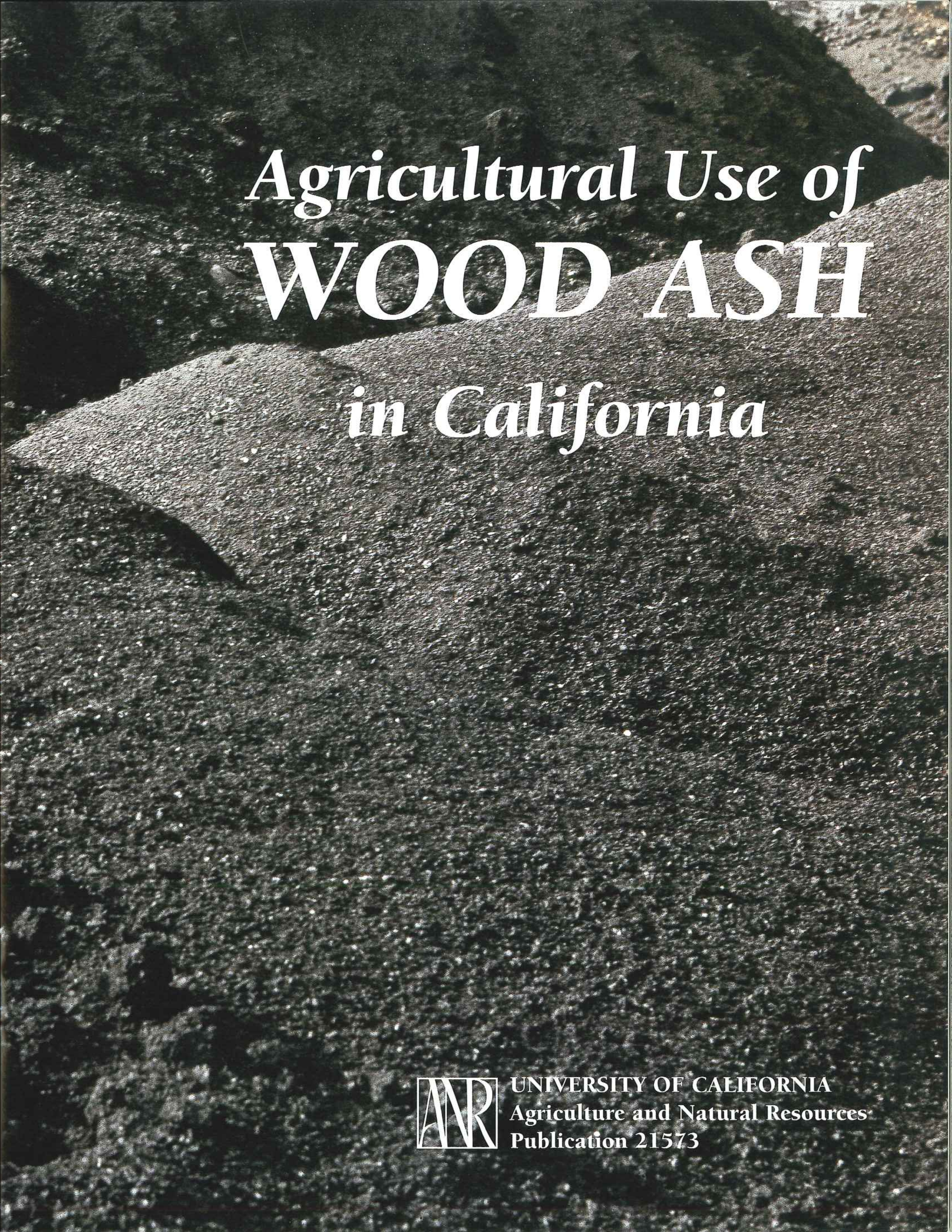

Agricultural Use of WOOD ASH *in California*

UNIVERSITY OF CALIFORNIA
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How to Use Wood Ash in Agriculture

Collect a soil sample and have a laboratory determine
- pH
- Saturation percentage (SP) or cation exchange capacity (CEC)
- Bicarbonate-P (phosphorus) concentration
- Exchangeable-K (potassium) concentration

Obtain a fertilizer label from the ash production facility containing
- Percentage of lime (calcium carbonate equivalent)
- Percentage of phosphorus (P_2O_5)
- Percentage of potassium (K_2O)

Calculate the amount of ash to apply using the soil pH and percentage of lime (calcium carbonate equivalent)

Follow up with soil and plant tissue analysis to determine other plant nutrient needs

After 3 to 5 years, collect soil samples for analysis to determine additional ash needs

Key Information about Agricultural Use of Wood Ash

Benefits
- Effective low-grade liming material for soils with a pH below 7.0
- Low-analysis potassium and phosphorus fertilizer

Concerns
- Use safety equipment when handling ash
- Avoid movement of ash by wind and water
- Prevent grazing livestock from having direct contact with ash
- Potentially high concentration of heavy metals

Guidelines for Use
- Apply ash only to soils with pH below 7.0
- Use proper rates of ash for each field
- Apply ash to the soil surface where standing plant residue prevents movement by wind or water
- Thoroughly incorporate high rates of ash into the soil
- Use caution before planting crops where high rates of ash have been applied
- Always take steps to avoid movement of ash by wind and water

AGRICULTURAL USE OF WOOD ASH IN CALIFORNIA

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According to the California Integrated Waste Management Board's *Phase 1 Report, Ash Quantification and Characterization Study* (Khan et al. 1992), approximately one-half million tons of wood ash were produced in California in 1989. Although most ash was initially taken to landfills, it is now being used in a variety of ways. Many of the current uses are in response to a California law (Public Resources Code §40000 et seq. [AB 939]) requiring the development of alternative disposal measures to reduce the amount of material sent to landfills. Since the mid-1980s, University of California Cooperative Extension personnel and many cooperating landowners have conducted field research studies to examine how wood ash can be used in agriculture. This publication discusses the benefits and potential risks of using wood ash as a low-value liming material and plant nutrient source in order to assist potential users of wood ash in distinguishing beneficial from nonbeneficial agricultural uses.

Origin and Composition of Wood Ash

Wood-fueled power plant ash (bottom ash and fly ash) is a byproduct of steam generation that is produced by burning wood chips in a furnace at 1,400° to 1,900°F (766° to 1,046°C). The wood fuel comes from in-forest operations, orchards, sawmills (bark, sawdust, shavings, or wood chips), and occasionally urban trees and shrubs (tree stems, limbs, stumps, leaves, or needles). One bone dry ton (BDT) (100 percent dry matter) of wood fuel produces about 1 megawatt-hour of electricity, sufficient to power 1,000 homes for 1 hour. Depending on the combustion characteristics of the furnace, 1 BDT also produces 3 to 7 cubic feet (0.08 to 0.20 m^3) of ash, which may weigh from 10 to 100 pounds per cubic foot (160 to 1,600 kg/m^3).

It is very important that ash produced from wood fuel (wood ash) be distinguished from ash produced from other fuel sources, particularly coal, sewage sludge, or urban waste. These other ash materials may contain lead and other heavy metals or organic compounds from burning plastics or petroleum products. They may not be suitable for agricultural applications. If the concentrations of these elements or compounds exceed prescribed limits, the ash is classified as a hazardous waste according to Title 22 of the California Code of Regulations.

The composition of wood ash is determined largely by the type of power plant, whether bottom and fly ash are mixed together, and how the ash is collected and removed from the facility. Wood ash typically contains carbon (unburned wood), calcium, magnesium, sodium, potassium, and phosphorus, and it may also contain beneficial amounts of sulfur, zinc, copper, and other micronutrients (fig. 1). Boron, molybdenum, and selenium may also be present at low concentrations, depending on the wood used in the power plant.

Some power plants produce a "high-carbon" ash as a result of incomplete combustion of fuel, while others produce a "low-carbon" ash. High-carbon ash can consist of

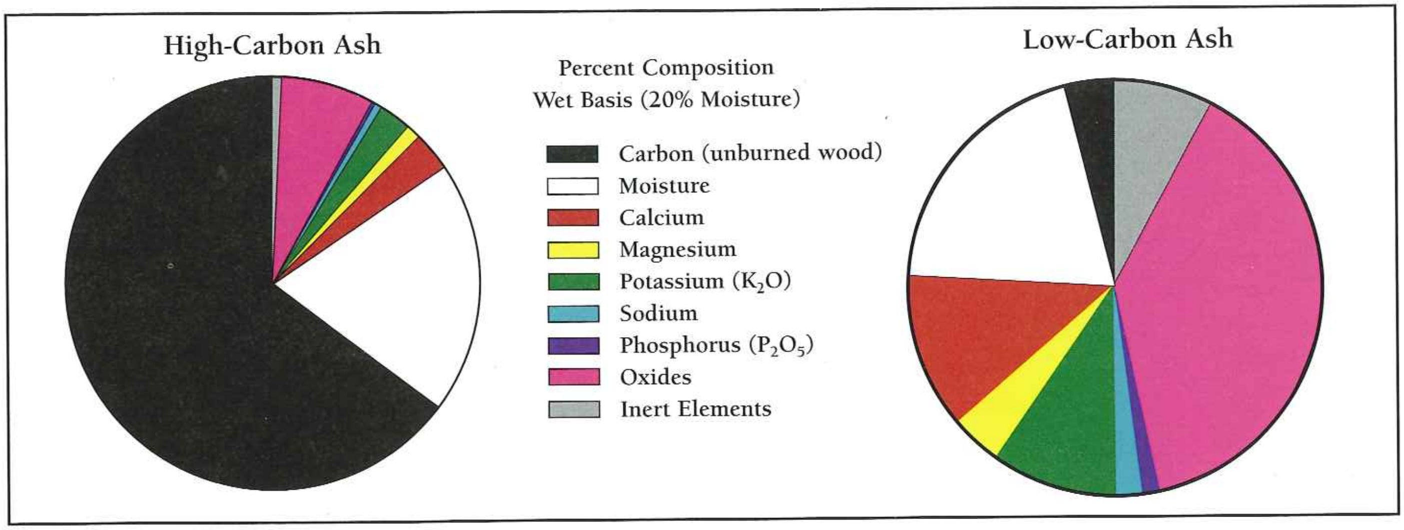

Figure 1. Composition of wood ash materials commonly used in agriculture in California.

more than 60 percent unburned carbon by weight; low-carbon ash generally consists of less than 10 percent unburned carbon by weight. A third type of ash comes from a fluidized bed furnace where sand or lime ($CaCO_3$) is used in the burning process. This ash may consist of as much as 60 percent or more sand or lime by weight, with concentrations of other components similar to high-carbon ash.

Although the moisture content of wood ash can vary from 0 percent to over 50 percent, it typically averages about 20 percent. The moisture content affects the weight transported and the ease of handling and spreading. Ash may also contain rocks, wood, and bark greater than 1 inch (2.5 cm) in diameter, which should be removed before the ash leaves the power plant. A spreader equipped with a grate or screen can be used to remove some of the larger materials.

Wood ash that comes directly from the boiler is hot and contains relatively caustic calcium, magnesium, potassium, and sodium oxides. Ash can sometimes exceed a pH of 12.5, above which materials are classified as hazardous waste under California's Hazardous Waste Act. However, Section 25143.5 of the California Health and Safety Code provides that the corrosivity test that generally applies to determine whether a material is hazardous does not apply to biomass combustion ash as long as certain conditions are met: the ash must be managed in accordance with applicable water regulations, used beneficially in a manner that results in lowering the pH below 12.5, not be accumulated speculatively, and be available for commercial use.

The primary agronomic value of wood ash comes from its liming capacity and from its potassium and phosphorus content. Ash should be analyzed for its liming capacity, fertilizer nutrients, and concentrations of potentially hazardous contaminant elements to determine the rate of application to crop, forest, and rangeland (see table 1). Landowners must balance the soil's or crop's need for liming and fertilization against the harmful contaminants added with the ash.

Table 1. Ash analyses needed to determine agricultural benefit.

Primary characteristics	Analysis
pH	Saturated paste
Phosphorus (P_2O_5)	Total nutrient content
Potassium (K_2O)	Total nutrient content
Sulfur (S)	Total nutrient content
Boron (B)	Total nutrient content
Liming capacity	Calcium carbonate ($CaCO_3$) equivalent*
Other elements†	Total threshold limit concentration (TTLC)

Note: Obtain these analyses from the power plant that supplies the ash. Request the two most recent TTLC analyses.

* *Source:* Association of Official Analytical Chemists 1997.

† Arsenic (As), cadmium (Cd), copper (Cu), lead (Pb), mercury (Hg), nickel (Ni), zinc (Zn), molybdenum (Mo), selenium (Se). Derived in part from *Standards for the Use or Disposal of Sewage Sludge,* table 3, part 503.13.

Wood Ash as a Liming Material

The most desirable range of soil pH for plant growth is from 6.5 to 7.0. Application of a liming material to soil is the normal method of raising the pH of an acid soil. Common liming materials are listed in table 2, and the amount of lime needed to raise the pH of various soil textures and degrees of soil acidity is indicated in table 3. Wood ash is an effective liming material because the calcium, magnesium, and potassium oxides in ash can neutralize the acidity in soils. A calcium carbonate equivalent test is used to assess the liming capacity of ash (see table 1), and the ash application rate is established by the liming rate calculation (see fig. 2). If the laboratory conducting the soil test does not indicate the soil texture, it can be determined from table 4 by using either the cation exchange capacity (CEC) or the saturation percentage (SP).

Table 2. Common liming materials.

Name	Chemical formula	($CaCO_3$) equivalent (%)	Source
Burned lime	CaO	150–175	Kiln burned
Hydrated lime	$Ca(OH)_2$	120–135	Steam burned
Dolomite*	$CaCO_3$, $MgCO_3$	110	Natural deposit
Limestone	$CaCO_3$	100	Pure form, finely ground
Sugar beet lime	$CaCO_3$	80–90	Sugar beet byproduct
Power plant ash	CaO, K_2O, MgO, Na_2O	5–50	Wood-fired power plants

Source: Western Fertilizer Handbook (1995), p. 219.
*High-magnesium dolomite should not be applied where magnesium exceeds calcium in soil.

Table 3. Amount of lime needed to change soil pH (soil reaction).

Change in pH desired	Tons of lime (100% of $CaCO_3$ equiv.) required per acre (6-inch depth) for various soil textures*					
	Sand	Sandy loam	Loam	Silt loam	Clay loam	Muck
4.0 to 6.5	1.3	2.5	3.5	4.2	5	9.5
4.5 to 6.5	1.1	2.1	2.9	3.5	4.2	8.1
5.0 to 6.5	0.9	1.7	2.3	2.8	3.3	6.3
5.5 to 6.5	0.6	1.3	1.7	2	2.3	4.3
6.0 to 6.5	0.3	0.7	0.9	1.1	1.2	2.2

Source: Western Fertilizer Handbook (1995), p. 218.
* This table gives the amount of 100% $CaCO_3$ equivalent required to change the soil pH of a 6-inch layer of soil. To alter the pH of the surface 12 inches of soil, twice the amount of lime should be applied.

Figure 2. Liming rate calculation.

Step 1. These steps determine the amount of ash to apply as a liming material to neutralize soil acidity and raise soil pH. First, obtain the lime ($CaCO_3$) equivalent from the ash analysis (table 1). We will assume 11% for our example.

Liming capacity
Lime equivalent = 11%
Percentage lime = 0.11

Step 2. From the soil test report, obtain the CEC and estimate the soil texture. In our example, the CEC is 6, which indicates that the soil has a sand or loamy sand texture (table 4). An alternative way to determine soil texture is to obtain the SP from the soil test report (table 4).

CEC of 6 = sand or loamy sand

Step 3. Use Table 3 to determine the amount of 100% $CaCO_3$ equivalent lime needed to raise the soil pH to the desired level by using the soil pH and texture. Obtain the soil pH from the soil test report. In our example, assume the pH is 4.6. To change the pH from 4.6 to 6.5 for a soil of sand texture, an application of 1.1 tons/acre of 100% limestone is required.

Change in pH desired in 6" plow depth layer = 4.5 to 6.5
Tons of lime required for different soil texture = Sand = 1.1 tons/acre

Step 4. Determine the amount of ash to apply. Divide the amount of 100% limestone by the percentage $CaCO_3$ equivalent of the ash. In our example, divide 1.1 from step 3 by 0.11 (the $CaCO_3$ equivalent of this ash) from step 1. We find 10.0 tons/acre of dry ash should be applied to get the desired pH change.

1.1 tons/acre ÷ 0.11 = 10.0 tons/acre of dry ash

Step 5. Adjust the amount of ash to apply for moisture percentage. Divide the amount of applied ash by the percentage of dry matter in the ash. In our example, if we assume that the percent moisture is 20%, then the percent dry matter is 80% (100% minus 20%). Divide 10.0 tons/acre of dry ash by 0.8 to determine that 12.5 tons/acre of ash with 20% moisture should be applied to raise the pH from 4.5 to 6.5.

10 tons/acre ÷ 0.8 (percentage dry matter) = 12.5 tons/acre of moist ash

Table 4. Approximate soil texture as determined from the cation exchange capacity (CEC) and saturation percentage (SP).

CEC (meq/100 g)*	SP†	Soil texture
2–6	less than 20	Sand or loamy sand
3–8	20–35	Sandy loam
7–18	35–50	Loam or silt loam
15–30	50–65	Clay loam
greater than 30	65–135	Clay (some clays go up to 150)
greater than 40	greater than 135	Usually organic (peat or muck)

Source: **Western Fertilizer Handbook* (1995), p. 13.
†Division of Agriculture and Natural Resources Analytical Laboratory, University of California, Davis.

Liming materials can be applied to a number of crops, but they are of questionable benefit when the soil pH is above 6.5 and should not be applied to soils with a pH above 7.0. Do not use ash rates that increase the pH of the soil to above 7.3 because essential micronutrients such as zinc become less available to growing plants.

Other Nutritional Benefits

Wood ash can supply the plant nutrients potassium and phosphorus because it contains from less than 1 percent to more than 10 percent potassium as K_2O and less than 2 percent phosphorus as P_2O_5. However, the maximum application rate of ash is usually determined by the liming rate calculation, and the amounts of potassium, phosphorus, and other nutrients applied may be rather small. Like other fertilizer materials, crops will respond to ash only when a nutrient is deficient. Plant tissue or soil tests should be used to indicate the need for potassium, phosphorus, or other nutrients.

Alfalfa, for example, is a crop that grows best when the soil pH is above 6.3 and when the soil supplies adequate potassium and phosphorus. Wood ash can be applied to raise the soil pH and supply some portion of the potassium and phosphorus needs. For alfalfa, potassium soil test results (exchangeable-K) below 80 parts per million (ppm) and plant tissue test results (midstem concentrations at 10 percent bloom) below 0.8 percent potassium indicate the potential for crop yield response to potassium (see *Soil and Plant Tissue Testing in California*, DANR Publication 1879 [Resienauer 1983]). Similarly, phosphorus soil test results (bicarbonate-P) below 10 ppm and plant tissue test results (midstem concentrations at 10 percent bloom) below 800 ppm PO_4-P indicate the potential for crop yield response to phosphorus. If alfalfa needs these nutrients, apply potassium according to the guidelines in table 5.8 of *Intermountain Alfalfa Management* (DANR Publication 3366 [Orloff and Carlson 1995]). If wood ash is used as the potassium or phosphorus source, first apply ash according to the liming rate calculation and then supplement with commercial fertilizer.

Addition of boron, molybdenum, and selenium may be beneficial to alfalfa and other crops in some areas of California and detrimental in other areas. Annual plant tissue testing should be used to monitor crop nutrient concentrations and determine the need for fertilization (see *Soil and Plant Tissue Testing in California* and *Intermountain Alfalfa Management*).

Handling, Transportation, and Field Storage

The primary concern in handling ash comes from its fine particle size and caustic nature. Handling precautions include using a dust mask, protective gloves, and eye protection. Before handling ash, review the Material Safety Data Sheet (MSDS), which is available from the ash supplier.

Steps should be taken during transport, storage, and field application to prevent wind or water from moving the ash. Ash can be hauled in enclosed vans or trucks covered with tarps. If trucks that do not have tarps are used, water should be mixed with or sprayed on the top of the ash prior to hauling to eliminate movement by wind. When storing ash, prevent the ash from moving by selecting sites with little wind exposure, covering the ash, or repeatedly applying small amounts of water to the ash with sprinklers. To minimize public exposure, ash should not be stored near residential, business, recreational, or other occupied areas such as homes, schools, shopping areas, etc.

Method and Rate of Application

The method used to apply ash depends upon the rate to be applied and the amount of plant cover. Application rates up to 20 tons per acre (45 Mg/ha) (20 percent moisture) can most effectively be applied with a lime or gypsum spreader having an opening of 24 to 28 inches (61 to 71 cm) wide. Ash is unloaded from dump trucks in a temporary storage area near the edge of the field where it is not subject to movement by wind or water. After sufficient ash has been delivered, a loader is used to move the ash from the pile into the spreader. Ash can be safely applied to rangeland or irrigated pasture at rates up to 20 tons per acre (45 Mg/ha) (20 percent moisture), which is approximately a depth of 0.5 inch (12.5 mm). Standing plant residue should be at least 1,000 pounds per acre (1,120 kg/ha) (100 percent dry matter) and 2 to 4 inches (5 to 10 cm) tall to minimize movement by wind or water. Prevent livestock from eating the ash by allowing rain to fall

Plate 1. Chipped wood, a fuel used by many power plants.

Plate 2. Large piles of wood chips are mixed together before being burned in the power plant in the background.

Plate 3. Two most common types of ash: high-carbon black ash, left, and low-carbon gray ash, right.

Plate 4. Large blocks of ash, rocks, and other debris should be removed from ash before spreading in the field.

Plate 5. A spreader equipped with a grate or screen on the top can be used to remove large particles from the ash.

Plate 6. A wide opening in the spreader—24 to 28 inches (61 to 71 cm) wide, as shown here—allows ash to feed properly onto the spinners for uniform distribution in the field.

Plate 7. Ash application rates (100 percent dry matter basis) on rangeland: 20 tons per acre (45 Mg/ha), right; 40 tons per acre (90 Mg/ha), left and in back; and 80 tons per acre (180 Mg/ha), center foreground.

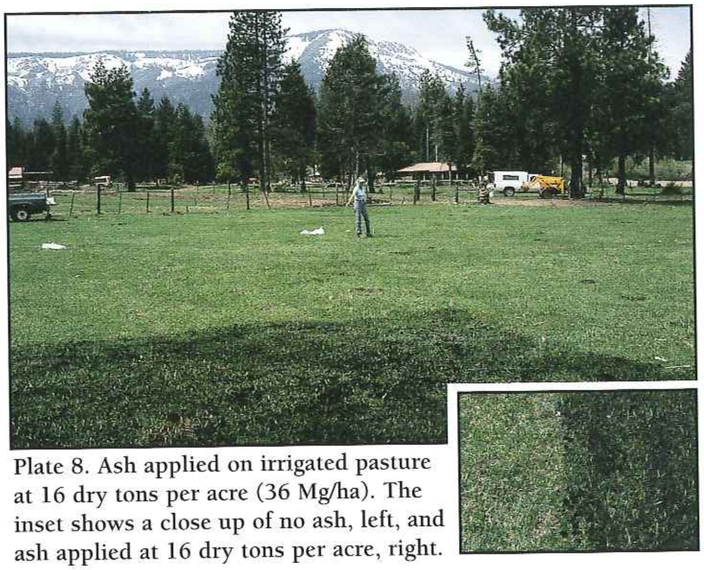

Plate 8. Ash applied on irrigated pasture at 16 dry tons per acre (36 Mg/ha). The inset shows a close up of no ash, left, and ash applied at 16 dry tons per acre, right.

Plate 9. A truck with a moving floor unloads ash in strips in a field.

Plate 10. Driving stakes in the field at planned spacing and intervals provides for more accurate rates of application.

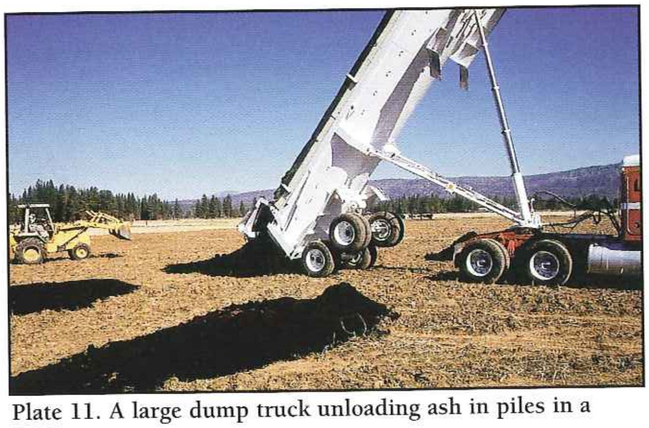

Plate 11. A large dump truck unloading ash in piles in a field.

Plate 12. Small, uniform windrows that are more closely spaced allow for uniform spreading in the field.

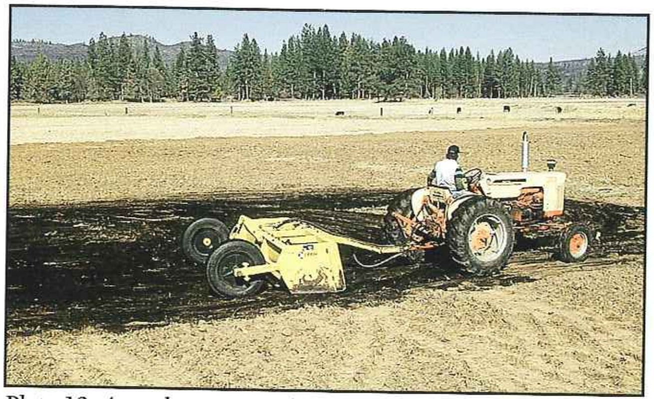

Plate 13. A grader, scraper (shown here), blade, or landplane traveling perpendicular to the windrows can be used to spread the ash uniformly in the field.

Plate 14. Ash is incorporated effectively using a large tandem or double disk with disks 18 to 24 inches (45.5 to 61 cm) in diameter.

Plate 15. A second pass over the field with the tandem disk at a 45° to 90° angle to the first disking assures more complete incorporation of the ash.

Plate 17. Areas of high ash application rates may reduce germination and early seedling growth, resulting in very low crop yields.

Plate 16. An aerial photograph showing very uneven spreading of ash in a field. Uneven spreading decreases the benefit of ash to crops.

Plate 18. The quarter gives a perspective as to how greatly plant density has been reduced by heavy ash application compared to the upper right corner of photo, where a higher plant density exists.

Plate 19. A large legume-wheat plant growth response of greater than 2.5 tons per acre (5.6 Mg/ha) from ash application of 100 dry tons per acre (225 Mg/ha), left, compared to no ash, right. The soil was slightly acidic (pH 5.7) and low in phosphorus and potassium.

Plate 20. Avoid storing or applying ash near streams or intermittent watercourses.

Plate 21. Ash should be stored in areas surrounded by trees where it can be protected from movement by wind. Some movement is unavoidable during loading and spreading of ash.

Plate 22. Avoid excessive movement by wind during spreading and incorporation of ash.

or sufficient time for ash to be removed from standing grass before grazing. Application of too much ash may cover up plants and inhibit their growth or burn them from the heat generated when caustic oxides in the ash come in contact with moisture. Ash applications made to dryland range followed by small amounts of rainfall (less than 1 inch [2.5 cm]) may cause germinating seedlings to die because the soluble oxides are leached from the ash into the seed zone. Normal vegetative species composition will usually appear in the second and following growing seasons.

Ash rates greater than 20 tons per acre (45 Mg/ha) (20 percent moisture) should be incorporated into the soil to obtain immediate crop response and reduce risk of movement by water or wind. Ash is generally unloaded in the field from dump trucks or other large trucks into strips, windrows, or piles and then spread over the field. It is easier to spread ash uniformly from small windrows that are close together than from larger piles or windrows that are farther apart. Drive stakes to mark where windrows should be laid out or the location of piles before unloading the ash in the field. If windrows are used, spread the ash with a grader, scraper, blade, or landplane traveling perpendicular to the windrows. To obtain uniform distribution of ash located in piles in the field, a dozer blade can be used to spread ash in one direction followed by a grader, scraper, or landplane traveling perpendicular to the direction of the dozer path. The ash should be thoroughly mixed into the soil by plowing or disking with a large tandem or double disk with disks 18 to 24 inches (46 to 61 cm) in diameter soon after application. Ash will normally not be incorporated to a depth greater than one-quarter of the disk diameter or one-half the depth of the moldboard plow. A second pass over the field at a 45° to 90° angle to the first disking assures more complete and uniform incorporation. Ash should be sufficiently incorporated to avoid contamination of forages grown for animal grazing or hay production.

An excellent job of incorporation will leave no visible evidence of ash on the soil surface. Establishing plant cover soon after ash is incorporated can reduce wind and water movement of soil and ash. Newly planted seedlings may be injured if ash is not uniformly mixed with the soil or if ash is applied at rates greater than 100 tons per acre (225 Mg/ha) (20 percent moisture), about 2 to 3 inches (5 to 7.5 cm) deep. In order to neutralize caustic oxides that may be present after incorporation, give the soil and ash more complete mixing (by disking) or allow a fallow period before planting a crop. Applying water (by rainfall or irrigation) to the field may shorten this fallow period. Where irrigation is not available or rainfall is minimal, the fallow period before planting may be more than one season. Very high rates of ash application—greater than 200 tons per acre (448 Mg/ha) or about 5 inches (12.5 cm) deep—may require waiting two or more seasons prior to planting, particularly under dryland conditions where little precipitation (less than 10 inches [25 cm]) is received. Test plantings may be useful in determining when conditions are safe for widespread planting. To reduce the potential movement of soil and ash during the dry fallow period, covering the soil surface with wood chips, manure, straw, or other plant residue or creating a rough soil surface by ripping perpendicular to the direction of prevailing wind or water runoff is suggested. To comply with local, state, or federal regulations, landowners should keep careful records of the amount and composition of ash applied.

Local, State, and Federal Regulations

Power plants that distribute ash must be licensed by the California Department of Food and Agriculture Fertilizer, Feed, and Animal Products Division in Sacramento. Ash must be registered as an agricultural mineral indicating its liming capacity (percentage calcium carbonate equivalent) and fertilizer constituents (percentage soluble potash [K_2O] and percentage available phosphoric acid [P_2O_5]).

Community concerns may develop because agronomic rates of ash application are often high. The determination of what constitutes beneficial use of ash on agricultural land is under the jurisdiction of the California Department of Food and Agriculture, and local enforcement may be provided by the county agricultural commissioner. Concerns relating to nonagricultural use are the responsibility of the state Integrated Waste Management Board along with local environmental health or solid waste officials. Undesirable impacts of ash on air and water quality are the responsibility of local and/or regional air and water quality control officials.

Records of ash application are sometimes required by local (air quality), state (Regional Water Quality Control Board), or federal (Environmental Protection Agency [EPA]) regulations. The ash-producing facility may be required to report the locations and rates of application to the regional water quality control board. The landowner has the primary responsibility for maintaining long-term records of ash application and calculations of metal accumulation, which may be of concern when ash is applied to agricultural land. Title 22 of the California Code of Regulations sets standards for identification of contaminated soils and water but does not prescribe maximum application rates of elements and compounds. The EPA standards for maximum element concentration and annual and cumulative loading rates of elements from sewage sludge are suggested for ash applications in table 5. Using the ash analysis information obtained from the power plants (table 1), calculate the contaminant potential (see fig. 3). Do not apply ash exceeding either the maximum annual loading rate or maximum cumulative loading rate (table 5). Good long-term ash application records are important for determining future rates of application of ash or other waste products.

Table 5. Standards for maximum element concentration and annual and cumulative loading rates for use of sewage sludge suggested for ash application.

Element	Maximum concentration (ppm or mg/kg)*	Maximum annual loading rate (lb/acre)†	Maximum cumulative loading rate (lb/acre)‡
U.S. Environmental Protection Agency standards			
Arsenic (As)	41	1.8	36
Cadmium (Cd)	39	1.7	35
Copper (Cu)	1,500	67.0	1,335
Lead (Pb)	300	13.0	267
Mercury (Hg)	17	0.7	15
Nickel (Ni)	420	19.0	374
Zinc (Zn)	2,800	125.0	2,500
Molybdenum (Mo)	75	Under review by EPA	Under review by EPA
University of California recommendations			
Molybdenum (Mo)	No more than 0.5 lb Mo/acre in any 4-year period in single or split applications with a total maximum cumulative loading of 5.0 lb Mo/acre§		
Selenium (Se)	No more than 0.025 lb Se/acre annually with a total maximum cumulative loading of 5.0 lb Se/acre#		
Boron (B)	Can be beneficial if added at the rate of 1.0–5.0 lb B/acre to soil that is deficient; but adding as little as 0.5 lb B/acre to soil with a high B level can be detrimental		

*Source: *Standards for the Use or Disposal of Sewage Sludge*, table 3, part 503.13.
†Source: *Standards for the Use or Disposal of Sewage Sludge*, table 4, part 503.13.
‡Source: *Standards for the Use or Disposal of Sewage Sludge*, table 2, part 503.13.
§Monitor forage concentrations; adjust livestock nutritional excesses in balance with copper.
#Monitor forage concentrations to assess potential deficiencies or excesses.

Figure 3. Contaminant potential calculation.

Step 1. Obtain the total threshold limit concentration (TTLC) analysis from the power plant (request the two most recent analyses). In our example, we will assume a concentration of 290 ppm lead in the ash product.

> 290 ppm lead in the ash product

Step 2. Obtain the ash application rate from step 4 of the liming rate calculation. Our liming rate calculation example applied 10 tons/acre of dry ash. Multiply the tons/acre times 2,000 lb/ton to determine lb/acre applied. Thus, 10 tons/acre × 2,000 lb/ton = 20,000 lbs/acre of dry ash.

> 10 tons/acre × 2,000 lbs/ton =
> 20,000 lbs/acre dry ash application rate

Step 3. Multiply the percentage of contaminant times the pounds applied to determine the pounds of contaminant applied per acre. Since 10,000 ppm = 1%, then 290 ppm = 0.029%, or 0.000290. In our example, 0.000290 × 20,000 lb/acre = 5.8 lb/acre of lead is applied.

> 290 ppm = 0.000290 (divide by 1,000,000)
> 0.000290 × 20,000 lb/acre = 5.8 lb/acre of applied lead

Step 4. Table 5 indicates an annual maximum loading of 13 lb/acre of lead. Thus, 5.8 lb/acre of lead applied in 10 tons/acre of ash falls below the annual maximum loading rate. To reach the maximum, 7.2 lb/acre of additional lead may be applied.

> 5.8 lb/acre is less than the annual loading rate limit of
> 13 lb/acre of lead in table 5

Step 5. Table 5 also indicates the maximum cumulative loading rate for lead, which is 267 lb/acre. Thus, 261.2 (267.0 minus 5.8) lb/acre of lead can be applied before reaching the maximum cumulative loading rate of the site.

> 267 lb – 5.8 lb = 261.2 lb/acre of lead can be applied before
> reaching the maximum cumulative loading rate of the site

Step 6. This procedure must be carried out for each of the elements listed in table 5. The highest rate of ash application to be used is established when the amount of any element reaches its maximum loading rate given in table 5.

> Repeat steps 1 to 5 above for each element in table 5

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Credits

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