NCASI Fact Sheet
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Wood Ash as a Soil Amendment

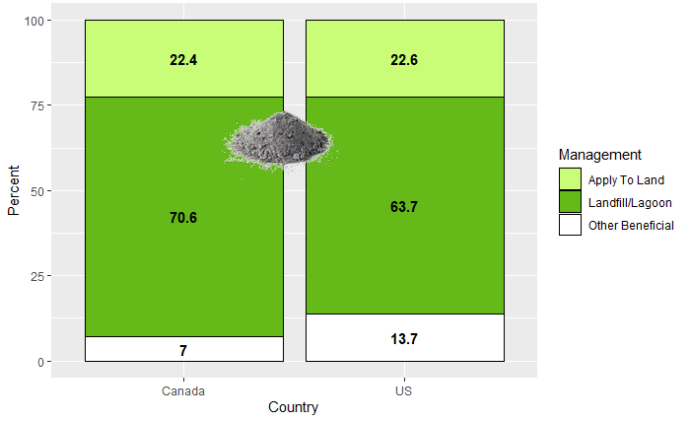
Background

Forest products manufacturing facilities generate large amounts of boiler ash from burning woody biomass. Most of this ash ends up in landfills and wastewater lagoons. This situation represents a relatively untapped opportunity to recycle a mill residual into a valuable soil amendment, replace commercial fertilizers and lime, reduce landfill disposal costs and, in some cases, add a source of revenue for mills.

Wood Ash Characteristics

Ash from the combustion of clean wood is an alkaline material rich in calcium, potassium, and magnesium, with a carbon content that varies significantly depending on combustion conditions. It also contains phosphorus, iron, sulphur, aluminum, and silicon, and micronutrients such as manganese, boron, zinc, and molybdenum. Nitrogen is present in negligible amounts. Heavy metal concentrations are variable and generally comparable to levels found in coal fly ash, pulp and paper wastewater treatment residuals, and limestone, but lower than those found in sewage sludges. Relatively higher concentrations of arsenic, chrome, and copper can be present in ash resulting from the combustion of wood treated with inorganic preservatives such as chromated copper arsenate (CCA). Higher concentrations of lead may be found in ash from burning old painted wood waste. Polycyclic aromatic hydrocarbons, polychlorinated biphenyls, and dioxins and furans are generally present in ashes at very low levels. Higher content of dioxins and furans in ash can occur from incomplete combustion of wood fuel that has been exposed to a source of chlorine (e.g., salt-laden wood, pentachlorophenol-treated wood).

Photo: Piles of wood ash in a field



Options used by North American Pulp and Paper Facilities to Manage Boiler Ash (Source: 2020 NCASI North American Pulp and Paper Benchmarking Survey Data)

Type of Wood Ash Generated at Forest Products Facilities

Two types of ash are collected at forest products facilities: *fly ash* and *bottom ash*. Fly ash is collected from flue gases by a particulate matter control device, while bottom ash is collected from the combustion chamber. Facilities can segregate ash by type or decide to combine them for disposal. Ash alkalinity and pH decrease with increased outdoor storage time.

Agricultural land application is by far the most common beneficial use of wood ash. The nutrient content of ash makes it an excellent soil amendment for healthy plant growth. Indeed, wood ash increases soil concentrations of phosphorus, potassium, calcium, magnesium, and sulphur; and if applied at agronomically recommended rates, it has no visible detrimental effects on plant growth and generally only negligible impact on concentrations of heavy metals in plant tissue. Its liming ability can help neutralize acidity in soil and counteract the expected reduction in soil pH over time, especially when ash is used with nitrogen fertilizers. Wood ash also improves soil conditions (e.g., soil tilth and structure, aeration, water-holding capacity), and stimulates soil microbial activity, thus helping enhance

nutrient recycling and availability to crops. The value of wood ash as a liming and fertilizing material is reflected in farmer testimonials, which suggest crop yields can increase significantly in areas where wood ash has been applied. In general, wood ash tends to provide a growth response similar to, and often better than, that of limestone, provided that increases in pH are progressive and do not occur beyond the intended crop's optimal pH range. Wood ash has also proven to be a cost-effective alternative liming material, especially in rural areas with limited access to commercial agricultural lime.

Application of wood ash to forest land is less common than agricultural land application in North America. Some of the factors limiting sylvicultural applications include uncertain response of trees due to longer growth cycles, competing understorey vegetation, complex nutrient dynamics, and the variety of wood species, climates, and soil conditions. Research conducted primarily in Scandinavian countries documents site-specific beneficial applications, particularly on organic soils that are poorly buffered and depleted in macronutrients due to intensive harvesting or acidic atmospheric deposition.

Some of the challenges associated with land application of wood ash include lengthy application processing in some jurisdictions; weather- and cost-related issues associated with delivery, storage, and application of wood ash; dust emissions resulting from the handling of dry ash; maintaining consistent ash quality as free as possible of foreign materials; inaccurate assessment of required ash testing; potential increased equipment maintenance; ineffective or inexistent coordination between facility representatives, ash users, trucking companies, and agrologists; and misconceptions on the part of some land owners/ash users and government agencies regarding the effect and efficacy of wood ash on soil quality and crop productivity.

Photo: Wood ash being scattered on plants

The table below lists information ash generators and potential ash users need in order to assess the technical viability of land applications.

Ash characteristics	Neutralizing value, pH, particle size distribution, form (dry, pelletized)
Nutrient content and fertilizing value of ash	Phosphorus (available phosphoric acid [P_2O_5]), potassium (soluble potash [K_2O]), calcium, magnesium, boron, zinc, and sulphur
Heavy metal concentrations (e.g., arsenic, cadmium, chromium, cobalt, copper, lead, mercury, molybdenum, nickel, selenium, zinc)	Generally present at levels imposing little to insignificant environmental risk for application rates determined on agronomic needs; however, they need to be checked against prescribed allowable concentrations or loadings
Application site-related characteristics	Targeted crops and nutrient requirements; distance between ash generator and site; soil conditions (e.g., liming requirements, pH, organic matter, moisture, soil texture and structure, cation exchange capacity, electrical conductivity, elemental composition); presence of competing vegetation; access to the site; on-site storage space

Ingredient in Compost and Topsoil Manufacture

Wood ash is an excellent ingredient in compost feedstock mixes, as it provides a significant source of plant nutrients and carbon. During composting, organic waste is biodegraded under controlled aerobic conditions to produce a relatively stable material (compost) useful as a soil amendment. The biodegradation of organic wastes into fertile compost relies heavily on achieving a proper balance between carbon- and nitrogen-rich materials. Accordingly, the addition of high-carbon wood ash to a lower-than-optimal C:N ratio mix helps reduce the loss of nitrogen to the atmosphere; increases the porosity of the substrate, thereby enhancing oxygen transfer within the composting pile; improves odour control; neutralizes fruit wastes and acidic materials; and imparts an appealing dark colour to the compost product. Wood ash has also been evaluated as a component in peat-based substrates for manufacturing container-grown greenhouse-grown crops such as flowers and tomatoes.

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