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:

<table>
<thead>
<tr>
<th>Rice/Crawfish/Rice</th>
<th>Rice/Crawfish/Soybeans</th>
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</thead>
<tbody>
<tr>
<td><strong>March-April</strong></td>
<td><strong>Plant rice</strong></td>
</tr>
<tr>
<td><strong>June</strong></td>
<td><strong>Stock 50 to 60 pounds adult crawfish per acre at permanent flood</strong></td>
</tr>
<tr>
<td><strong>August</strong></td>
<td><strong>Drain field and harvest rice</strong></td>
</tr>
<tr>
<td><strong>October</strong></td>
<td><strong>Reflood rice field</strong></td>
</tr>
<tr>
<td><strong>November-May</strong></td>
<td><strong>Harvest crawfish</strong></td>
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<tr>
<td><strong>Late May-June</strong></td>
<td><strong>Plant soybeans</strong></td>
</tr>
<tr>
<td><strong>October-November</strong></td>
<td><strong>Harvest soybeans</strong></td>
</tr>
<tr>
<td><strong>November-March</strong></td>
<td><strong>Reflood pond and harvest crawfish or leave pond dry</strong></td>
</tr>
<tr>
<td><strong>March-April</strong></td>
<td><strong>Plant rice</strong></td>
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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.

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.

<table>
<thead>
<tr>
<th>Crawfish/Rice/Set-Aside</th>
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<tbody>
<tr>
<td><strong>April-May</strong></td>
</tr>
<tr>
<td><strong>May</strong></td>
</tr>
<tr>
<td><strong>August</strong></td>
</tr>
<tr>
<td><strong>October</strong></td>
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<tr>
<td><strong>January-May</strong></td>
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<tr>
<td><strong>May</strong></td>
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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
cultivate crawfish. Restrictions on rice planting dates, crawfish harvest and pond draining are regulated by the ASCS.

<table>
<thead>
<tr>
<th>Permanent Crawfish Ponds</th>
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<tbody>
<tr>
<td>April-May</td>
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<tr>
<td>May-June</td>
</tr>
<tr>
<td>June-August</td>
</tr>
<tr>
<td>October</td>
</tr>
<tr>
<td>November-May/June</td>
</tr>
<tr>
<td>May-June</td>
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</tbody>
</table>

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 occurring 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 spermaphore 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 "swimmerets". 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 (YOT) 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 YOT 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 YOT 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
(Alternanthera philoxeroides) and
smartweed (Polygonium spp.) are su-
perior to terrestrial grasses because
they do not significantly deteriorate
water quality. However, like ter-
restrial 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 circula-
tion and crawfish harvest. Millets
(Echinochloa spp.) are sometimes
used as cultivated forage for craw-
fish but millets lodge soon after
ponds are flooded, and this in-
creases the severity of oxygen
deficiency. Millet, though easy and
inexpensive to plant, is not recom-
mended 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 craw-
fish include soil preparation, plan-
ting techniques, water management,
recommended rice varieties and fer-
tilization. Factors considered in rice
variety selection include culture sys-
tem (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 pes-
ticides or apply them when crawfish
are not exposed (e.g., when crawfish
are in burrows). Another problem
with rice as forage is that it is often
deplored by March or April in ponds
with large crawfish population.
Forage depletion causes a cessation
in crawfish growth resulting in craw-
fish "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 ra-
tions 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 un-
likely to be feasible using current
culture techniques without a con-
comitant decrease in other produc-
tion costs. Formulated rations have
the potential to increase crawfish
growth and production; minimize or
prevent crawfish stunting at sub-
marketable 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 rela-
tively 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 ensure that live to eight
recruitment classes will be hatched
from October through March of the
next production season, thereby
maintaining a population of harvest-
able 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 en-
vironmental conditions are main-
tained in the fall, many of these
YOY are marketable by late Novem-
ber-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 result-
ing 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 recruit-
ment 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 ade-
quate 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 popula-
tion 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.

<table>
<thead>
<tr>
<th>JUN</th>
<th>JUL</th>
<th>AUG</th>
<th>SEP</th>
<th>OCT</th>
<th>NOV</th>
<th>DEC</th>
<th>JAN</th>
<th>FEB</th>
<th>MAR</th>
<th>APR</th>
<th>MAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>DRAIN POND</td>
<td>PLANT FORAGE</td>
<td>FLOOD POND</td>
<td>DRAIN POND</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adult</td>
<td>Crawfish Brown, Tan, Orange</td>
<td>Eggs</td>
<td>in Burrows</td>
<td>YOY Growing</td>
<td>Harvest YOY</td>
<td>YOY Adults Burrow</td>
<td>Harvest Holdover Adults</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medium</td>
<td>Crawfish With Yellow</td>
<td>Eggs</td>
<td>in Burrows</td>
<td>Medium Adults Re-Burrow</td>
<td>YOY Growing</td>
<td>Harvest YOY</td>
<td>YOY Adults Burrow</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Immature</td>
<td>Crawfish White</td>
<td>Eggs</td>
<td>in Burrows</td>
<td>Adults, Mating</td>
<td>Adults Burrowing</td>
<td>YOY Growing</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

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

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Louisiana Cooperative Extension Service, Denver T. Loupe, Vice-Chancellor and Director

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