MINISTRY OF AGRICULTURE, FISHERIES AND FOOD

RESEARCH AND DEVELOPMENT - FINAL PROJECT REPORT

NF0403 - MISCANTHUS AGRONOMY (FOR FUEL AND INDUSTRIAL USES)

EXECUTIVE SUMMARY

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Introduction:

The UK is committed to generating 10% of its electricity from renewable resources by 2010 and energy crops have been identified as key to achieving this. In addition, there is a continual quest to identify crops that may be suitable for set-aside. An ideal energy crop will provide a high yield of harvestable biomass on an annual basis whilst at the same time requiring few agrochemical or mechanical inputs. A central MAFF policy objective is to broaden the crop base for energy production, and this project has examined the potential of a novel perennial grass, miscanthus, as an energy crop suited for set-aside.

1. The project had the following major scientific objectives:
2. To determine the basic agronomy and yield potential of miscanthus in the UK.
3. To understand the processes which contribute to yield formation in the crop and to identify potential problems with the crop.
4. To determine the costs of production, likely economic returns as an energy crop and identify alternative markets for the feedstock.

The basic agronomy and yield potential of miscanthus in the UK:

We have determined that the husbandry of the available species, Miscanthus x giganteus and M. sacchariflorus, is relatively straightforward. Optimal establishment is from rhizome cuttings which are planted in May at a density of 10-20,000 ha-1. Subsequent crop development is related to accumulated temperature above a 6°C base, and in most years and sites the crop will attain a height in excess of 2.5m. The crop senesces during the autumn and winter, and by harvest time in February or March there is only a small quantity of N, P and K remaining in the stems (88, 11 and 95 kg ha-1, respectively). The nitrogen fertiliser requirement of the growing crop is also low, with only 150 kg ha-1 N needed for a full crop canopy. Yields in the year of establishment are low at 2-7 odt ha-1 (oven dry tonnes ha-1). Depending on location and climatic conditions, yields then increase incrementally until a plateau is reached. At some sites this occurs by the second harvest, at others, such as High Mowthorpe and Gleadthorpe, the plateau has not yet been achieved after five years. Moisture contents at harvest are high and variable; between 35 and 70%. Of total productivity, approximately 25% of recovered yield is in leaf litter, only a proportion of which will be collected by the harvesting operation. In this study experimental sites have been differentiated in terms of yield profile. A mean annual yield of 18 odt ha-1 has been achieved at the best sites, with variation from 12 – 24 odt ha-1 in individual years and sites. As such, miscanthus is an energy crop with high potential. Current limitations to yield have been seen at sites with free draining soils, or elevated northerly sites. Until a larger data set becomes available it is considered that a productive zone south of a line drawn between the Severn and the Wash will denote arable areas which can reliably expect harvested yields of 15 odt ha-1 or more. There will be many locations north of this line that will achieve the same yields. Temperature and water requirement limitations to yield indicate that production may be suited to lowland ex-grassland sites.

The processes which contribute to yield formation and potential problems with the crop:

We have shown, in a study of *M. x giganteus*, that across the entire season miscanthus is no more efficient at converting radiant energy to biomass than other crops growing in the UK. High yields are achieved by a large canopy duration and consequently large quantity of sunlight intercepted. Key climatic constraints on yield are moisture availability and low spring-time temperatures which can destroy the developing crop canopy. The varieties of miscanthus investigated in this project do not represent material specifically bred for agricultural purposes and this should be a future research priority. There is tremendous opportunity to utilise the national miscanthus collection held at ADAS Arthur Rickwood in order to initiate a breeding programme which will select for improved low temperature tolerance and drought resistance. Two potentially economic pests have been recorded on the crop for the first time; the larvae of the common rustic moth kills newly emerged shoots in the spring and the ghost moth's larvae feed on rhizomes. Neither pest has yet caused significant yield loss. Stem lodging due to stem basal diseases and mechanical failure has been noted. Over-winter failure will not be a significant issue in the UK.

The costs of production, likely economic returns as an energy crop and alternative markets for the feedstock:

The only market for miscanthus feedstock that is considered viable at the moment is electricity generation. The production of paper and building materials has been demonstrated as feasible, but the crop cannot undercut existing inexpensive feedstocks. Other markets, such as animal bedding, are potentially extremely lucrative markets, yet the product is completely untested for this market. For energy production it is calculated that, in the absence of any form of subsidy, an average crop (18 odt ha-1 yr-1) will require a price of £46 odt-1 simply to cover production costs. Inclusion of set-aside reduces this cost to £22 odt ha-1 yr-1. However, to stimulate farmer interest in the crop additional planting grants of c.£1,000 would be needed to compensate for the current high cost of establishment, the increased risk of the venture and opportunity costs. At this level of support, the crop would compete with other arable enterprises.

During the seven years of this project there has been a significant technology transfer initiative which has taken this crop from purely developmental to, now, being on the verge of commercial planting. Technology transfer has taken the form of press and radio articles, scientific papers and open days where all aspects of the husbandry of the crop have been covered.

Future research priorities:

1. Continuation of existing experiments in order to identify yield profile and crop longevity into the ‘middle term’ of crop lifetime.
2. Research to improve rhizome establishment and develop the most appropriate planting methods.
3. Investigation into the suitability of lowland ex-grassland for Miscanthus cropping, and the likely yield profile on such sites.
4. Further taxonomic and breeding studies with the genus in order to identify cold tolerant strains, high yielding strains and lower moisture requirements.
5. Studies to improve harvesting efficiency and reduce storage/transport losses.