Bulletin #2279

Using Wood Ash on Your Farm

2004 reprint. This fact sheet is based on research done between 1990 and 1993 (see references). Much of the information is still valid and valuable; however, please be aware that the content of Maine ash sources may have undergone change in the intervening years.

Pulp and paper companies in Maine often burn wood, bark or paper-mill sludge to make electricity. **Every year, more than 300,000 tons of wood ash is produced in this way.** One way to dispose of this wood ash is to put it in a landfill. However, landfill space is becoming scarce and costly. That's why other methods of ash disposal have been developed. One method that has become common in Maine is to spread the ash on fields. People have used ash as a low-grade fertilizer and liming agent for a long time.

Up to 70,000 tons of wood ash are spread on farmland every year in Maine. This figure will probably continue to increase. It is important that farmers and communities know the *benefits* and the *problems* of using wood ash. This fact sheet covers research on

- nutrients in wood ash,
- the effect of wood ash on soil nutrient levels, and
- the effect of wood ash on plant growth.

Much of the research summarized in this fact sheet was conducted through the Maine Agricultural and Forest Experiment Station.

Nutrients in Wood Ash

You know what wood ash looks like. It's a fine black material, like the ash left in a wood-burning stove or after a campfire. But what is wood ash made of?

Calcium is the most abundant nutrient, averaging almost 20 percent of the ash. (As we will see later, this means that ash can be used to raise soil pH, just as agricultural lime is used.) If you applied five tons of ash per acre, you would be applying about one ton of calcium. Compared to calcium, other

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nutrients are present in much smaller amounts. Wood ash is about four percent potassium, and less than two percent phosphorus, magnesium, aluminum and sodium. The small amounts of these nutrients is the reason that ash is considered a "low grade"fertilizer. In terms of commercial fertilizer, average wood ash would be about 0-1-3 (N-P-K).

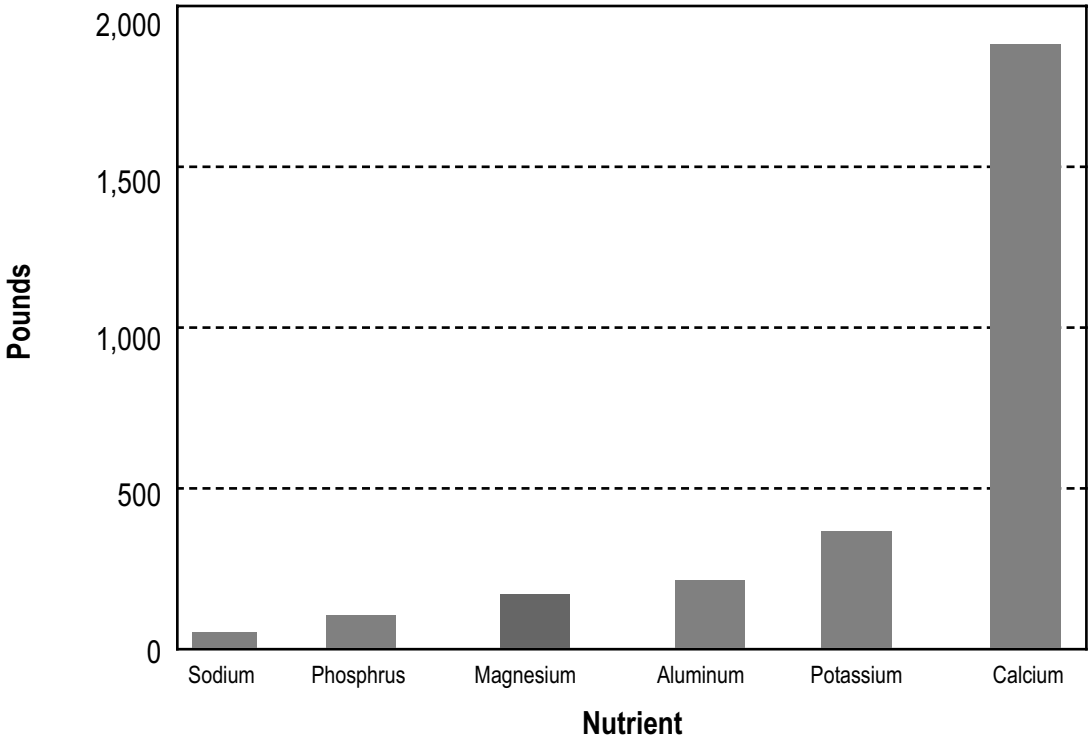
Figure 1 shows the average amount of calcium, potassium, phosphorus, magnesium, aluminum and sodium in wood ash. These averages amounts are from 12 different wood ashes—six produced in Maine and six produced in other states.

Other nutrients are present in wood ash in much smaller amounts. Some of these nutrients, like boron, copper, molybdenum, sulfur, and zinc, are needed in trace amounts by plants. Wood ash may also contain *heavy metals*. These metals are of concern because they may cause health problems for humans, livestock or wildlife. Both micronutrient and heavy metal concentration in wood ash are usually measured in parts per million (ppm). In other words, the number of pounds contained in every million pounds (or 500 tons) of ash.

If you applied five tons of ash per acre, you would be applying about one ton of calcium.

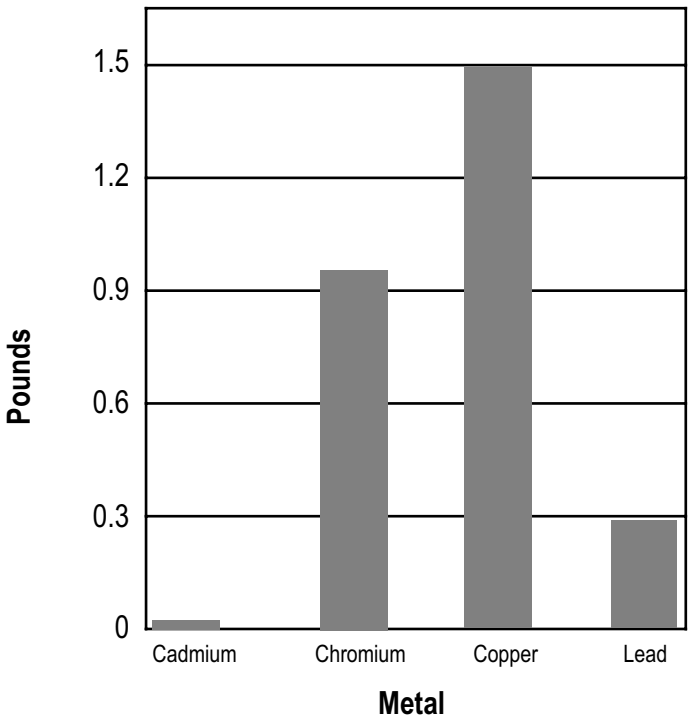
Figure 2 on page three provides an example of the heavy metal content of wood ash. As you can see by looking at this

Figure 1. Pounds of nutrient per acre in five tons of wood ash

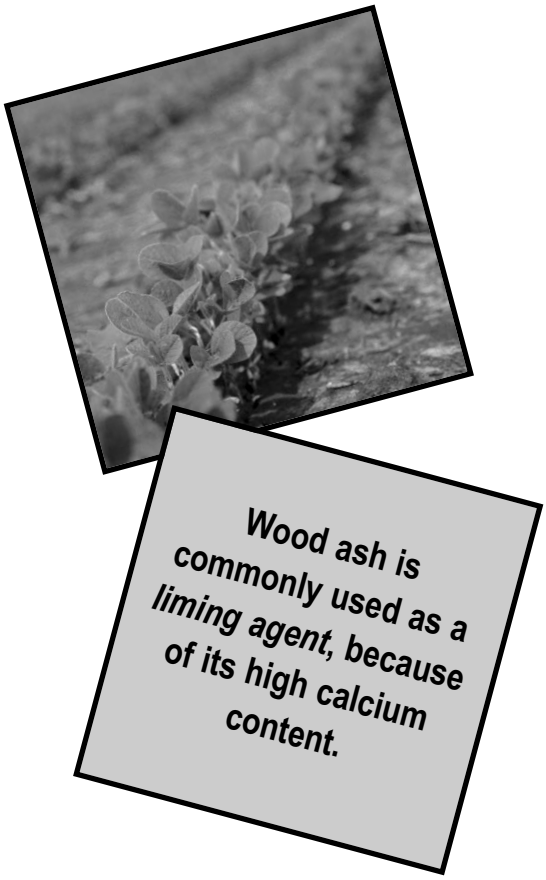


Nutrient content calculated as average of 12 different wood ashes. (See appendix tables for more detailed information.)

Figure 2. Pounds of heavy metal per acre in five tons of wood ash



(See appendix tables for more detailed information.)



figure, applying five tons of ash adds less than two pounds of these elements. If concentrations of cadmium, chromium or lead are too high, you may not be able to use wood ash.

Wood Ash as a Liming Agent

Wood ash is commonly used as a *liming agent*, because of its high calcium content. Liming agents are used to increase soil pH (pH is a measure of how acid a soil is). Soils in the Northeast are naturally acid. Soil pH of 4.5 to 6.0 is common. A soil pH of 7.0 is neutral. Most plants prefer soil pH between 6 and 7 (although potatoes and blueberries prefer lower soil pH).

There are several ways to estimate the liming of wood ash. Lab measurements can be taken (by boiling the ash in acid) to find out the *calcium carbonate equivalent* (CCE). The CCE tells you how well the wood ash would raise soil pH *compared to lime* (calcium carbonate). Like the wood ash nutrients discussed above, there are big differences in wood ash CCEs. When CCE was determined in the lab, it ranged from 25 to 59 percent. This is shown on page four in Table 1. This means that if you added the same amount of lime and wood ash, the wood ash should be 25 to 59 percent as effective in raising soil pH.

Wood ash CCE can also be determined in the lab by mixing ash with soil and

measuring the change in soil pH over time. Then this is compared to soil pH after adding lime. These figures are also shown below in Table 1, in the column "CCE (incubation)."

You will notice that, in most cases, the CCE determined with this method is lower than the other lab method. Using this method, wood ash CCE ranged from 14 to 56 percent. Again, remember that there are **big** differences in how well wood ashes increase soil pH.

Let's look at what happens to soil pH when wood ash is applied. Figure 3 shows how soil pH increases as wood ash rate increases. This relationship between soil pH and ash rate is *linear*. This means that twice as much ash raises the soil pH twice as much.

In Maine, top-dressed applications of wood ash are usually limited to two tons of lime equivalent per acre. If the ash is tilled in, the limit is set at three tons per acre. The actual ash applied may range from about three to eight tons of dry ash per acre, depending on the CCE. The amount of moisture in the ash also affects the application rate. Water is commonly added to the ash at the power plant to cut down on dust. The more water in the ash, the higher the application rate on an "as is" basis.

Table 1. Calcium carbonate equivalents (CCEs) for six Maine wood ashes

Ash Source	CCE (in acid)	CCE (incubation)
	%	
Ultrapower	56	33
Greenville Steam	26	24
Beaverwood Chester	53	56
Sludge-Ash mixture	50	40
Bioash	25	14
Pinetree	59	34

Average CCE from incubation in three different Maine soils. Data from: Ohno and Erich. 1990

In Maine, top-dressed applications of wood ash are usually limited to two tons of lime equivalent per acre.

Potassium and Phosphorus in Wood Ash

Plants remove large amounts of phosphorus (**P**) and potassium (**K**) from the soil. One ton of alfalfa hay contains about six pounds of P (14 pounds of P_2O_5) and 48 pounds of K (56 pounds of K_2O). Corn silage yielding 15 tons per acre removes about 50 pounds of P_2O_5 and 120 pounds of K_2O. Over time, P and K must be added to the soil to maintain crop yields. How good is wood ash in meeting crop needs?

There is a difference between the *total* and *available* P and K in wood ash. Three different methods are used to estimate how much of these nutrients are available:

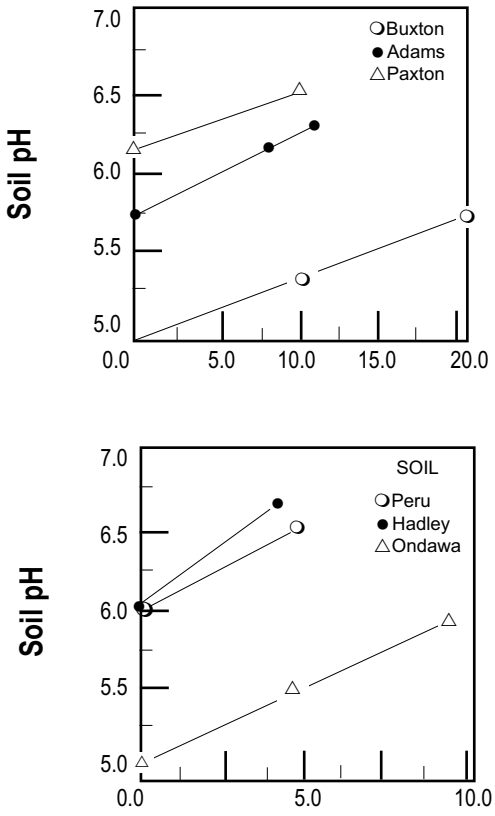
1. A standard fertilizer test procedure, which extracts nutrients from the ash in an ammonium citrate solution, treating the ash the same as a commercially available fertilizer
2. The Maine Soil Test extraction, which measures changes in the amount of available P and K in the soil after ash application, using ammonium acetate
3. Measurement of differences in plant uptake of P and K after ash application

We use methods 1 and 2 in research because we want to know quickly what nutrients are available from the ash. However, it is important to compare these laboratory methods with method 3.

The percentage of P and K that is available using methods 1 and 2 is shown in Table 2 on page six. From this table, you can see that wood ash P and K are **not** completely available to the crop. If wood ash containing 100 pounds of P and 100 pounds of K were applied, soil tests results would increase only about five pounds for P and 40 pounds for K. Again, there are differences between the ash samples. Availability of these nutrients, especially P, is affected by the ash itself, the pH of the soil, and the nutrient level in the soil before you apply ash.

Plant uptake of P and K following wood ash application has been measured in greenhouse studies. The relationship of soil test procedure and plant uptake is usually linear or straight-line. This relationship is important. It is the first step in being able to predict crop response to nutrients in wood ash.

Figure 3. Effect of wood ash application rate on soil pH



Wood Ash Application Rate, g kg^{-1} soil.

Application of 10 g kg^{-1} soil is approximately 11 tons ash/acre. Data from Ohno and Erich, 1990.

There is a difference between *total* and *available* phosphorus and potassium in wood ash.

Being certified for ash application may require soil test results, a location map and ash nutrient analysis.

Table 2. Available phosphorus (P) and potassium (K) in Maine wood ashes

	Using fertilizer test extraction		Using increase in soil test	
Ash Source	**P**	**K**	**P**	**K**
Ultrapower	56	82	4.6	45
Greenville Steam	45	62	7.7	38
Beaverwood Chester	46	70	6.0	43
Sludge-Ash mixture	44	69	3.8	59
Bioash	46	39	3.8	18
Pinetree	43	72	6.3	39
Average	**47**	**66**	**5.4**	**40**

Ash extracted using ammonium citrate solution. Change in soil nutrient level, using standard soil test prodcedure, before and after ash application. Average of three soils per ash source. Data from Ohno and Erich, 1990.

Should You Use Wood Ash?

Wood ash can be useful in increasing soil pH and supplying plant nutrients. However, you must follow certain procedures before (and possibly after) each ash application. Wood ash applications are currently regulated by the Maine Department of Environmental Protection (DEP). The current regulations are available from the Maine DEP. Being certified for ash application may require soil test results, a location map and ash nutrient analysis. The amount of ash that you can apply varies by field. It depends on CCEs, potassium content of soil and soil pH.

Although ash is often mixed with water ("conditioned") before leaving the power plant, it can dry out after being stored in the field. Be careful when you handle any dusty soil amendment (like ash, lime or dry fertilizer). Avoid inhaling the dust and avoid spreading on windy days. Ash can also cause skin and eye irritation. Wear protective clothing (gloves, long-sleeve shirt) and safety glasses if skin contact is likely. **Use common sense when handling ash.**

References

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Appendix

Appendix Table 1. **Nutrients present in large amounts in wood ash (% of ash dry matter)**

	Calcium	Potassium	Phosphorus	Magnesium	Aluminum	Sodium
Ashes from Maine						
1	24.00	2.70	0.60	1.10	0.20	0.01
2	7.40	2.70	0.50	0.90	1.70	0.20
3	28.00	7.40	1.40	2.20	0.60	0.60
4	22.00	3.90	1.30	2.00	1.50	0.30
5	8.80	3.90	0.60	0.90	3.20	0.30
6	22.00	6.00	1.30	2.00	0.50	0.20
Ashes from other locations						
1	33.10	4.20	1.40	2.20	2.40	0.30
2	10.90	2.90	0.70	1.60	—	0.20
3	12.80	1.70	0.30	0.80	1.60	0.20
4	27.00	3.10	0.80	1.60	1.60	0.30
5	7.40	2.60	—	0.70	3.20	0.50
6	13.60	3.00	0.90	1.40	2.00	0.20
Average	**18.10**	**3.68**	**0.89**	**1.45**	**1.68**	**0.28**
lb/acre in 5 tons of ash	1810.00	368.00	89.00	145.00	168.00	28.00

From Ohno and Erich, 1990; Campbell, 1990.

Appendix Table 2. **Nutrients and metals present in small amounts in wood ash samples (given in parts per million or ppm)**

Sample #	Ba	B	Cd	Cr	Cu	Pb	Mo	Ni	Se	S	Zn
1	549	—	<1.0	103	151	32	61	65	183	—	423
2	—	8	26	92	140	127	123	50	—	4354	692
3	—	127	3	14	78	66	—	12	<1.0	6800	794
4	—	—	4.2	9.1	40	38	—	12	—	—	200
5	—	—	7.9	21.1	90	72	—	49	—	—	381
6	910	55	4.4	27	120	59	—	47	11	—	370
7	0.5	290	16	25	70	70	3	50	—	—	560
lb/acre in #1 in 5 tons of ash	5.54	—	<0.01	1	1.5	0.3	0.6	0.65	1.8	—	4.2

From Ohno and Erich, 1993. Average of four ash samples from same Maine location. Ashes 2 through 7 from Campbell, 1990.

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