Enterprise Cost Assignment and Land Tenure Implications in Crop Rotation Systems: A Rice/Crawfish Rotation Case Study

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Abstract

Crop rotation systems are a commonly used production practice with primary benefits including the suppression of soil pathogens and crop pests as well as the reduction of soil nutrient depletion. Realized economic benefits are observed as increased revenue resulting from higher yields, or as reduced pesticide or fertilization expenses. In some instances, the inclusion of one crop in a rotation system may impose costs on another crop. A rice/crawfish rotation is utilized as a case study in this article to illustrate this relationship and to present implications for enterprise cost assignment and land tenure adjustments in situations where this relationship might occur.

Introduction

Many of the major crops produced in the United States are grown on crop land which is utilized in some type of crop rotation system. The practice of crop rotation has several benefits, most important of which are to limit the build up of soil pathogens (diseases) and pests (weeds and insects), and to avoid depletion of soil fertility which can result from continuous production of the same crop on a tract of land year after year. Some examples of typical crop rotation systems include two-year rotations (e.g., corn/soybeans, rice/soybeans and corn/cotton) and three-year rotations (e.g., corn/soybeans/wheat and rice/cotton/soybeans).

Economic evaluation of the relative profitability of a particular crop rotation system generally includes the economic benefit of the production of one crop on the other crop or crops, in an indirect manner. For example, this economic benefit could be observed as higher yields in cotton following corn, as opposed to cotton production following another crop or in continuous production. The economic benefit could also be indirectly observed in potentially lower herbicide, insecticide or fertilization costs for a crop in a specific rotation system as compared with the crop produced in a different rotation pattern.



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A less discussed and perhaps less noticed issue concerning crop rotations is the case where the production of one crop in a rotation system imposes costs on the production of another crop. Examples of such imposed costs could include actual expenses which would increase the production cost of an enterprise or could be realized as opportunity costs (foregone revenue) from production options prevented by the particular crop rotation system employed. In cases where this situation occurs, the assignment of costs to the proper crop enterprise is essential in correctly evaluating the relative profitability of the production of each enterprise as well as the profitability of the crop rotation system as a whole. The production of rice and crawfish in a crop rotation system in Louisiana is a very good example of this type of situation and is presented in this article as an illustration of the relationship.

Rice and crawfish are commonly produced together in alternative crop rotation systems in the southeastern part of the United States. The majority of crawfish in the U.S. are produced on over 100,000 farmed acres annually in Louisiana. Most of this production occurs in the southwestern part of the state. However, with the growing consumer demand for crawfish, production of crawfish in permanent dedicated ponds or in rotation with rice production is increasing in other states, including Texas, Arkansas and Mississippi.

Crawfish can be produced in a monoculture or rotational production system. Production of crawfish in a monoculture or single-crop system is a common practice for many small farms or where marginal land, unsuitable for production of other crops, is available. This type of production system utilizes permanent ponds or sites devoted to several consecutive years of crawfish production.

Production of crawfish in a crop rotation system is more typical of larger farming operations. Establishing crawfish in a rice field requires an initial stocking of 40 to 50 pounds of adult crawfish per acre. Crawfish production relies on the natural reproduction of adult crawfish existing in a rice field. Once a field has been stocked for crawfish production, restocking is usually not necessary since the population is relatively self-sustaining as long as a sufficient quantity of water is applied to the field during each season. Rice and crawfish are ideal as rotation crops, due primarily to the use of rice as a crawfish forage and the availability of irrigation pumping facilities on rice farms.

Production of crawfish within a rice rotational production system presents a unique illustration of the economics and farm accounting aspects of crop rotation. Due to the nature and timeframe of its production cycle, crawfish production has a different impact on the economics of the rice enterprise in the rotation system compared with an alternative rotational crop such as soybeans. This article evaluates the economic impact of crawfish as a rotational crop on the rice enterprise, identifying cost differences unique to crawfish production and presenting relevant economic principles in the assignment of production costs to alternative farm enterprises and its implication for crop rental arrangements.

Rice/Crawfish Double-Cropping Systems

Rice and crawfish have traditionally been produced in a double-crop rotation system. Under these rotation systems, three crops are generally produced over a two-year time span. McClain et al. have identified three typical rice and crawfish double cropping systems which have been traditionally utilized. In each of the three double cropping systems, crawfish production follows harvest of a rice crop. Reflooding the field for crawfish following the rice harvest precludes the ability to harvest a rice ratoon crop in that year. A summary of these production systems is presented below.

Rice-Crawfish-Rice

This double crop system has the advantage of allowing the rice producer to use the same land, equipment and irrigation pumping availability for both crawfish and rice production. After the rice crop is harvested in late summer, the field is re-flooded and the rice stubble crop is allowed to re-grow. This rice re-growth, or ratoon crop, serves as the primary forage for crawfish production. Since rice is the primary crop in this type of rotation, timing of production sequences do not allow for maximum crawfish production. Because the field is only drained to allow for the harvest of the rice crop, after which the field is immediately re-flooded, crawfish are only required to be stocked in the field initially. Natural reproduction in the almost continually flooded field eliminates the need for restocking of crawfish in later years. The initial stocking usually occurs 4 to 7 seven weeks after planting the rice crop. Crawfish harvest needs to be terminated in early April to allow for optimum planting of the following rice crop. A typical rotation timeline is as follows:

Year 1:

March – April: Plant rice.

August: Drain field and harvest rice.

October: Re-flood rice field.

December: Begin harvest of crawfish.

Year 2:
January – April: Harvest crawfish.
March – April: Drain field and replant rice.

Rice-Crawfish-Soybeans

Soybean, with its later planting dates, can also be included in a rice and crawfish double cropping system, with soybeans planted following crawfish harvest in the second year of the rotation. The inclusion of a soybean rotation crop provides two advantages over just rice and crawfish. Soybean production provides an interruption of the aquatic field condition, providing better weed control. In addition, the later planting dates for soybeans allow a longer crawfish harvest season. Some disadvantages of this rotation systems, along with the rice-crawfish-fallow system discussed below, are the need to restock crawfish every year and routinely low population densities. A typical timeline for this rotation is as follows:

Year 1:
March – April: Plant rice.
August: Drain field and harvest rice.
October: Re-flood rice field.
December: Begin harvest of crawfish.

Year 2:
January – May: Harvest crawfish.
Late May – June: Drain field and plant soybeans.
October – November: Harvest soybeans.

Rice-Crawfish-Fallow

A third crop rotation option commonly found is to leave the field fallow for one season following crawfish harvest. The primary advantages of including a fallow season are better weed and disease control in the succeeding rice crop by interrupting the natural cycle of weeds and disease, as well as preventing overpopulation of crawfish in the field. Fallowing is also common in locations where there are few crop production alternatives, due to soil type or other limiting factors. A typical timeline for this rotation is as follows:

Year 1:
March – April: Plant rice.
August: Drain field and harvest rice.
October: Re-flood rice field.
December: Begin harvest of crawfish.

Year 2:
January – June: Harvest crawfish.
July: Drain field.
August – December: Fallow field.

Identification of Rice Enterprise Impacts

Certain alternative rice land lease arrangements can result in adverse economic impacts to the rice enterprise when crawfish production are included in the rotation. Specifically, complications can arise in rental arrangements for land leased for crawfish production following a rice crop to a third party individual who is not the rice producer.

Two example rice land lease arrangements are used here to illustrate this situation. Both example lease situations are over a three-year period. In the first example, the land is leased to the rice producer, who produces rice in years 1 and 3 and produces soybeans in year 2 as the rotational crop. In the second example, the land is leased to the rice producer in years 1 and 3 for rice production. However, the land is leased to a third party individual for crawfish production in year 2.

Optimum rice planting dates are recommended as March 15 through April 20 for southwest Louisiana (Linscombe et al.). Harvest of the first rice crop generally occurs in July or August. The rice field can then be reflooded for production of a ratoon, or second rice crop, with harvest in October. As shown below, the production of soybeans as a rotational crop does not interfere with the rice production cycle in either year 1 or year 3. Production of soybeans in year 2 of the rotational does not preclude harvest of a rice ratoon crop in year 1 nor does it impose additional production costs on the rice crop in year 3. The same would be true if the rice field was fallowed in year 2.

Rice-Soybeans-Rice

Year 1:
March – April: Plant rice.
July – August: Drain field and harvest rice.
September: Re-flood rice field.
October: Drain field and harvest rice ratoon crop.

Year 2:
May: Plant soybeans.
October – November: Harvest soybeans.

Year 3:
March – April: Plant rice.
July – August: Drain field and harvest rice.
September: Re-flood rice field.
October: Drain field and harvest rice ratoon crop.

The production of crawfish as the rotational crop, however, does have an impact on the rice enterprise. Three common impacts of a crawfish rotational crop on the rice enterprise have been identified in rice/crawfish/rice rotation systems. One impact affects the preceding rice crop in year 1 and the other two impacts affect the following rice crop in year 3.

Rice-Crawfish-Rice

Year 1:
March – April: Plant rice.
August: Drain field and harvest rice.
October: Re-flood rice field.
December: Begin harvest of crawfish.

Year 2:
January – June: Harvest crawfish.
July: Drain field and leave fallow.
October-December: Reform fields for rice.

Year 3:
March – April: Plant rice
July – August: Drain field and harvest rice.
October: Re-flood rice field.
December: Begin harvest of crawfish.

Harvest of crawfish produced in year 2 or the rotation would generally start in January. Rice fields therefore must be flooded for crawfish production in October of the preceding year. The flooding of the rice field in October of year 1 for crawfish production in the following year, therefore, precludes the ability to produce and harvest a ratoon crop of rice in year 1.

Crawfish are harvested frequently during the season (Romaire, et al.). Harvest boats travel across the field 3-5 days per week, every week, generally over a six-month period (January-June). The impact of these harvest boats repeatedly traveling over the field in very shallow water causes ruts to be formed in the boat path across the field. Following crawfish production, additional field tillage operations are generally required to smooth out these boat ruts in advance of rice seedbed preparation and planting.

When a rice crop following crawfish is planted in year 3, that rice field has been in an aquatic state for as much as 18 months with no chemical weed control measures employed. As a result, aquatic weeds in the following rice crop are much more difficult to control than if rice was following a different rotation crop such as soybeans where herbicides could have been used to control weeds.

Rice and the rotational crop, crawfish or soybeans for example, represent separate enterprises within the farming operation. Although whole-farm and enterprise budgeting are important tools for farm planning (Doye), enterprise budget analysis is of primary interest in crop rotation systems. Enterprise analysis is the economic analysis of the income and production expenses associated with a single enterprise (Kay, et al.). Correct enterprise analysis requires the correct estimation of returns and costs associated with that enterprise. Most enterprise returns and costs are relatively easy to estimate and assign to the appropriate crop enterprise. A rice and crawfish crop rotation, however, presents some unique, yet important, aspects of enterprise analysis and farm accounting.

The three impacts of the rotational crawfish crop production on the rice enterprise identified here, at first glance, all appear to be *associated with rice production*. Loss of first year rice ratoon crop, additional field tillage in the second year to prepare ground for rice planting and additional herbicide requirements to control weeds in the third year rice crop are all related to the rice enterprise. However, these additional costs (or foregone revenue) are *caused by the production of crawfish* as the rotational crop. In enterprise farm accounting, farm costs should be attributable to the responsible enterprise (commodity) in an appropriate allocated manner. Costs attributable to, or caused by, the production of crawfish should be correctly charged to the crawfish enterprise.

Estimation of Crawfish Impact Costs

In the example rice/crawfish/rice rotational system illustrated here, production of crawfish in year 2 precludes the production and harvest of a rice ratoon crop in year 1. Although the inability to harvest a rice ratoon crop and receive revenue from the sale of that rice is not an actual, out-of-pocket cash "expense" for the rice enterprise, it is an economic cost nonetheless.

The loss of potential net revenue from a rice ratoon crop production in year 1 is caused by the farm management production decision to produce crawfish in year 2. This potential net revenue loss is referred to, in economic terms, as an opportunity cost. This opportunity cost is caused by the decision to produce crawfish in year 2 and therefore should correctly be charged as a cost to the crawfish enterprise.

The opportunity cost of the inability to produce a rice ratoon crop can be estimated as the net returns the rice producer would have received if the ratoon crop would have been produced. Producer net returns from a ratoon crop is affected by many factors including, ratoon crop yield, rice market price, ratoon crop production expenses and rice rental arrangements.

As an example, assume that the potential ratoon crop yield is 18.0 cwt. (11.1 bbl.) per acre and the rice producer has a 70/30 share rental arrangement, with the landlord receiving 30 percent of the crop proceeds and is paying the ratoon crop pumping cost. Using the projected seasonal average rough rice market price for the 2007/08 marketing year of $12.00 per cwt. (ERS,USDA) and estimated variable ratoon crop production expenses of $81.60 per acre (Salassi and Deliberto), the opportunity cost to the rice producer of not harvesting a rice ratoon crop in year 1 of the rotation can be estimated as follows:

($12.00/cwt x 18.0 cwt. x 70%) - $81.60
= $69.60 per acre net return

Smoothing boat ruts in the field following the crawfish crop generally requires additional field operations not needed when rice is following soybeans as the rotational crop. Costs for additional field operations estimated here includes two passes each over the field with a disk and land level. Tillage costs are estimated for a 300 hp tractor pulling a 32 ft. disk and a 24 ft. land level (Salassi and Deliberto). The performance rate (hours per acre) for the disk operations were increased by 50 percent (from 0.06 to 0.09 hours per acre per pass) to account for overlap of disk passes to smooth out ruts. Estimation of these additional tillage costs would be the variable costs (fuel, labor and repairs) of performing these two operations.

Operation	Perf. rate	Times over	Total variable cost
Disk	0.09	2.0	$10.26
Land level	0.15	2.0	14.50
			$24.76 per acre

The costs of additional herbicides on the rice crop in year 3 following crawfish can vary widely from field to field and are directly impacted by the variety of rice grown, specific weed pressure in the field and selection of herbicides used. Costs estimated here are presented as an example of the possible range in values of these additional rice herbicide costs can be.

In the conventional rice variety production example, a typical herbicide program for rice following soybeans might include Facet (0.5 lbs), Londax (1.0 oz.) and 2,4-D (2.5 pts.). However, to combat the greater aquatic weed pressure following crawfish, a typical rice herbicide program might include Command (12.0 oz.), Clincher (15.0 oz.) and Permit (1.0 oz.). The additional herbicide cost for this after-crawfish herbicide program is $11.67 per acre in material cost.

Herbicide Program for Conventional Rice Variety:

Following soybeans		Following crawfish	
Facet	0.5 lbs.	Command	12.0 oz.
Londax	1.0 oz.	Clincher	15.0 oz.
2,4-D	2.5 pts.	Permit	1.0 oz.
Cost/acre	$40.93	Cost/acre	$52.59
Additional cost per acre			**$11.67**

For production of Clearfield rice, a typical herbicide program for rice following soybeans might include Newpath (8.0 oz.) and Aim (1.6 oz.). Following crawfish, a typical Clearfield rice herbicide program might include a higher rate of Newpath (12.0 oz.), plus an application of Grasp (2.8 oz.) and Londax (1.6 oz). The additional herbicide cost for this after-crawfish herbicide program is $52.07 per acre in material cost.

Herbicide Program for Clearfield Rice Variety:

Following soybeans		Following crawfish	
Newpath	8.0 oz.	Newpath	12.0 oz.
Aim	1.6 oz.	Grasp	2.8 oz.
		Londax	1.6 oz.
Cost/acre	$38.11	Cost/acre	$90.18
Additional cost per acre			**$52.07**

As stated above, this additional herbicide cost for rice following crawfish can vary greatly from field to field. The average of the two example cases presented here, $31.87 per acre, provides an estimate of the likely level of increase in herbicide cost on the year 3 rice enterprise caused by crawfish production in year 2.

The summation of these estimated costs provides an estimate of the economic impact of crawfish as a rotational crop on the rice enterprise in a rice/crawfish/rice rotation system. In the example presented here, production of crawfish had estimated costs of $126.23 per acre which impacted the rice crops in years 1 and 3. These additional costs were the result of crawfish production as the rotational crop and should, correctly, be charged as expenses to the crawfish enterprise.

Additional Rice Production Expenses:

Ratoon crop net income loss in year 1	$69.60
Additional tillage for boat ruts in year 2	$24.76
Additional herbicide costs in year 3	$31.87
Total estimated increase in rice expenses	$126.23

Implications for Crop Rental Arrangements

The production of crawfish as a rotational crop within a rice production system has an economic impact on the rice enterprise in ways that other rotational crops do not. As a result, correctly charging production expenses or opportunity costs to the appropriate enterprise means that a rice and crawfish crop rotation has important implications for crop land rental arrangements.

In situations where the rice producer is the single and only tenant over the entire crop rotation cycle, the enterprise farm accounting is fairly straight forward. Production expenses (or opportunity costs) imposed on the rice enterprise, but caused by the crawfish operation, would be charged as expenses to the crawfish enterprise from a farm accounting perspective. Revenue from the crawfish operation would be credited to the crawfish enterprise and would be available to offset these additional costs impacting the rice enterprise in years 1 and 3. Cash or share land rent payments would be paid to the landlord as agreed to in the land rental arrangement.

In situations where the land in year 2 is being rented out by the landowner for crawfish production to a third party who is not the rice producer, that crawfish production is imposing economic costs on the rice producer for which no revenue is available to help offset those additional costs. These additional rice production expenses cannot, in reality, be charged to the crawfish enterprise because it is associated with a third party individual. In these situations, the rental arrangement between the landowner and the rice producer should reflect the fact that these additional costs are being imposed on the rice producer. This can be accomplished in a relatively fair manner by reducing either the share rent or cash rent paid by the rice producer to the landowner. Additional rice production expenses incurred as a percent of total value of rent paid for the rice crop can serve as a basis for the adjustment of rice rental rates.

Summary

This article illustrated the case in which one crop produced in a crop rotation system imposed costs on another rotation crop. The specific example presented in this article provided an estimate of the relative economic impact of crawfish production on the rice enterprise in a rice/crawfish/rice production system. Crawfish production in this rotation most commonly impacts the proceeding year rice ratoon crop, as well as tillage operations and herbicides programs for the following year rice crop. The economic value of these impacts are not insignificant and should be fairly accounted for in crop land rental arrangements, particularly in cases where the crawfish are being produced by a third party.

The primary point emphasized here is that, in certain crop rotation systems, there could exist a situation in which the production of one enterprise imposes costs, either real expenses or opportunity costs, on the production of either the preceding or succeeding crop in the rotation. This situation could become more prevalent in the future as more nontraditional enterprises, such as game/bird hunting or wildlife habitat management, become part of a crop rotation system. In cases where this situation occurs, the assignment of costs to the proper crop enterprise is essential in correctly evaluating the relative profitability of the production of each enterprise as well as the profitability of the crop rotation system as a whole.

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Table 1. Comparative enterprise net returns above variable production costs

	Conventional Variety Rice	Clearfield Variety Rice	Ratoon Crop Rice	Crawfish	Soybeans
			(dollars per acre)		
Market Income [1/]	$742.40	$742.40	$204.80	$936.00	$300.00
Variable Costs:					
Custom Application	$25.65	$25.65	$0.35	$11.59	$14.55
Bait	--	--	--	$127.75	--
Dry	$58.50	$58.50	$16.11	--	--
Fertilizer	$109.40	$109.40	$29.70	$13.50	$40.00
Fungicide	$19.70	$19.70	--	--	--
Herbicides	$40.93	$38.11	--	--	$24.22
Insecticides	$12.40	$12.40	--	--	$4.26
Irrigation Supplies	$3.65	$3.65	--	--	--
Seed	$31.20	$50.00	--	$36.40	$49.50
Custom Fertilize	$19.00	$19.00	$6.00	--	$4.50
Custom Plant	$6.72	$5.60	--	--	-
Haul/Harvest	$17.40	$17.40	$4.80	--	$6.00
Labor	$16.17	$16.17	$7.00	$103.22	$8.98
Fuel	$194.55	$195.93	$71.92	$227.00	$14.15
Misc. Supplies	--	--	--	$12.26	--
Repair and Maint	$23.21	$23.23	$13.61	$29.82	$12.53
Interest on Capital	$20.58	$20.91	$3.33	$25.40	$7.07
Total Variable Costs	$599.06	$615.65	$152.82	$586.94	$185.76
Net Returns Above Variable Costs	$143.34	$126.75	$51.98	$349.06	$114.24

[1/] Market income for conventional and Clearfield rice varieties calculated as $12.80/cwt with a yield of 58.0 cwt/ac. Market income for ratoon crop rice calculated as $12.80/cwt with a yield of 16.0 cwt/ac. Market income for crawfish calculated as $0.78/lb with a yield of 1,200 lbs/ac. Market income for soybeans calculated as $10.00/bu with a yield of 30 bu/ac.