A loss of production on recently precision-leveled rice fields in a rice-crawfish-rice rotation has become a common occurrence in commercial Louisiana rice production. This is especially true on mechanically altered silt loam soils of the coastal plains found in southwest Louisiana.

The use of poultry litter on unproductive areas has increased productivity levels in many cases above those realized prior to precision-leveling. The use of litter in conjunction with inorganic fertilizers also has been reported to improve yields above those found when using inorganic fertilizers alone. Research in organic fertilizers such as poultry litter in southwest Louisiana rice production has been neglected in the past because transportation and application costs have traditionally exceeded the nutritional benefit of the poultry litter.

The absence of a poultry industry in southwest Louisiana has accounted for the high transportation costs. In the past few years, however, the costs associated with delivery and application of poultry litter in the southwestern part of the state have declined to levels reasonable for the use of litter in rice production. The purpose of this publication is to provide a basic understanding of poultry litter as a fertilizer source and provide best management practices for its effective use in a rice production setting.

**THE BASICS**

Poultry litter is made up of the bedding material and manure from birds used in a commercial poultry facility. The most common litter material available in Louisiana is obtained from commercial broiler houses. The most common bedding materials used in commercial broiler houses include wood shavings, rice hulls and sawdust. As the bedding material is used it forms a hard layer on the surface often referred to as a cake. This cake can be removed (decaked) after one flock has been grown or can be removed after several flocks have been grown, depending on the management practices of the producer. Therefore, nutritive value of litter is not constant between sources. The nutrient content can vary considerably depending on the bedding material used, number of flocks grown between decaking, feed source and feed efficiency, bird type, management practices and whether the litter has been composted or is fresh. This variability makes it imperative that every delivered batch of litter be tested to determine the nutrient and water content. Two laboratories in Louisiana are capable of testing the nutrient content of poultry litter – the Louisiana Department of Agriculture and Forestry Poultry Disease Diagnostics Laboratory and the LSU AgCenter Department of Agricultural Chemistry (contact information at the end of this publication).

### NUTRIENT CONTENT

Poultry litter contains nitrogen (N), phosphorus (P) and potassium (K) as well as several micronutrients and organic acids. Poultry litter on average contains N-P₂O₅-K₂O at a concentration around 60 pounds of each nutrient per ton of material on a dry basis. The actual content, however, varies greatly between batches and must always be analyzed prior to determining an application rate.

Poultry litter contains multiple organic and inorganic forms of N. Rice takes up the inorganic forms of N including NH₄⁺ and NO₃⁻ during the growth and development of the crop. Initially, the inorganic N content is only 10 percent or less of the total N content in the litter. Some of the inorganic N is mineralized during the first year and made available for uptake by rice. However, once the rice crop is flooded and the soil converts to an anaerobic (without oxygen) condition, NO₃⁻-N quickly is lost because of denitrification and will no longer be available for uptake by rice. This is one of the reasons that N-use efficiency of poultry litter by rice is less compared to that of upland crops.

Research has shown the pre-flood urea-N equivalence for rice ranges from 25 to 41 percent of the N content of the poultry litter. Therefore, a conservative estimate is that 25 percent of the N contained in the poultry litter will count towards the normal recommended pre-flood N rate for a particular rice cultivar, and the rate of applied urea should be reduced to represent the litter N contribution. These estimates were developed from poultry litter applied the same...
day that rice was drill-seeded. Application of litter several weeks before planting may further reduce N availability for drill seeded rice.

Research has not evaluated the urea-N equivalence of litter in water-seeded systems. The urea equivalence of litter in a water-seeded system, however, is expected to be slightly greater than a drill-seeded, delayed flood production system because the litter would be in a saturated anaerobic condition at an earlier point in the season, which would limit the nitrification and subsequent denitrification of mineralized NH$_4$-N.

Total P$_2$O$_5$ and K$_2$O concentrations of litter are often very close in concentration to that of total N. Like N, the total P and K found in litter are made up of both organic and inorganic forms. The alternating flooding and draining (flushing) associated with early-season, drill-seeded rice management and the establishment of the permanent flood tends to accelerate the mineralization of organic bound nutrients into inorganic, plant available forms.

Research comparing the rice uptake efficiency of P and K between inorganic fertilizers and poultry litter when applied at equal concentrations of P$_2$O$_5$ and K$_2$O has shown that the P and K applied from poultry litter is an equivalent source of these nutrients. Therefore, 100 percent of the P and K found in poultry litter can be applied towards the needs of the rice crop during the first year for a drill-seeded, delayed flood rice production system.

The P needs of rice are less than the N needs. It is estimated that a 7,000 lb/A (43 barrels) rice yield will remove approximately 112, 60 and 168 lb of N, P$_2$O$_5$ and K$_2$O from the soil, respectively. If poultry litter is applied based on the N needs of rice, an over-application of P will occur. The surplus P will build up soil test P to excessive levels with repeated applications over several years and has the potential to cause environmental problems. This excess P can be lost through run-off from fields that can contribute to eutrophication of nearby surface waters. This is a problem often seen in pastures grown for forage in areas near poultry facilities where poultry litter has been used repeatedly in this fashion. Therefore, it is important that poultry litter only be applied based on the P needs of the rice crop as indicated from a current soil test.

**LITTER SAMPLING**

Litter is generally delivered to field edges and stacked into piles prior to spreading. Physical and chemical variability of poultry litter between delivered batches are not uncommon. It is important to sample each delivered source to account for this variability. When sampling poultry litter for nutrient analysis, it is best to take multiple samples from all depths and sides of the litter pile. The samples then can be physically combined to create one composite sample. The composite sample will improve chemical analysis and will be more representative of the litter as a whole. Litter samples are generally analyzed on a wet, as-is basis.

Samples taken only from one location of the litter pile can alter analysis results. For example, litter stacked in the field waiting to be applied is often rained on prior to spreading. Simply taking a surface sample of the litter may result in a sample that has an elevated water content compared with the litter pile as a whole. This, in turn, will subsequently alter the N, P$_2$O$_5$ and K$_2$O concentration of the litter. In cases where it is known that the litter will be stored for long periods before spreading, samples can be taken immediately after delivery to the field when the litter is the driest.

Although litter samples are generally analyzed on a moist basis, the results may be reported on a wet or dry basis depending on the laboratory used. The Louisiana Department of Agriculture and Forestry Poultry Disease Diagnostics Laboratory reports on a dry basis, and the LSU AgCenter Department of Agricultural Chemistry reports on an “as-is,” wet basis.
LITTER SOURCES

Poultry litter can be purchased fresh, composted or in pellet form. Pellets have a lower water content, are easier to handle and apply and make equipment clean-up easier; however, this form is more expensive per unit. Research has shown that nutrient availability among fresh, composted and pelletized litter is equivalent when they are applied at similar N, P₂O₅ and K₂O levels. When determinations are being made on which form of litter to use, the ease of handling of the pellet form must be weighed against the extra expense.

GENERAL RECOMMENDATIONS

The use efficiency of nutrients in poultry litter is maximized when the litter is applied and incorporated immediately prior to drill-seeding. An evaluation of the time of application of poultry litter indicated that the N-uptake by rice was reduced by 16 percent when the litter was applied 10 days prior to seeding compared to application immediately prior to seeding. The urea-N equivalence of the litter during this study was 41 percent. Other yield-based research also has shown that litter applied in the fall results in lower yields compared to litter applied in the spring prior to seeding. Although not as efficient, litter can be surface-applied in a reduced tillage system. Because of the alkaline nature of poultry litter, volatilization losses can be excessive on surface-applied litter. Surface losses of P and K also can be expected from runoff events associated with field flushing.

Other general observations of the use of poultry litter in a rice production system include:

- The responses of litter applied on precision-leveled clay soils are generally not as great compared to precision-leveled silt loam soils.
- Consultants and producers have noted that even distribution of litter at rates less than 1 ton per acre are difficult. The cake and clods of the litter and the use of poor application equipment are the main culprits of the distribution problem. For this reason, rates of less than 1 ton are rarely used. The use of properly calibrated spreading equipment in good operating condition always should be used to maximize even distribution.
- Producers and consultants also have noted an increase in weed seed germination as a result of the use of poultry litter. Although not substantiated, the increase of weed incidence seen when using poultry litter is most likely a derivative of the organic acids enhancing weed germination and the additional nutrients enhancing weed growth. It is highly unlikely that the increased weed pressure is caused by weed seed being introduced by the litter itself.
- Continued use of litter can increase organic matter, soil structure and CEC – cation exchange capacity. A significant increase in these soil properties, however, should not be expected from one-time or sporadic use.

Best Management Practices for the Use of Poultry Litter

- Obtain a soil test on precision-leveled and problem areas of fields separate from productive areas.
- Obtain a composite poultry litter sample and send off for N-P-K and water content analysis. Generally, one to two weeks are needed for chemical analysis.
- Determine litter rate based on P₂O₅ recommendations provided by a soil test.
- Determine supplemental K needs, if any, based on soil test results.
- Apply poultry litter and K as close to planting as possible using calibrated equipment and incorporate.
- Determine supplemental preflood N needs based on a 25 percent urea equivalence.
- Resample precision-leveled and problem areas in subsequent years to monitor nutrient changes.
Example of Poultry Litter Rate Determinations

A soil test of a precision-leveled area indicated that 40 lb of \( P_2O_5 \) and 60 lb of \( K_2O \) are required to grow a rice crop. Poultry litter analysis indicated that the litter contains 2.5% N, 3.2% \( P_2O_5 \), 2.7% \( K_2O \) and 40% moisture. Litter analysis is reported on an “as-is” wet basis.

Determine how much total litter will be needed to supply 40 lb of \( P_2O_5 \). Calculate nutrients based on dry basis first then adjust to wet (as applied) basis.

- Divide total lb needed by % \( P_2O_5 \) in litter.
  
  
  \[ \frac{40 \text{ lb } P_2O_5}{0.032} = 1250 \]

- Convert to as applied (wet) basis.
  
  - Need 1,250 lb dry
  - Litter is 40% water
  - 100% - 40% = 60% dry matter
  - 1,250 lb dry litter / 0.60 dry matter = \( \frac{2083 \text{ lb as-is}}{0.60} \) litter needed

Determine how much additional K from potash is needed.

- Determine amount of \( K_2O \) supplied by litter.
  
  \[ \frac{2.083 \text{ lb (wet) applied}}{0.60} \times \frac{1.250 \text{ lb dry litter}}{0.60} = 26.3 \text{ lb } K_2O \text{ needed} \]

- Litter contains 2.7% \( K_2O \)
  
  \[ 0.027 \times 1.250 = 33.7 \text{ lb } K_2O \]

- Determine additional \( K_2O \) needed from potash (0-0-60). A total of 60 lb \( K_2O \) is needed based on the soil test.
  
  \[ 60 \text{ lb needed} - 33.7 \text{ lb supplied by litter} = 26.3 \text{ lb } K_2O \text{ needed} \]

- Determine potash rate.
  
  \[ \frac{K_2O \text{ fertilizer (0-0-60)}}{0.60} = 60\% \text{ } K_2O \]

  \[ \frac{26.3 \text{ lb } K_2O \text{ needed}}{0.60} \times \frac{1.250 \text{ lb } K_2O \text{ per lb of 0-0-60}}{0.60} = 43.8 \text{ lb of 0-0-60} \]

Determine how much preflood N is supplied by litter and how much additional urea is needed based on a 90 lb/A preflood N rate.

- Determine N supplied by litter. Assume that the litter will provide a 25 percent urea equivalent.
  
  \[ \frac{2.083 \text{ lb (wet) applied}}{0.60} \times \frac{1.250 \text{ lb dry litter}}{0.60} = 1.250 \text{ lb dry litter} \]

  \[ \text{Litter contains 2.5 percent N} \]

  \[ -2.5\% \text{ of } 1.250 \text{ lb } = 0.025 \times 1.250 = 31.2 \text{ lb of N} \]

  \[ \text{N in litter is only 25 percent of the value of urea} \]

  \[ -25\% \text{ of } 31.2 = 0.025 \text{ N in litter} \times 0.25 \text{ urea equivalent} = 7.8 \text{ lb N supplied by litter} \]

- Determine additional preflood N needed.
  
  \[ 90 \text{ lb needed} - 7.8 \text{ lb N supplied} = 82.2 \text{ lb N needed} \]

- Convert to lb of urea.
  
  \[ \text{Urea (46-0-0) is 46 percent N} \]

  \[ \frac{82.2 \text{ lb N}}{0.46} = 178.7 \text{ lb urea needed to supply} \]

  \[ 82.2 \text{ lb N} \]