ENVIRONMENTAL AND ECONOMIC RESEARCH AND DEVELOPMENT PROGRAM

Identifying Suitable Areas for Woody Crop Production Systems in Wisconsin and Minnesota to Maximize Productivity, Increase Ecosystem Services and Meet Energy Feedstock Demands

Executive Summary
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Executive Summary

Short rotation woody crops (SRWC) such as *Populus* species and hybrids (hereafter referred to as poplars) are renewable energy feedstocks that can potentially be used to offset electricity generation and natural gas use in many temperature regions, such as Wisconsin and Minnesota, USA. Highly productive poplars grown primarily on marginal agricultural sites are an important component of our future Midwest energy strategy. Additionally, poplars can be strategically placed in the landscape to conserve soil and water, recycle nutrients, and sequester carbon. These purpose-grown trees are vital to reducing our dependence on non-renewable and foreign sources of energy used for heat and power. Establishing poplar genotypes that are adapted to local environmental conditions substantially increases establishment success and productivity. But, it is difficult to predict field trial success in landscapes where the crop has not been previously deployed.

To address this information shortfall, ***our overarching objective was to integrate large-scale biophysical spatial data and local-site information with 3-PG growth productivity modeling to assess where IMPPs can be established and grown with high expected returns and minimal impacts to the environment***.

We had five specific objectives:

1) Use available social (i.e., land ownership and cover) and biophysical (i.e., climate, soil characteristics) spatial data to map eligible lands suitable for establishing and growing poplar biomass and bioenergy crops across Minnesota and Wisconsin, USA.
2) Confirm the validity of this mapping technique by sampling and assessing biotic variables within eligible lands identified on the maps.
3) Parameterize, calibrate, and validate the 3-PG model for hybrid poplars in the region, and use the validated model to map potential biomass yields for Minnesota and Wisconsin.
4) Estimate potential poplar productivity within identified areas using 3-PG to determine spatial distribution of productive lands across the study area developed in 1).
5) Construct a comprehensive database of information pertaining to poplar growth and development to inform the mapping approach and poplar productivity modeling.

The database developed to inform much of the information in this study contains 862 unique citations that are cross-listed among up to three of thirteen topic areas, resulting in 1,398 total entries. Overall, eligible lands suitable for poplar production systems totaled 373,630 ha across both states; these lands represented 30.8% of the study area. Soil texture had the greatest influence on predicted biomass, which ranged from 9.5 ± 0.3 to 11.9 ± 0.2 Mg ha^{-1} yr^{-1} across both states, with an overall mean of 10.0 ± 0.1 Mg ha^{-1} yr^{-1}. Biomass predictions of specialist clones grown under optimal climate conditions (i.e., specialists) were 18% to 20% greater than their generalist counterparts, across both states. While this novel approach was validated for Minnesota and Wisconsin, our methodology was developed to be useful across a wide range of geographic conditions, irrespective of intra-regional variability in site and climate parameters. This is important because development and selection of appropriate energy crops lags behind anticipated need in most regions of the United States, especially the Midwest. Establishing poplar genotypes that are adapted to local environmental conditions substantially increases plantation success, subsequent productivity, and the ability of the trees to contribute to soil and water quality, nutrient recycling, and carbon sequestration. Failure to match proper genotypes with sites of deployment may curtail potential economic and environmental benefits associated with the dedicated poplar energy crops. Furthermore, success of these plantations and subsequent production of electricity and thermal energy using woody biomass can be used to offset electricity generation and natural gas use in Wisconsin, Minnesota, and other states.

Key Words

3-PG, biofuels, bioenergy, bioproducts, geographic information system (GIS), intensively-managed poplar plantations (IMPPs), *Populus*, productivity modeling, short rotation woody crops (SRWCs), site quality, yield

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List of Acronyms

CEC, cation exchange capacity

EC, electrical conductivity

ECEC, effective cation exchange capacity

FR, fertility rating

GDD, growing degree days

GIS, geographic information system

IMPP, intensively managed poplar plantation

NARR, National American Regional Reanalysis

NCEP, National Centers for Environmental Prediction

NLCD, National Land Cover Database

NOAA, National Oceanic and Atmospheric Administration

NOMADS, National Operational Model Archive and Distribution System

NRCS, Natural Resources Conservation Service

RMSE, root mean square error

SRWC, short rotation woody crops

SSURGO, Soil Survey Geographic Database

STATSGO, State Soil Geographic Database

UMGAP, Upper Midwest Gap Analysis

USGS, United States Geological Survey