MiscanMod: a model for estimating biomass production from *Miscanthus* throughout Europe

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Policy makers involved in developing the exploitation of biomass crops are increasingly interested in simulating potential yields over large geographical domains. Direct measurements of yields are generally few and far between, but decision-making needs to be based on estimates of the spatial variability in yield over large areas at spatial resolutions which are finer than that provided by observed data alone. Also, following the assessments of the UN International Panel on Climate Change (IPCC), which have predicted significant changes in climate over future centuries, global resource managers are interested in the effects of climate change on future crop yields. Such macro-scale questions require a simple model that can be scaled up to a large geographic regions.

A number of field trials throughout Europe have now confirmed the potential for high biomass production from *Miscanthus*; a giant perennial rhizomatous grass with C_4 photosynthesis [1]. Most trials have been conducted with a single clone of *Miscanthus* called *M. x giganteus* (GREEF et DEU) [2]. Reports of over-winter plant losses in some climates have motivated more recent field trials on other hybrid *Miscanthus* genotypes [3]. However, where no over-wintering problems have occurred, *M. x giganteus* has proven to be among the most productive genotypes [4] and a study in the UK has shown that *M. x giganteus* reaches near to the theoretical radiation use efficiency for plants with C_4 photosynthesis [5]. Therefore, a productivity model parameterised for *M. x giganteus* and combined with broad-scale climate data, is an ideal system to predict potential ceiling yields for *Miscanthus*. Such a model for predicting the yield from *M. x giganteus* has been produced for Ireland [6]. Here the model, which is now named MiscanMod, is further developed and verified for up scaling to continental scales.

A method was developed for scaling-up a model for *Miscanthus* productivity from the site to the continental scale. MiscanMod uses three main components to estimate potential non-water limited yield: the calculation of leaf area index, radiation use efficiency and the thermal time for termination of the growing season. Previously published model parameters from a field trial in Ireland were used. In scaling the model two issues were addressed: (i) the estimation of daily climatic data from monthly values and (ii) the validation of the broad-scale model with observed yields at five sites in Europe. Estimation of daily mean temperatures from monthly values was made by linear interpolation and thermal time calculated from this estimated daily data agreed well with those calculated from observed daily data. Model yield predictions were compared at 5 sites with actual harvested yields to validate the model. The continental scale model was implemented at a spatial resolution of 0.5 x 0.5º because this is the resolution of the available climatic input data. Non-water limited potential yields in Europe ranged between 0 and 70 t dm ha^{-1} y^{-1}. Yields in excess of 15 t dm ha^{-1} were expected for 66 % of 'greater' Europe as defined by Hulme *et al.* [7].

References

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