CCSN

Carbon Cycles &
Sinks Network

The Costs and Benefits of Moving out of Beef and into Biofuel

Introduction

Around 120,000 farmers are engaged in beef production in Ireland, either as an offshoot of their milk production or as dedicated beef enterprises. They use 2.5 million hectares of grass to rear and fatten the progeny of 1.2 million dairy and 1.1 million beef cows.[i] As a result, about 2 million animals are available for slaughter or for live export each year.

Most of the 80,000 or so dedicated beef farmers currently make a loss when they sell the animals they produce. As they carry the loss themselves, the government's policy could be that if they choose to keep cattle as a hobby rather than as a business enterprise, that's up to them. However, Ireland as a country is also believed to be making a loss on the farmers' animals because the methane produced by the cattle's digestive systems has to be included in the greenhouse gas returns the EPA submits to the EU each year. The EU effort-sharing decision 406/2009/EC requires Ireland to reduce its emissions from activities not covered by the Emissions Trading System (ETS) by 20% of their 2005 level by 2020. If it fails to do so, the state will have to buy emissions allowances to cover the overshoot.

A beef animal unit (A livestock unit is a mature animal or the equivalent in younger stock) can emit 100 kg of methane each year, and methane is 23 times more warming a gas than CO_2. As a result, the animal emits the equivalent of 2.3 tonnes of CO_2. There is no realistic way of reducing this amount. Consequently, if cattle numbers are not cut by 20%, or cuts of more than 20% are made in the other non-ETS sectors, it would cost the state €57.50 for each excess livestock unit if the price of the allowances was €25 per tonne of carbon dioxide[1].

The prospects of greater than 20% cuts being made in the other non-ETS sectors – predominantly road transport and home heating - seem remote so, if the present level of cattle numbers is to be maintained, the state will have to buy permits to cover the excess emissions. Even if cuts of more than 20% could be made in the other non-ETS sectors, they would entail some economic cost which ought to be charged to the cattle farmers.

There is also the question of who owns the rights to the 80% of the 2005 emissions that the country will still be able to release in 2020. Specifically, does 80% of the 2005 agricultural emissions belong to the farming sector, or do they belong to the country as a whole? If one

1 The current price of an emissions allowance is around €15 but there is a widespread view that this is so low only because activity in the EU economy was depressed by the credit crunch. We therefore chose to use a higher figure.

takes the latter view, then the sector should be charged by the state for all its emissions, not just the excess over the 80% target. On this basis, if the whole beef herd of 2 million animal units was slaughtered, the state would be able to sell the permits this freed up. This would bring in €110 million a year if the price of permits was €25 per tonne of CO_2. Accordingly, we can regard the emissions from the beef animals owned by 120,000 farmers as costing the country an average of €900 per farmer.

In view of this, some policymakers and commentators think that it would be in the national interest to encourage the specialist beef farmers to give up their loss-making hobby and to switch to growing biofuels instead. They claim that this would be doubly beneficial because not only would the methane not be produced but the use of the biofuel would reduce the tonnage of fossil fuel emissions included in the EPA's returns. This paper uses published data to determine whether switching farmers out of beef would really be advantageous and, if so, whether a programme could be developed which stood a reasonable chance of being successful. It looks at the potential consequences of the transition in three areas – for the national economy, for emissions, and for the individual farmer.

The loss per hectare from beef production

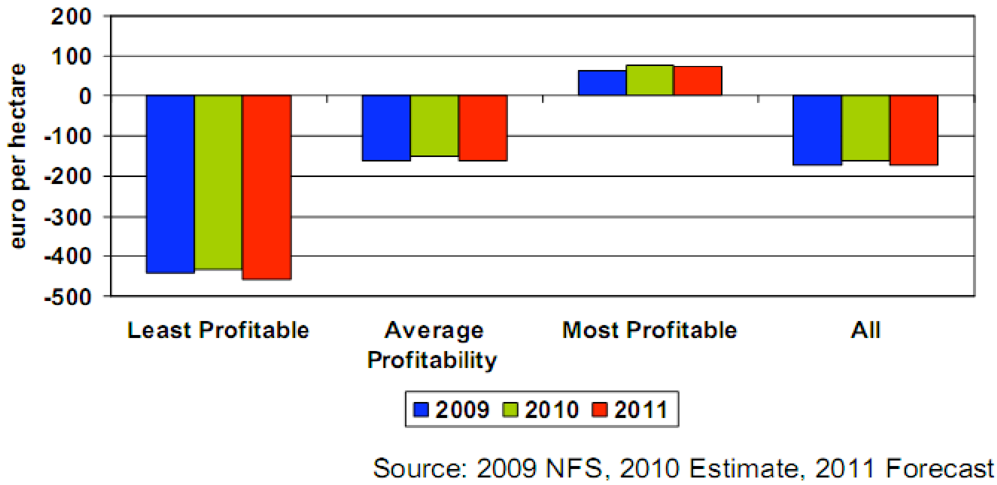

Illustration 1: Almost all beef farmers are losing money according to this graph prepared by the Teagasc Rural Economy Research Centre. The average loss is around €150 per hectare. Note that only the 2009 figure was based on actual figures. The 2010 figure is an estimate and the 2011 a projection.[ii]

1. The economic balance

The Teagasc figures in graph 1 clearly show that most beef farmers are losing money. A spokesperson for the Irish Cattle and Sheep Farmers' Association, the ICSA, says that if a beef farmer receives a single farm payment of €20,000, roughly a third of that is needed to cover the losses on his or her cattle. Why then do farmers keep them? “It's what they do. It's their way of life” is a frequent answer. An article by John Shirley in the *Irish Independent* (February 01 2011))[iii] expands on this and suggests that people raise beef cattle because:

- People like working with cattle. It is a tradition and a way of life.
- The land can be hobby farmed with cattle because the main household income arises

from other sources;
- The land involved is not good enough for tillage and the farmers are slow to make the irreversible switch into forestry;
- Fragmentation of the farms involved may make them unsuited to dairying;
- Farmers fear that if they reduce cattle numbers it may adversely impact on their Single Farm Payment after 2013;
- There is hope, even optimism,that a big jump in cattle prices is around the corner.

However, although the farmers are losing money, the country as a whole is not, even if the animals go as live exports. The farmers are losing money purely because of the way the beef market is structured. The price the consumer pays for Irish beef is set by the availability of beef from other countries and by the price being paid for other types of meat. "The British housewife, the main customer for Irish beef, can walk into any of the large retailers this week and buy three whole chickens for £10 (€11). For the same money she can only buy three sirloin steaks." Justin McCarthy wrote in the *Farmers' Journal* in February 2009[iv].

The supermarket takes its cut out of the price paid by the consumer, as does the company which slaughtered the animal and then cut, packed, chilled and transported its meat. If the amount left for the farmer is insufficient to pay his or her costs after both firms have taken their margins, that's just the way the market works. "Beef farmers lack market power" says Trevor Donnellan of Teagasc[v]. "They do not own or have an interest in the processing facilities or marketing of Irish beef, in marked contrast to the situation in the dairy sector. Therefore it is not surprising that other participants in the production chain capture the profit in the system." Donnellan adds that another reason for their losses is that many beef farms are small so that overhead costs are spread across a relatively small volume of output.

So, while the farmers are losing money, the beef processors are not. Nor is the country as a whole since the processors employ more than 5,000 people directly and perhaps twice that number indirectly if the work created by the way the beef factories spend meeting their requirements and their employees spend their wages are both taken into account. All these employees pay income tax and VAT, so the tax raised as a result of beef production must be many times the amount that emissions permits might cost. In addition, the costs the farmer has to bear to produce the beef also generate incomes for other people. Feed and fertiliser suppliers, hauliers, vets, insurers, power companies and building repairers all get work and pay taxes thanks to the farmers' loss-making spend.

It is true that the farmers would spend some of the money they lose on their cattle in other ways if they were not raising animals and this spending would also provide work. However, given the farmers' average age (54.5 in the sample of beef farmers studied in 2009 National Farm Survey) it is likely that a lot of the money being lost on cattle rearing would be saved for retirement. The part saved would not generate employment.

In short, from an economic perspective, the fact that beef farmers are losing money personally is irrelevant from a national point of view because their efforts are generating incomes for thousands of other people. Leaving emissions aside for the moment, the only national-level question which arises is one of opportunity cost - could the land being used for beef generate higher incomes around the country if it was used for something else?

Beef exports in 2010 were worth €1.51 billion. To this must be added the wholesale value of the beef sold on the home market. According to Bord Bia, this was €0.19 billion[vi]. The total value of the incomes generated in Ireland by beef production is therefore around €1.7 billion less the cost of imported fertiliser, feed and other foreign inputs. The value of the feed is hard to assess since an estimated 40% of the feed the CSO records as having been imported in 2009 was consumed by pigs and poultry and a lot of the rest by the dairy herd. If we deduct an arbitrary 10% from the €1.7 billion to allow for the imported feed and fertiliser and also the value of the culled cows from the dairy herd, Irish incomes totalling €1.53 billion were earned in 2010 from beef production.

This production is estimated by Trevor Donnellan of Teagasc[vii] to have used 2.6 million hectares, slightly higher than the Casey and Holden estimate quoted earlier, so the average value of production per hectare was €590. This figure seems reasonable in the light of the gross returns per hectare for various types of beef enterprise quoted by the Agricultural Consultants' Association at http://aca.ie/agri-faq/gross-margin-budget/ if one remembers that its returns are based on the price the farmer receives rather than the wholesale price of the meat after it has been prepared in the factory and also omits the costs that the farmer has to pay which generate incomes for other people. According to the ACA, calf to beef production can give a return of €1480 per hectare per year even at the ex-farm rather than the ex-factory meat price.

Could switching some the land currently used for beef to miscanthus or some other biofuel crop generate the same level of incomes per hectare? According to a Rural Economy Research Centre Working Paper, from the second year onwards, miscanthus can be expected to yield 12 tonnes per hectare at 20% moisture content which should realise €60 per tonne. This gives a gross return of €720 per hectare. If willow was grown instead, about 9 tonnes per hectare should be produced annually which could fetch €36 per tonne[2]. As a result, the gross return per hectare would be around €325 – considerably less than from miscanthus.

To the returns from both types of fuel must be added the savings the country makes by not having to buy emissions permits or the income it makes from having extra ones to sell. We discuss what this income might be in the next section.

2 Tom Bruton of the Irish BioEnergy Association thinks that the willow yield used in the Rural Economy Research Centre Paper, is too low and that the income that can be earned from it should be equal to that from miscanthus.

Carbon sequestration in the crop and the soil

A 2007 EPA report, *Energy Crops in Ireland: An Assessment of their Potential Contribution to Sustainable Agriculture, Electricity and Heat Production,* by Dr. David Styles and Professor Michael Jones[viii] (S&J) states that the rate at which miscanthus sequesters carbon in the soil is 1.16 tonnes of carbon per hectare per year. This is equivalent to 4.25 tonnes of CO_2 a year. Their figure ignores the carbon taken up by the rhizomes and the roots which is rapid in the first few years while the crop is establishing itself. The omission is surprising as they cite a study which found that this once-off increase could be as much as 26 tonnes of carbon per hectare. As the productive life of a miscanthus stand is often taken as 25 years, this means that the average take-up of carbon by the plant is of the order of two tonnes of carbon, or 8 tonnes of CO_2 per year, until the rhizomes are destroyed when the plot is switched to another use.

S&J do not give a figure for the rate at which grazing land sequesters carbon but Soussanna *et al*[ix] give a figure of 1.28 tonnes of carbon per hectare or 4.7 tonnes of CO_2 per year, adding that some farm gate studies have shown sequestration at twice that rate. For example, when switchgrass was grown in the US for the production of cellulosic ethanol.carbon sequestration rates of $4tCO_2$/ha/yr were recorded in the top 30 cm of the soil and $10.6tCO_2$/ha/yr in the top 120 cm. This was despite the fact that all the aboveground biomass was removed each year and the test sites had a low-to-medium rainfall and a relatively short growing season[x].

Higher rates have been reported from Ireland too. For example, a study[xi] of two dairy farms in the southwest found that about two tonnes of carbon (7.32 tonnes of CO_2) were taken up per hectare each year. Although the uptake was not allocated between the vegetation and the soil, most of it is likely to have been in the soil as the length of the grass being grazed is unlikely to have been allowed to increase.

The figures above for the amount of carbon being sequestered in the soil whether by growing miscanthus or by grazing are almost certainly underestimates. This is because, as the switchgrass study showed, a lot of carbon is sequestered deep below the soil surface and core samples are not usually taken so deep down. In addition, one of the most persistent components of soil carbon, glomalin, cannot be extracted by conventional methods. However, it does appear that miscanthus sequesters more carboin than ordinary pasture grass. This is not unexpected as the rate at which carbon is sequestered by plants has been shown to be related to the rate at which they grow.

Unfortunately, the soil carbon sequestered by both grasses does not count as an offset to the country's greenhouse emissions under the current accounting rules. This has a distorting effect on emissions policy. If the national cattle herd is a constant size, the cloud of enteric methane it releases into the atmosphere is a constant size too because an equilibrium is reached after a few years at which the methane in the cloud is breaking down to CO_2 and water as rapidly as new methane is being added. This constant cloud has a constant warming effect which can be expressed in watts per square metre. Over the years, however, the pasture on which the animals graze will have been taking in CO_2, preventing it having a warming effect. After some time, therefore, the warming effect of the enteric methane will be cancelled out by the reduction in the heating effect of the CO_2 taken up by the soil. If one animal unit is grazed per hectare and releases 100kg of methane a year, and the pasture is absorbing carbon at the rate Soussanna quotes, 4.7 tonnes a year, then the warming caused by the methane is completely offset after 6 or 7 years and, after that, the land becomes a net sink[3].

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[3] The calculation is as follows. As the half-life of methane is about 8 years, the atmospheric stock produced by any animal will be 11.54 times its annual emission. Thus, if we use a figure of 100 kg of methane emitted each year per livestock unit, each unit produces a constant cloud of 1,154 kg of methane. One part per billion of methane in the atmosphere has a warning effect of 0.00037 watts per square metre, whereas one part per billion of CO_2 has a warming effect of 0.000014 watts per square metre. As a result, a kilo of methane has the same warming effect as 37/1.4 = 26 kg of CO_2. So the methane released by an animal unit produces the same amount of warming that would be produced by 1.154 x 26 = 30 tonnes of CO_2. This would be removed from the air by the hectare of pasture within six or seven years, so that is the period in which the warming effect of the animal's enteric methane is neutralised.

One factor which seems to influence the rate at which carbon is sequestered in the soil is how nitrogen is applied. Mycorrhizal fungi are thought to be the main agent responsible for the build-up of the longer-lasting forms of soil carbon, the humic substances. They get the carbon from carbohydrates dissolved in the sap of the plants with which they have a symbiotic relationship and use some for their own development. They pass the remainder to colonies of bacteria located at their hyphal tips in exchange for nutrients such as phosphorus, organic nitrogen and calcium, trace elements such as zinc, boron and copper, and plant-growth stimulating substances which go back to the plant. These fungi and their associated bacteria are damaged by the high levels of water-soluble phosphorus and nitrogen commonly used in modern agriculture[xii] which significantly reduces the carbon flow. According to an Australian scientist, Christine Jones[xiii], "The presence of high levels of water-soluble nitrogen in soil sends a signal to plants to reduce the supply of liquid carbon to microbial symbionts, effectively inhibiting the microbial associations that would otherwise supply atmospheric nitrogen for free. This contradicts the widely promoted belief that nitrogenous fertiliser needs to be added in order for stable soil carbon to form. Indeed, the opposite is true"

Several research studies support Dr. Jones' view. For example, Khan *et al* found[xiv] that the excessive use of artificial nitrogenous fertilisers can reduce the level of organic carbon in the soil by promoting its breakdown by microbes.

By contrast, the nitrogen fixed in the soil by legumes has a positive effect on the fungal and bacterial population and it is therefore likely that pasture which includes clover fixes more carbon than that which is treated with a synthetic form of nitrogen. There are certainly indications that compatible combinations of nitrogen-fixing rhizobium bacteria and arbuscular mycorrhizal fungi enhance plant development[xv] and that nitrogen-fixing rhizobia and nutrient-absorbing arbuscular mycorrhizal fungi often interact synergistically to produce better root nodulation, nutrient uptake, and plant yields compared with plants grown without the bacterial and fungal combination[xvi]. Another indication of the damage done to soil carbon by synthetic nitrogen is the evidence that organic farming practices increased the organic carbon content of surface soils by 14% compared with conventional growing methods involving synthetics[xvii].

The strongest policy conclusions that can be drawn from this discussion are that enteric methane emissions should not be regarded as equivalent to the release of methane or carbon dioxide from fossil sources in national greenhouse gas inventories and that Irish pasture land has considerable potential to absorb carbon and that it should be possible to treat the carbon it absorbs as an offset to the carbon released by the country's fossil fuel use.

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2. The emissions balance

Figures from the very careful life-cycle analysis of the emissions involved in cattle rearing and growing miscanthus given in the 2007 EPA report, *Energy Crops in Ireland: An Assessment of their Potential Contribution to Sustainable Agriculture, Electricity and Heat Production* by Styles and Jones[xviii] will be used here.

Styles and Jones (S&J) found that the emissions from growing a hectare of miscanthus amount to 1,938 kg of CO_2 equivalent per year, that from willow 1,346 kg while those from a hectare of land used to graze beef are around 5,237 kg. The saving is therefore 3.3 tonnes for miscanthus and 3.9 tonnes for willow. About a third of the grazing emissions are from enteric methane and the next largest source is nitrous oxide from fertiliser use.

However, the major emissions reduction as a result of moving from beef to miscanthus or willow comes from the displacement of fossil fuels when the biofuels are burned. S&J assume that the biofuels will be burned in a power station to replace coal or peat and calculate that each hectare of miscanthus will save 25 tonnes of CO_2 being released if the dirtiest fuel, peat, is displaced and 21.4 tonnes if used to replace coal. The equivalent figures for willow are 18.3 tonnes (peat) and 15.6 tonnes (coal). We will use the peat figure here as the peat stations have equipped themselves to co-fire with biomass whereas the coal-burning station, Moneypoint, has not.

Consequently, if soil sequestration is ignored, the actual emissions reduction that can be achieved by switching land from beef to miscanthus are 25 tonnes per hectare from fuel switching plus the 3.3 tonnes because of the lower agricultural emissions from switching the crops themselves, a total of 28.3 tonnes a year per hectare. At €25 per tonne, this would be worth €700 a year to the country if the emissions reduced were in a sector not covered by the Emissions Trading System and the same amount to a power company if the emissions reduced were within it. With willow, the total emissions saved would be 22 tonnes worth €550.

It should be noted that neither sum accrues to the farmer. A reduction in non-ETS emissions benefits the taxpayer because it saves the government from having to buy emissions permits or gives it extra ones to sell. Reduced emissions within the ETS benefit the company that purchases the biofuel. As a result, the state should only offer planting grants or subsidies for biofuel production that will reduce the country's non-ETS emissions. The €700 and €550 figures represent the absolute maximum amounts that should be paid in subsidies to encourage miscanthus and willow production for the non-ETS sector if it is thought that the country is going to have to buy emissions permits at €25 per tonne. If other carbon prices are anticipated, the incentives should be adjusted accordingly.

The emissions advantage of growing the biofuels would be reduced marginally if the dung produced by the cattle was put through an anaerobic digester. In 2003 the national cattle herd of 6.3 million animals is estimated to have produced 37 million tonnes of dung over the winter housing period, 29.3 million tonnes of which was slurry with the remainder as solid manure[xix]. Beef animals accounted for 72% of the slurry and 93% of the manure.

Beef slurry is 72% of 29.3 Mt = 21,096,000 t from 2.6m hectares = 8.11 tonnes per hectare
Beef manure is 93% of 7.7 Mt = 7,161,000 t = 2.75 tonnes per hectare

Let us assume that all the slurry and manure produced on farms equipped with digesters actually gets digested. Each tonne of slurry can produce 20 cubic metres of biogas, each of which can release 5.83 kWh when burned. If the gas was burned in a gas engine powered generator working at 35% efficiency, each tonne would deliver

5.83 kWh x 20 x 8.11 X 0 .35 = 40.8 kWh, so a hectare's worth of slurry could convert to 331 kWh.

The beef manure, because it has a lower water content, is more calorific. Each of the 2.75 tonnes per hectare can produce 65 cubic metres of biogas which, using the same gas-engine generator, would deliver

65 x 2.75 x 5.83 x .35 = 365 kWh

We can therefore expect to get about 737kWh from the beef animals grazing each hectare. If we assume that this electricity displaces electricity generated in a peat-fired power station S&J calculate that each kWh of peat-generated electricity involved the release of about 1.15 kg of CO_2. On that basis, the 737 kWh would prevent the release of 848kg of CO_2, far short of the 25 tonnes saved by burning miscanthus and the 22 tonnes saved by willow. Even if the waste heat from the gas engine was used to replace heating oil, the biofuels would still give a much better performance. If the gas was used to replace petrol or diesel in road vehicles or the farm's tractors, it would give the equivalent of 2105kwh or 217 litres of petrol per hectare. Burning this rather than petrol would cut emissions by 503 kg but would probably be more profitable for the farmer than selling the electricity and save the country the cost of the imported vehicle fuel.

Is a switch socially and agronomically feasible?

Only part of the land currently used for grazing is likely to be suitable for switching to miscanthus. One reason for this is that the grass needs to be harvested in February and March during its dormant period. If harvested earlier or later, the nutrients which the plant withdraws to its rhizomes for the winter are found in the leaves and stems and would be removed with the crop. They would consequently need to be replaced which would involve both expense and an increase in emissions. As a result, since February and March are high rainfall months, the land chosen needs to be well drained so that harvesting equipment can be used without churning it up. In addition, the land needs to be level enough for the harvesting equipment to be used safely and should have good road access. Sites exposed to the wind should be avoided and the grass does best in the south of the country although JHM Crops Lid., which buys miscanthus from farmers under contract, reports that it is being grown as far north as Crossmolina, Co. Mayo, with good results.

An estimate[xx] of the amount of land available for growing miscanthus has been published by a team at UCC. According to its report, only land potentially suited to tillage should be considered as the grass needs a "medium soil such as sandy or silty loam (brown earth or para brown earth) with a good air movement, a high water-holding capacity and organic matter content. Soil that is suitable for growing maize is also likely to be suitable for miscanthus" The slope should be 12° or less and the pH between 5.5 and 7.5 Despite this, it estimates that 30% of the country could be suitable or highly suitable – in other words, most of the better land.

Willow's land requirements are equally restrictive. According to Teagasc it needs "high quality fertile agricultural land (former tillage land or improved grassland) capable of being ploughed to a depth greater than 20 cm. Peaty soils are unsuitable, as are soils that dry out quickly or are waterlogged for prolonged periods. The site must have a low elevation and be moderately sheltered (sites of higher elevations may be suitable, if well-sheltered). To facilitate machine operations and to minimise potential runoff, slope should be minimal (not exceeding 15°). Hard access to the site is essential, to facilitate machine access and the removal of the harvested material. The access track should lead to a landing area, where the harvested material can be handled." [xxi]

If the emissions reductions anticipated by S&J are to be achieved, the land selected also needs to be reasonably close to one of the three peat-burning power stations to avoid transport costs eroding too much of the grower's income. While transporting the crop a long distance to burn would not reduce the total incomes gained from growing it except insofar that imported inputs such as fuel and vehicles parts were used, it would necessarily reduce the amount of emissions saved. The three stations limit the amount of miscanthus they will mix with the peat to less than 10% as they are concerned that the chlorine it contains will corrode their boilers at the high temperatures at which they operate. This obviously limits the potential market for the crop although there is some way to go before that limit is reached.

Bord na Mona is on record[xxii] as saying that it prefers to burn willow instead of miscanthus in its power station as it not only avoids the corrosion problem but also the risk of slag building up. The reason slag forms is that miscanthus ash melts at a lower temperature than wood ash and so needs to be burned at a lower temperature than the willow, reducing the efficiency at which the boiler operates. If miscanthus is burned at above 1,220°C the molten ash can slide to the bottom of the furnace, blocking the grate, or can stick to the furnace wall, making it inefficient. Research at Oak Park has shown that these problems are particularly acute if miscanthus is burned in fixed grate boilers.

In future it should be possible to burn miscanthus or willow in combined heat and power plants close to where it grew. However, this option seems closed at present as plans to build a 5000MW per year plant near Cork were dropped when it was calculated that the electricity from it would cost about 19 cents per kWh which the promoter said was almost twice the price being charged for electricity bought at the normal commercial rate. If the plant had been paid for the emissions its use saved, the cost per unit would have fallen to about 15 cents. This indicates that the capital cost of the plant and its depreciation charge were too high to be viable. The REFIT price at which electricity from a biomass-fired CHP plant can be sold into the grid is 14 cents.

A third long-term limit on the amount of land than can be switched to miscanthus or any other biofuel crop are the EU's cross-compliance rules which limit the reduction which can be made in the area Ireland has under permanent pasture to 10% of the total.

What would it take to get farmers to make the transition to biofuels?

Switching land to miscanthus or to willow is a long-term commitment and requires a significant capital outlay – around €2,600 for both biofuels, only half of which is currently covered by a state grant. Moreover, there is no income in the first year and a reduced income in Year Two and the net income to the farmer, after harvesting and other ex-farm costs have been paid, is a modest €342 per hectare for miscanthus according to Teagasc specialist Barry Caslin[xxiii]. JHM Crops Ltd puts the income figure rather higher telling farmers they can expect

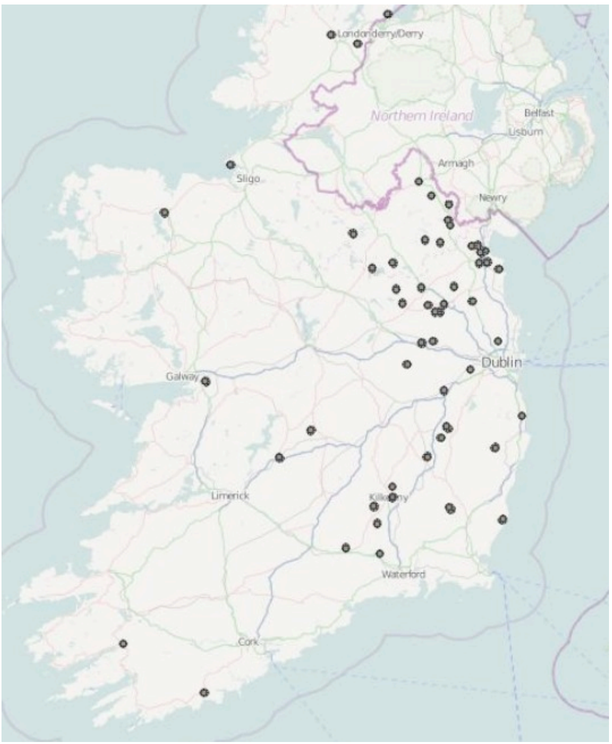

Illustration 2: Sites where willow is being grown. Source: SEAI

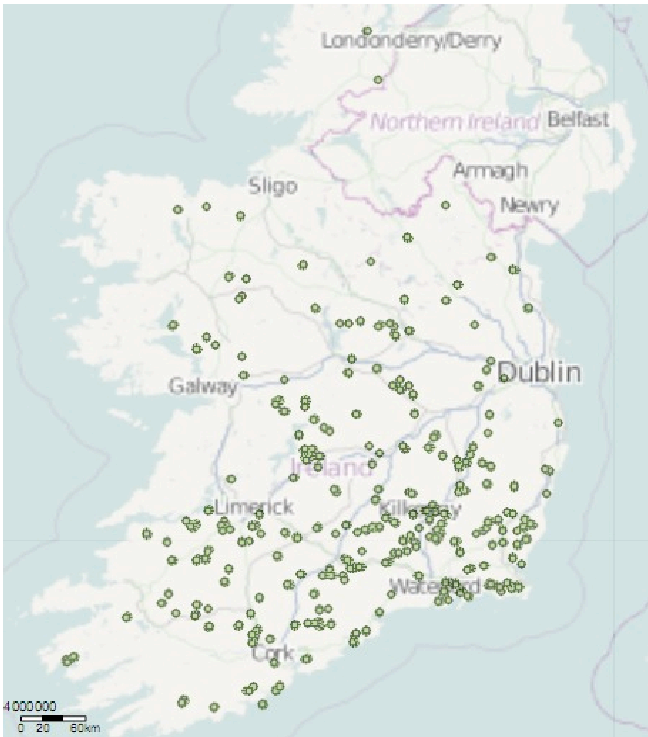

Illustration 3: Sites where miscanthus is being grown. Source: SEAI

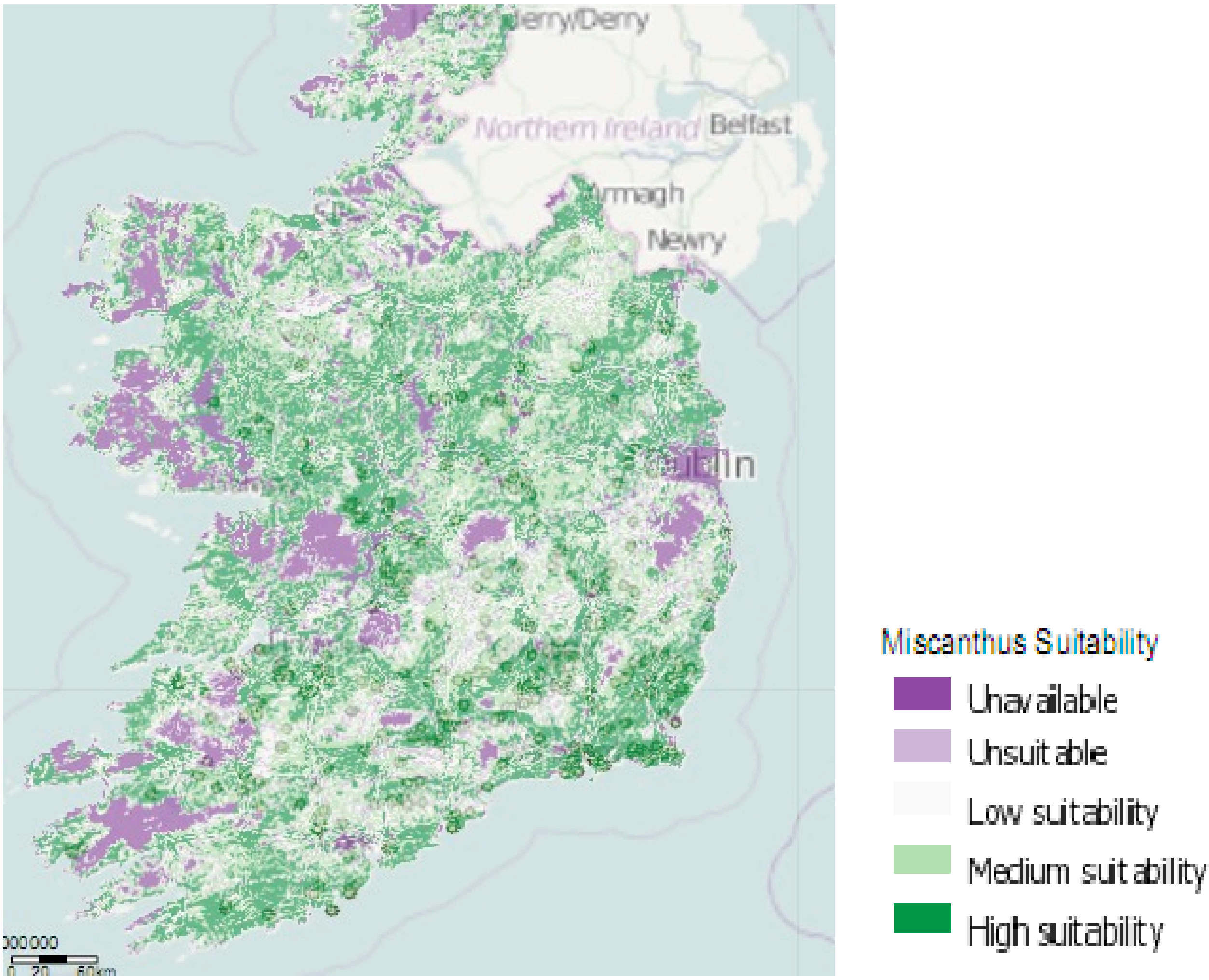

Illustration 4: Where miscanthus might best be grown. The most suitable areas are in dark green. Source: SEAI

to earn between €330 and €660 a year from miscanthus and around €330 from willow. The company offers seven-year contracts for both crops, paying €60 per tonne for miscanthus at 20% water content and €36 per tonne for willow because its water content is higher at around 50%. These prices are paid regardless of the farms' locations and JHM Crops bears the cost of transport to the power stations. It is, however, working with large energy users such as hotels to get them to install miscanthus-burning boilers so that the crop can be burned much closer to where it is grown.

Both biofuel crops require some of a pasture farm's better land (most of the land currently going into miscanthus production is arable rather than pasture). As the rate of return on such land is relatively poor, the rate of planting has been low. Only 80 farmers applied for pre-planting grant approval in 2010. 38 applications were for a total of 360ha of willow, while 44 farmers applied for grants to plant miscanthus, a smaller number than the previous year[xxiv]. The fall was attributed to the difficulty potential applicants were experiencing in obtaining loans to cover their share of the establishment cost rather than the poor return.

Teagasc research[xxv] has shown that the owners of larger farms are more likely to grow energy crops than those with smaller holdings, especially if they have greater farming experience. This might be because bigger farmers have better access to capital and hope to achieve a more balanced product portfolio. Indeed many may be able to continue with their existing enterprises without making significant reductions to their scale. If this is correct, the number of beef cattle kept may not fall very much as a limited amount of grazing land is switched to biofuels. In other words, the emissions from the national herd may stay much the same while emissions from the power sector or the non-ETS sector are reduced.

Policy conclusions

At present, there is little point in reducing emissions from the power sector since doing so will merely leave the operators with more emissions permits to sell, permits which they obtained free. It will simply increase their profits and allow fossil fuel users elsewhere in the EU to consume more fossil fuel as more permits will be available and they will cost less to buy. Even when power companies have to buy their permits, the result will be the same – using the biofuel will save them the price of the permits. Consequently, the only reason the state should subsidise biofuel production for power station use is to reduce the sector's extreme dependence on imported fuel. However, if this is its strategy, there is no reason why the taxpayer should pay for its implementation – a levy on the generators would be a better course. Ideally it would be on their use of fuels imported from outside the EU but international trade rules might make that impossible.

There are two other reasons why the state should not support the burning of biofuels in the peat stations. One is that only about 35% of the energy in the fuel is converted to electricity. The rest is wasted as unused heat. More local combustion of the fuel would be more energy efficient. The second reason is that the peat burning power stations should be closed. We make a very strong recommendation to this effect in our forthcoming report because they contribute 7.6% of the country's fossil fuel emissions but provide only 3.6% of the fossil energy actually used and the cost of running them will soar in future when they no longer get "free" emissions permits as the permits have to be bought.

The main thrust of the biofuel programme should therefore be to lower emissions not covered by the ETS, which are mainly those of the heating and transport sectors, as these are the emissions which the country will struggle to reduce to meet its EU targets. As the state will capture the benefits of reducing these emissions, it needs to pass those benefits on in ways which will benefit the growers by both giving them a better price and by helping develop a market for their products in their own areas. A tonne of either miscanthus or willow at 20% moisture is equivalent in heating terms to about 400 litres of oil. Not burning that oil would save 1.2 tonnes of CO_2, worth €30. If all this was passed on to the grower it would more than double the net return.

Paying a subsidy at such a rate would not exhaust the benefits Ireland got from making the switch because the cost of the imported oil would stay in the country and increase incomes and the tax take. Specifying the most effective way of paying the €30 subsidy is beyond the scope of this paper. Some combination of planting grants, grants to those installing woodchip and miscanthus heating equipment and higher prices to growers might be more effective than giving higher prices to growers alone. At present, although grants are paid for the installation of wood-burning equipment, no equivalent grants are paid for miscanthus burners. This anomaly should be removed.

Even with higher prices, only a fraction of the country's grazing land would and could be used for growing biofuel and Ireland will – and should - continue to be a substantial producer of beef and dairy products. The idea that the country can trim its enteric methane emissions by 20-30% by 2020 by a rapid reduction of the beef herd is unrealistic particularly as many of the calves being raised for beef are born to dairy cows and there are no plans to cut dairy production as it is the most lucrative agricultural sector. Indeed, milk production could well increase when the quotas restricting production are lifted in 2015.

The only assumption that policymakers can safely make is that the emission of enteric methane from Irish cattle will stay much the same. Rather than distorting the agricultural sector to try to change that, they should challenge simplistic international attitude that enteric methane is as damaging to the climate as 23 times its weight of CO_2 from burning fossil fuels. A twin track policy should be adopted. On one track, they should move the country to full-carbon accounting so that the carbon taken up by pasture can offset fossil fuel emissions. The second track should be to use a greater share of the benefits that accrue to the country from reducing emissions and the cost of imported fuel to expand biomass production very much more rapidly than at present.

Summary of policy conclusions

1. **From both an emissions-reduction and energy-security perspective, Ireland would benefit from a substantial increase in the amount of miscanthus and willow grown for use as fuel. However, the reduction in the numbers of cattle kept as a result of this increase might be small particularly if better grazing methods were adopted.**
2. **Willow and miscanthus production needs some of a farm's better land. The return from growing them should reflect this if their area is to increase.**
3. **At present, producing these fuels on grazing land generates the same level of incomes as beef for the nation as a whole – as opposed to savings for the state – only if the state's savings are passed on either though incentive schemes or higher prices.**

4. **The policy of producing the two fuels to burn in the peat stations should be scrapped. Instead, the emphasis should be on growing fuel for local use, to cut emissions from the non-ETS sectors.**
5. **Grazing land can absorb considerable amounts of CO_2 each year if managed well. It should be made possible to use the tonnage it absorbs as an offset in the national greenhouse gas accounts but research is needed to fully quantify the carbon balances of Irish grasslands.**
6. **Nitrous oxide emissions from pasture land can be reduced significantly by avoiding or minimising the use of artificial nitrogenous fertiliser. Legumes should be grown to provide the nitrogen instead and this is likely to increase the rate of carbon sequestration.**
7. **Strenuous efforts should be made at EU level to have enteric methane emissions from the national herd excluded from the national greenhouse gas accounts as the land on which the animals graze has already absorbed enough carbon to offset their impact. In any case, it would make no sense to attempt to reduce the Irish herd if beef cattle numbers increased elsewhere to make up for the fall in supply.**

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