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Using industrial wood ash as a soil amendment

Mark J. Kopecky, N. Larry Meyers and Wally Wasko

Wisconsin industries produce approximately 50,000–80,000 tons of wood ash each year. Even though wood ash has been used as a beneficial agricultural soil amendment for centuries, much of the ash generated today is stored in landfills at significant expense to industry. This publication explains how ash generated by woodburning industries (such as paper mills and wood products processors) can be used as a safe, effective and economical soil amendment.

The potential of wood ash as a soil amendment

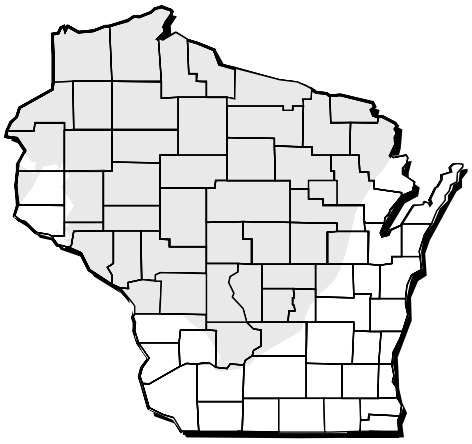
Many of Wisconsin's agricultural soils are naturally acidic and low in available potassium. This limits their ability to produce high yields of legume forage crops such as alfalfa or red clover—the main species that support Wisconsin's dairy industry.

To grow these crops, Wisconsin farmers invest millions of dollars each year in lime and fertilizer.

Wood ash currently being put in landfills has properties that make it a valuable soil amendment and a potential substitute for much of the commercial lime and fertilizer now used on Wisconsin farms. Since there are no limestone deposits in northern Wisconsin (see figure 1), farmers in this region pay high prices ($20–$30 per ton) for agricultural lime.

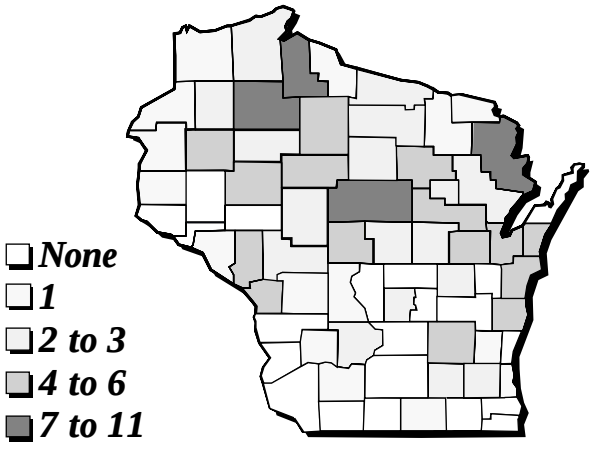
Each ton of wood ash could substitute for one-half to one ton of agricultural limestone, and could supply 25–70 pounds of potash (K_2O equivalent) and 30–32 pounds of phosphate (P_2O_5 equivalent). Based on current lime and fertilizer prices, average ash is worth $24–$38 per ton. Much of the state's ash production takes place in areas that could benefit greatly from an alternative lime source (figure 2).

Figure 1. Limestone deposits



Light portions of the map show areas with limestone deposits.

Figure 2. Commercial woodburning facilities in 1990 by county



Source: Wisconsin Energy Bureau

Chemical characteristics

Benefits

Wood ash from different sources varies in the nutrients it contains and in its ability to neutralize soil acidity. Depending on the burning process and the type of wood, the neutralizing index (NI) of industrial wood ash may vary from grade 40–49 to 80–89 on the scale used to rate commercial aglime. This means that ash must be applied at from one to two times the recommended rate of 80-89 ag lime to achieve the same effect. Wood ash's small particle size may bring about a more rapid soil pH change than that produced by agricultural lime.

Table 1 shows the concentration levels of several chemical elements in 16 ash samples. The samples came from both bottom ash and fly ash sources from the northern part of Wisconsin.

Lime and fertilizer value of wood ash

When wood ash is applied at rates likely to adjust soil pH, it also supplies substantial amounts of several plant nutrients including potassium, phosphorus, calcium and magnesium. The monetary value of wood ash is greatest in areas where agricultural limestone prices are high and where ash sources are located nearby. The potential dollar value of wood ash is shown in table 2. Depending on the source of the ash and soil test recommendations, a wood ash application may satisfy a field's fertilizer needs in the year it is applied. In addition to its value as a substitute for lime and macronutrients, ash can also supply significant amounts of sulfur, boron and other micro-nutrients.

Heavy metal content

The concentration of heavy metals in wood ash is very low. Table 1 shows the range of concentrations of some heavy metals in ash samples taken from northern Wisconsin. An application of one ton of wood ash per acre would apply less than 1% of the cumulative loading limit of heavy metal elements (Cd, Cr, Cu, Ni, Pb Zn) regulated by the Wisconsin Department of Natural Resources (DNR).

Table 1. Elements found in 16 ash samples taken from northern Wisconsin.

Element	Range of concentrations	Pounds applied in 10–ton/acre ash application
Calcium (Ca)	22–45%	4,400–9,200
Magnesium (Mg)	1.2–2.2%	240–440
Phosphorus (P_2O_5 equivalent)	1.1–2.3%	230–460
Potassium (K_2O equivalent)	1.3–4.6%	260–910
Aluminum (Al)	0.2–1.1%	42–230
Iron (Fe)	0.1–1.1%	26–210
Manganese (Mn)	0.06–0.3%	12–56
Zinc (Zn)	0.01–0.5%	3–100
Boron (B)	0–210 ppm1	0–4
Chromium (Cr)	0–14 ppm	0–0.3
Copper (Cu)	0–54 ppm	0–1.1
Nickel (Ni)	0–7 ppm	0–0.1
Cadmium (Cd)	0–22 ppm	0–0.4
Cobalt (Co)	0–6 ppm	0–0.1
Lead (Pb)	–17 ppm	0–0.3
Sulfur (S)	See footnote 2	See footnote 2

[1] ppm = parts per million
[2] Sulfur concentration was not determined in the Wisconsin research. Other research reports sulfur concentrations of 0.38%–2.0% in wood ash, which would yield 76–400 lbs in a 10–T/A application.

Research results

Research conducted recently in Minnesota and Wisconsin demonstrates that wood ash can be a safe and effective soil amendment. Greenhouse studies at the University of Wisconsin–River Falls show alfalfa and barley yields from wood ash applications of 5–20 tons per acre to be significantly greater than those from commercial lime and fertilizer applied at rates recommended by soil test.

Crop responses under field conditions show favorable trends similar to those observed in greenhouse studies with no statistically significant differences. Alfalfa plots in Price County, treated with ash at rates from 2.5–20 tons per acre exhibited yields comparable to plots treated with commercial lime and fertilizer applied at rates recommended by soil test. No harmful crop effects were noted when ash was applied at rates of up to 20 tons per acre.

Using wood ash

Transportation and storage

Wood ash is a caustic substance (strongly alkaline) that is very dusty when it is first taken from a combustion facility. Its disposal is regulated by the DNR. Ash that is stockpiled in the open tends to hydrate (absorb moisture) after several months, becoming less dusty. Some combustion facilities add water directly to ash to reduce dustiness.

Dry ash must always be covered during transport. It can be stockpiled next to fields until it is spread. Once ash is stockpiled it quickly forms a crust, so having it blow away in the wind is not usually a problem. If the ash is very fluid, storage areas can be banked with low earthen berms to contain the pile.

(*Note*: Fresh ash can be very hot—keep all flammable objects away from it.)

Spreading wood ash

Fresh ash is very difficult to spread because of its dustiness; therefore, water should be added to it before it is spread. Wood ash that has been hydrated can be spread with manure spreaders, lime trucks, or fertilizer wagons, depending on the equipment available. For many farmers, manure spreaders will be the most practical. Ash can be loaded from the stockpile with a skid steer or a tractor with a front end loader.

Regardless of the spreading equipment used, it's important to calibrate the application to obtain the desired rate. Ash must be analyzed for chemical characteristics before it is applied. Ash should usually be applied at the rate that will satisfy soil test recommendations for lime, but recommendations for potash or phosphate can also be used in certain situations. This is especially important when using ash with very high levels of these nutrients. For detailed information on calibrating manure spreaders, see the University of Wisconsin-Extension publication *Nitrogen Credits for Manure Applications* (A3537).

Table 2. Economic value of wood ash at various nutrient levels and limestone costs.

Constituent	Range in content	Economic value (dollars per ton)[1] at different limestone costs[2]
Lime Value (NI)	40–49 to 80–89	$10–30
Potash (K_2O)	26–92 lb/ton	$2.86–10.12
Phosphate (P_2O_5)	22–46 lb/ton	$5.06–10.58
	Total range in value:	$17.92–50.70

[1] Assumes cost of nitrogen (from urea) equals $0.22/lb N; cost of potash (from 0–0–60) equals $0.11/lb of K_2O; cost of phosphate (from diammonium phosphate) equals $0.23/lb P_2O_5.

[2] Based on NI 80–89 limestone, ranging from $20–30/ton.

Safety considerations

When working around ash, wear personal protection equipment (goggles, dust mask and protective clothing). Ash can be harmful if it is inhaled or comes into contact with eyes or skin.

Landspreading regulations

Wood ash landspreading is regulated under Wisconsin's solid waste management rules. The state landspreading code (NR 518.04(5)) exempts ash from spreading prohibitions if certain requirements are met. The requirements state that the wood ash must be tested according to the code; it must be shown to have value as a soil amendment, and it must be applied according to standard agricultural practices with a written approval from the DNR.

To receive a "grant of exemption," follow the general procedures outlined below.

1. The firm generating the ash should submit a request to the DNR asking for an exemption to landspreading prohibitions under NR 518.04(5). The request should include information on:
   a) the source of the wood ash;
   b) the volume of ash produced;
   c) the process used to burn the wood;
   d) any chemicals added during processing;
   e) any other relevant information.
2. Representative ash samples must be tested according to NR 518.06 to determine liming value and metal content.
3. Fields proposed for ash spreading must be identified and soils must be tested to determine lime needs.
4. The request for exemption should also include information on how the ash will be stored, transported to farms, and spread.

Exemption permits will specify how ash can be stored and spread and will indicate setbacks to wells, waterways, homes, wetlands, and other sensitive areas.

More detailed information on requirements for landspreading exemptions is available from your DNR area solid waste specialist. For the phone number of the specialist for your part of the state, contact your local DNR office.

Summary

Industrial wood ash can be used as a safe, effective, and economical soil amendment. It is especially useful where lime and potash needs are high or where forage legumes are grown.

Ash from woodburning industries can potentially be spread on agricultural lands instead of being landfilled. This practice can substantially reduce ash disposal costs and provide increased crop yield at low cost to farmers.

For more information

To obtain more information about using wood ash as a soil amendment, contact your Wisconsin county Extension office or local DNR district office.

Acknowledgments: This publication was made possible by a grant from the Sustainable Agriculture Program, Agricultural Resource Management Divison, Wisconsin Department of Agriculture, Trade, and Consumer Protection with funding from the Wisconsin Energy Bureau, Department of Administration. Research support came from the University of Wisconsin–River Falls, Solid Waste Experiment Center, Wisconsin Department of Natural Resources, and Pri-Ru-Ta Resource Conservation and Development Council.

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