Utilization Opportunities and Economics

Hybrid Poplar Best Management Practices

Growth and Yield
Growth and yield of poplars in Minnesota depends upon geographic location, site quality, clone, age, spacing, and silvicultural conditions. On average, poplars typically grow in height from 2.5 to 7.0 feet per year. Diameter growth ranged from 7 to 9 inches in 10 years. Average annual diameter growth ranges from 0.5 inch per year to 4.25 inches per year. New cottonwood clones are expected to grow even faster. Biomass yields ranges from 2.6 to 4.5 tons per acre in 8 to 10 years, and currently operational plantings in Minnesota yield over 4 tons per acre. A goal of 6 tons per acre has been set by geneticists.

The productivity of hybrid poplar trees across Minnesota depends on site, location, and clone. Some trees attain 200 lbs of leafless dry weight in 10 years. Thus, 10 trees of this size would yield a ton of biomass. Volume growth for poplars in Minnesota varies from 100 to 350 ft$^3$ per acre per year in 10 to 20 years. There are reports of annual volume growth of 100 ft$^3$ per acre in 5 years, to over 400 ft$^3$ per acre per year after 12 years (Dickmann et al, 2001). Improved volume growth could be expected with the new clones grown under the Best Management Practices (BMPs).

Traditional Wood Products
Aspen (trembling and bigtooth) are the most important and frequently used poplars in Minnesota. However, hybrid poplars are good substitutes for aspen in utilization for traditional wood products (Balatinecz et al, 2001).

Pulp and paper:
The most important use of poplar wood in Minnesota is pulp and paper. Poplar wood substitutes well for aspen for pulp and paper products, and is being grown for pulpwood extensively in other parts of the state.

Solid wood products:
Poplar wood has been used locally for construction lumber. Currently, it is used for a broad range of the solid wood products including pallets, crates, boxes, and furniture components. The advent of modern dry kilns with improved drying capabilities has opened up more poplar lumber opportunities including molding, paneling, flooring, fine furniture, picture frames, and decorative boxes (Kretchman et al, 1999).

Composite products:
Poplar wood is increasingly used for composite wood products. These products are in high demand for construction in the housing industry. These products include particleboard, fiberboard, waferboard, oriented strandboard, veneer, plywood, and composite lumber such as laminated veneer lumber (LVL), laminated strand lumber (LSL) and composite I-beams.

Other Benefits
Bioenergy:
Poplar wood, chips, or pellets can be burned directly for energy production or mixed with coal to produce electricity (Licht and Isebrands, 2005). This co-firing approach is a cleaner, cheaper, and more environmentally acceptable than burning coal alone. Bio-fuels are renewable fuels that are neutral with respect to carbon dioxide emissions, thus, decreasing greenhouse gas emissions.
Another bioenergy application for poplar wood is the small scale close-coupled gasifier for home and farm use. Moreover, hundreds of farmers in the Midwest are burning wood pellets in small scale indoor and exterior home and farm wood burning stoves. Many are burning a combination of wood pellets and corn as an alternative energy source and to save money. Poplar wood contains between 7,000 and 8,000 BTU per pound depending on its moisture content. Therefore, a ton of poplar contains nearly 16 million BTU of energy (Isebrands et al, 1979). That energy equivalent is over 4 million kilo-calories, or 133 gallons of gasoline, or more than 16,000 ft$^3$ of natural gas.

**Animal feed products:**
The foliage from poplars is rich in nitrogen and protein and can provide a valuable source of animal feed. Poplar leaves are used for fodder in many parts of the world especially for sheep and goats, and may have potential for organic farmers in Minnesota (Balatinecz et al, 2001).

**Agroforestry benefits:**
There are numerous Agroforestry benefits that can add income or benefits for the landowner. The primary benefit of poplars is livestock protection through windbreaks that increases production efficiencies such as daily milk yields of dairy cattle, as well as weight gains on cattle, swine, and poultry. An often overlooked gain is the energy savings in summer and winter provided by windbreaks and shelterbelts around animal confinements (Malone and Abbott-Donnelly, 2001). Other Agroforestry related gains for landowners are enhanced agricultural crop yields, crop diversification, and less crop damage, enhanced snow (moisture) management, enhanced property values, and income from wildlife hunting fees.

**Intangible Products**

**Soil erosion control:**
Planting multi-species in riparian buffers with trees and shrubs (e.g., poplars and willows) and grasses along the streams stabilize the streambanks, decrease soil erosion, and thereby decrease total nitrogen and phosphorous runoff causing the dead zone in the Gulf of Mexico. The buffers increase the quantity of total organic carbon retained in soil compared to agricultural crops while providing more biodiversity including beneficial soil microbes and greater fish, small mammal, and bird populations. Poplars are an important part of this multi-species buffer approach. In this way, a poplar planting is serving society and landowners are able to realize some income for their efforts.

**Protection:**
Poplars are often used as windbreaks or shelterbelt systems to protect property and livestock. Windbreaks and shelterbelts consisting of single or multiple rows of trees and/or shrubs are established for environmental purposes around farmsteads and agricultural fields. They moderate heat in summer and cold in winter for people or livestock, thereby enhancing land value, beauty, noise reduction, and wildlife habitat. Around fields they protect crops by decreasing soil erosion and moisture loss, serve as sites for animal manure removal, and produce biomass for bioenergy and wood. These plantings increase crop yields by decreasing stress on crops. They also can produce salable small diameter wood products from “timberbelts” in a short time frame, while improving wildlife habitat and other environmental benefits.

**Wildlife benefits:**
A multitude of research studies throughout the Midwest and the world have shown how best management practices of poplar plantings can increase wildlife diversity. For example, streams with native multi-species riparian buffers exhibit greater stream invertebrates and fish species diversity, more vole and mouse species,
and 5 times the number of bird species as agricultural row crops or grazed riparian areas (Schulz et al, 2004). Well established riparian buffers are excellent winter habitat for upland birds in Minnesota (Edwards, 2005). Multi-species multi-row shelterbelts of trees and shrubs with corridors provide wildlife excellent refuge from predators, protection from inclement weather, and safe travel between habitat areas.


Livestock operations benefits:
There are an increasing number of livestock confinement operations in Minnesota. Some of the most challenging interrelated problems associated with these confinements are odor and animal waste management. Multi-species shelterbelts that include poplars can mitigate these animal confinement problems in several ways by odor plume interception, disruption and dilution (Tyndall and Colletti, 2006). Shelterbelts dilute manure-generated odor compounds in the atmosphere, deposit dust by decreasing wind speeds, physically intercept dust that is the primary cause of odor, and absorb volatile compounds into the tree. The shelterbelts also provide visual and sound barriers to animal feeding operations that are appreciated by neighbors.

Emerging Opportunities

Carbon sequestration:
Hybrid poplars are promoted as a species that could sequester significant amount of carbon from the atmosphere. Poplar plantings grown under best management practices can increase soil organic carbon over time, and more importantly sequester carbon by replacing fossil fuels with a renewable biofuel and/or by increasing the long term storage of carbon in solid wood products (Tuskan and Walsh, 2001). Annual aboveground carbon accumulation in shelterbelts has been estimated up to 10 tons of carbon per acre per year. Tree plantings will also reduce carbon dioxide use on farms by lowering heating costs, decreasing snow removals, reducing fertilizers, lowering feeding demands for livestock, and improving water use efficiency.

Phyto remediation:
Poplars including willows are the most important trees in Minnesota for phyto remediation applications. Their rapid growth and high water use make them excellent choices for phyto remediation of industrial wastewater, wellhead protection areas, animal confinement wastes, pesticide spills, and leaking landfills in Minnesota. The phyto remediation technologies include streamside buffers, vegetation filters, directed plantings and vegetation caps. Poplars are often used to phyto remediate recycled animal wastewater and manure near confined animal feeding operations (CAFOs) and recycle wellhead water that is contaminated with high levels of nitrates and pesticides.

Cellulosic ethanol production
The high cost of gasoline and the increased corn-based ethanol industry in Minnesota has opened up the opportunity for cellulose biomass to ethanol conversion. Hybrid poplars are seen as a potential feedstock to produce cellulosic ethanol. Hybrid poplars could also be used to produce energy through bio-refining. Bio-refining is the refining of biomass to produce value-added chemicals including bioplastics without using additional fossil fuel energy.

Economics
Important variable costs to consider in an economic analysis of poplar production include: land, planting stock, fuel, labor, site preparation, weed control, fertilizer, irrigation, harvesting, property tax, income tax, and
insurance as well as market values (revenues) for products at harvest (Rose et al, 1981, Lothner, 1983). These variables have not changed much over the years, but the absolute costs and revenues have changed markedly caused by fuel costs. Fuel prices have doubled in the past several years making long distance hauling of some poplar products uneconomic. Thus, market driven changes in poplar utilization are occurring rapidly throughout North America (Stanton et al, 2002). Changes can be expected if poplar wood can be used for producing transportation fuels or if landowners can get credit for carbon sequestration and/or eco-system services in the future (Tuscan and Walsh, 2001). Government programs may also change to include more cost share for poplar plantings and establishment costs for conservation efforts. Costs of growing poplar are changing rapidly in Minnesota, so we refer the readers to visit an up-to-date University of Minnesota hybrid poplar economics webpage located at www.cinram.umn.edu/srwc/economics.

For more information visit: www.extension.umn.edu/agroforestry “Growing Hybrid Poplar in MN”

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