were randomly placed over areas of rice within each field. These enclosures were placed a short distance from the levee and formed an enclosure within the natural pond environment as described by McClain (1995a). Random samples of crawfish were confined to the enclosures at approximately the same density as those relayed directly into the field. Enclosures were checked for acute crawfish mortality after 24 hours and assessed for delayed mortality after 7 days.

All fields were maintained with an average water depth of 8 to 10 inches. Dissolved oxygen (DO) and water temperature were monitored 3 to 5 days/week. Fields containing crawfish were flushed with fresh water only when early morning DO levels declined below 1.0 mg/L (average = 3.4 occasions/yr). Crawfish growth was monitored weekly with baited wire-mesh traps (0.75-inch mesh), and all crawfish were returned to the field. Harvesting commenced (except in certain fields) when test traps revealed that crawfish growth had ceased (no change in average individual weight from the previous week).

Crawfish were captured with pyramid-style traps (0.75-inch wire mesh) typically used in crawfish aquaculture (Romaire 1995). Traps were set in designated linear trapping lanes 6 feet wide and 42 feet apart, at a density of 32 traps/A. Approximately 15% of the field area was devoted to trapping lanes that were devoid of rice. Traps were baited with 0.35 lb of formulated

bait (Purina, Purina Mills, Inc., St. Louis, MO)/trap and emptied 5 to 7 days/week. Harvesting ceased when average catch-per-unit-effort (CPUE) consistently fell below 0.25 lb/trap.

Conventional trap harvesting typically accounts for 50% to 70% of the total direct expenses of crawfish production (Romaire 1995). To mitigate the cost of harvesting and to spare that portion of the rice crop destroyed by the use of trapping lanes, an alternate means of recovering the relayed crawfish was tested as an additional component of the study. In lieu of trap harvesting, a passive method was tested to capture crawfish during the normal discharge of water from rice fields. Water is normally discharged from rice fields prior to the rice harvest to better accommodate harvest machinery. The passive method of crawfish recovery employed hoop nets (0.75-inch nylon mesh) attached to the drain structure to capture crawfish flushed out by the exiting water. Because crawfish movement patterns were unknown, several draining strategies were utilized. Fields were drained either at night, during daylight, or during combinations of night and day by partially refilling and then draining the field, or by continuous flushing. This alternate, passive, harvest strategy was tested at two crawfish stocking densities (250 and 750 lb/A), and results were compared with crawfish and rice responses when crawfish were trap harvested. Each treatment was replicated in seven field plots over 2 years.

A third component of the study examined the effects of preplanting condition on crawfish and rice yield from intercropping. Preplanting conditions, or prior field use and corresponding seedbed condition, consisted of fields that were previously fallow and had well tilled seedbeds (controls) or fields that were formerly used for crawfish production and had “stale” or untilled seedbeds. It was unclear what impact residual crawfish from previous production might have on both crawfish and rice yield. The corresponding seedbed condition could also potentially affect rice production and crawfish yield. Fields previously in crawfish production were partially drained just prior to rice planting. Water level was reduced to about 2- to 3-inch depth, and pre-sprouted rice seed was broadcast into the shallow flooded fields and generally managed according to recommended practices for water seeding of rice (Bollich et al. 1987). However, pesticide use was restricted, and all fertilizer applications were made post-planting. After establishment of the permanent flood, experimental conditions were the same as for other trap-harvested fields. The experimental conditions (prior field use and corresponding seedbed condition) were implemented for 2 years, one year at the crawfish stocking rate of 750 lb/A and the other year at 1,000 lb/A. Treatments were replicated in two plots each year.

All harvested crawfish were mechanically graded with the use of a passive, water-based grader as described by Rollason and McClain (1995) and sorted into three size categories. The largest category contained crawfish that averaged 33 g or larger, the medium category comprised crawfish that were 24 to 32 g, and the smallest size category included crawfish less than 24 g.

At rice maturity, after trapping had ceased, water was discharged from all fields. Rice was combine harvested, and grain yield/A (adjusted to 12% moisture) was determined. For 1991 to 1993, small areas (426 ft^2) of the fields, with and without crawfish and away from field perimeters and trapping lanes, were randomly sampled for grain yield prior to total field harvest. Comparisons were made to assess the effects of crawfish presence and density on intrinsic rice yield. Fields stocked with crawfish at 0, 500, 750, and 1,000 lb/A were subsampled.

This study used a completely randomized design except where a flooded treatment (preplanting condition) dictated forced randomization. Data were statistically analyzed using the general linear model procedure of the Micro-SAS Statistical Software System (SAS version 6.10, SAS Institute, Cary, NC). A significant difference in treatment means was determined using Duncan's New Multiple Range Test, and all tests of significance were declared to be significant at $P \leq 0.05$.

Economic Analysis

An economic analysis was conducted to determine the profitability of relaying under the described intercropping approach. Costs and returns estimations were made for rice-only and relaying strategies at the 250, 500, 750, and 1,000- lb/A stocking rates. These estimations were made using the Mississippi State Budget Generator (Department of Agricultural Economics, Mississippi State University, Starkville, Mississippi), assuming input usages consistent with those of the field trials.

Because different stocking rates were tested in different years, resulting in confounded data, a method was needed to determine the yield that would be expected given the stocking rate in a "typical" year. A biological response function was estimated to determine the expected yield. Equation (1) presents the function.

$$(1)\ CFYield_s = \beta_0 + \beta_1{*}Y92 + \beta_2{*}Y93 + \beta_3{*}Y94 + \beta_4{*}Y95 + \beta_5{*}Stk500 + \beta_6{*}Stk750 + \beta_7{*}Stk1000$$

$CFYield_s$ represents crawfish yield of size s; Y92, . . ., Y95 represent

discrete variables for years 1992 through 1995; Stk500, Stk750, and Stk1000 represent discrete variables for stocking rates 500, 750, and 1,000 lb/A, respectively; and parameters $\hat{a}_0 \ldots \hat{a}_7$ are regression coefficients determined from the statistical analyses. Other factors that might influence the yield included rice variety, initial crawfish size, and harvest method. The levels of these factors were consistent within a given year for all assessed treatments, allowing their effects to be accounted for in the "Y92...Y95" variables. Thus, variation is assessed with the yield and stocking rate variables since all other variables are held constant either by year or stocking rate. The limitation of this type of analysis is that linearity is assumed; in years of high production, the absolute differences in yields among treatments are assumed equal to the absolute differences in years of lower production. However, because of the confounded data and limited observations, it would be inappropriate to impose an alternative functional form. Equations were estimated using the general linear model (GLM) procedure in SAS. Three equations were estimated, one for each size category — small, medium, and large crawfish. Least squares means were used to determine the yields. These yields were used to calculate net returns.

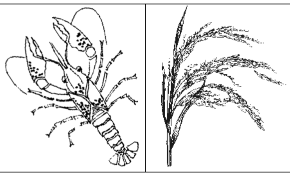
In assessing the costs associated with relaying, it was assumed that an airplane was used for three purposes: (1) to spread 150 lb of rice seed/A at planting, (2) to apply a 132-34-34 N-P-K fertilizer, and (3) to spread 3 qt and 1 pt/A of herbicides propanil and bentazon, respectively. It was assumed that 34.6 acre-inches of water were pumped, and 32 traps/A were used. The bait used for crawfish was a manufactured bait at 193.4 lb/A. It was assumed that 175 traps/hr were harvested with a 1-person-operated boat. The cost of seed crawfish was assumed to be $0.25/lb. Prices for other inputs are found in Table 9, estimated costs and returns/A for the different field operations.

Prices for harvested crawfish were assumed to be large grade, $0.91/lb; medium grade, $0.49/lb; and small, $0.31/lb, based upon a 1993 survey of Louisiana buyers (Landreneau, 1995). The price for rice was assumed to be $8.50/cwt (Giesler and Salassi, 1996).

Sensitivity analysis was conducted for two different scenarios: (1) the profitability of rice production relative to rice-crawfish intercropping given the state average rice yield and (2) the profitability of rice production relative to rice-crawfish intercropping given actual experimental crawfish yields. Crawfish yields were the average yields obtained, with no adjustment for year variability.

Analysis was also conducted to determine whether it was more profitable to relay in (1) a rice field that had previously been in crawfish produc-

tion and was planted as a flooded and untilled seedbed or (2) a rice field that had been fallowed and tilled prior to rice establishment. The fallowed rice field was the baseline scenario. Field operations that were not conducted with the flooded scenario were disking, plowing the levees, dozer blading, and using a rotary ditcher in November; disking in February; and field cultivating, using a rotary ditcher, dozer blading, and using a drag in March. Sprouted rice seed was used in the flooded scenario. Propanil and bentazon were not used, and there was one less flush involved in the flooded scenario. Flooded versus fallow seedbeds were compared for the 750 lb/A stocking rates. Crawfish yields used were those in Table 5 for the 750 lb/A stocking rate.



Results and Discussion

Crawfish Harvest

Relaying small, often stunted, crawfish from poor environments, characterized by overcrowded conditions and food shortages, to the improved environment of a rice field consistently resulted in additional and substantial crawfish growth. Over the 5-year period, crawfish of questionable marketing size (mean weight = 13.5 g) increased to more than 200% of their initial weight after relaying, with nearly 40% of the harvest grading in the largest, most valuable size category (Table 2). Only 13% of the reharvested crawfish (by weight) remained in the smallest size class; however, average individual weight for that category was 19 g, a 41% increase from the average weight at stocking. Mean individual weight for the largest size category was 35 g, 259% heavier than mean initial weight.

Other attempts to effect additional crawfish growth in stunted populations have generally been ineffective. Supplemental feeding of hays or agricultural by-products (Rivas et al. 1979, Day and Avault 1986) and even high quality formulated feeds (Martinez et al. 1990, Whaley and Eversole 1993, Jarboe and Romaire 1995, McClain 1995b) have not been successful in preventing stunting or significantly increasing crawfish size. Crawfish

Table 2. Mean yield and size (±SD) of trap harvested crawfish after relaying at different densities into a growing rice crop for the purpose of increasing crawfish size and value. Means followed by the same letter within a row were not significantly different (P>0.05). Rice Research Station, Crowley, LA

	Crawfish Stocking Rate (lb/A) and Average Initial Size (g)				
	250 (12.6)	500 (14.3)	750 (12.6)	1,000 (14.6)	Mean
			Yields (lb/A)		
Large (>32 g)	164±12^{B}	209±60^{B}	151±69^{B}	267±71^{A}	
Medium (24 - 32 g)	129±57^{D}	218±55^{C}	303±48^{B}	417±77^{A}	
Small (<24 g)	35±18^{B}	66±50^{B}	123±38^{A}	64±25^{B}	
Total	328±80^{C}	492±88^{B}	577±58.9^{B}	748±111^{A}	
			Size-at-Harvest (g)		
Large	38.6±1.7^{A}	35.6±3.4^{B}	32.9±0.8^{C}	34.1±2.5^{BC}	35.3
Medium	30.5±1.0^{A}	28.0±1.5^{B}	27.1±0.5^{B}	27.0±1.3^{B}	28.1
Small	19.3±1.8^{A}	18.6±2.4^{B}	18.4±1.7^{B}	19.3±1.5^{A}	18.9
Weighted Average	31.9	28.7	25.7	28.2	28.6
			Yields (as % of Total)		
Large (>32 g)	50.2±10.8^{A}	42.4±13.4^{AB}	26.2±11.5^{C}	35.8±8.5^{B}	38.6
Medium (24 - 32 g)	39.3±8.5^{C}	44.2±5.5^{B}	52.6±6.8^{A}	55.7±6.8^{A}	47.9
Small (<24 g)	10.6±2.3^{BC}	13.4±8.9^{B}	21.3±5.3^{A}	8.5±2.6^{C}	13.4

growth and harvest size have been shown to be highly affected by population density (Lutz and Wolters 1986, Villagran 1993, McClain 1995b), but reduction of crawfish density late in the season (April), after growth had ceased, did not affect subsequent crawfish size-at-harvest, even with supplemental feeds (Jarboe and Romaire 1995). Only when crawfish population density was reduced early in the season (February) was size-at-harvest significantly increased (McClain and Romaire 1995b). This study demonstrated that crawfish size can be substantially increased, even late in the season, by relaying crawfish into a different environment. A rice field in which rice is in its vegetative growth phase provides a suitable environment for further crawfish growth.

Although crawfish size was greatly increased each year and at each stocking rate by relaying, the magnitude of that increase and the total proportion of crawfish retrieved were dependent largely on initial stocking rate (Table 2). As stocking rate increased from 250 to 1,000 lb/A, the mean percentage increase in weight and the total amount of crawfish retrieved as a percentage of that stocked generally decreased. Average crawfish weight gain (as a % of initial weight) was 153% at the lowest stocking rate and 93% at the highest stocking rate, but final weight was partially dependent on initial size at stocking. The percentage of the catch grading as large was also greatest at the low stocking rate and was partially related to stocking rate or population density. Population density has been indicated as being the principal factor affecting crawfish size-at-harvest in commercial ponds in Louisiana (McClain and Romaire 1995a). The effect of population density on crawfish size also apparently applies to the practice of intercropping, as indicated by these data, where vegetative resources were not limiting.

The dynamics of crawfish recovery from the relay-reharvest approach used in this study are presented in Table 3. Although mean individual crawfish weight more than doubled after relaying, on average, only 95% of the total weight at stocking was recovered. Recovery, expressed as a percentage of the total weight stocked, exceeded 100% only in the lowest stocking treatment and decreased as stocking rate was increased. Based on the number of individuals stocked, an average of just 45% of the crawfish were recovered. The recovery data may be partially explained by mortality and crawfish growth responses. Mortality estimates were intended to assess acute (1-day) and delayed (7-day) stress-induced mortality due to the relay process. However, when the 7-day mortality estimates were used to adjust for surviving population density, average recovery of surviving individuals was 69% rather than 45%. Mortality through the harvest period may

Table 3. Dynamics of crawfish recovery by trap harvest after relaying crawfish into a growing rice crop at different densities. Estimated 7-day mortalities were used to predict mortality from handling and stocking. Rice Research Station, Crowley, LA

	Crawfish Stocking Rate (lb/A) and Average Initial Size (g)				
	250 (12.7)	500 (14.3)	750 (12.7)	1,000 (14.6)	Mean
Total Crawfish Stocked (No./A)	8,929	15,860	26,787	31,068	
(No./m^2)	2.2	3.9	6.6	7.7	
Estimated Mortality (%)					
1-day	2.4	19.7	14.4	14.2	12.7
7-day	19.6	39.5	33.7	47.1	35.0
Est. Crawfish Surviving (No./A)	7,179	9,595	17,760	16,435	
(No./m^2)	1.8	2.4	4.4	4.1	
Total Crawfish Retrieved (No./A)	4,661	7,778	10,192	12,049	
(No./m^2)	1.2	1.9	2.5	3.0	
Retrieval Rate					
(As % of No. Stocked)	52.2	49.0	38.0	38.8	44.5
(As % of No. Surviving)	64.9	81.1	57.4	73.3	69.2
(As % of lb Stocked)	131.0	98.4	76.9	74.8	95.3

have been higher; thus, actual recovery of survivors may have been higher than 69%. In addition, trap harvesting is not fully efficient; some crawfish burrowed during the study, others remained after the harvest. Recovery, as a percentage of individuals stocked, was usually inversely proportional to stocking rate; however, compensating for mortalities, recovery of survivors may have been similar for all stocking rates or affected by factors other than stocking rate. Recovery rates by total weight were near 100%, on average, because of the growth response prior to harvest.

In few studies have earthen ponds been stocked with procambarid crawfish with the intention of reharvesting after a growout period (Perry and Trimble 1990, Huner 1992). The results of those studies were often confounded by natural recruitment or high numbers of predators. One comparable study did examine the growth and recovery after stocking low numbers (0.65 - 2.75/m^2) of 13- to 19-g crawfish (Huner 1992). Mortality was not estimated, but recovery was similar to that achieved in this study and averaged 47% (range, 34% to 62% of individuals stocked).

Crawfish harvest data previously presented describe results obtained from trap harvest of relayed crawfish. An alternate means of recovering the relayed crawfish was tested as an additional component of this study. Hoop nets attached to drain structures were used to entrap crawfish during routine draining of a field in preparation for the rice harvest. Results of that component of the study are presented in Table 4 and show a dramatic reduction in crawfish recovery when the drain method of harvest was used. Recovery was drastically reduced at both stocking rates, and reduction in total yield compared with conventional trapping averaged 90%. Crawfish size-at-harvest was little affected by the alternate harvest method. Results were consistent for both years, whether ponds were drained nocturnally or diurnally and whether fresh water was flushed through the field during draining. The use of nets attached to drain structures appears to be an ineffective technique for recovering red swamp crawfish from rice fields during the routine discharge of water. Crawfish were reluctant to move with the flow of water, and many were observed moving against the flow. The propensity of crawfish to move against the water flow has been used to develop a technique for harvesting the Australian red claw crayfish, *Cherax quadricarinatus*, in small ponds (Curtis and Jones 1995). That technique would likely be ineffective in large rice fields.

The third component of this study examined effects of previous field history and condition on yield and size of crawfish after relaying. Rice is usually planted in tilled fields that were previously fallow, but often crawfish ponds are drained earlier than normal and used to grow a rice crop. In

Table 4. Effects of harvest method on yields and size of relayed crawfish stocked at two densities. Harvest methods consisted of either a traditional trapping approach or net harvest at the drain site during the water discharge period. Values are presented as means ± SD. Means followed by the same letter by row within stocking rate category were not significantly different (P>0.05). Rice Research Station, Crowley, LA

	Crawfish Stocking Rate (lb/A) and Average Initial Size (g)				
	250 (12.7)		750 (12.7)		Average[1]
	Trap Harvest	Net Harvest	Trap Harvest	Net Harvest	% Change
			Yields (lb/A)		
Large (>32 g)	164±12^{A}	18±9^{B}	151±69^{a}	23±8^{b}	-86.8
Medium (24 - 32 g)	129±57^{A}	8±5^{B}	303±48^{a}	29±21^{b}	-92.0
Small (<24 g)	35±18^{A}	2±1^{B}	123±38^{a}	11±11^{b}	-92.5
Total	329±80^{A}	28±13^{B}	577±59^{a}	63±39^{b}	-90.3
Total as % of lb stocked	131.7%	11.3%	76.9%	8.4%	
			Size-at-Harvest (g)		
Large	38.6±1.7^{A}	38.1±1.1^{A}	32.9±0.8^{a}	33.1±2.4^{a}	-0.3
Medium	30.5±1.0^{A}	31.7±2.2^{A}	27.1±0.5^{b}	28.6±2.8^{a}	+4.7
Small	19.3±1.8^{A}	17.3±2.8^{B}	18.4±1.7^{b}	21.4±3.9^{a}	+3.2

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[1] The % increase or decrease in variable response from net harvest at the drain site when compared with trap harvesting was calculated for each stocking rate and then averaged.

many cases those fields are not tilled; rather, rice seed is broadcast into a seedbed containing shallow water and a soft bottom. This study tested the concept of intercropping under such conditions. Results (Table 5) indicated that intercropping crawfish at high stocking densities (750 and 1,000 lb/A) in rice fields previously used to produce crawfish had little effect on crawfish yield and size-at-harvest. Although not statistically significant, total crawfish yield was reduced by an average of 14% in these ponds. Most of the yield reduction occurred at the highest stocking rate.

Similar weight gain of individual crawfish indicates that previous field history and condition had little impact on crawfish growth. Crawfish are thought to rely on soft bodied metazoans as major food components in detrital-based production ponds (Momot 1995). One unknown consequence from a field previously in crawfish production was the resulting effect on the metazoan component of the food resource. Previous production might have severely cropped or depleted such resources or somehow curbed the productivity of the benthic environment for intercropping. Similar production outcomes suggest that previous field condition had little negative effect on this component of the food web. Another unknown factor was the potential for overcrowding if large numbers of residual crawfish from the previous production scenario existed. The small difference in crawfish recovery and size-at-harvest of crawfish from previously flooded fields indicated overcrowding from residual crawfish was not a problem in this study.

Rice Harvest

Each year and at each stocking rate, the crawfish harvest was completed prior to rice maturity and did not interfere with the rice harvest. Water was discharged from the fields at rice maturity, and rice was harvested by combine in the conventional manner. Rice yields in the control fields averaged 5,903 lb/A (Table 6). The overall mean rice yield for Louisiana during the test period was 4,807 lb/A with annual averages ranging from 4,629 to 5,144 lb/A (LCES 1991, 1992, 1993, 1994, 1995). Rice yield in this study was largely affected by rice variety; Orion outyielded Mars. This may be partially explained by the inherent resistance of Orion to blast disease (Groth 1995). Mars is especially susceptible to blast. No attempt was made to quantify the presence of blast in this study, but blast was particularly damaging to the commercial rice crop during 1991 to 1993 (Don Groth, Plant Pathologist, Rice Research Station, Louisiana Agricultural Experiment Station, personal communication). Orion also outyielded Mars in yield tests performed at the Rice Research Station (Bollich et al. 1991, 1992). No effort was made to compare rice variety performance in

Table 5. Effects of previous field conditions on harvest of relayed crawfish stocked at two densities. Fields were either fallowed and tilled prior to rice establishment or previously in crawfish production, whereby rice was planted in flooded and untilled seedbeds. Values are presented as means ± SD. Comparisons within stocking rate category were not significantly different ($P>0.05$). Rice Research Station, Crowley, LA

	Crawfish Stocking Rate (lb/A) and Average Initial Size (g)				
	750 (13.5)		1,000 (14.0)		Average[1]
	Fallow	Flooded	Fallow	Flooded	% Change
Yields (lb/A)					
Large (>32 g)	209±71	187±39	251±124	184±2	-18.8
Medium (24 - 32 g)	259±16	260±0	379±12	283±30	-12.4
Small (<24 g)	93±14	104±6	44±7	28±4	-12.6
Total	561±50	551±33	674±129	494±31	-14.2
Total as % of lb stocked	74.8%	73.4%	67.4%	49.4%	
Size-at-Harvest (g)					
Large	33.2±0.8	33.0± 0.1	31.6±1.4	32.9±0.7	+1.7
Medium	27.0±0.2	26.5±0.4	25.9±0.8	26.8±0.1	+0.9
Small	16.6±0.6	16.6±0.1	17.8±0.1	17.6±0.1	-0.8

[1] The % increase or decrease in variable response from fields previously in crawfish when compared with fallow fields was calculated for each stocking rate and then averaged.

Table 6. Effects of intercropping, previous field condition, and crawfish harvest methods on rice yield (lb/A) following the relay/harvest of crawfish at different densities within a growing rice crop. Values presented are mean yield ±SD adjusted to 12% moisture. Comparisons within columns by treatment category were significantly different ($P<0.05$) with exception of the one noted*. Rice Research Station, Crowley, LA

	Crawfish Stocking Rate (lb/A)				
	250	**500**	**750**	**1000**	**Mean**
Effect of Intercropping					
Rice Variety	Orion	Mars	Orion	Mars	
Control (Without Crawfish)	6674±227	4954±301	6803±105	5181±373	5903
With Crawfish	5191±459	3713±340	5181±621	3894±421	4495
% Change[1]	-22.2	-25.1	-23.8	-24.8	-23.9
Effect of Previous Field Condition					
Rice Variety			Mars	Mars	
Control (Fallow, Tilled Seedbed)			3356±750	4343±81	3850
Flooded, Stale Seedbed			2672±172	2194±189	2433
% Change[1]			-20.4*	-49.5	-34.9
Effect of Harvest Method					
Rice Variety	Orion		Orion		
Control (Trap Harvest)	5191±459		5181±621		5186
Drain Harvest	6577±302		6482±249		6530
% Change[1]	+26.7		+25.1		+25.9

[1] The % increase or decrease in rice yield relative to the control group within treatment category.

the presence of crawfish. Also, because different rice varieties were used, no effort was made to correlate rice yield with crawfish stocking rate. However, within the respective stocking rates for each variety, little impact of stocking rate on rice yield was apparent.

The main intent of this aspect of the study was to assess the impact of the intercropping operation on rice yield. Fields receiving crawfish averaged nearly 24% lower rice yields than fields not receiving crawfish (Table 6). A large proportion of this reduction in yield can be attributed to the reduction in rice cultivation area from the construction of trapping lanes. There was no rice production in areas devoted to trapping lanes. Area allocated to trapping lanes averaged 15.5%, 15.4%, 16.7%, and 13.8% for fields stocked at rates of 250, 500, 750, and 1,000 lb/A, respectively. Therefore, reductions in rice yield not attributable to presence of trapping lanes were 6.6%, 9.7%, 7.1%, and 11.0% for the respective stocking-rate treatments. These reductions were apparently due to the presence of crawfish and averaged 8.6%. The greatest reduction in rice yield (11%) attributable to crawfish from this inference occurred at the highest stocking rate. Subsample analysis of rice yield taken in random areas of the field, away from trapping lanes, showed slightly less impact from crawfish. Intrinsic rice yields were negatively impacted in the subsampled areas only at the highest stocking rate and averaged 6.1%. The impact of high crawfish densities on macrophyte destruction and disappearance are well documented (Huner 1994). However, the biggest threat to rice yield with intercropping appears to be from destruction of rice in the trapping lanes. The area of the field allocated to trapping lanes in this study (approximately 15%) may be higher than necessary for commercial size fields.

Rice (variety, Orion) harvested from fields where crawfish retrieval was attempted by net harvest during the water discharge period resulted in rice yields nearly 26% higher than when crawfish were trap harvested (Table 6). This can be largely explained by the lack of trapping lanes that reduced rice yield. Drain-harvested fields had rice yields averaging only 3.1% less than similar fields containing no crawfish, with the greatest reduction (4.7%) occurring in the 750 lb/A treatment. Despite the improvement in rice yield when the alternate method of crawfish retrieval was used, the poor crawfish yield makes this method useless for intercropping.

Previous field condition was also evaluated for effect on rice yield after intercropping. The rice variety Mars was used for this aspect, and treatments consisted of either previously fallow fields with well tilled seedbeds or previously flooded fields (in crawfish production) with untilled seedbeds. For this evaluation, crawfish were stocked in all fields at the higher stocking rates (750 or 1,000 lb/A). Rice yield after intercropping averaged 3,850 lb/A for previously fallow fields and 2,433 lb/A for previously flooded fields, a 35% decrease. A significant difference existed only at the highest stocking rate (Table 6). Though emergence data were not collected, it was observed that rice emergence was generally lower in previously flooded fields, particularly during 1992, when the weather turned unseasonably cool after planting. Inferior rice stands could have been caused by a stale seedbed and/or by the presence of crawfish at seeding. Reduced rice yields were likely associated with poor stands. High crawfish density (1,000 lb/A stocking rate) may have exacerbated the reduction of rice yield in that treatment group.

Economic Evaluation

The estimates of the biological response function are presented in Table 7. The estimates for variables STOC500, STOC750, STOC1000, YEAR92, YEAR93, YEAR94, and YEAR95 represent differences from the base, a 250-lb, 1991 yield, that a producer might expect in a typical year. Most of the estimates are significant at the 0.05 level of significance, lending evidence that stocking rate and year have an influence upon yields. Least squares means yields for crawfish are presented in Table 8, under column “Quantity.” Note that there is a negative estimated yield for the small size of crawfish in the 250-lb relay. Yields of small crawfish were relatively high in 1994 and 1995, the years when the 250-lb relay was conducted. When placed in the context of a typical year, the negative was estimated because in the years when the 250-lb relay was not conducted, yields for small crawfish were low. This illustrates the type of problem that can occur when there is not a complete set of data available for each year.

Tables 8, 9, and 10 provide the returns and costs associated with each of the operations. It was assumed that the rice yield was 5,903 lb/A for rice-only; this yield was decreased 23.9% for relaying, due primarily to lanes constructed for harvesting crawfish. Returns are higher with higher crawfish stocking rates. Direct costs increase with stocking rate as more crawfish are purchased. (We assume that the price of purchased stocker crawfish is equal to the price at which the farmer could sell small crawfish; thus, this cost represents the farmer’s opportunity cost for small crawfish.) Fixed costs are the same for all stocking rates.

Table 11 presents results of the costs and returns estimations for relaying of crawfish into rice. Note that returns above total specified expenses for rice are $71.96/A. This is less than might be expected with a 250-lb stocking rate in a relay operation, $124.88. As the stocking rate increases,

Table 7. Partial regression coefficient estimates of the biological response function

Measure	Bi Estimate	Standard Error of Bi
Small Crawfish Yield Equation		
Intercept	-76.00**	30.55
STOCK500	106.33**	3.95
STOCK750	98.00****	17.64
STOC1000	153.00***	33.77
YEAR92	-33.00	22.77
YEAR93	70.67**	20.37
YEAR94	123.25***	27.89
YEAR95	93.67**	33.77
	F = 9.97****, R-Square = 0.8041	
Medium Crawfish Yield Equation		
Intercept	70.67	59.12
STOCK500	135.67**	52.14
STOCK750	166.00****	34.14
STOC1000	371.33****	65.36
YEAR92	-63.50	44.07
YEAR93	22.33	39.42
YEAR94	100.08*	53.97
YEAR95	1.67	65.36
	F = 18.38****, R-Square = 0.8833	
Large Crawfish Yield Equation		
Intercept	362.42****	56.81
STOCK500	-108.42**	50.10
STOCK750	-62.75*	32.80
STOC1000	-84.08	62.81
YEAR92	-27.33	42.34
YEAR93	-90.67**	37.87
YEAR94	-192.42**	51.86
YEAR95	-205.75**	62.81
	F= 5.22**, R-Square = 0.6824	

* indicates significance at the 0.10 level; ** indicates significance at the 0.05 level; *** indicates significance at the 0.001 level; **** indicates significance at the 0.0001 level.

Table 8. Estimated returns/A, rice-only and relaying operations

Item	Unit	Price	Quantity	Amount, $
		RICE ONLY		
Rice	cwt	8.50	59.03	501.76
Rice Checkoff	cwt	0.06	-59.03	-3.54
Total Income				498.21
		250-LB RELAY		
Crawfish (July) small	lbs	0.31	-25.00	-7.75
Crawfish (July) med	lbs	0.49	83.00	40.67
Crawfish (July) large	lbs	0.91	259.00	235.69
Rice	cwt	8.50	44.95	382.08
Rice Checkoff	cwt	0.06	-44.95	-2.70
Total Income				655.73
		500-LB RELAY		
Crawfish (July) small	lbs	0.31	81.00	25.11
Crawfish (July) med	lbs	0.49	218.00	106.82
Crawfish (July) large	lbs	0.91	151.00	137.41
Rice	cwt	8.50	44.95	382.08
Rice Checkoff	cwt	0.06	-44.95	-2.70
Total Income				648.71
		750-LB RELAY		
Crawfish (July) small	lbs	0.31	73.00	22.63
Crawfish (July) med	lbs	0.49	249.00	122.01
Crawfish (July) large	lbs	0.91	196.00	178.36
Rice	cwt	8.50	44.95	382.08
Rice Checkoff	cwt	0.06	-44.95	-2.70
Total Income				702.37
		1000-LB RELAY		
Crawfish (July) small	lbs	0.31	128.00	39.68
Crawfish (July) med	lbs	0.49	454.00	222.46
Crawfish (July) large	lbs	0.91	175.00	159.25
Rice	cwt	8.50	44.95	382.08
Rice Checkoff	cwt	0.06	-44.95	-2.70
Total Income				800.76

Table 9. Direct expenses/A, rice-only and crawfish relaying operations

Measure	Rice Only	250# Relay	500# Relay	750# Relay	1000# Relay
CUSTOM					
Airplane Fertilizer	15.08	15.08	15.08	15.08	15.08
Airplane Seeding	6.57	6.57	6.57	6.57	6.57
Global Pos System	1.20	1.20	1.20	1.20	1.20
Airplane Propanil	4.75	4.75	4.75	4.75	4.75
Drying Rice	63.00	47.97	47.97	47.97	47.97
Rice Storage	23.61	17.98	17.98	17.98	17.98
CRAWFISH BAIT	N/A	32.89	32.89	32.89	32.89
FERTILIZER					
Nitrogen	34.32	34.32	34.32	34.32	34.32
Phosphorus	7.14	7.14	7.14	7.14	7.14
Potassium	4.08	4.08	4.08	4.08	4.08
HERBICIDES					
Propanil	14.64	14.64	14.64	14.64	14.64
Bentazon	8.19	8.19	8.19	8.19	8.19
LABOR	25.32	44.47	45.67	46.87	48.07
OTHER					
Plastic	1.08	1.08	1.08	1.08	1.08
Sacks	N/A	1.20	1.84	2.17	2.81
SEED					
Stocker Crawfish	N/A62.50	125.00	187.50	250.00	
Rice Seed	24.00	24.00	24.00	24.00	24.00
FUEL					
Diesel	60.41	60.41	60.41	60.41	60.41
Gasoline	2.09	2.99	2.99	2.99	2.99
REPAIR & MAINT	36.34	37.04	37.04	37.04	37.04
INT ON OPER CAP	9.62	12.47	14.60	16.73	18.87
TOT DIRECT EXP	342.51	442.03	508.50	574.66	641.15

Table 10. Fixed expenses/A, rice-only and crawfish relaying operations

Measure	Rice Only	250# Relay	500# Relay	750# Relay	1000# Relay
Implements	5.37	5.37	5.37	5.37	5.37
Tractors	12.17	12.17	12.17	12.17	12.17
Self-Propelled Equip	34.14	36.15	36.15	36.15	36.15
Irrigation Sys 9 fl wp	32.07	32.07	32.07	32.07	32.07
Crawfish Traps	N/A	3.06	3.06	3.06	3.06
Total Fixed Expenses	83.74	88.82	88.82	88.82	88.82

Table 11. Estimated costs and returns/A, rice-only and crawfish relay operations

Measure	Rice Only	250# Relay	500# Relay	750# Relay	1000# Relay
Total Income	498.21	655.73	648.71	702.37	800.76
Total Direct Expenses	342.51	442.03	508.50	574.66	641.14
Returns Above Direct Expenses	155.71	213.70	140.21	127.71	159.62
Total Fixed Expenses	83.74	88.82	88.82	88.82	88.82
Total Specified Expenses	426.25	530.85	597.33	663.48	729.95
Returns Above Total Specified Expenses	71.96	124.88	51.39	38.89	70.80

less of the $0.91/lb large crawfish are harvested; thus, the yield of the crawfish with the highest price is decreased, decreasing net returns. While smaller crawfish are increased, they do little to increase net returns since they are priced at only $0.31/lb. The boost in the net returns of the 1,000-lb stocking rate was due to a large estimated increase in the medium-sized crawfish harvest for that rate.

A relatively high yield for rice was assumed in this analysis because higher yields were obtained under experimental conditions. However, if lower yields were obtained for rice, the relaying operations would become relatively more profitable than rice-only. This is because as rice yields increase, the opportunity cost of taking out 23.9% of the rice crop for crawfish lanes becomes higher. Table 12 presents a sensitivity analysis where state average rice yields were used. When state average rice yields were assumed, both the 250- and 1,000-lb relay operations were profitable. Thus, crawfish relaying should be more profitable in lower yielding rice fields.

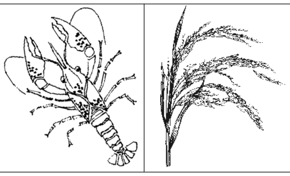
Table 12. Results of the economic sensitivity analysis

	Returns Above Specified Expenses				
Scenario	Rice Only	250# Relay	500# Relay	750# Relay	1000# Relay
Experimental Rice Yield, Estimated Crawfish Yields (Baseline)	71.96	124.88	51.39	38.89	70.80
Experimental Rice Yield, and Experimental Crawfish Yields	71.96	70.36	97.39	37.64	113.14
State Average Rice Yield, Estimated Crawfish Yield	-4.81	65.92	-7.57	-20.08	11.84
State Average Rice Yield, Experimental Crawfish Yields	-4.81	11.40	38.43	-21.33	54.18

Sensitivity analysis is also provided where actual yields for crawfish harvest were used. Results are fairly consistent with estimated crawfish yields, except that the 1,000-lb crawfish relay is deemed the most profitable, rather than the 250-lb crawfish relay. The 1,000-lb crawfish relay trials were conducted in years when crawfish yields were high relative to other years. Thus, these results should be viewed with caution. Using estimated yields, the 1,000-lb relay was the second most profitable, behind the 250-lb relay.

Effect of previous field condition appears to have a significant impact on rice yield, as indicated in Table 6. Economic analysis indicates that it is not as profitable to relay in flooded, untilled seedbeds for the 750-lb/A relay operation if the reduction in rice yield is greater than approximately 21%. While fewer field operations and less herbicide are used, the reduction in rice yields causes returns to suffer dramatically. Returns over specified expenses were $61.82/A under the fallow seedbed scenario and $63.09/A under the flooded seedbed scenario when a reduction in rice yield of 20.4% was used. Results from the 1,000-lb/A relay flooded operation indicate that rice yields may be reduced by as much as 49% due to field condition. It is not the opinion of the authors that this higher reduction in the 1,000-lb/A relay was due solely to stocking rate, but rather due mostly to weather conditions in the year in which the trial was conducted. These results suggest that relaying in rice fields that have been planted in untilled, flooded seedbeds of previous crawfish ponds might lead to high yield risk. High yield risk implies high risk in returns over specified expenses.

An additional significant economic benefit of relaying as an intercropping approach in rice should be noted. When intercropping is used, broodstock crawfish are not needed for the subsequent season's crawfish crop. If a producer plans to double crop crawfish the following winter, intercropping can reduce broodstock costs in that operation significantly. Boucher and Gillespie (1996) estimate the current cost/A for seed crawfish to be $30.00. Thus, for those rice producers who plan to double crop rice and crawfish in the subsequent year, the reduced cost of $30.00/A for crawfish seed stock should be considered.



Summary and Conclusions

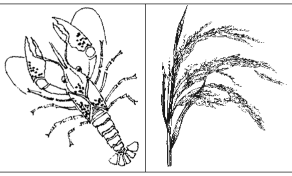
While it is widely accepted that overproduction of small, low-value crawfish is a serious impediment to economic competitiveness for many producers, dependable management strategies to mitigate this problem have not been previously demonstrated. This research has shown that relaying small crawfish from overcrowded, food-deficient production ponds to a rice field encourages further growth, thus increasing market value of the crawfish. Crawfish of minimal market size more than doubled in weight after relaying, and 87% of the reharvested crawfish were in the top two most valuable size categories. Average recovery ranged from 75% of the total weight stocked to 131% and was affected by stocking rate. Highest recovery percentages and largest crawfish were generally inversely proportional to stocking rate.

Moreover, results from this study indicate that it may be possible to achieve satisfactory rice yield after relayed crawfish have been reharvested, thus, lending credence to the feasibility of the intercropping concept. Rice yield was reduced 24% by intercropping (due mainly to presence of trapping lanes), but under certain conditions, the economic gain from relaying may more than offset the net loss from rice alone. The drain method of harvesting crawfish was shown to spare most of the loss in rice yield but was deemed unsuitable because of its low rate of crawfish recovery. Crawfish recovery was only slightly reduced when crawfish were relayed into a rice crop that was established immediately following a crawfish crop, but low rice yield coupled with lower crawfish yield suggests this practice may be less predictable. Therefore, the authors caution against relaying in rice fields that have been planted in flooded, untilled seedbeds of previous crawfish ponds. These conditions are likely to lead to high amounts of yield risk and, thus, high amounts of risk to returns over specified expenses. More research is needed before recommendations can by made to use the drain method of harvest following relaying or to use the relay-reharvest approach in rice crops that immediately follow crawfish production.

Economic analysis supports the practice of relaying under certain conditions. A stocking rate of 250 lb/A produced returns above specified expenses higher than those of rice-only. Where rice yields are lower, relaying will be relatively more profitable since the producer will not be giving up high yielding rice land for crawfish harvest lanes. The reported returns above specified expenses do not account for the reduced costs associated with seed crawfish in a rice-crawfish double crop scenario. Under this scenario, the reduced cost of crawfish seed stock needs to be assessed, because relaying could be more attractive than the economic analysis in Table 12 suggests.

Results from this study support the concept of integrating crawfish and rice production in a relay-reharvest management approach. Producers who would likely benefit the most from an intercropping operation are those who have the ability to, or who are already, culturing rice and crawfish in traditional double-cropping systems. It would be logical for those producers who normally seed their rice fields with crawfish broodstock to consider relaying. The remaining crawfish in a field after intercropping would serve as broodstock for the subsequent crawfish season. After the rice harvest, fields could be managed according to the recommended practices for typical crawfish operations in rice-crawfish double-cropping programs.

Intercropping may also function to extend the crawfish harvest season for individual producers, thereby allowing them to serve customers for a longer period in a seasonal market. However, caution must be emphasized when directly extrapolating the results of this research to a commercial operation. Though this research project has established some important baseline information for a new production concept, this concept has not yet been tried on a commercial basis. Furthermore, because culture practices and environmental conditions are highly variable, outcomes will be variable. The economic feasibility of this production scheme should be scrutinized on an individual basis. Relaying will likely be feasible only when there is an abundant supply of small crawfish and substantially higher prices exist for larger crawfish. Intercropping feasibility with rice will also depend on rice markets and prices.



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Rice was harvested at maturity following the crawfish harvest. Rice yields were affected mainly by destruction of rice in the trapping lanes, although average yields were greater than the statewide commercial average.

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Harvesting "relayed" crawfish from a rice field used in an experimental intercropping approach to obtain additional growth of crawfish while preserving acceptable rice yields.

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