BIOMASS CROPS IN WALES – AN ENVIRONMENTAL PERSPECTIVE

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Introduction

Agriculture is entering another period of change, we have become used to a number of environmental buzzwords such as; sustainability, diversification and biodiversity they are now being joined by a range of energy related phrases such as carbon-balance, greenhouse gas emissions, renewables, biofuels and biomass. Wales is predominantly agricultural with roughly 74% of the total land area classified as agricultural. Government statistics released in June 2006 record the total agricultural land area of Wales as 1,629,000 ha. Roughly 65% of this is grassland, be it permanent pasture or rough grazing; 11% is arable; and 4% is woodland or set-aside.

Our agricultural land resource is valuable both in economic and environmental terms. New crops such as Miscanthus and Short Rotation Willow Coppice (SRC) are set to change cropping patterns and open up a new energy market to growers and the wider rural community. As "custodians of the environment" the choices that farmers and landowners make have direct implications, both positive and negative for the rest of the community.

The wider picture

Changes in the energy market have ensured that renewables have moved to centre stage. For UK and Welsh governments the key driver is Climate Change. The greenhouse effect is a natural phenomenon, caused by the gases in the earth's atmosphere absorbing the heat emitted by the earth's surface and re-radiating it back to the surface and within the atmosphere. It is a necessary process, without which the earth's average temperature would be a rather inhospitable -18^{o}C. However, human activities such as the burning of fossil fuels and the destruction of rainforests, add to the concentration of greenhouse gases, particularly carbon dioxide, in the atmosphere. This increase in gases is having a warming effect and leading to climate change. The 1990s were the warmest decade on record, and even more recently this September has been declared the warmest in UK records. Scientists from the MET Office have also recently confirmed that regional trends in the UK do have implications on the wider global scale. There is now no doubt that our climate is changing and there are two ways in which we can respond. The first is through mitigation (reducing green house gas emissions) and the second is through adaptation (responding to the impacts of climate change). Mitigation actions include changing the way we farm, by reducing carbon emissions for example, and by replacing processes that emit greenhouse gases with carbon neutral energy sources. Biomass crops such as Miscanthus and SRC fall into this category.

Biomass crops are widely regarded as being almost "carbon neutral" because the carbon-dioxide released when these crops are burnt as a fuel for heat and/or electricity, is matched by the amount of carbon-dioxide the plants absorbed when they were growing, in the process of photosynthesis. Hence, there is no net increase to carbon-dioxide levels in the atmosphere. As a fuel therefore, they are substantially more environmentally friendly than fossil fuels.

However, this doesn't give us the full environmental picture. The way the crops are grown, the land use they replace and biodiversity all need to be considered for a good understanding of the environmental impact of introducing these crops into the Welsh landscape.

Agricultural inputs

Miscanthus and Short Rotation Willow Coppice (SRC) are both long-term perennial crops. Miscanthus is a not a UK native, which may start the hackles rising in some circles. However, the current commercial variety *Miscanthus x giganteus* is a sterile hybrid which does not produce seed. It is a fast growing, clump forming non-invasive grass with its origins in Asia. It is a long-term perennial crop with a potential productive life of 20 or so years. Many willow species are native to the UK where they have been part of the UK landscape for hundreds of years. Willow (*Salix.spp*.) is a diverse species, with several hundred varieties readily available within Wales. The Osier or basket willow, *Salix viminalis,* is a shrub form native to the UK and it is the parental stock to many of the willow varieties planted for use as short rotation coppice (SRC). Its production is more comparable to agricultural cropping methods than it is to forestry.

Both crops are planted in the spring, Miscanthus as rhizomes and SRC as rods. Weed control is essential during the establishment phases (years 1 and 2) and herbicides are routinely used. Mulches or cover crops can be used

to help control weeds, with the added benefits of soil improvement. On more fertile lowland sites fertilisers are not used in the establishment year. Trials on willow in upland areas of Wales though, suggest fertiliser applications may be beneficial and the addition of lime is likely to be essential in these areas. Using organic wastes such as cattle slurry or treated sewage sludge can reduce the environmental impact compared to inorganic fertiliser applications. This gives the additional environmental benefit of waste disposal. Fertiliser applications are generally not applied after year three. As the crops approach harvest they translocate nutrients back into the rhizomes in case of Miscanthus, or into the stools in the case of SRC. Leaves drop in the winter adding organic matter and increasing soil nutrient status. Both crops have much lower agricultural inputs compared to conventional arable crops and the risk of ground water contamination by agro-chemical is very low.

There are no yield damaging pests and diseases in Miscanthus crops currently, though this is not the case in willow. SRC crops attract a lot of invertebrates and hence the crop is susceptible to a number of insect pests most particularly willow beetles which can cause considerable damage. The crop is also susceptible to a number of diseases, the most important of which is rust. Willow plantations are composed of a mix of varieties to help reduce the impacts of willow beetle and rust. The need to use insecticides to control pest and disease attacks in SRC can be minimised by careful plantation design and varietal selection. Varieties are now being bred with resistance to pest and diseases in an effort to reduce dependence on fungicides and insecticides.

The crops also have what is known as a high energy ratio (in crop terms) of between 30 to 36:1, which means that the harvested crop contains 30 to 36 times more energy than that used in growing the crop.

Soil, water and nitrogen considerations

Both crops have a good root system and well-developed mechanisms for recycling mineral nutrients. The crops can be used as buffers along rivers, blocking surface runoff and phosphorus pollution, particularly at the bottom of slopes. As the crops are perennial, soil disturbance is reduced with the potentially damaging effect of yearly soil cultivations being avoided. The roots of the crops help bind the soil together, stabilising it and reducing the risk of soil erosion. Miscanthus has a C4 photosynthetic pathway and hence a very efficient conversion of radiation to biomass and a higher dry matter yield potential than C3 grass cereal crops such as wheat or barley. Both crops use a large amount of water. The water use for SRC in the summer is higher than from all other forms of vegetation. In addition SRC is deep rooting and can damage land drains. The water use for Miscanthus is lower, but still relatively high compared to cereal crops. High water use isn't necessarily a hydrological disaster but it is certainly something that needs to be considered, particularly if the cropped area is to be extensive and within a single water catchment.

Site considerations

Miscanthus and SRC are fast growing tall crops that can radically change the appearance of a site. As a result it is important that thought is given to the sites ecological and historical value as well as the visual impact of the crop on the landscape. For this reason it is currently a requirement that those proposing to grow SRC, complete an environmental statement provided by the Forestry Commission. This will then determine whether a full Environmental Impact Assessment (EIA) is required.

The land use that is replaced by the energy crop will also have an effect on its environmental credentials. For example if willow were to replace an intensively grown arable crop, the environmental benefits could be high as soil cultivations, carbon emissions, agrochemical and energy inputs, would be reduced and biodiversity potentially increased. However, it is unlikely that farmers would turn over their most productive land to these crops and would be looking to produce them on more marginal sites or set-aside land. The use of energy crops for land restoration on brown field sites is from an environmental point of view, very promising. Whether economic returns can be made on such ground is probably less clear, though the economic case may be improved if the crops can be used to dispose of slurry and treated sewage sludge, which could provide an additional environmental bonus.

Replacement of grassland with biomass crops may, however, have greater environmental implications. With 65% of Wales' agricultural land under grass this is likely to be particularly an issue in Wales. Ploughing up long-term grassland releases large amounts of carbon to the atmosphere and this adversely affects the greenhouse gas abatement objective of biomass production. Most of the carbon stocks in grassland are in the soil, ploughing opens up the soil and mixes in oxygen. The oxidation of carbon in the soil leads to carbon dioxide being released. In addition nitrogen can be released. The overall environmental and carbon impacts of replacing grassland will depend on a number of factors: the way the grassland was managed, how long the area has been under grass and the levels of biodiversity in the grassland system, and the cultivation methods used to establish the crop.

There is a big difference between replacing a 50-year-old species rich meadow, and replacing a 3-year-old intensively managed rotational grass crop for example. Energy grass crops can be grown on set-aside land and can make farmers useful additional income in the process, though from an environmental perspective this may not be desirable, again much would depend on how species rich the set-aside is and how long it has been set-aside.

Transport considerations also need to be taken into account. In order to be both economically and environmentally viable crops need to be grown close to where they will be used as a fuel. The harvested crop is a bulky commodity, the further it is transported the higher the carbon and financial costs.

Impacts on biodiversity

Good planning and management practices include avoidance of priority habitats and untouched wildlife niches and minimisation of the use of insecticides and herbicides. These measures alone can go a long way to ensuring biodiversity is maintained or increased over previous land use. These crops need to added to a mix of farming land uses. Avoiding the creation of a monoculture will go a long way to ensuring biodiversity within farms. The crops can create new habitats and new opportunities for colonisation by many species of plants and animals. A number of studies have been carried out in this area. SRC has been found to be particularly species diverse, generally increasing biodiversity levels over previous land use. A study by Sage and Tucker (1998) found that SRC crops held 3 times as many invertebrates as a cereal crops. The Department of Trade and Industry funded ARBRE project was a four-year study looking at wildlife populations in commercial SRC. It found that SRC held a higher density of birds and more species than cereal crops. The age of the crop also tended to have an effect of species. Most species preferred a young crop, whilst tit numbers increased as the SRC crops became more established. On the negative side SRC was found to be potentially detrimental to some species that prefer a more open habitat. Less bird species are found in Miscanthus crops, though young crops of Miscanthus offer patches of bare ground that are popular with birds such as skylarks and lapwings. In addition the crop offers a good over winter habitat. Both SRC and Miscanthus are harvested in winter, which is outside breeding times and summer migrants are not present. A report by Semere and Slater (2005) found that two/three year old Miscanthus plantations were used as over-wintering sites for birds, small-mammals and invertebrates suggesting immediate benefits to biodiversity. It would appear that the younger crops of both SRC and Miscanthus have the highest level of biodiveristy than older fully established crops. Of the two crops willow can be seen as being richer in biodiversity terms, with Miscanthus having biodiversity levels more comparable to arable crops, though with the added bonus of no insecticide and fertiliser requirements.

If properly planned, SRC and Miscanthus plantations have the potential to enhance the landscape and environment, reduce our dependence on fossil fuels and bring new markets to the rural economy. Farmers are the “custodians of the environment” and keeping them in business is key to keeping our rural heritage alive.

Papers quoted:

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