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Biochar-amended poultry litter as an approach to nutrient management, soil health, and water quality in Northwest Arkansas

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Introduction

Poultry litter management is a significant challenge for producers in Northwest Arkansas, where the health of Beaver Lake, the region's primary drinking water source for more than 450,000 people, depends in part on how nutrients from agricultural lands are managed. Biochar-amended poultry litter (BAPL) is a value-added amendment that combines poultry litter with biochar. It may help producers make better use of poultry litter nutrients, improve select soil properties, and reduce the amount of easily dissolved nutrients after application.

Nutrient loss from land-applied poultry litter remains an important water quality concern in regions with concentrated animal production. When nutrients are not retained in soil or taken up by plants, they can be transported in runoff or lost to the atmosphere, reducing fertilizer value and increasing the environmental risk. Biochar-amended poultry litter is a developing soil amendment that may change how quickly some nutrients dissolve after application, while supporting productive use of agricultural soils. This factsheet explains what BAPL is, what benefits have been observed in research, and what producers should consider before using it as a soil amendment.

Background Information

Biochar-amended poultry litter is produced by combining poultry litter with biochar. Biochar is a carbon-rich material made by heating biomass such as wood, manure, or crop residues at high temperatures with limited oxygen, a process called pyrolysis. Biochar can have a porous structure and a large surface area. These properties may help it hold water and some nutrients and improve soil physical properties. Performance of biochar depends on the source material (i.e., wood, crop residues), production temperature, and application conditions.

In this factsheet, BAPL means raw or composted poultry litter that has been mixed with biochar (Figure 1) which is different from poultry-litter biochar, where the poultry litter itself is heated to make biochar. This distinction matters because research results from biochar alone, poultry-litter biochar, raw poultry litter, or other manure-biochar blends

may not apply directly to every BAPL product. Importantly, if biochar is applied alone without other organic amendments, it can retain nutrients and result in temporary nutrient deficiency in plants. However, combining biochar with poultry litter prior to application, as in a finished, pelletized BAPL product, helps reduce this risk by adding nutrients to the biochar before it reaches the soil. When biochar is combined with poultry litter, BAPL may slow nutrient release and improve handling compared to raw litter, while providing more plant-available nutrients than biochar alone. Some products may also add beneficial soil microbes to the final pelletized BAPL product, which may provide additional benefits. The possible benefits of BAPL are most likely to be realized when the product is matched to local soils, crop needs, and a current nutrient management plan.

Figure 1. Photo of generation of BAPL with a small pellet machine (left) and BAPL application in the farm field (right)

Biochar-amended poultry litter may be particularly relevant in Arkansas because poultry production and poultry litter management are important to the state economy. Arkansas was one of the top broiler-producing states in 2025, producing about 1.05 billion broilers and 7.79 billion pounds of live-weight broilers (USDA NASS, 2026). Poultry litter is a mixture of manure, bedding material, feathers, and spilled feed from poultry houses. It contains valuable nutrients, but repeated application in poultry-dense areas can increase the need for careful nutrient planning, especially for phosphorus (Chakraborty et al., 2021). For Arkansas producers, BAPL may provide another way to use poultry litter as a local nutrient resource, creating a unique opportunity to establish a closed cycle for waste and nutrient management.

Potential Benefits for Farm and Farmer

Biochar-amended poultry litter may also offer agronomic benefits by combining the nutrient supply of poultry litter with some of the soil-conditioning functions associated with biochar. In some soils, this combination may help to hold more moisture, keep nutrients available longer, and support crop growth. The extent of these benefits will depend on the properties of the biochar and the soil where the application is made. Specific benefits to the farm and farmer may include:

- **Potential for increased crop productivity.** Research on biochar and poultry litter products shows mixed but promising results. Some laboratory tests show lower water-soluble nutrient release from poultry litter-biochar mixtures. Some field studies show crop or soil benefits when biochar is used with poultry litter or manure. For example, a recent study in Georgia found greater tomato plant growth and marketable yield following BAPL application, attributed to both direct nutrient supply and improved soil conditions (SARE 2025). However, results depend on the product, soil, crop, application rate, and weather. More Arkansas field-scale data is needed before broad recommendations can be made.

- **Improved soil health.** Some studies have found that BAPL application can reduce soil bulk density and increase porosity, improving water retention, aeration, and the soil environment for root development and microbial activity (Adekiya et al., 2019). These effects on soil physical properties may support long-term soil fertility, though responses will vary by soil type, product, and application rate.

- **Improved nutrient retention and reduce runoff.** Biochar-amended poultry litter may slow the initial release of phosphorus and nitrogen compared to raw poultry litter, reducing the fraction of nutrients lost in runoff during rainfall events. Laboratory studies suggest that pelletizing poultry litter with biochar may reduce water-soluble phosphorus and ammonium release compared to non-pelletized raw poultry litter (Gupta et al., 2026), though field-scale confirmation under Arkansas conditions is needed.
- **Reduced costs and potential income stream.** In areas with concentrated poultry production, excess litter can present both an environmental concern and a disposal cost for producers. By providing an avenue to convert poultry litter waste into a useful fertilizer and soil amendment, farmers may potentially decrease disposal costs and earn additional income. Using BAPL as an alternative to synthetic fertilizer may reduce input costs, while allowing nutrients to cycle within the local agricultural system. Whether BAPL offsets synthetic fertilizer costs will depend on site-specific factors including the product's nutrient analysis and availability, crop nutrient requirements, application rate, hauling distance, and spreading costs. Producers should evaluate BAPL on a cost-per-unit-nutrient basis relative to other available fertilizer sources before committing to large-scale use.

Potential Water Quality Benefits and Considerations

Water quality protection is a key reason for interest in BAPL in Northwest Arkansas. Beaver Lake Reservoir, the region's primary drinking water resource, has experienced increased streamflow over the last 20 years, highlighting the challenge of managing nutrient inputs to the reservoir and increasing the risk of harmful algal blooms (Speir et al., 2025). Additionally, direct land application of manure fertilizers can lead to high nutrient runoff. Therefore, reducing nutrient loss from agricultural lands is a regional priority to protect drinking water supplies.

When applied as a soil amendment, BAPL may reduce the fraction of applied phosphorus and nitrogen that is lost in runoff compared to raw poultry litter, as the biochar component can adsorb nutrients and slow their release. The porous structure and high surface area of BAPL can increase soil water retention and promote infiltration on the landscape, potentially reducing the total amount of surface runoff that carries nutrients downstream. However, results vary, with some studies finding that phosphorus losses increase rather than decrease with BAPL depending on application rate, soil phosphorus saturation, and hydrologic conditions, highlighting the need for site-specific planning. Overall, BAPL shows promise as a nutrient management tool with benefits for water quality, but field-scale evidence in Arkansas is needed before making conclusions about downstream water quality impacts.

Limitations and Practical Considerations

The performance of biochar-amended poultry litter depends on the properties of both the poultry litter and the added biochar, as well as on application rate, application method, soil conditions, weather, and management. Not all biochars behave the same way, and differences in feedstock, pyrolysis conditions, pH, ash content, porosity, and sorption capacity can all affect field performance. Furthermore, for this reason, product characterization, soil testing, and site-specific nutrient planning are important before broad use. Prior to application, producers should obtain basic product characterization data from the supplier and complete a current soil test. Key product parameters to review and their corresponding impacts are listed in Table 1 below. Soil test results should be used in conjunction with the Arkansas Phosphorus Index and a nutrient management plan to determine appropriate application rates of BAPL. The University of Arkansas Cooperative Extension Service can provide technical assistance with nutrient management planning.

Table 1. Key BAPL parameters and corresponding impacts

Key Parameter	Corresponding Impacts
N-P-K content	Indicates the nutrient content of the product. Nitrogen supports vegetative growth, phosphorus supports root development and flowering, and potassium improves plant stress tolerance. Compare with crop nutrient needs and soil test results to determine whether the product and rate are appropriate.
Water-extractable phosphorus (WEP)	Measures how much phosphorus can dissolve and move with water. Elevated WEP increases the risk of phosphorus loss in runoff. Products with high WEP require careful rate management and attention to the Arkansas Phosphorus Index.
pH	pH tells whether the soil is acidic or alkaline and affects nutrient availability. Biochar-based products are often alkaline; consider soil pH and crop requirements when selecting and applying BAPL.
Electrical conductivity/salts	High salt content can reduce germination and seedling establishment, particularly in dry conditions. Request EC data from the supplier and consider cumulative salt loading with repeated applications.
Moisture content	Affects storage, handling, and application uniformity. Confirm moisture specifications with the supplier and account for weight-based nutrient calculations accordingly.
Particle size	Affects application uniformity and nutrient release rate. Pelletized products generally improve handling and spreading consistency.
Contaminant screening	Request screening results for heavy metals and other regulated contaminants prior to purchase. See product quality and certification considerations below.

Some other specific limitations and considerations may include:

- **Application rates** are site-specific and must be consistent with Arkansas nutrient management planning requirements. Because soils, crops, and litter properties vary, BAPL application rates should be determined on a field-by-field basis using soil test results and the Arkansas Phosphorus Index. Note that BAPL may not yet be represented as a standard nutrient source coefficient in Arkansas nutrient management planning tools; producers should consult with their nutrient management planner or University of Arkansas Cooperative Extension Service agent regarding how to account for BAPL in their plan.
- **Application method** may impact the benefits of BAPL. Many of the soil conditioning benefits of biochar or BAPL require tillage or product incorporation into the soil. Therefore, the benefits of BAPL may not be fully realized from surface applications without incorporation to pasture and forage production systems. It is important to consider that where soil conditions meet the needs for incorporation that the preferred method of BAPL application may be incorporation.
- **Product quality and certification.** As with any soil amendment, producers should request product characterization data from the supplier before purchase and application. Reputable suppliers should be able to provide contaminant screening results, including heavy metals and documentation of production conditions. The International Biochar Initiative (IBI) and European Biochar Certificate (EBC) maintain product certification programs that can help producers identify tested, certified products (Tsai & Chang, 2022). Such IBI or EBC certification may be useful, but certification does not replace product testing, soil testing, Arkansas nutrient management planning, or local regulatory requirements.
- **Regulatory compliance.** During production, storage, handling, and transporting, as well as soil applications, producers should follow applicable Arkansas nutrient management requirements and best management practices. Producers should consult the Arkansas Department of Agriculture Nutrient Management Program, Natural Resource Conservation Service (NRCS), a certified nutrient planner, or their local University of Arkansas Cooperative Extension Service

agent if permits, nutrient management plans, or application records are required.

- **Product availability and cost.** The market for commercially available BAPL products is still developing in Arkansas. Producers should compare the delivered and applied cost of BAPL with other fertilizer sources based on nutrient value, hauling distance, storage, spreading, and product testing requirements. Producers interested in conservation or nutrient-management assistance should check with NRCS, local conservation districts, or other programs to determine whether cost-share opportunities are available for their operation.

Conclusion

Biochar-amended poultry litter represents a promising approach to nutrient management in regions with concentrated poultry production, such as Northwest Arkansas. By combining the nutrient supply of poultry litter with selected soil-conditioning and nutrient-retention properties of biochar, BAPL may support productive farm operations and help reduce nutrient loss under the right conditions. Realizing these benefits will require careful product selection, site-specific nutrient management planning, and ongoing research to establish locally appropriate application guidelines. Overall, BAPL is a promising tool for regions with concentrated poultry production as BAPL may serve as an integrated solution addressing agronomic, environmental, and economic challenges. Producers interested in learning more about BAPL are encouraged to contact their University of Arkansas Cooperative Extension Service agent.

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