Equipment for Spreading Organic Solid Waste on Forest Land

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ABSTRACT

Forest land utilization is becoming an important disposal alternative for paper mill wastes. Interest in this disposal alternative for other organic solid wastes such as poultry litter and compost is likely to grow as well. Three main types of spreader mechanisms that have been tried for forest waste spreading operations are vertical impeller/blower units, horizontal-axis beater-type spreaders, and horizontal spinner-type spreaders. The main considerations in selecting equipment for forest spreading operations are the carrier, the type of spreading mechanism, hopper configuration, and self-loading capabilities (if the carrier is a forwarder). These considerations are discussed in terms of site/stand conditions as they affect manoeuvrability and access, the materials to be spread, costs, and the scale of the spreading operations.

Keywords: *spreaders, land application, waste disposal.*

INTRODUCTION

Forest land application is a promising disposal alternative for organic solid wastes because of environmental regulations that are making landfill sites less available and more expensive and the high proportion of the total land area in forests in many areas. This alternative is becoming increasingly important to the forest products industry for disposing of the large quantities of wood ash and sludge generated at pulp and paper mills. Forest land may also be a good disposal option for other materials such as poultry litter and compost which are generated in significant quantities in close proximity to large areas of forest.

Spreading solid waste materials on forest land presents some unique challenges in terms of materials handling and equipment considerations. Waste materials such as wood ash, sludge, and poultry litter are bulky, so they must be applied to forest land using ground-based spreaders. Forest terrain can be rough and uneven, and plantations also have the particular problems of limited mobility, due to the presence of the forest stand, and concerns about damage to that stand. There are also difficulties and cost considerations associated with transporting equipment and waste materials to remote forest sites and loading waste materials at the site.

Important considerations which directly affect equipment requirements for spreading organic solid waste materials on forest land include site conditions, the characteristics of the material to be spread, and the scale of the disposal operations. Important design aspects of the spreader itself include the carrier, the configuration and capacity of the hopper, the type of spreader mechanism and the distance that it can throw the material, and capital and operating costs. Various combinations of carrier and spreader types are possible, and many have been tried for spreading wood ash and similar types of waste materials on forest land.

Horizontal spinner-type spreaders, which are standard for use in agriculture for lime and poultry litter applications, have been tried for spreading wood ash and other paper mill wastes on agricultural and forest land. A project investigating the application of organic solid wastes to forest land in the southeastern United States using this type of spreader has been initiated at Auburn University. An experimental forest spreader has so far only been used for applying poultry litter to thinned, mid-rotation-age pine plantation research plots. Further calibration and distribution pattern tests with this spreader broadcasting poultry litter, wood ash, and fly ash on forest land are planned.

This paper reviews different organic solid wastes for which forest land application is likely to be an important disposal option and describes some of the different combinations of carriers and spreaders that have been tried for this application. Details about the forest spreader unit that we are working with are also reported. We hope that this information will be useful as more and more companies and public

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agencies look at forest land application as a disposal alternative for their organic solid wastes.

ORGANIC SOLID WASTE MATERIALS

Forest land utilization is especially attractive to the forest products industry because they can use their own land for waste disposal. The forest products industry generates substantial amounts of wood ash through the combustion of waste wood to produce electricity at pulp and paper mills. Some paper mills in Alabama can produce as much as 135 t of ashes per day [1]. Wood ash has been shown to be a safe and effective soil amendment valued primarily as a liming material [5, 9]. A significant amount of the wood ash produced in the northeastern United States is land-applied [6]. In Alabama, Scott Paper Company began a pilot program in 1987 to make ashes from their paper mill in Mobile available to farmers for liming their fields [8]. The ash was being spread using horizontal spinner-type spreaders standard for use with poultry litter and lime.

The pulp and paper making process also generates large quantities of sludges of various types. Paper mill sludges vary considerably in consistency and composition depending on the source and process. Like wood ash, some sludges have significant neutralizing value. Paper mill sludge and fine-textured lime sludge have been shown to react faster than agricultural limestone when applied at equivalent rates based on neutralizing value [11, 12]. Secondary sludges sometimes contain beneficial nutrients such as slow-release nitrogen as well.

Forest land utilization may become a good waste disposal alternative for the poultry industry, which ranks second only to forestry in value in many states in the southeastern USA. The poultry industry generates vast quantities of poultry litter, close to 2 million t a year in Alabama alone [16], and is in close proximity to large areas of forest. The litter, a mixture of partially decomposed bedding material such as wood shavings and accumulated manure that is cleaned out of broiler houses, is valued as a fertilizer and soil amendment for agricultural land. Poultry litter samples taken over a ten year period in Alabama averaged 20% moisture content, 3.9% N, 3.7% P2O5, and 2.5% K2O [8]. It has typically been applied to pasture land, and high application rates are common because poultry litter production tends to be concentrated in small areas and transportation costs limit the distance that the bulky litter can be hauled economically [13]. Excess nutrients from poultry litter are a water-quality concern. Compost is another poultry waste being produced in increasing quantities as more and more broiler producers use composting to process dead birds [4]. The compost is usually applied to agricultural fields in the same manner as poultry litter, using spinner-type spreaders.

Interest in disposal alternatives for other organic waste materials is likely to grow as environmental restrictions tighten and landfill costs increase. The production of fly ash, which is scrubbed from the stacks of electric generating plants, has increased as pollution control requirements have become more stringent. Municipal sewage sludge, already land-applied to agricultural fields in significant quantities, could be spread on forest land in dewatered or composted form. Many municipal programs for composting yard wastes, thereby keeping them out of landfills, have recently been started. Composting reduces the volume of the original material, but the compost still has to be disposed of or utilized.

SPREADERS FOR WASTE APPLICATION TO FOREST LAND

Very little has been reported about spreaders for organic type materials. Wilhoit et al. [15] evaluated the distribution pattern of a poultry litter spreader, concluding that the distance between swaths should be much closer than manufacturer's recommendations in order to maximize uniformity. The only report relating specifically to forest land spreading operations concerned a prototype spreader designed to disperse debris produced by a delimber/debarker/chipper in Canada [2]. The spreader, a trailer model pulled by a skidder, had a hopper with floor conveyor, similar to poultry litter spreaders but with an open back, and two horizontal spinning chain-flail discs for breaking up clumps of debris and flinging them in a radius of up to 7 m behind the spreader.

Although very little has been reported about spreaders operating on forest land, there has been considerable activity in the spreading of wood ash and paper mill sludges on forest land by forest products companies. The spreader mechanisms that have been tried for these operations have been of three main types. They are 1) vertical impeller/blower units designed to propel organic-type materials long distances, 2) horizontal-axis beaters designed for spreading sludges and other heavy materials, and 3) horizontal spinner spreaders of the type

previously mentioned for distributing poultry litter and wood ash.

Vertical Impeller/Blower

In Maine, Resource Conservation Services (RCS, now part of Browning Ferris Ind., Bangor, Maine) has been spreading wood ash and various paper mill sludge mixtures on forest land operationally for several years. They contract primarily with forest products companies to spread wastes on their own land. They started out using a horizontal-axis, side-discharge manure spreader but switched to a unit with a vertical impeller/blower because it had a far greater throw distance (up to 35 m to one side instead of 9 m or less). The spreader unit, called Aero-Spread and made by Highway Equipment Company (Cedar Rapids, Iowa), has a three-bladed blower attached to the rear of a hopper- type body with floor chain conveyor. The hydraulic-powered unit has a high power requirement, so it has its own separate diesel engine. The units are mounted on the back of six-wheel drive Rottne forwarders with the loaders removed. They are used for one-time applications of wood ash and paper mill sludge at rates of up to 40 t/ha on clear cuts and thinned stands. The spreaders have difficulties propelling the material far enough in mature stands because of the interference of the crown with the parabolic path of the material, but have no problems in trees 4 to 6 m tall that have been thinned.

Horizontal-Axis Beater-Type Spreaders

Other companies besides RCS have tried side-discharge spreaders. Georgia-Pacific had a paper mill sludge spreading program that was operational for a couple of years in Wisconsin [10]. They used a heavy-duty side-discharge spreader mounted on the back of a large, 6- wheel drive construction-type tractor. The damp sludge was applied either to young plantations, straddling the trees which were less than 1 m tall, or to thinned stands, driving down a take-out row. Side-discharge spreaders, such as the Scavenger II manufactured by Gehl (West Bend, Wisconsin) specifically for sludge and organic wastes, have a high-speed (810 rpm) expeller reel that dispenses the material to one side. A heavy-duty auger along the bottom of the V-shaped hopper helps break up the material and delivers it to the expeller for discharge.

Another type of spreader for sludge and organic wastes uses a beater mounted horizontally across the rear of the spreader to pulverize and disperse the material, similar to the traditional manure spreader. Ag-Chem Equipment Co. Inc. (Minneapolis, MN) makes spreaders of this type under the Terra-Gator and Ag-Gator equipment lines. These large-scale, self-propelled machines (150 to 250 kw engine power, 8 to 12 m^3 hopper capacity) use a ram blade to push the material in the rectangular hopper back to the beater which disperses it over a swath approximately 4 m wide. These spreaders have been used extensively for sludge disposal operations in open field situations. They have not been used under forested conditions because of their large size and narrow swath. It may be possible to use them in certain clear cut or site preparation situations with very smooth, open field conditions.

Horizontal Spinner-Type Spreaders

Horizontal spinner-type spreaders mounted on skidders or forwarders have been used for applying both granular fertilizers and wastes such as wood ash and sludge to forest land. The spreaders are usually powered hydraulically from the skidder or forwarder hydraulic system or via a PTO shaft driving a separate hydraulic system for the spreader. Weyerhauser uses horizontal spinner-type spreaders mounted on the back of skidders to fertilize several thousand acres every year in the coastal plains of North Carolina [3]. A company in the south Georgia/north Florida area has spread sludge on thousands of acres of forest land for several forest products companies using horizontal spinner-type spreaders mounted on the back of skidders [14]. They apply the sludge to cut-over sites and to both thinned and unthinned plantations stands. They also use the same units for applying granular fertilizer to forest land. Other forest products companies in the Southeast have already started or are planning to start ash and sludge spreading programs using some type of horizontal spinner spreaders.

The spreaders used for these forest spreading operations are similar to those used for poultry litter. Poultry litter spreaders typically have floor chain conveyors 60 to 90 cm wide at the bottom of the hopper for moving the material, a gate at the back that can be adjusted to an opening height up to approximately 35 cm, and two horizontal, ribbed spinners that rotate at 600 to 700 rpm. The experimental forest spreader being used for the Auburn University study was assembled by mounting a poultry litter spreader on the back of a Franklin Pack-A-Back forwarder and replacing the loader

grapple with clamshell buckets to give the unit self-loading capabilities. The spreader, made by Chandler Equipment Co. (Gainesville, Georgia), has a 60 cm wide floor chain, a PTO-powered self-contained hydraulic system, and a stainless steel hopper 3.7 m long with a capacity of approximately 8.5 m^3. During spreading operations, the knuckleboom with the buckets must be held in position out of the way of the spinners. This is accomplished by fully extending the knuckleboom to the rear and resting the buckets on a bumper guard to the rear of the hopper and above the spinners.

The forwarder/spreader unit has so far only been used to apply poultry litter treatments to a recently thinned 19-year-old upland plantation pine stand in Cullman County, Alabama. A third row thinning was used, and the forwarder was driven down the take-out rows which ranged from 7 to 9 m apart. The poultry litter was loaded into the hopper using the clamshell buckets.

DISCUSSION

In selecting equipment for forest spreading operations, the most important considerations are the carrier and the type of spreading mechanism to use. Additional design aspects, secondary in nature but still important, include hopper configuration (both capacity and shape) and, if the carrier is a forwarder, self-loading capabilities. These considerations are interrelated, and they are also strongly influenced by the issues of site/stand conditions as they affect manoeuvrability and access, the materials to be spread, and costs. Overall costs, not just the cost of the spreader itself, must be taken into account. For example, large-scale spreading operations may require equipment to process and load waste material on site, with considerable associated costs for equipment and transportation. The following is a discussion of the important equipment selection considerations in terms of some of these issues based on our own experiences with forest spreading operations.

Carrier

Organic solid wastes are bulky, so large hopper capacity (usually 10 m^3 or larger) is needed to minimize spreader travel time back to landings for reloading. This requirement, combined with rough terrain conditions in the forest, necessitates the use of heavy-duty carriers such as skidders and forwarders. Using machines that are already well-proven for operation in the forest makes good sense, and this type of carrier has been used more than any other for forestry spreaders. Franklin Equipment Co. (Franklin, Virginia) now markets a skidder/forwarder body specifically intended as a carrier for ash spreaders. This carrier, the 170 Ash Hauler, features a 130 kw engine and is designed for a spreader box 5 m long.

A limitation to the use of this type of carrier is obstructed view for the operator because the hopper has to sit up high on the carrier frame. We experienced this problem in Alabama, where we frequently had to back the forwarder out of the stand. This same problem was encountered by RCS in their spreader operations in Maine. The placement of the hopper also has the effect of raising the overall centre of gravity of the carrier/spreader unit, making stability a concern on steep side slopes. Stability concerns limited manoeuvrability and access on our upland site in Alabama, and they were also a consideration in Maine, where regulations limit forest spreading operations to a 20% side slope but 15% was considered maximum operationally.

Trailer-model spreaders, such as the debris spreader used in Canada [14], are an alternative carrier arrangement that can have a lower hopper configuration and therefore lower centre of gravity and possibly less obstruction of view. The discharge point will be lower with such an arrangement, however, which could be a disadvantage in terms of throw distance with side-discharge and spinner-type spreaders. Manoeuvrability within the stand will be more restricted with a trailer spreader as well.

Spreader Mechanism

Throw distance and costs are important considerations in matching spreader type to stand and travel spacing requirements and the material to be spread. Vertical impeller/blower spreaders can propel material much farther than other types of spreaders, but they have a high power requirement and are therefore fairly expensive. Spinner-type spreaders, on the other hand, have limited throw distances but are relatively inexpensive because they are a standard type of agricultural equipment. Both of these types of spreaders can handle a wide range of waste materials, but more care is required with the vertical impeller/blower spreaders to keep contaminants that could damage the blower out of the waste material. Also, the actual throw distance will vary considerably depending on the properties of the waste material. Side-discharge spreaders have a

shorter throw distance, but they may be able to handle wetter, heavier materials than the other spreader types.

Hopper Configuration

The need to maximize hopper capacity has to be balanced with manoeuvrability, soil compaction, and floatation concerns which will limit the overall weight and size of the carrier/spreader unit. Width limitations, both for the carrier and the hopper, will be a particular concern within plantation stands. Hopper shape can have an effect on the potential for bridging. For vertical impeller/blower and horizontal spinner spreaders, which have the same basic hopper configuration, bridging should be less of a problem the steeper the sides of the hopper and the wider the floor chain are. Bridging potential is material-dependent, with heavier materials such as secondary paper mill sludge more likely to have problems. Agitator mechanisms are a possibility for alleviating bridging problems, but they add to the complexity (cost) and weight of the spreader.

Self-Loading Capability

The self-loading capability is only a possibility for spreaders mounted on forwarders with knuckleboom loaders. Our experience with this feature on our own spreader is still somewhat limited, but several shortcomings have already become evident. Poor visibility, due to the hopper, and stability considerations which limited the lifting capacity of the buckets made loading operations with our spreader rather slow. The added weight of the loader and buckets is a further disadvantage of this feature. RCS had similar experiences with self-loading capabilities with a spreader mounted on a forwarder. They ended up removing the knuckleboom altogether and loading using separate loading equipment. The self-loading feature could offer time and money savings for smaller-scale operations at more remote sites because of reduced equipment requirements, but the loading rate is probably much too slow to make this feature practical for large-scale spreading operations.

SUMMARY AND CONCLUSIONS

More and more forest products companies are spreading their wastes on their own land in the Southeast and in other parts of the country. Interest in forest land utilization for disposal of other organic solid waste materials is likely to grow as well. Three main types of spreader mechanisms that have been tried for forest waste spreading operations are vertical impeller/blower units, horizontal-axis beater-type spreaders, and horizontal spinner-type spreaders. Besides the type of spreader mechanism, other important considerations in selecting equipment for forest spreading operations are the carrier, hopper configuration, and self-loading capabilities (if the carrier is a forwarder). These considerations are interrelated, and they are also strongly influenced by site/stand conditions, the materials to be spread, and costs. As forest land waste spreading operations become more commonplace, the manufacture and operation of spreading equipment will become more standardized. However, increasing environmental regulations and the need for disposal alternatives for more types of waste materials will continue to complicate the selection of equipment for forest land waste spreading operations. Careful planning will remain critical to the success of forest waste spreading operations.

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