



Best Management Practices for Wood Ash as Agricultural Soil Amendment

Wood was burned in the United States in the 1700s through the early 1900s to produce ash for chemical extraction. The ash was used mainly to produce potash for fertilizer and alkali for industry. As other potash production technologies became more economical, the value of wood ash as a raw material dropped.

Recently, ash has been considered a waste product instead of a resource, because few industries have taken advantage of its beneficial properties. Approximately 3 million tons of wood ash are produced annually in the United States. While approximately 80 percent of all ash is land applied in the Northeast United States, less than 10 percent is land applied in the Southeast. The other 90 percent in the Southeast is landfilled. Several alternative uses for wood ash have been developed. Land application is one of the best because nutrients taken from the land during harvest are recycled back to the land. In a survey of more than 80 Southeastern paper mills, 60 percent of the respondents reported interest in land application of wood ash.

WHAT IS WOOD ASH?

Wood ash is the inorganic and organic residue remaining after combustion of wood or unbleached wood fiber. The physical and chemical properties of wood ash vary significantly depending on many factors. Hardwoods usually produce more ash than softwoods, and the bark and leaves generally produce more ash than the inner woody parts of the tree. On average, the burning of wood results in 6 to 10 percent ashes. When ash is produced in industrial combustion systems, the temperature of combustion, cleanliness of

the fuel wood, the collection location, and the process can also have profound effects on the nature of the ash material. Therefore, wood ash composition can vary depending on geographical location and industrial processes. This makes testing the ash extremely important.

Ash is composed of many major and minor elements which trees need for growth (Table 1, page 3). Since most of these elements are extracted from the soil and atmosphere during the tree's growth, they are common in our environment and are also essential in production of crops and forages.

Calcium is the most abundant element in wood ash and gives ash properties similar to agricultural lime. Ash is also a good source of potassium, phosphorus, and magnesium. In terms of commercial fertilizer, average wood ash would be about 0-1-3 (N-P-K). In addition to these macro-nutrients, wood ash is a good source of many micronutrients needed in trace amounts for adequate plant growth. Wood ash contains few elements that pose environmental problems. Heavy metal concentrations are typically low.

Field and greenhouse research confirms the safety and practicality of recycling wood ash on agricultural lands. Wood ash has a liming effect of between 8 and 90 percent of the total neutralizing power of lime, and can increase plant growth up to 45 percent over traditional limestone. The major constraints to land application of wood ash are transportation costs, low fertilizer analysis, and handling constraints. With ever-increasing disposal costs, land application of wood ash will probably be the disposal choice in the coming century as it results in savings for the industry, an opportunity for agriculture and conservation of our resources.

CAN I APPLY WOOD ASH?

Georgia's regulations concerning wood ash application can be difficult to follow. Wood ash is specifically exempted from the Georgia Department of Agriculture's fertilizer act and does not meet the specification in the regulations governing agricultural lime distribution. Depending on the interpretation, it could be registered under the soil amendment act; however, the Department of Agriculture has not registered it in the past. To facilitate the distribution of wood ash, a recommended procedure for land application has been established and approved by the Georgia Department of Agriculture and Environmental Protection Division of the Georgia Department of Natural Resources. Basically, these recommendations outline a procedure that protects the supplier, the landowner and the public. Though not required, the wood ash supplier should follow these procedures to ensure that the wood ash composition is environmentally safe.

To distribute wood ash to landowners, the supplier should require the landowner to show that proper soil tests and analysis have been performed to calculate the optimum application rate. In addition, the supplier should keep records on the distribution of the wood ash and ask the landowner to sign a release form. The landowner is responsible for obtaining a soil test and calculating the appropriate application rate; however, these services may be provided through the Cooperative Extension Service or other qualified individuals. A copy of the publication, *Recommended Practices for the Utilization of Wood Ash as an Agricultural Soil Amendment in Georgia*, is available through the University of Georgia Cooperative Extension Service.

Most of Georgia's soils are naturally infertile, acidic and low in organic matter. Therefore, additions of nutrients are required for adequate plant growth. Nitrogen fertilizers often lower the soil pH, which makes neutralizing agents such as lime or wood ash a necessity on most Georgia soils. Liming improves crop growth by increasing the availability of nutrients such as phosphorus, providing calcium and magnesium to crops, and decreasing the availability of certain metals. While dolomitic and some calcitic limestone are the most common liming agents used in Georgia, wood ash has many of the same effects. It also can replace many of the macro and micronutrients removed during plant growth and harvesting.

Several studies compare plant growth using traditional limestone and wood ash. Most conclude that ash gives better growth responses than limestone. While some studies have reported detrimental effects at extremely high application rates, these responses were explained by the drastic increases in soil pH beyond the plant's optimal level. As long as the soil pH is maintained at the proper level, productivity will be enhanced by using wood ash as a soil amendment.

WHAT ELSE DO I NEED TO KNOW?

Planning for wood ash application requires several considerations. Before planting any crop, determine the soil's nutrient level and pH through proper soil testing. Landowners should contact their local extension office or soil testing laboratory for a bulletin outlining the proper procedures for soil sampling and determining proper liming rates. The essentials of these procedures are reviewed here. Take soil samples in the fall or winter. Pastures should be sampled from the soil surface to a 4-inch depth, crop fields should be sampled from the surface to 6-inch depth. If fields contain different soil types, they should be divided into blocks with similar characteristics and sampled individually. It is important to obtain a representative sample. This can be accomplished by mixing several cores from a variety of locations within each sampling area. Keeping accurate records is an important aspect of soil testing. Past records can identify the buildup or decline of any chemical component in the soil profile so that changes in the inputs can be made.

Limit wood ash applications to a level that maintains the soil pH within the optimum range for the intended crop. The liming ability of wood ash is usually estimated using a laboratory-measured parameter called the calcium carbonate or lime equivalent (CCE). The CCE tells you how well the wood ash will raise the soil pH compared to lime (calcium carbonate). As with the nutrient composition of wood ash, the CCE of different wood ashes may vary considerably; however, most are within the range of 25 to 60 percent. With proper soil tests and the CCE of the wood ash, application rates for wood ash can be calculated by dividing the recommended lime application rate by the lime equivalency or CCE of the wood ash as shown:

$$\text{Wood ash application rate (tons/acre)} = \frac{\text{Recommended liming rate (tons/acre)}}{\text{Percent lime equivalency (\%)} \div 100}$$

For example, if two tons of lime are needed per acre and the ash has a CCE of 50 percent, then four tons of ash would be required to raise the pH to the desired level. While this calculation is relatively easy to make, it is strongly recommended that producers allow the county extension agent or other qualified individuals to calculate appropriate application rates. At times, fertilizer application rates may need to be reduced when liming with wood ash because the ash may contain significant amounts of plant nutrients. If additional fertilizer applications are used, formulate them to ensure that the plant requirements for these elements are not being exceeded.

During application of wood ash to the soil, take special care to prevent the ash from entering any surface or ground water. A distance of at least 50 feet should separate the wood ash from any farm ditches, wells, or other bodies of water. This distance should be increased to 100 feet in highly erodible areas or areas without riparian stream side vegetation or

Table 1. Range in elemental composition of industrial wood ash samples and ground limestone.

ELEMENT	WOOD ASH*	LIMESTONE**
Macroelements	----- Concentration in % -----	
Calcium	15 (2.5-33)	31
Potassium	2.6 (0.1-13)	0.13
Aluminum	1.6 (0.5-3.2)	0.25
Magnesium	1.0 (0.1-2.5)	5.1
Iron	0.84 (0.2-2.1)	0.29
Phosphorus	0.53 (0.1-1.4)	0.06
Manganese	0.41 (0-1.3)	0.05
Sodium	0.19 (0-0.54)	0.07
Nitrogen	0.15 (0.02-0.77)	0.01
MICROELEMENTS	----- CONCENTRATION IN MG/KG -----	
Arsenic	6 (3-10)	—
Boron	123 (14-290)	—
Cadmium	3 (0.2-26)	0.7
Chromium	57 (7-386)	6.0
Copper	70 (37-207)	10
Lead	65 (16-137)	55
Mercury	1.9 (0-5)	—
Molybdenum	19 (0-123)	—
Nickel	20 (0-63)	20
Selenium	0.9 (0-11)	—
Zinc	233 (35-1250)	113
OTHER CHEMICAL PROPERTIES		
CaCO ₃ (%)	43 (22-92)	100
pH	10.4 (9-13.5)	9.9
Total solids (%)	75 (31-100)	100

* Mean and (Range) taken from analysis of 37 ash samples from studies of Campbell, 1990; White and Rice, 1993; Naylor and Schmidt, 1986; Muse and Mitchell, 1995; and Huang *et al.*, 1992.

** Limestone analysis from Campbell, 1990.

buffer zones. Karst areas in Georgia present unique conditions where surface waters can rapidly reach the groundwater with little filtering of pollutants. In these areas, or within wellhead protection areas where local ordinances may impose additional restrictions, reduce application rates or use larger buffer zones. Do not apply wood ash to areas with water standing on the soil surface. Avoid wood ash applications immediately before periods of prolonged rainfall or when large storms are expected.

Wood ash should be land applied as soon as possible to avoid the need for on-site storage. When conditions such as inclement weather require on-site storage, the wood ash should be stored so that run-off from the pile will not enter surface or ground water. Indoor storage is ideal; however, when it must be stored outdoors, place it on packed soil or a pad surrounded by a small berm to prevent surface water

from entering or leaving the storage area. Store it away from wells, surface water and animal watering areas, and cover or shield it as much as possible to protect it from dry or windy weather.

One of the major obstacles to land application of wood ash is the undesirable handling and spreading characteristics of ash. Most ash has a low density and small particle size. This can create dust problems during transport and application. Always cover wood ash during transport to prevent losses enroute to the application site. Studies indicate that the handling characteristics of ash generally improve with increasing relative humidity so avoid spreading on extremely dry days. Moisture can be added to improve the handling characteristics of ash; however, if too much moisture is added the ash will cake and become difficult to spread uniformly. Ash can be spread with a conventional manure spreader or with lime application equipment. It can be top dressed or incorporated. To get the full benefit, incorporate the wood ash throughout the root zone whenever possible because the benefits only occur where the ash and soil are in contact. Calibrate the spreader to ensure that the target application rate is met. Due to the physical characteristics of ash, it is often difficult to obtain uniform application, but calibration of the spreader and knowledge of the spread pattern can minimize non-uniformity.

The fall is generally the best time for wood ash application. Applications at this time allow the ash enough time to react with the soil before rapid spring growth. Soils are also usually drier and more accessible. Application at other times throughout the year is acceptable. However, do not apply ash immediately before planting or during early emergence as it could cause short term concentrated alkaline conditions that could interfere with plant growth. Ash may also absorb pesticides if not given time to neutralize in the soil, so avoid chemical applications for three to five days before or after wood ash application.

Take health considerations into account when dealing with ash to prevent both particle inhalation and contact with the skin. Inhaling any small particle is dangerous, so wear masks during application or when dusty conditions warrant them. Ash is an alkaline material with a pH ranging from 9 to 13 and could irritate the skin. To prevent this, cover skin during application and transport; wash exposed areas and thoroughly rinse with water immediately following application. Remember that fresh ash can still retain hot coals which are a health risk and a fire hazard.

SUMMARY

Wood ash application is similar to lime application. Both can benefit crop productivity, but wood ash supplies additional nutrients. Both materials are also alkaline and could cause crop damage if overapplied or misused. Landowners should follow the prescribed application rates and use common sense to prevent accidents and avoid environmental contamination.

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*Prepared by Mark Risse, Professor, Crop and Soil Sciences
Updated 2002 by Julia Gaskin, Land Application Specialist*

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