cropgen

IEA Bioenergy
Task 37

Crops for biogas production; yields, suitability and energy balances
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When farmers realise they can produce energy from crops, the question often asked is “Which crop should I grow?”. Bio-ethanol and bio-diesel can only be produced from a relatively limited range of crops, although the production of ethanol from lignocellulosic materials will lead to an increased range of materials used. In contrast to these liquid bio-fuels, one of the advantages of anaerobic digestion is that almost any organic material can be used. Crops with high lignin content can be more difficult to digest but most crops, at some growth stage, can be used.

The amount of biogas that can be produced from any crop is a result of the methane potential (how much methane can be produced from each kilo of volatile solids) and the overall yield of the crop (how much volatile material can be produced per hectare). Both of these are affected by climate, and crop growth conditions and growth stage at harvest. Some of these effects are discussed in other papers at this workshop. Crop selection is affected by geographic location and crops which are ideal at one location will not be suitable at another. Thus in Austria and Germany, maize provides a good source of feedstock for digesters but in Finland maize grows very badly and does not provide a suitable source of material.

The ability to choose from a wide range of crops allows the farmer to use other advantages of the material grown. Most of the crops used to date for bio-fuel production have high requirements for nitrogen, usually supplied in a form produced using fossil fuels. Legumes have a symbiotic relationship with certain bacteria (rhizobia) which gives them the ability to fix nitrogen from the atmosphere and soil resulting in a reduced requirement for the application of mineral based nitrogen. This has multiple benefits including: reduced use of fossil fuels and therefore reduced CO_2 emissions, improvement of the soil quality, and reduction of farmers costs. Legumes may also be intercropped with other species, for example vetches and oats, to increase yield. Farmers may therefore look beyond the crop solely as producer of energy but select species that have added benefits for the soil and following crops.

In producing renewable energy it is also vital to consider the energy balance - how much energy is required to produce and process the crop into a form of usable energy, compared to the energy value of the fuel produced. Values have been reported in the literature for the energy requirement of various farming operations. Given knowledge of the operations for land preparation, sowing, maintaining and harvesting a crop it is possible to derive an energy requirement for crop production. When combined with the energy requirements for operating a digester, and disposal of the digestate, it is possible to derive an energy balance for the production of biogas. A guide to energy balances for a number of crops and the required growing conditions have been included in a crop database developed as part of the Cropgen project. The energy balances can be used to compare crops and the relative efficiencies of the different bio-fuels. Thus depending on the crop grown; AD production of biogas has an energy efficiency ranging between 4 and 7, output to input, bio-ethanol has an efficiency of 2 to 2.5 and bio-diesel production using solvent extraction 1.5 to 2.

There is no single answer to the farmer’s question “which crop should I grow?”. The ‘simplest’ answer is to grow the crops which give the highest yields at the required harvested growth stages, but the farmer should also be considering crops that will reduce fertiliser requirement, enhance soil structure and reduce costs.