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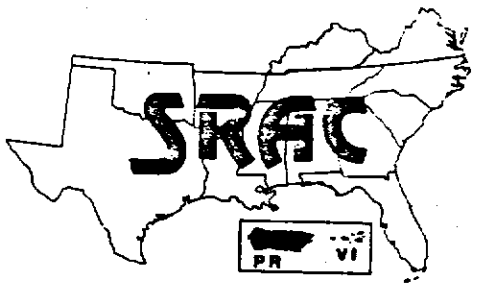

Crawfish Production Systems

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Crawfish are amenable to culture because they are hardy. The life cycle can be easily manipulated to fit a variety of cultural situations, and they can be easily integrated into agricultural crop rotation. The most common crawfish/agronomic crop rotations are rice/crawfish/rice, rice/crawfish/soybeans, and crawfish/rice/set-aside. The various agricultural/crawfish culture cycles are as follows:

Rice/Crawfish/Rice

March-April	Plant rice
June	At permanent flood (rice 8 to 10 inches high) stock 50 to 60 pounds of adult crawfish per acre
August	Drain pond and harvest rice
October	Reflood rice field
November-April	Harvest crawfish
March-April	Plant rice

The rice/crawfish/rice rotation has been practiced for years. Problems encountered include pesticide use on rice, poor water circulation and a shorter crawfish harvest period. About 30,000 acres of crawfish are cultured in this rotation in Louisiana.

Rice/Crawfish/Soybeans

March-April	Plant rice
June	Stock 50 to 60 pounds adult crawfish per acre at permanent flood
August	Drain field and harvest rice
October	Reflood rice field
November-May	Harvest crawfish
Late May-June	Plant soybeans
October-November	Harvest soybeans
November-March	Reflood pond and harvest crawfish or leave pond dry
March-April	Plant rice

The rice/crawfish/soybean rotation allows for the production of three crops in two years, and has the additional advantage of a longer crawfish harvest season than the rice/crawfish/rice rotation. Pesticide use is also an important management consideration in this rotation.

Crawfish/Rice/Set-Aside

April-May	Flood pond and stock 50 to 60 pounds of crawfish per acre
May	Drain pond over 2 to 4 weeks
August	Plant rice according to Agricultural Stabilization and Conservation Service (ASCS) guidelines
October	Reflood pond
January-May	Harvest crawfish (according to ASCS regulations)
May	Drain pond over a 2- to 4-week period

In the set-aside rotation rice grain cannot be harvested. The crawfish/rice/set-aside program allows rice farmers to use idle land registered in the federal rice set-aside program to

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cultivate crawfish. Restrictions on rice planting dates, crawfish harvest and pond draining are regulated by the ASCS.

Permanent Crawfish Ponds	
April-May	Stock 50 to 60 pounds of adult crawfish per acre
May-June	Drain pond over 2 to 4 weeks
June-August	Plant rice, sorghum, or other vegetation as crawfish forage
October	Reflood pond
November-May/June	Harvest crawfish
May-June	Drain pond, and repeat cycle

Permanent crawfish ponds make up about 65 to 70 percent of the crawfish production area in Louisiana. The permanent culture system allows producers to design the system for optimal crawfish production with no concerns regarding planting date requirement, draining time, and pesticide use for agricultural crops.

Crawfish life cycle

There are at least 32 described species of crawfishes in Louisiana but only *Procambarus clarkii* and *Procambarus acutus acutus* are cultivated. The red swamp crawfish (*P. clarkii*) is preferred over the white river crawfish (*P. acutus acutus*) because it produces more consistent yields and is more valued in international and southern Louisiana markets. Unlike other cultured aquatic animals that require hatcheries to produce young for stocking, cambarid crawfish aquaculture as currently practiced relies on control of the pond hydrology to simulate optimal conditions occuring in the natural habitat for the species.

Mature *P. clarkii* and *P. acutus acutus* mate in open water in all months, but mating peaks in May and June. The female stores the spermatophore in a seminal receptacle for 2 to 8 months until spawning. After mating, the female burrows into the levee, 4 inches above the water level. The burrow extends in depth to the water table, generally 1 to 3 feet in Louisiana. The burrow is capped with soil to maintain a humid environment. A male may occupy a burrow with the female. Crawfish ponds are slowly drained over 2 to 4 weeks in May and June to stimulate burrowing and reproductive activities of the remaining crawfish population.

After an ovarian development period of 2 to 5 months and while crawfish are in burrows, oocytes (eggs) are extruded through the oviducts, fertilized and attached to the pleopods or "swimmerettes". About 300 eggs are extruded by females, with a range of 100 to 700 eggs, depending on the female's size. The female repeatedly dips the eggs in water in the burrow chamber to keep them moist. The eggs usually hatch in 2 to 3 weeks but may take up to 3 to 4 months to hatch at lower temperatures.

Crawfish ponds are filled in the fall to coincide with peak spawning of females in burrows. When burrows are filled with water, adults and young-of-the-year (YOY) leave the burrows and distribute themselves throughout the pond.

When crawfish ponds are initially stocked with brood crawfish in spring, ovaries of females should be checked to determine stage of maturity. Females with advanced oocyte development (tan to brown eggs) in May or June will spawn in August-September, and females with yellow eggs will spawn in October-December. Females with white eggs or undeveloped ovaries are immature, and they do not spawn until March-April.

Young-of-the-year grow rapidly and can obtain harvestable size in 2 to 4 months. Crawfish hatched in late fall or mid-winter require 4 to 5 months to attain harvestable size. *P. clarkii* and *P. acutus acutus* have a natural life span of no more than 2 or 3 years in the Southeast.

Stocking brood crawfish

Brood crawfish should be stocked in April-May. Mature crawfish, harvested from another crawfish pond, should be stocked within 2 to 3 hours after capture. Crawfish stored in a cooler should not be used. The majority of the crawfish should be *P. clarkii*, and the sex ratio should be 1 male:1 female. At least 20 percent of the females should have tan to brown eggs in the ovary. About 50 to 60 pounds of broodstock per acre should be stocked in areas with established crawfish culture, and 70 to 80 pounds per acre in new or recently established crawfish production areas.

Brood crawfish should be transported to the pond in a covered vehicle to avoid exposure to wind and sun. Crawfish should be stocked throughout the pond in water adjacent to baffle levees or perimeter levees. Water should be drained slowly over 2 to 4 weeks to stimulate burrowing by crawfish. Because of the inefficiency of the harvesting process there are usually enough mature crawfish after the production season to supply YOY for the following production season; thus, restocking the pond is generally not necessary. However, crawfish producers should sample female crawfish prior to draining the ponds in May or June to insure enough females have advanced ovarian development to supply YOY early in the next production season.

Forages

Crawfish are benthic omnivores. They rely on aquatic flora and fauna, and detritus for their energy needs. Crawfish are not fed formulated rations as are other cultured aquatic animals; rather, vegetation is either allowed to become established naturally in the summer months when the pond is dry, or selected agronomic crops are planted as forage for the crawfish. Vegetation is

the base of the detrital food web on which crawfish rely to satisfy their nutrient requirements.

Volunteer terrestrial grasses do not supply sufficient forage to support high levels of crawfish production. Water quality is also poorer in ponds with large amounts of terrestrial vegetation. Aquatic and semi-aquatic plants such as alligatorweed (*Alternathera philoxeroides*) and smartweed (*Polygonium* spp.) are superior to terrestrial grasses because they do not significantly deteriorate water quality. However, like terrestrial grasses, alligatorweed and smartweed do not supply sufficient food to sustain good crawfish growth and high yields. Additionally, aquatic plants can become so dense that they interfere with water circulation and crawfish harvest. Millets (*Echinochloa* spp.) are sometimes used as cultivated forage for crawfish but millets lodge soon after ponds are flooded, and this increases the severity of oxygen deficiency. Millet, though easy and inexpensive to plant, is not recommended as a crawfish forage.

The preferred forage to plant for crawfish is rice, *Oryza sativa*. Rice is semi-aquatic and it has less negative impact on water quality compared to terrestrial plants. Rice can be planted for grain production with the post-harvest residue serving as crawfish forage, or it can be planted solely as a crawfish forage. Rice as forage is normally planted from June-August at a seeding rate of 90 to 120 pounds per acre. Procedures for planting rice as forage for crawfish include soil preparation, planting techniques, water management, recommended rice varieties and fertilization. Factors considered in rice variety selection include culture system (double-cropping), rice biomass, lodging characteristics and rice re-growth (ratoon) potential. Recommended rice varieties include Mars, Starbonnet, Newbonnet and Labelle.

Crawfish are highly susceptible to pesticides used to control insects in rice production. Crawfish producers must either avoid the use of pesticides or apply them when crawfish are not exposed (e.g., when crawfish are in burrows). Another problem with rice as a forage is that it is often depleted by March or April in ponds with large crawfish population. Forage depletion causes a cessation in crawfish growth resulting in crawfish "stunting" at non-desirable market size.

Sorghum-sudan grass hybrids are presently being evaluated and may have good potential as forage for crawfish. Sorghum hybrids produce large quantities of forage biomass and are less expensive to plant than rice.

Crawfish are not fed formulated rations on a large scale in the crawfish aquaculture industry. Experimental studies are inconclusive as to whether or not it is economically feasible to feed crawfish, but it is unlikely to be feasible using current culture techniques without a concomitant decrease in other production costs. Formulated rations have the potential to increase crawfish growth and production; minimize or prevent crawfish stunting at submarketable sizes when vegetation is depleted; and to extend the crawfish season into the summer for "off-season" production.

Crawfish population dynamics

Although cambarid crawfish are relatively easy to culture, the dynamics of populations in ponds is complex. High crawfish yield is dependent on having multiple recruitment classes of crawfish during the September/October-May/June production season. A population of both mature females with various stages of ovarian development and immature females should be present in the pond prior to draining in May-June. This will insure that five to eight recruitment classes will be hatched from October through March of the next production season, thereby maintaining a population of harvestable crawfish from late November through May. Although *P. clarkii* spawn in all months in which the pond is flooded, there is a primary hatching peak in fall, and lesser, secondary peaks in mid-winter and spring. *Procambarus acutus acutus* in culture systems spawn in fall and winter only.

Mature females that have orange, tan, and brown eggs in May-June produce three to five recruitment classes of YOY over a 2-month period after the pond is flooded in September-October. If adequate environmental conditions are maintained in the fall, many of these YOY are marketable by late November-December ("early crop") and can be harvested with holdover adults from the preceding season. Poor water quality management in the fall often kills many YOY resulting in a low crawfish harvest in fall and winter when crawfish prices are highest.

Females with yellow eggs in May-June re-burrow 4 to 8 weeks after the pond is flooded, and one to two recruitment classes from these females are hatched in November-January. These mid-winter recruitment classes attain market size in late March through May ("late crop"). Large crawfish that were immature (white eggs) in May-June mature after flooding, mate, and re-burrow in January-February. These adults produce one or two recruitment classes in March and April but the YOY do not attain market size before the ponds are drained in May or June. The pond can remain flooded through summer to harvest this YOY recruitment class. This is seldom done because by May forage is generally not adequate to sustain acceptable crawfish growth.

Crawfish should not be intensively harvested in October or November because a significant portion of the catch may consist of holdover adults that produce the mid-winter YOY recruitment classes. Harvest should be minimal until these holdover adults have burrowed. The population dynamics cycle of *Procambarus* in culture is depicted in Figure 1.

Recruitment of YOY crawfish is monitored by pulling a fine mesh dip

net along the pond bottom in various locations around the pond. As a general rule, the relationship between mean number of crawfish caught per dip 6 to 8 weeks post-flooding and the potential crawfish yield is as follows: 0 to 1 per dip, 500 to 600 pounds per acre; 3 to 5 crawfish per dip, 1,000 to 1,500 pounds per acre; and 8 to 10 crawfish per dip, 2,000 pounds per acre or more.

Major sources of YOY crawfish mortality are poor water quality, predation by fishes and cannibalism following molting.

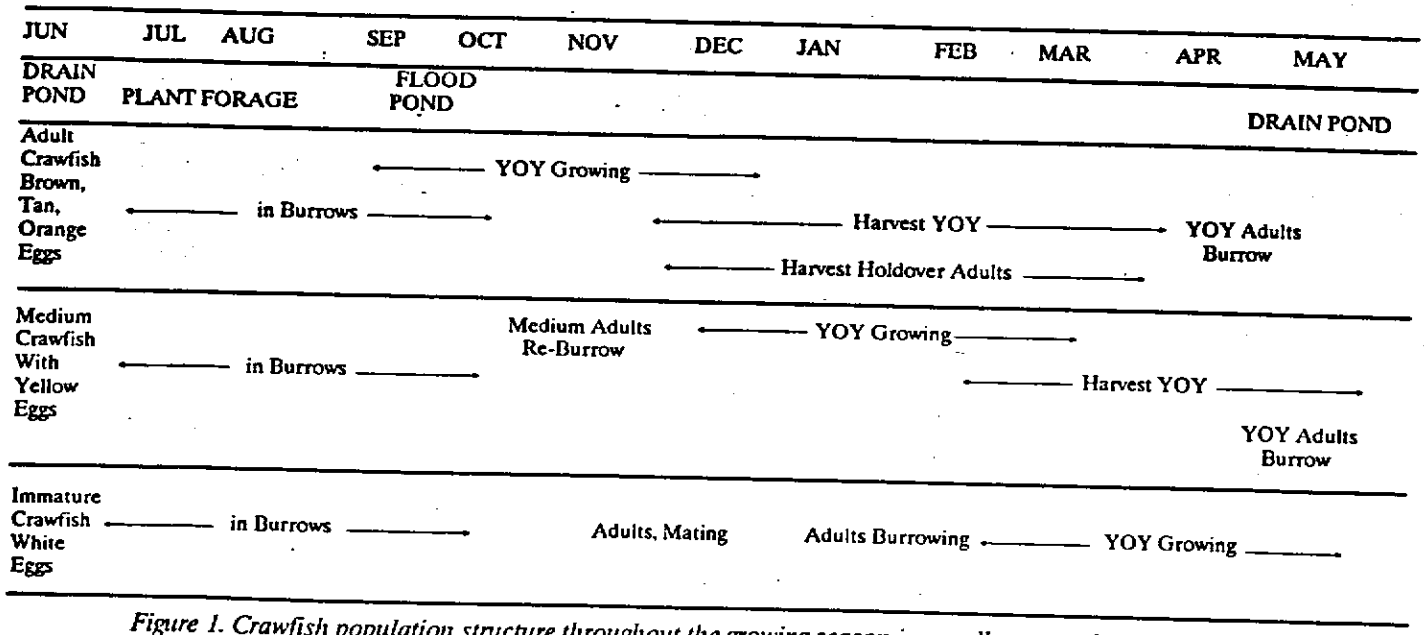

Figure 1. Crawfish population structure throughout the growing season in a well-managed crawfish pond.

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