Using Municipal Waste Sites for Cellulosic Biomass Production in North Carolina

As North Carolina strives to meet its renewable energy needs researchers are seeking ways to use marginal lands for the production of feedstocks for liquid fuel production. One type of marginal land that is readily available in NC is Municipal Waste sites - lands that receive municipal wastewater and biosolids. These sites use permitted acreage for land application of municipal wastes and can grow perennial crops such as coniferous and hardwood trees. Cellulosic biomass feedstocks produced from these sites avoid the controversy of growing feedstock for biofuels production on lands suitable for human food-crop production. The use of plant biomass from these particular sites for liquid fuel production also prevents the introduction of waste materials into the human food supply system.

This fact sheet explores the potential for trees to renovate municipal waste materials, to produce cellulosic feedstock, and to meet regulatory requirements for land application of municipal waste.

Trees have been used as receiver crops on municipal wastewater sites throughout North Carolina and the USA since the late 1980s. Managed tree plantations, primarily native or exotic hardwood species, are especially well-suited for renovating nutrients and most metals in municipal wastes. Coniferous species are less well-suited for this purpose because they are more sensitive to saturated soils and high nutrient loading, but coniferous trees can be used with success in some situations.

Hardwood trees can produce large quantities of cellulosic biomass (Cowling et al., 2005), and the entire system, from aboveground trees and understory plants to belowground soil and microorganisms, are important to municipal wastewater renovation. These natural systems sequester and utilize nutrients and water from waste streams and grow large quantities of cellulosic biomass. In addition, they prevent contamination of soils and groundwater and improve site soil conditions. This can be a win-win system for North Carolina and many other locations in the USA.

Many hardwood species are excellent for municipal wastewater renovation on a wide variety of soils, including saturated soils; hardwood species have high capacity for nutrient removal and sequestration.

Hardwood trees provide the following advantages for renovating municipal wastewater as well as producing large quantities of cellulosic biomass:

- Wide variety of species available
- Adapted to many soil types
- Fast growth in short rotations
- Use large quantities of water and nutrients
- Extensive and perennial root systems
- High evapotranspiration and transpiration rates
- Coppicing (sprouting) ability for sequential cropping
- Ability to improve soil infiltration and drainage over time
- Production of large quantities of cellulosic biomass
- Low establishment and maintenance costs compared to other crops

In 2011, North Carolina had over 90,000 acres permitted for land-application of wastewater and

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biosolids that could be used in the production of cellulosic feedstock. There were 86 municipalities permitted to land-apply wastewater on 8,749 acres and 117 municipalities permitted to apply biosolids on 81,805 acres (Figure 1).

Conifers and hardwood trees currently constitute 57% of the crops on municipal wastewater sites (Figure 2) but only a small portion of municipal biosolids sites (Figure 3) (Nielsen, 2011).

About 56% (4,900 acres) of the municipal wastewater sites used pine or hardwood species for renovation. The major pine species growing on these sites was loblolly pine. Other conifers planted on a small scale include bald cypress, Atlantic white cedar and eastern red cedar. Some of the hardwood species include green ash, sycamore, sweet gum, river birch, black gum, willow oak, water oak, swamp chestnut oak, overcup oak, and hybrid poplar. There are significant opportunities to expand the use of forest systems on municipal waste management sites by converting some of the sites to trees that are currently in hay or turf/sod production. Harvesting of the tree crops in North Carolina has been limited because most plantations are less than 15 years old. However, in 1997 the Town of Edenton, North Carolina harvested sycamore and sweet gum plantations established in 1987 and is now growing second coppice rotations from those original trees.

Figure 1. Locations of municipal facilities (WWTPs) permitted for land application of treated wastewater and/or biosolids residuals. Symbols depict the acreage range held by a facility.¹

¹The database does not include acreage where municipal wastes may be applied, but the permit-holder is a private, contracted sludge-management company. Additionally, some land (shown) subject to municipal permits is leased by the facility.

Figure 2. Land-use categories for municipal waste-management sites applying treated wastewater (spray irrigation or reuse application). Total permitted acres = 8,749.

For biosolids, permit restrictions and crop production logistics have limited the choices and use of trees for receiver crops on waste management fields. Municipalities are required to spread and incorporate biosolids frequently without damaging conventional row-crop plants during the growing
season, and regulations prohibit the harvest of feed or fiber crops for 30 days after any residuals land application event. For these and other reasons, the predominant use for fields receiving municipal biosolids in North Carolina is currently pasture or hay production (Figure 3).

Most facilities reported actively using only a portion of their total permitted land-application acreage, with the remainder reserved as backup. However, there is opportunity for converting some of this biosolids area to trees in the future. There are many advantages of doing this, as stated above; the major restrictions are current permit requirements on nutrient levels the receiver crop must take up as required by the North Carolina Department of the Environment and Natural Resources – Division of Water Quality. There have been discussions to change these requirements. If that happens, there will be new opportunities to use managed tree plantations for municipal biosolids renovation and to produce cellulosic biomass for liquid fuel production.

Discussion and Conclusions

Development of home-grown biofuel feedstock is an important goal for North Carolina. The potential to produce cellulosic biomass from trees on municipal land application sites concurrent with renovating wastewater is a win-win situation. North Carolina already has 203 facilities that use 90,554 acres for municipal waste application. Unfortunately, only about 5% of that area is currently using tree plantations. There is a significant opportunity to expand the acreage of waste application sites using managed tree plantations rather than annual crops.

To increase the acreage under managed tree plantations shortcomings in application logistics and policies will need to be addressed.

References


We wish to thank the N.C. Department of Environment and Natural Resources (NCDENR) Aquifer Protection Section for assistance with development of the database.
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