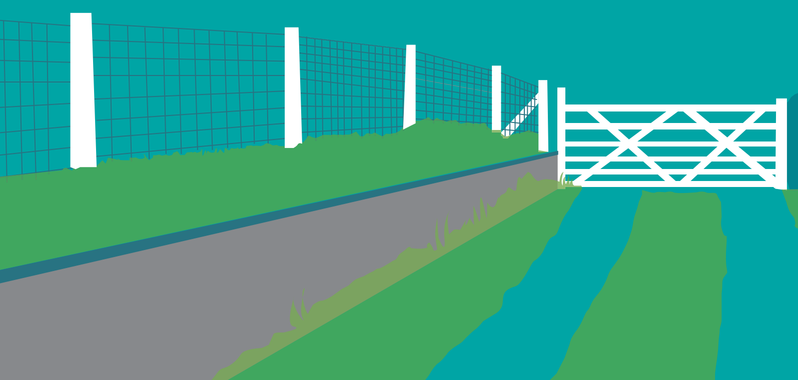
energy technologies institute

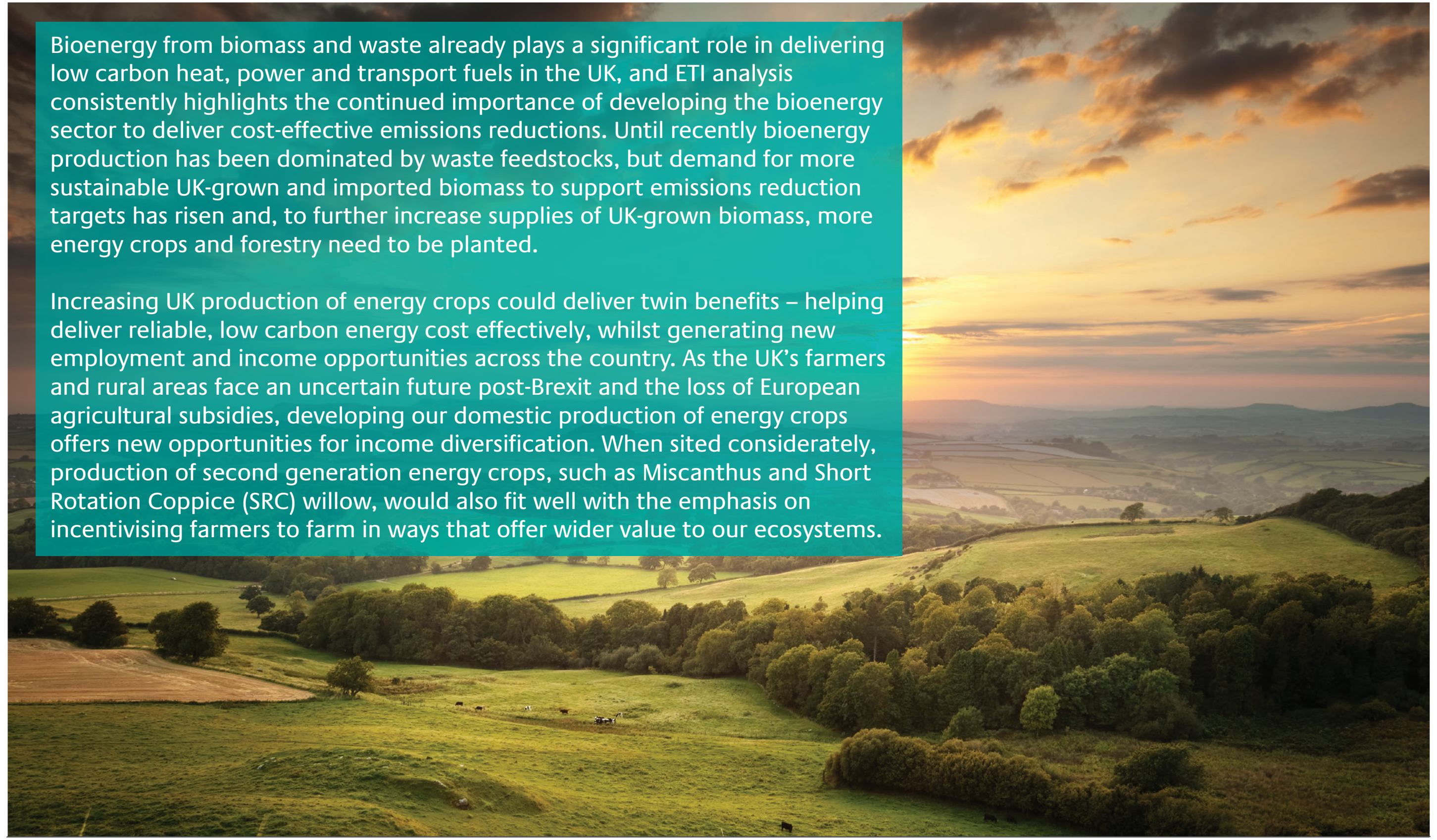
An ETI Perspective

Opportunities for rural job creation in the UK energy crops sector



ETI 10 TEN YEARS OF INNOVATION 2007 – 2017

INTRODUCTION



Bioenergy from biomass and waste already plays a significant role in delivering low carbon heat, power and transport fuels in the UK, and ETI analysis consistently highlights the continued importance of developing the bioenergy sector to deliver cost-effective emissions reductions. Until recently bioenergy production has been dominated by waste feedstocks, but demand for more sustainable UK-grown and imported biomass to support emissions reduction targets has risen and, to further increase supplies of UK-grown biomass, more energy crops and forestry need to be planted.

Increasing UK production of energy crops could deliver twin benefits – helping deliver reliable, low carbon energy cost effectively, whilst generating new employment and income opportunities across the country. As the UK's farmers and rural areas face an uncertain future post-Brexit and the loss of European agricultural subsidies, developing our domestic production of energy crops offers new opportunities for income diversification. When sited considerately, production of second generation energy crops, such as Miscanthus and Short Rotation Coppice (SRC) willow, would also fit well with the emphasis on incentivising farmers to farm in ways that offer wider value to our ecosystems.

KEY HEADLINES

- Planting 30 - 35 kha/yr of second generation crops (Miscanthus, Short Rotation Coppice (SRC) willow and Short Rotation Forestry (SRF)) would keep the UK on the trajectory to deliver a bioenergy sector of the scale needed to help cost-effectively decarbonise the UK energy system.

- Due to the seasonal nature of bioenergy crop planting, management and harvesting, the majority of job opportunities will be part-time, but are complimentary to the seasonal demands of other roles in the agricultural and forestry sectors, particularly arable farming.

- By 2032, a 30 kha/yr planting rate could create around 8,100 job opportunities in the busiest months (or 4,300 Full Time Equivalent (FTE) jobs when averaged across the year). By the 2050s, around 16,700 opportunities could be created during peak periods (9,100 FTE jobs across the year).

- The UK is not currently in a position to deliver a planting rate of 30 kha/yr – the total planted area of Miscanthus and SRC willow has remained at around 10 kha in recent years with a limited number of players in the market. Investment is needed in the production of plant breeding materials, including research into new establishment techniques to reduce costs. Investment is also needed in training and specialised equipment for planting and harvesting.

- As the UK prepares to leave the European Union, there is an opportunity to restructure farming support in a way which encourages the sustainable growth of the UK biomass sector. This could place a value on the wider environmental benefits growing second generation energy crops can make to the farming landscape.

Why Bioenergy?

Bioenergy is a hugely valuable source of low carbon renewable energy because it can be stored and used flexibly to produce heat, power, liquid and gaseous fuels. Combined with Carbon Capture and Storage (CCS), it has the potential to deliver negative emissions which the ETI anticipates are needed to deliver a cost-effective, low carbon energy system in 2050. The ETI's internationally peer-reviewed Energy System Modelling Environment (ESME)[1], a national energy system design and planning capability, suggests that bioenergy, in combination with CCS, could provide around 10% of projected UK energy demand (~130 TWh/yr) whilst delivering net negative emissions of approximately -55Mt CO_2 per year in the 2050s. This is roughly equivalent to half the UK's 2050 emissions target and reduces the need for other, more expensive, decarbonisation measures. Using bioenergy in this way could reduce the cost of meeting the UK's 2050 emissions target by more than 1% of gross domestic product (GDP). Even in the absence of CCS, bioenergy is still a cost-effective means of decarbonisation and should play an important role in meeting the UK's 2050 emissions target.

Delivering 130 TWh/yr of bioenergy

ETI analysis using its Bioenergy Value Chain Model (BVCM)[2] indicates that producing ~130 TWh/yr bioenergy by the 2050s will require around three times more feedstock (on an energy basis) than is currently used. While there are opportunities to use residual waste feedstocks more effectively in the UK, their availability is limited meaning that the majority of this increase will need to be sourced from imported and UK-grown biomass feedstocks. This presents an opportunity for the UK to further develop its biomass sector in order to make a significant contribution towards bioenergy feedstock needs and reduce the risk of sustainable biomass availability becoming a limiting factor in the growth of the sector.

In the UK, Defra estimate that around 93 kha of land were planted with energy crops in 2015, of which 10 kha were second generation crops (Miscanthus and SRC willow), the remainder being first generation arable crops[3]. While first generation crops currently dominate the energy crops sector, ETI analysis indicates that second generation crops can deliver greater greenhouse gas emissions savings across a range of end vectors[4].

1 ETI (2017). ESME [online] Available at: http://www.eti.co.uk/programmes/strategy/esme
2 ETI (2015). Overview of the ETI's BVCM Capabilities [online] Available at: http://www.eti.co.uk/library/overview-of-the-etis-bioenergy-value-chain-model-bvcm-capabilities
3 Defra (2016). Area of crops grown for bioenergy in England and the UK: 2008-2015 [online]
Available at: https://www.gov.uk/government/statistics/area-of-crops-grown-for-bioenergy-in-england-and-the-uk-2008-2015
4 Newton-Cross, G. (2016). Delivering greenhouse gas emission savings through UK bioenergy value chains [online].
Available at: http://www.eti.co.uk/insights/delivering-greenhouse-gas-emission-savings-through-uk-bioenergy-value-chains

The UK could convert a total of 1,400 kha of UK land to bioenergy crops by the mid-2050s, without impacting on the level of UK-grown food consumed, by planting a mixture of Miscanthus, SRC willow and Short Rotation Forestry (SRF)[5]. This is an average of 30 - 35 kha/yr. Achieving this level of planting would make a significant contribution towards the 130 TWh/yr target – roughly equal to the contribution of imported feedstocks[6].

5 ETI (2017). Increasing UK biomass production through more productive use of land [online].
Available at: http://www.eti.co.uk/library/an-eti-perspective-increasing-uk-biomass-production-through-more-productive-use-of-land
6 ETI (2016). The evidence for deploying BECCS in the UK. See pages 12-13 for further details. Available at: http://www.eti.co.uk/insights/the-evidence-for-deploying-bioenergy-with-ccs-beccs-in-the-uk

Calculating the job implications of planting energy crops and forestry

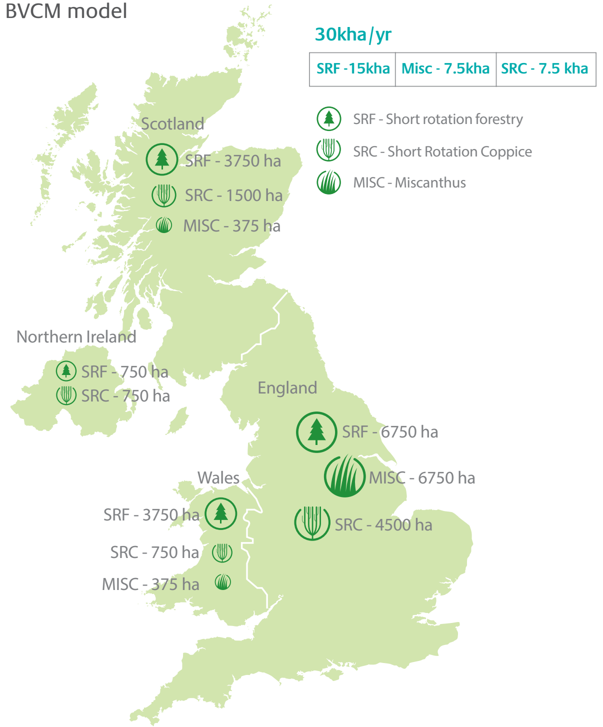
The second generation energy crop market in the UK is nascent. The area of Miscanthus and SRC willow has remained fairly stable over the last five years – 10 kha out of a total agricultural area of 17,000 kha – and Short Rotation Forestry (SRF) has not yet been planted commercially for energy production in the UK[7].

Expanding the sector such that it can deliver a planting rate of 30 - 35 kha/yr will not happen overnight. As part of the ETI's wider work on bioenergy crop business models[8], the ETI commissioned ADAS[9] to research the jobs, skills and equipment implications of delivering a planting rate of 30 kha/yr into the 2050s.

As part of their review, which is published alongside this perspective, the following assumptions were agreed:

- 30 kha/yr planting rate from 2017 – 2055, made up of 15 kha SRF and 7.5 kha each of Miscanthus and SRC willow, in addition to the current planted area
- The location of each crop (and thus the location of the job opportunities created) is based on yield maps and analysis of likely planting areas using the ETI's Bioenergy Value Chain Model (BVCM), (Figure 1)

Figure 1 - Assumed locations of second generation crops based on the ETI's BVCM model



7 McKay, H. (ed.) (2011). Short Rotation Forestry: review of growth and environmental impacts. Forest Research Monograph, 2, Forest Research, Surrey, 212pp. [online]. Available at: http://www.forestry.gov.uk/pdf/frmg002_short_rotation_forestry.pdf
8 Day, G. (2015) Enabling UK Biomass [online]. Available at: http://www.eti.co.uk/library/bioenergy-enabling-uk-biomass
9 http://www.adas.uk/

The ADAS review considered the jobs, skills and equipment required to produce Miscanthus, SRC willow and SRF up to and including transport of the biomass off-farm or out of the forest. This included:

- Planting material production, such as rhizomes for Miscanthus or cuttings for SRC willow
- Advice and technical support on crop establishment and management
- Ground preparation, fencing, and crop establishment
- Annual management of the crops
- Harvest and on-site processing or storage
- Crop removal and land clearance at the end of the crop's lifespan
- Transportation and logistics off-farm – direct to end user or processing site

The review did not include jobs associated with biomass processing (e.g. chipping or pelleting) or conversion to energy. Ancillary services such as marketing and finance roles were also excluded.

For each crop, the tasks involved in producing and transporting it were identified and quantified in hrs/ha/yr, and consideration was given as to when during the year these tasks could be carried out, and by whom[10]. Jobs were classified into five categories:

1. Off-farm specialists including plant breeders, agronomists and technical advisors
2. Famers or farm employees
3. Specialist contractors – typically involved in planting or harvesting crops using specialist equipment
4. Casual labour – potentially seasonal labour
5. Logistics – Drivers employed to transport crops off-farm

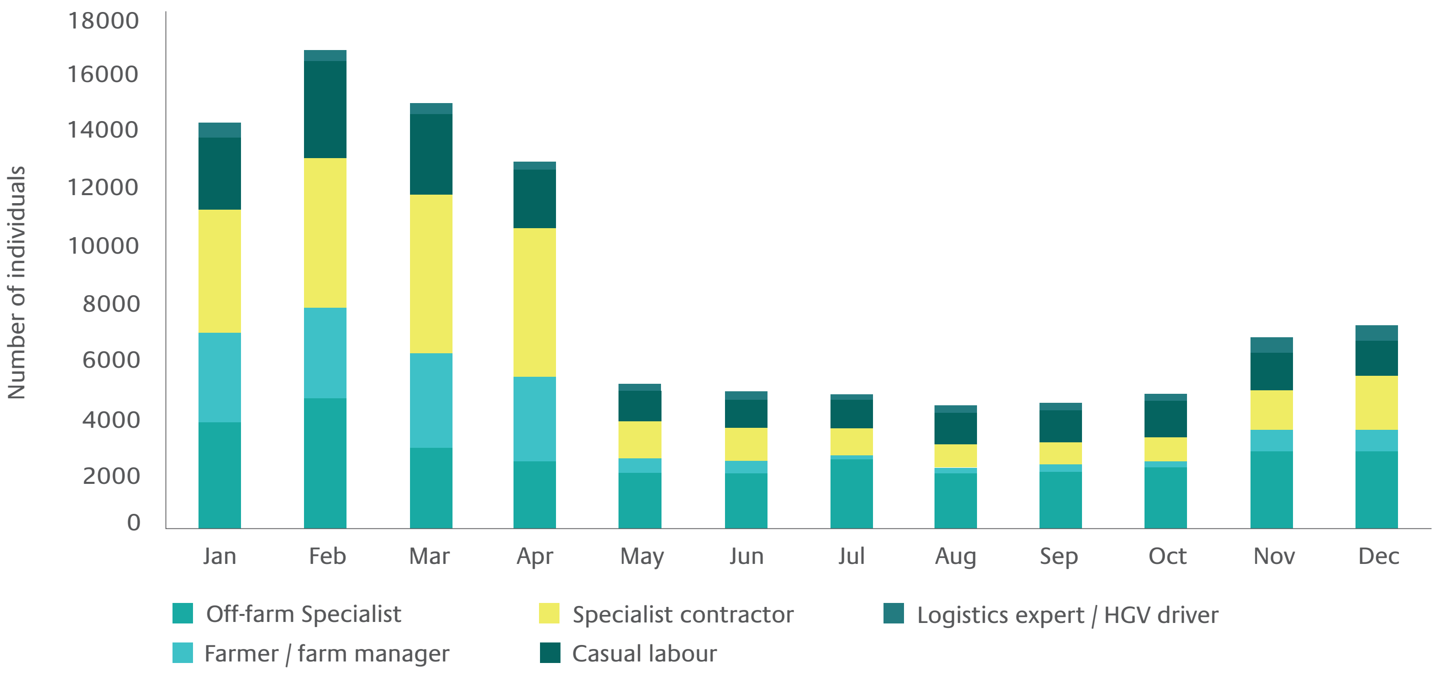
10 A detailed breakdown of the tasks performed, their duration and frequency are provided in the accompanying spreadsheet and Section 3.2 of the accompanying report.

By 2032, a planting rate of 30 kha/yr could create around 8,100 job opportunities in the busiest months of January to March, reducing to 2,000 during the quietest periods (July – October). Across the year, this is equivalent to 4,300 Full Time Equivalent (FTE) roles. By the 2050s around 16,700 opportunities could be created in the peak period reducing to 4,300 between July and October (equivalent to 9,100 FTE: 5,600 FTE in the SRF sector, 2,200 FTE in Miscanthus and 1,300 FTE in SRC willow). Opportunities are split relatively equally across four of the five job categories, with a smaller opportunity to generate new HGV driver roles[11] (Figure 2).

The following sections look at each of the three energy crops in turn.

11 It is important to note that this study only includes transport of biomass off-site (farm/forest) to its first destination. It doesn't include transport of biomass between processing sites and end users, nor does it consider transport of imported biomass or waste for energy feedstocks.

Figure 2 - Labour profile of bioenergy crop production by month, in 2055



Miscanthus

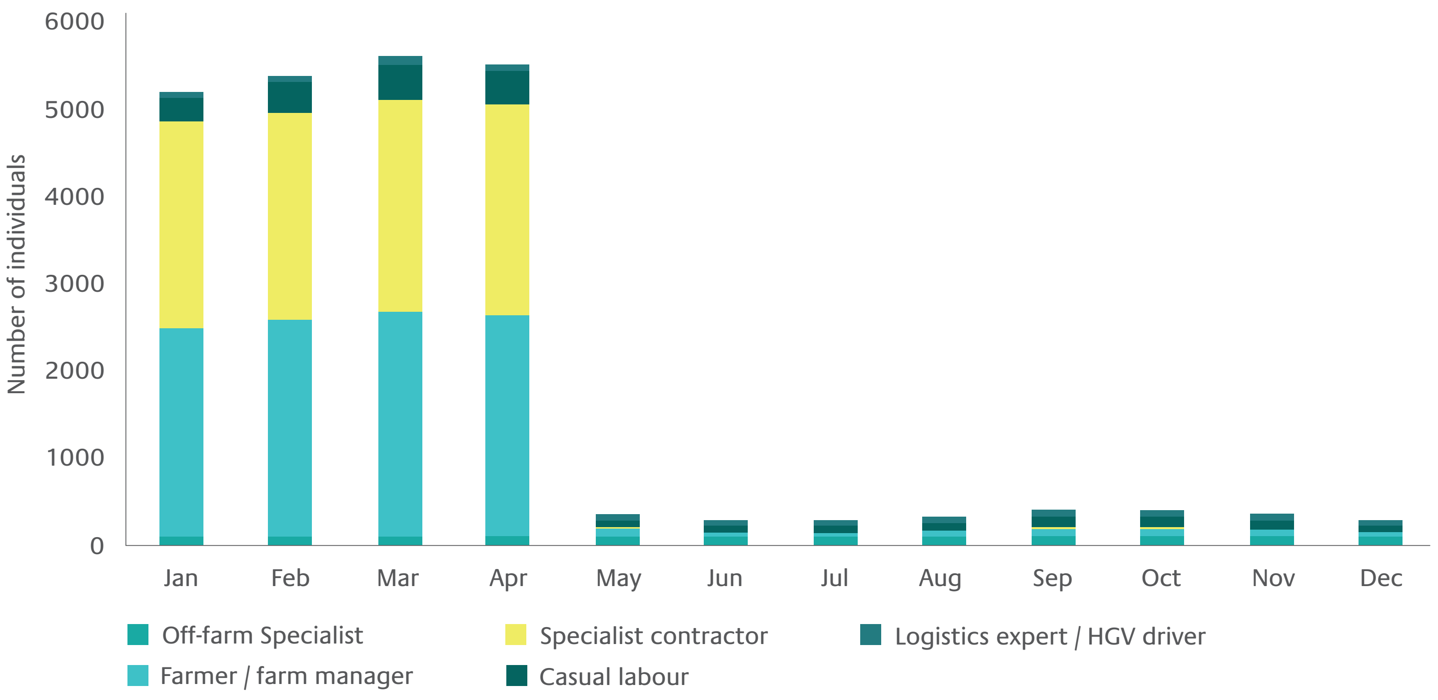
Miscanthus is a perennial energy grass which can grow to heights of 2.5 -3.5 m. Once established (2 - 3 years) it is harvested annually, with a typical crop lifespan of 25 years. The crop is planted and harvested between January and April with minimal input required over the remainder of the year. The establishment phase - site selection, ground preparation and planting - is the most labour intensive period of the Miscanthus crop lifecycle. Currently, Miscanthus is planted using self-propagating rhizomes which can be relatively time consuming to plant. However, the longer term aim is to be able to breed Miscanthus from plug plants (young plants with well established, completed and independent root systems) and ultimately from seed which would reduce the time and cost associated with planting[12].

Planting 7.5 kha/yr between 2017 and 2055 (in addition to the current area of ~7 kha) will result in a total area of Miscanthus of just under 300 kha. In the early years, the majority of jobs would be associated with producing rhizomes and establishing the crop as this is the most labour intensive element of the lifecycle. Over time, jobs associated with harvesting would increase annually in line with the increasing total area of Miscanthus, while jobs associated with planting would remain relatively stable until the first areas planted reached the end of their lifecycle. At this point, the number of planting roles would double as 7.5 kha/yr would need to be replanted alongside the 7.5 kha/yr of new planting.

By the 2050s the Miscanthus sector could support up to 5,600 individuals during the planting and harvesting season between January and April, dropping to 300 - 400 for the remainder of the year – predominantly specialists involved in the production of planting material or site selection, as well as drivers transporting the Miscanthus off farm (this can take place later in the year if the farmer is able to store the Miscanthus bales on site) (Figure 3). Averaged across the whole year this equates to 2,200 FTE roles, 90% of which would be involved in harvesting (carried out by a farmer or contractor) and transport, with the remaining 10% involved in planting and establishing new crops where there is a greater role for off-farm specialists (plant breeders) as well as specialist contractors.

12 Further information on the UK's Miscanthus breeding programme is available at: http://www.miscanthusbreeding.org/

Figure 3 - Labour profile of Miscanthus production by month, in 2055 (~300 kha total planted area and 7.5 kha/yr annual planting rate)



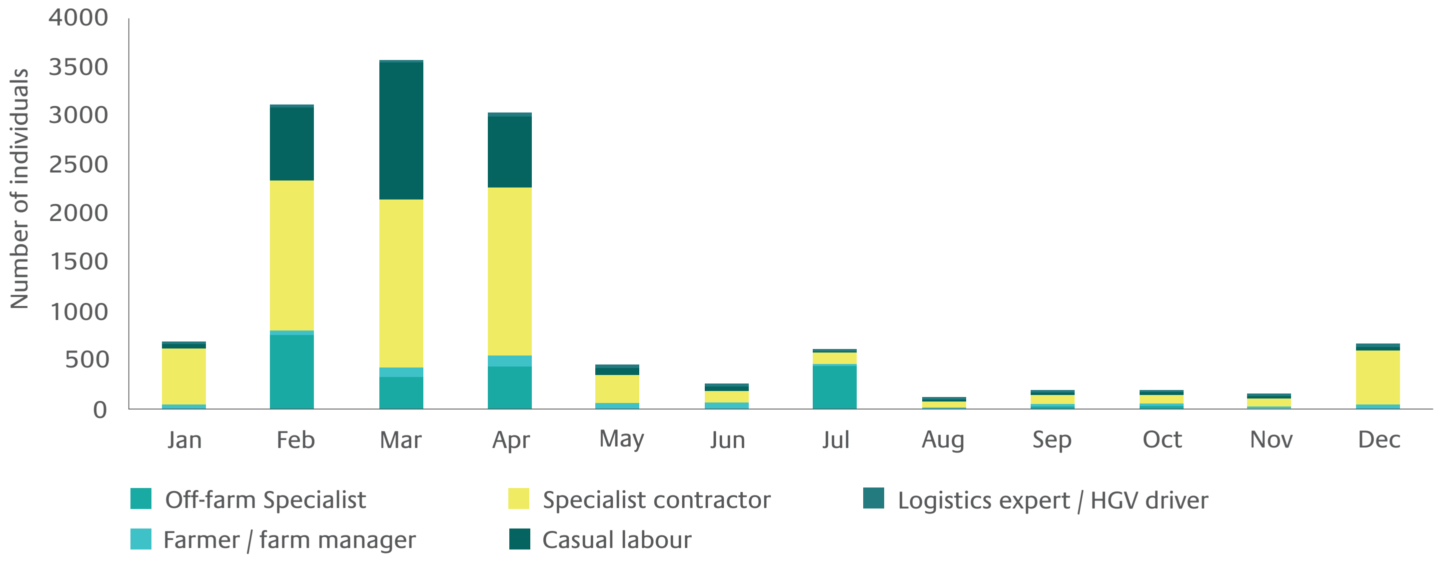
SRC Willow

SRC willow is planted as rods or cuttings in the spring using specialist equipment. The willow stools readily develop multiple shoots when coppiced and several varieties have been specifically bred with characteristics well suited for use as energy crops. The first crop is harvested in winter, typically three years after being cut back, again using specialist equipment. The crop is harvested every three years subsequently, giving a total of seven harvests over a typical crop lifetime.

As for Miscanthus, the establishment of SRC willow is the most labour intensive part of the lifecycle, particularly the production and transport of planting material which is produced by dedicated breeding companies or research institutions. Planting 7.5 kha/yr between 2017 and 2055 (in addition to the current area of ~ 3 kha) would result in a total area of SRC willow of just under 300 kha. Initially, as with Miscanthus, developing capabilities in plant breeding material production and crop establishment will be most important, but over time the number of roles associated with harvesting would increase alongside the need for investment in specialist harvesting equipment. In the late 2030s / early 2040s, as the first areas planted reach the end of their lifecycle, there would be an increase in demand for SRC willow planting as existing SRC willow growing areas and new land are planted.

By the 2050s, SRC willow could support around 3,500 individuals when the planting and harvesting seasons overlap between February and April, dropping to 100 - 200 between August and November for ongoing maintenance of the crop as well as site selection and advice for the following years' planting (Figure 4). Averaged across the whole year this equates to 1,300 FTE roles - fairly evenly split across planting/establishment, annual management and harvesting. This is a different profile to Miscanthus as SRC willow is only harvested every three years, not annually, and a larger proportion of the roles are carried out by specialist contractors due to the need for dedicated SRC planting and harvesting equipment. The majority of time spent by off-farm specialists and casual labour is in the production of willow cuttings for planting.

Figure 4 - Labour profile of SRC willow production by month, in 2055 (~300 kha total planted area and 7.5 kha/yr annual planting rate)



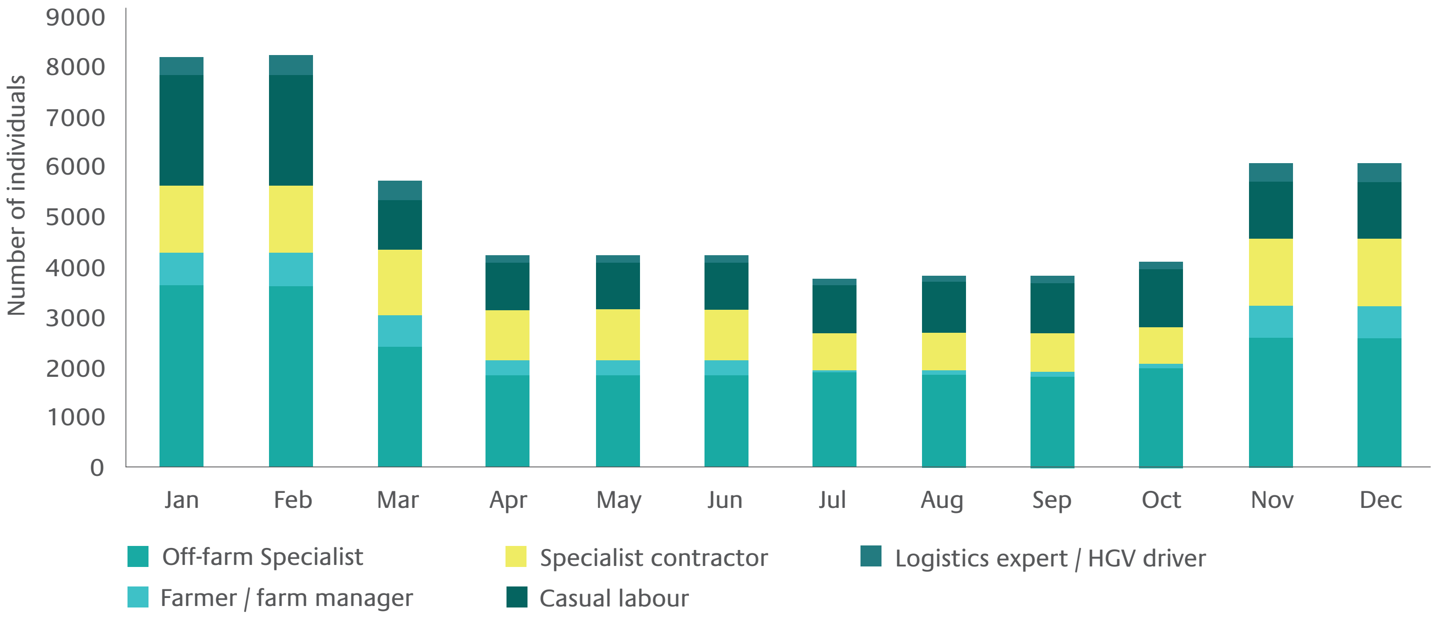
Short Rotation Forestry (SRF)

SRF is the practice of cultivating fast-growing trees that reach their economically optimum size between 10 and 30 years from planting, depending on the species used; a 15-yr rotation was assumed for this study. Planting is normally carried out between November and February while annual maintenance and harvesting can take place year round. However, harvesting tends to take place during the winter months to minimise impact on breeding birds or other wildlife.

Planting 15 kha/yr between 2017 and 2055 would result in a total area of SRF of around 585 kha. This could support around 8,200 individuals during the main planting and harvesting season in January and February, dropping to around 4,000 between April and October (Figure 5). Averaged across the whole year this equates to 5,600 FTE roles, relatively evenly split between planting/establishment, annual management and harvesting. The majority of these roles are carried out by forestry specialists – both on– and off-farm. Casual labour and farmers can assist with the planting and maintenance of the crop.

Because of the assumed rotation length (15-yrs), by the 2050s it is assumed that around 45 kha of planting will be taking place each year (30 kha of planting to replace areas harvested at the end of their 1st and 2nd rotation) as well as 15 kha of new planting. As with both Miscanthus and SRC willow, in the early years the main job opportunities would be associated with planting new areas, but as the total area planted increases, roles in crop management and harvesting would increase.

Figure 5 - Labour profile of SRF production by month, in 2055 (585 kha total planted area and 15 kha/yr annual planting rate)



Incorporating second generation energy crops into farming practices

The varying labour profile of all energy crops means that the bioenergy sector will only be able to provide a limited number of full time jobs, with most workers also working in other areas of the agricultural or forestry industries.

Focusing on farming, ADAS created annual labour profiles for different arable crops and livestock, comparing them to the 'on-farm'[13] labour required to grow Miscanthus, SRC willow or SRF. For arable crops, such as winter wheat, oilseed rape or spring barley, the peak labour requirements tend to be in the summer and early autumn (July to October), while harvesting of second generation bioenergy crops tends to take place between January and April. This is illustrated in Figure 6 which shows the hrs/ha profile of wheat production alongside the annual, post-planting, on-farm labour requirements of Miscanthus maintenance and harvest.

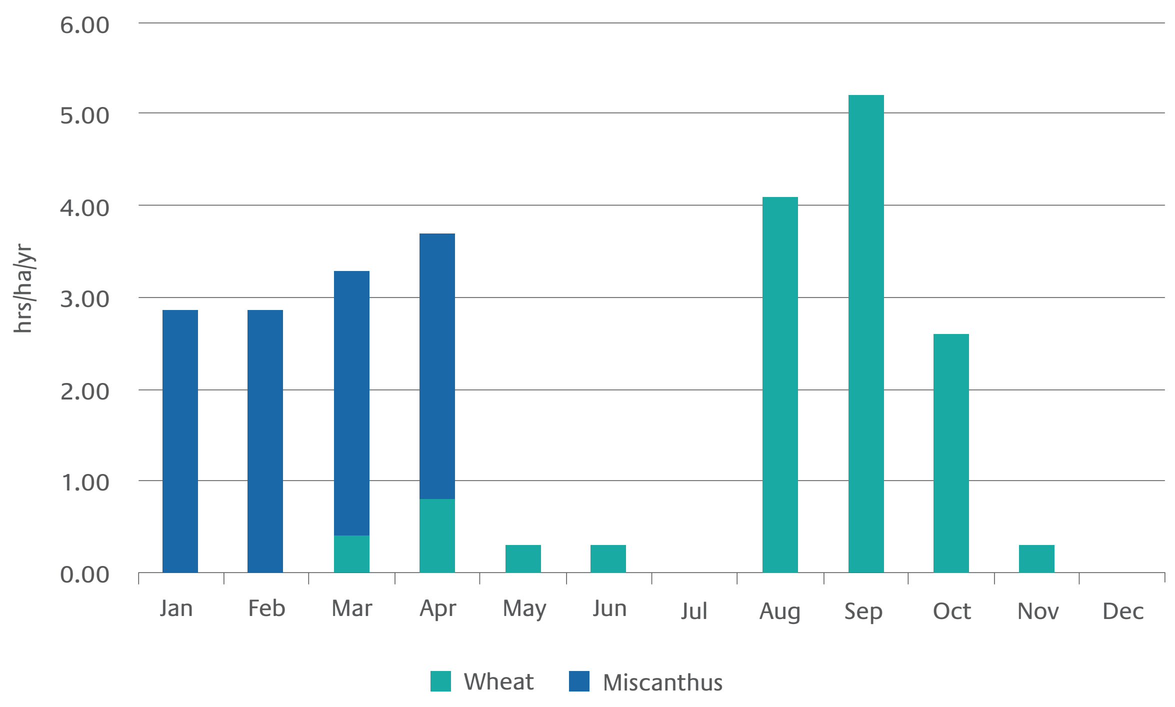
The potential for second generation crops to help smooth out the labour profile on arable farms, compliments the ETI's wider work on UK bioenergy crops, which has examined the extent to which they can deliver genuine greenhouse gas savings. This found that planting SRC willow or Miscanthus on marginal arable land in particular can increase soil carbon sequestration and deliver low carbon bioenergy value chains[4].

It is important to note that while Miscanthus harvesting can take place between January and April (as shown in Figure 6), at an individual farm level it is likely to take place over a few days or weeks (depending on the area planted) within that period. This is pertinent when considering livestock farming where, although the labour profile is more consistent as stock need to be cared for year-round, there are peaks in labour requirements over the spring during the calving and lambing seasons. These could coincide with the busiest period for bioenergy crop planting and harvesting so, prior to planting, consideration would need to be given as to how these demands could be managed or staggered.

More detail is provided in Appendix A of the accompanying report and examples of where farms have managed bioenergy crops as part of a wider arable, livestock or mixed farm can be found in the ETI's publication, Bioenergy crops in the UK: Case studies of successful whole farm integration[14].

13 This includes: farmer/farm manger, specialist contractor and casual labour. It excludes HGV drivers and off-farm specialist.
14 ETI (2016) Bioenergy crops in the UK: Case studies of successful whole farm integration [online].
Available at: http://www.eti.co.uk/library/bioenergy-crops-in-the-uk-case-studies-on-successful-whole-farm-integration-evidence-pack

Figure 6 - 'On-farm' labour requirements for maintaining and harvesting Miscanthus alongside Winter Wheat



CONCLUSION

Realising job creation opportunities in the bioenergy sector

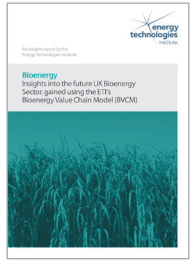
Planting bioenergy crops presents an opportunity to create new jobs and support existing jobs in the farming and forestry sectors. While ADAS' analysis has assumed a planting rate of 30 kha/yr, in reality it will take time to build up the capability to deliver this. While many of the skills required to grow second generation bioenergy crops are similar to those required for food crops, farmers and farm workers will need an understanding of the basic crop agronomy, e.g. understanding how to establish and maintain the crop.

In addition, investment is needed 'off-farm' to develop the capabilities of the specialist contractor base involved in planting, harvesting, and the production of plant breeding material as they require expensive specialist machinery. At present it is not possible to source sufficient breeding material (rhizomes, cuttings or saplings) to plant 30 kha of energy crops.

Given that the second generation energy crop sector is nascent, for companies to invest in new equipment or staff training they need a degree of confidence that their investment will be worthwhile. A long-term mechanism that recognises the value of bioenergy in meeting our climate change targets would be an important step in delivering this confidence. As the UK prepares to leave the European Union, there is an opportunity to restructure farming support in a way which encourages the sustainable growth of the UK biomass sector. This could place a value on the wider environmental benefits growing second generation energy crops can make to the farming landscape, such as improved farm-scale biodiversity and soil carbon sequestration, particularly when transitioning from arable land[15]. This would reduce the risk to farmers by providing a degree of income security. In addition, support for 'off-farm' businesses involved in the bioenergy crops sector, such as funding for apprentices or enhanced capital allowances for new machinery, could encourage investment in this sector.

15 Milner, S., Holland, R. A., Lovett, A., Sunnenberg, G., Hastings, A., Smith, P., Wang, S. and Taylor, G. (2016), Potential impacts on ecosystem services of land use transitions to second-generation bioenergy crops in GB. GCB Bioenergy, 8: 317–333. doi:10.1111/gcbb.12263

FURTHER READING



Insights into the future UK Bioenergy sector, gained using the ETI's Bioenergy Value Chain Model (BVCM)

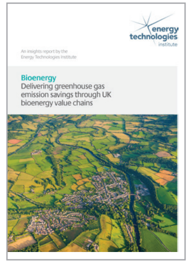
http://www.eti.co.uk/insights/bioenergy-insights-into-the-future-uk-bioenergy-sector-gained-using-the-etis-bioenergy-value-chain-model-bvcm

An ADAS report RELB: Job implications of establishing a bioenergy market

http://www.eti.co.uk/library/adas-relb-job-implications-of-establishing-a-bioenergy-market

Enabling UK Biomass

http://www.eti.co.uk/insights bioenergy-enabling-uk-biomass



Delivering greenhouse gas emission savings through UK bioenergy value chains

http://www.eti.co.uk/insights/delivering-greenhouse-gas-emission-savings-through-uk-bioenergy-value-chains

An ETI Perspective - Increasing UK biomass production through more productive use of land

http://www.eti.co.uk/library/an-eti-perspective-increasing-uk-biomass-production-through-more-productive-use-of-land

An ETI Perspective - Bioenergy crops in the UK: Case studies of successful whole farm integration

http://www.eti.co.uk/library/an-eti-perspective-bioenergy-crops-in-the-uk-case-studies-of-successful-whole-farm-integration

ETI publications can all be accessed through the ETI's reference library: http://www.eti.co.uk/library

An ETI Perspective

01509 202020
www.eti.co.uk
info@eti.co.uk
@the_ETI