MINISTRY OF AGRICULTURE, FISHERIES AND FOOD

CSG 15

Research and Development

Final Project Report

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Project title	Yield models for energy coppice of poplar and willow
MAFF project code	**NF 0407**
Contractor organisation and location	Forest Research Alice Holt Lodge Farnham Surrey GU10 4LH
Total MAFF project costs	£ 90,000
Project start date	01/06/98
Project end date	31/05/99

Executive summary (maximum 2 sides A4)

This summary report has been prepared for MAFF at the conclusion of phase 3 of a 4-phase project. The main report giving detail of the work and preliminary results is due to be published by ETSU for DTI.

Scientific background

At the inception of this project there was a wealth of knowledge regarding the husbandry of growing short rotation coppice crops (Ledin and Alriksson, 1992). Similarly there was a wealth of knowledge on yields from experiments conducted by various research establishments. A study of these experiments was conducted by the Forestry Commission Research Division (Tabbush, 1994) who concluded that existing coppice yield trials were too heterogenous in terms of site types represented, species included and measurements collected to be of use in constructing reliable yield models. The situation, at that time was that it was impossible to advise planners, growers and energy producers as to: 1. where the most appropriate locations where for establishing power stations (in terms of an adequate supply of high yielding soil types). 2. which varieties to use to maximise yield and 3. the likely yield that could be achieved.

The 'Yield models for Energy Coppice of Willow and Poplar' project was designed to allow yield to be measured from a range of poplar and willow varieties grown on a range of characterised soil types. Previous research had shown that existing soil maps and databases were of insufficient resolution for characterising soil properties at specific sites, therefore an in-detail soil physical and chemical survey was carried out to characterise each site. Sites were selected to cover a range of climate types using an Ecological Site Classification (ESC) developed by Pyatt (1995) ensuring that a wide geographical

spread was achieved. Unfortunately the ESC is based on data supplied by the Meteorological Office, and many parameters for example accumulated temperature and rainfall are based on 20 year means, and are often interpolated from the nearest available meteorological station. Many meteorological variables fluctuate considerably from year to year about the time averaged value. The time averaged data are perfect for modelling site yield relationships for studies in high forest crops, since trees typically take several decades to grow, but such data are not suitable for studies in coppice grown for less than 5 years. Each site was therefore equipped with meteorological instrumentation to relate growth to a specific meteorological data set. The resultant data set will be used to define and calibrate empirical relationships between biomass yield and site variables.

Situation at the start

The first three phases of this project have concentrated on establishing the network of forty-two 'extensive sites' and seven 'intensive' sites and collection of data for modelling purposes. The 'extensive' sites used 3 poplar and 3 willow varieties, selected to be representative of the form and growth of the principal varietal groups planted across a range of sites representative of agro-climatic conditions in the UK. Additionally sixteen of these 'extensive' sites included the same varieties planted in mixture. The 'intensive' sites included the same varieties but also included an additional wider genetic range of varieties to give sixteen poplar and sixteen willow varieties. The extensive and intensive trials were designed to provide complementary data for development and calibration of a number of models for predicting yield. In general, extensive trials will give information on the generic variation in SRC yield across a wide range of site types, whilst the intensive trials will provide information on the interactions between variety and site.

Progress so far and interim results

All sites have been assessed for yield annually using a non-destructive method developed by Matthews (1996). The method is described in the main report and estimates of yield are presented. The data have been calculated to biomass and annual increment. The main report gives detail of yield assessment and insect and disease assessment methodology. Provisional yield data are given for all sites for all years up to and including the 1998/1999 assessment period. This has entailed modelling of over 250 million data points. Provisional examination of yield data reveals that geographical location does not appear a good predictor of yield. The three highest yielding 'intensive' sites are in Northern Ireland, Fife in Scotland and Trumpington near Cambridge. This would also imply that climate (by itself) is also not a good predictor of yield. Examples of both high and low yield can be found in the same soil sub-groups. Varieties that performed well in year one where not the same varieties that gave the highest yield by year three, suggesting that varieties differ in the way they develop over time. There are many varieties at the 'intensive' sites, particularly of willow, that out perform the three 'extensive' varieties of both poplar and willow. An examination of the mixture sites shows that in nearly all instances the yield of the best variety planted pure is greater than the combined yield from the mixture. A number of suggestions have been identified in the yield data and these have been outlined in the main report. Multivariate analysis will be carried out on this data during Phase 4.

In order to account for unexplained variance in yield, surveys of damage caused by insects, diseases, and abiotic factors have been carried out in all of the SRC plots of poplar and willow during the early summer (Survey 1) and the autumn (Survey 2) in each year. Survey 1 has generally been completed during June and July, and Survey 2 has usually been completed during September and October, although surveys at a few sites were completed outside these dates in 1997. The timing of surveys at each site has been matched, as far as possible, with the phenological development of the earliest varieties to flush at the site in the spring.

All plots have been surveyed using a standardised protocol, which allows results for different varieties, plots and sites to be compared directly. The most important categories of damage have been similar each year, namely:

- leaf rust caused by *Melampsora* spp.
- defoliation by insects
- diseases characterised by spots and blotches on leaves

Leaf rust was more severe in 1998 than in the previous two years, and the geographic distribution of serious infection changed. Leaf distortion, and to some extent discoloration and chlorosis, were particularly noticeable at some sites in 1996, and could often be attributed to early-season herbicide damage, but both were much less apparent in 1997 and 1998. Frost, shoot dieback, stem lesion damage and infestations of aphids on stems were severe at certain sites each year and in some cases were associated with death of stools. Other forms of damage or infestation were less important.

Soil moisture blocks have been installed at the Alice Holt intensive site. Growth bands were attached in 1998 to allow some data to be collected for calibration purposes. Once calibrated all bands were installed in spring 1999 to allow within year growth to be measured against soil water availability. Data from this study are currently being analysed and will be reported on in the next scheduled report.

Current situation

Data collection will continue for a further three years to allow the effects of a second rotation to be considered in the modelling effort that will form the main part of phase 4 of the project. Calculation of biomass will be refined in the light of new data. A further experiment has been established to allow for physiological measurements to be taken. A new experiment had to be established to allow for irrigation and rust control (potentially limiting factors), which could not easily be achieved at the existing sites. Respiration, photosynthesis and leaf development will be measured in the coming year while canopy architecture studies will take place in the following year.

As a result of the project:

1. Investors considering investing in power stations capable of using wood will be able to calculate their needs in terms of area required depending on soil type, and make financial appraisals of any proposed investment for any geographical area.

2. Growers will be able to plant the most appropriate variety for their location and be able to estimate the likely yield for a given site type.

3. Yield models produced can be adapted to make predictions for new varieties coming out of breeding programmes based on general characteristics, either by parent group or physiological characteristics.

4. Policy makers will be able to use the results of the project to inform decisions on support regimes for short rotation coppice.

Scientific report (maximum 20 sides A4)

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