Interreg North-West Europe
BIOWILL
European Regional Development Fund

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NEWS

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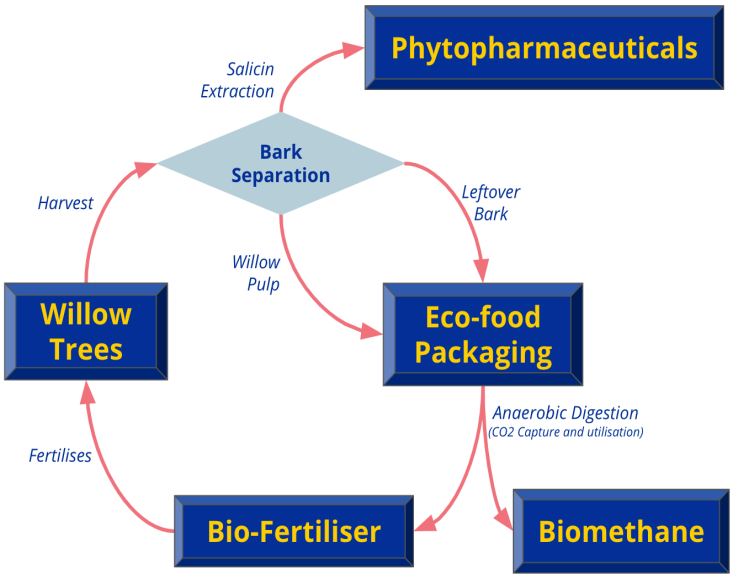
What is the BioWILL Project?

BioWILL is an Interreg NWE funded project aiming to establish a zero-waste bio-refinery by using willow-extracted salicin for bioactive phytopharmaceutical applications.

More precisely, utilising high value salicin extracted from the bark of naturally grown willow short rotation crops. In turn, the residual pulp will be transformed into more sustainable paper food packaging products and the remaining substrate/residuals will be anaerobically digested into biogas (biomethane) to be used for renewable energy, heating, and transportation. The digestate may also be used as nutrient rich fertiliser to reduce long-term CO2 emissions.



Background

There has been interest in using willow grown as Short Rotation Coppice (SRC) as a perennial energy crop since the early 1970s.

The concept was instigated in Sweden and Northern Ireland, two countries that have little indigenous fossil fuels and were badly affected by the OPEC oil crises in 1973 and 1979. At this time there was also a shortage of pulp for paper production. These twin needs led to initial research activities in these countries.

Willow harvest

Interest in commercial planting of willow increased in the 1980's with the introduction of set-a-side under the Common Agricultural Policy (CAP). Even greater impetus came in the 1990's when scientific understanding of global warming and the greenhouse effect became mainstream and led to the Earth Summit in 1992 and the Kyoto Protocol in 1997. SRC and other energy crops were seen as one of the ways that fossil fuels could be replaced by biomass sources and reduce GHG emissions.

Currently however, the uptake of these crops as a diversified agricultural option remains low due mainly to unreliable financial returns.

If commercial viability could be improved, it may be possible to further encourage the interest in these crops so all the other environmental benefits they present can be realised.

Written by Chris Johnston from AFBI (Agri-Food and Biosciences Institute)

Why is BioWILL Necessary ?

Around the world, existing biorefinery technologies utilise a linear production chain focused on food waste, forestry residue, and algae for the production of biopolymers and chemicals such as butanol and resin acids.

In contrast, BioWILL focuses on high value bioactive extractives, in this case, salicin from willow harvesting for medical applications. At the same time, the remaining bark-free pulp will be used to manufacture food packaging materials, with the waste of this process transformed into biogas and biofertilisers, thus creating a circular production system.

Currently, there is no extractive based cascade biorefinery within the EU, therefore an establishment of such a refinery presents significant economic potentials, especially one based around willow bark. Indeed, willow bark is one of the rare plant materials to contain salicin which can be as or even more effective for analgesic and anti-inflammatory properties than synthetic equivalents, with fewer undesirable side effects.

Meet the Team

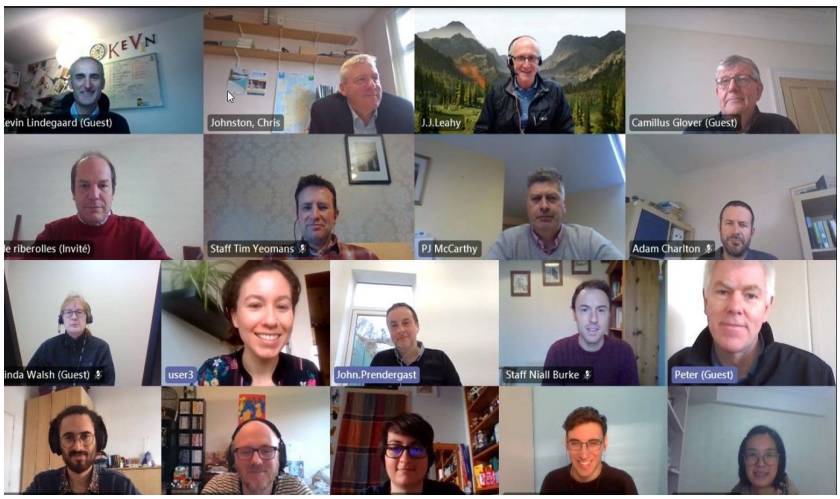
BioWILL consists of 10 project partners in four countries across Northwest Europe (Belgium, France, Ireland and the United Kingdom).

Coordinated by the University of Limerick, the consortium comprises of:

BioWILL Partners				
Type	***University***	***Research Institute***	***SME***	***Consultancy***
Partner	University of Limerick Bangor University University College Cork	Agri-Food and Biosciences Institute Institute of Technology Tralee Materia Nova	Cellulac Plc Epitheal Ltd Agriland Helicon	Crops for Energy
Type	***Industry Forum***	***Gas Company***	***Farmers and Landowners Organisation***	
Partner	The Renewable Gas Forum of Ireland	Gas Networks Ireland	European Landowners' Organization (ELO)	

November Meeting Update

Through the greatness of technology, members from Ireland, the UK, France, and Belgium were able to get together in November last year, summarise their work throughout the past year, and collectively create a plan of action for the upcoming year. The meeting was also an opportunity for new members to present themselves, become familiar with the various work packages, as well as everybody's field of work.



Work Package 1

First, Work Package 1 was presented, focusing on the willow plantation in Ireland, which had a very productive harvest with a success rate of 99.1%, due to a variety of reasons such as sufficient rainfall, adequate plantation depth, and maintenance. More information can be found below in "A Tale of Two Plantations".

After summarising the success of the Irish plantations, project leader Prof. J.J. Leahy moved on to announce that early February would mark the beginning of the salicin sampling from the harvest, by separating the salicin from the bark and the thin, narrow stems and then grinding the bark. In the long-term, the goal will be to balance the yield of biomass with the yield of salicin in the willows.

After celebrating the success of the Irish plantation, it was time to move on to the summary of the French plantation, in the Northeast of the country.

The 2 French trials proved to be unsuccessful, mainly due to hazardous climatic conditions (i.e. drought) and late plantation dates (April instead of February). On top of this, it was also suggested that a lack of adequate depth could have been a hindering factor. However, the plantation showcased that there was no major difference between wet and dry soils for salicin extraction from willows.

For the next plantations, recommendations included using a subsoiler, increasing spacing between the willows, and starting the plantation process earlier.

Other members of the team will travel to France to aid in the plantation, which is scheduled to take place in several weeks.

Work Package Communication

Here, the group discussed the current communication strategies related to the project, focusing on planning future meetings, this newsletter, as well as what can be included in project news over the coming months.

An exciting update was the talks of creating a documentary about the entire project, and several ideas were bounced around, with the idea of using a drone seeming to spark particular interest amongst the members. It was agreed that Spring 2022 would mark the most optimal time to start creating the documentary, if possible.

Finally, it was agreed upon that more photos would be taken of the plantation process and be disseminated on, based upon local regulations linked to movement restrictions in light of the COVID-19 crisis.

Other Work Packages

For the other work packages, very little was discussed as they come into action once the salicin has been harvested and worked upon by the appropriate members. At the current stage, the project is in the early stages of establishing the circular motion of salicin extraction from willows (then to sustainabileity food packaging, then biogas and/or biofertiliser).

Please stay updated on our website and throughout our social media channels for updates on project results.

Member Spotlight: Kevin Lindegaard

Member Spotlight is a new aspect of the BioWILL newsletter where in every issue we have a deep dive into one of our members, their thoughts on the project, and on the issue of sustainable willow harvesting for circular development as a whole.

In this edition, we caught up with Kevin Lindegaard, director of Crops for Energy in the UK and a willow grower for over 25 years. His expertise on willows has provided crucial insight into the BioWILL project:

Kevin, let's start at the beginning: how and how long ago did you become interested in willows?

I have been involved with willows for over 25 years. I originally started out as a casual worker at Long Ashton Research Station (LARS) back in 1993. I had a degree in Environmental Biology but wasn't sure what to do next. I sent a letter to LARS and was given a job (without an interview!) measuring willow trees. I did this for 6 months and enjoyed the field work and fell in love with the genus Salix.

I then went to the University of Wales Aberystwyth to do a two year Masters in Plant Breeding. My luck was in as just as I was graduating LARS were looking to employ a willow breeder and use the National Willow Collection to produce high yielding varieties for biomass energy production.

I landed the job and did this from 1996 - 2003. Whilst in post, I was responsible for breeding some pretty decent varieties (if I say so myself!) including Endurance, Resolution, Terra Nova, and Endeavour. LARS was closed in 2003. I had the chance to go to Rothamsted Research and continue my breeding work.

However, I was interested in a new challenge.

So what did you decide to do?

It disappointed me that the energy crops industry was still embryonic.

I wanted to get more involved in the practical side of things encouraging more growers to plant and getting involved in lobbying. I set up my own company Crops for Energy in 2004. For the first few years I combined this with other jobs involving general renewable energy. However, in 2009 I took the plunge and went full time.

Over the years my skill set has widened and now I am involved in all aspects of biomass. I have done consultancy work for farmers, waste contractors, water companies, airports, and local authorities.

Through my website I sell willow and poplar rods and cuttings, miscanthus rhizomes, and eucalyptus plug plants. I do lots of biomass sustainability work and set up a service called the Sustainable Fuel Register. I am active on Twitter and help the REA Wood Heat Forum (formerly the Wood Heat Association) with their social media messaging.

What an interesting journey you have had! And now you are involved in the BioWILL project: how does it feel to apply your knowledge on a wider scale?

BioWILL is the second European project I've been involved in. It's a thrill to find a use for all the information on willows and their medicinal benefits that I have accrued throughout my working life. My ears prick up whenever I hear about a new application for willow and I file this information hoping that it might become useful. BioWILL provides the perfect outlet for this knowledge.

The versatility and usefulness of the genus Salix is so well known that people and scientists will often investigate willow for new uses or adaptations of existing uses. Throughout my 25 year career I have come across all sorts of novel services for which willow is being trialled. Many of these exploits are based on the amazing chemical makeup of willow which, of course includes many types of salicins.

This information, which is often from a single scientific paper or anecdotal information from an individual or organisation working with willows has helped inform the choice of material in the BioWILL trials.

Could you provide some more insight into willows and the benefits they can provide?

Intriguing uses for willow include as a natural plant protecting pesticide, as ramial woodchip mulch to help protect orchards against apple scab disease, and the use of willows as fodder and a natural anthelmintic (treatment against parasitic worms) in organic sheep rearing.

Many papers indicate that certain willows have particular elevated levels of salicins. These include Salix purpurea (the purple or bitter willow) and exotic relatives such as S. miyabeana and S. koriyanagi. The latter are from East Asia (China, Korea, and Japan). Many Asian willows have much longer growing seasons than European or North American willows. It is not unusual for Asian willows to flush in February and senesce as late as December or even January!

I have always been intrigued by these willows and used them a great deal in crosses back when I was a willow breeder at LARS in the late 1990s. There are a couple of varieties that I bred that have frequently been found to have intriguing adaptations and uses and both have some East Asian heritage.

Are there any specific species that you can think of?

The variety Endurance (Salix dasyclados x S. redheriana) has frequently yielded highly in UK and Irish trials particularly in the wetter west. This variety was recently found to contain a novel compound called miyabeacin which can be used as a treatment for brain cancer in children (Ward et al 2020 - Miyabeacin: A new cyclodimer presents a potential role for willow in cancer therapy).

Another variety called Terra Nova (Salix viminalis x triandra x miyabeana) is not a particularly high yielding variety but seems to be incredibly resilient, growing reasonably well in altitude trials in Wales, in drier countries such as Portugal and Greece and on landfill sites and other sites contaminated with heavy metals. Both of these varieties are also less prone to predation by rabbits and deer which is also a good sign of high levels of salicins.

What are the next steps of the BioWILL project?

We're really looking forward to harvesting the willows from the UK, Irish and French trials in due course and seeing which out of the 30+ types included in the trial have novel salicins that can be used for their anti-inflammatory properties. I will be helping the scientists interpret the results based on my knowledge of willow taxonomy.

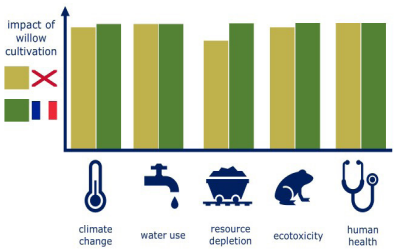
So please read future newsletters to follow our progress!

Thank you very much for your time Kevin!

Life Cycle Analysis Input

In BioWILL, Life Cycle Assessment (LCA) tools are used to evaluate and optimise the environmental footprint of the products and processes that are developed.

The whole life cycle of willow-based products will be inventoried for environmental impacts calculation along the project. In a first step, thanks to data collected from partners growing willows in France (Agriland) and Northern Ireland (AFBI), the LCA experts of Materia Nova have started to model willow cultivation in both regions.



Text written and LCA undertaken by Olivier Talon and Laura Yonge at Materia Nova

Preliminary results of this work in progress are shown in the illustration below. Models for further life cycle steps will follow, starting in the next few months with the extraction of salicin from the harvested willows.

A Tale of Two Plantations

On November 24th, project partners met virtually to discuss updates on the two willow plantations, the first in Ireland and the second in Northern France.

After managing both plantations and their yields over the course of the summer and the autumn, a clear picture could be made of the plantation outcomes and lessons learned for future plantation and salicin extraction.

Against All Odds

Spring 2020 was one of the driest springs in recorded history in Ireland, with very little to no rainfall throughout the entire season, rain being essential for growing crops.

The rule of thumb in the region is to plant after March, yet this willow plantation took place in June.

It is not recommended to plant crops during such a dry season. Yet the plantation team still had their hopes and decided to plant their willow seeds in the ground, which in a dry soil was very difficult to do so.

Planting sites - Geographical locations of the trial sites at AFBI Loughgall (UK) and at Claremorris Republic of Ireland (University of Limerick)

The day after the seeds were planted, it rained 3 times a week for the foreseeable future.

Having timed it just right, and after several months of letting the seeds germinate, the plantation showcased very promising results, with a success rate of 99.1%!

An interesting story to tell is how, due to the different jurisdictions and COVID-19 restrictions between the Republic of Ireland and Northern Ireland, members of the former were not allowed to venture more than several kilometers from their location due to their restrictions, hence could not work on the plantation. However, workers from Northern Ireland were allowed to do so due to different COVID-19 restrictions in the UK, allowing them to do the essential work on the plantation and assist in achieving such positive results.

Currently, the willow plants are being extracted and working on them will begin shortly for the next stage of the salicin extraction process.

Planting sites - Geographical locations of the trial sites at Agriland Noreuil and Gouy-Sous-Bellonne

A Series of Unfortunate Events

In contrast, the situation in Northern France was not as fortunate.

Just like in Ireland, France also experienced one of its worst droughts in recorded history, with the vast majority of spring plantations in 2020 resulting in very little to no agricultural yields due to a significant lack of water.

Usually, the Northeast of France, where the plantations are, experience roughly 70 mm of rainfall per month during the spring. This allows the crops to grow and, usually, have a relatively productive harvest. In 2020, the region experienced approximately 12 mm of rainfall per month. Approximately 6x less than usual. On top of this, just like in Ireland, the planting of the willows took place in April, whereas they usually take place in February.

This late plantation, on top of the climatic stress of very little rainfall led to an unsuccessful willow harvest for the French plantations.

A Look to the Future

Learning from the events of both plantations, the success of the Irish trials allow the team to go forward in the salicin experience whilst the French plantations are scheduled to plant earlier in 2021 (planting in February/March instead of April), with assistance from the Irish plantation team.

In France, the willows will also be planted deeper into the soil and further apart from each other, in contrast to the 2020 plantations, in hopes to mitigate against previous results. The crops are scheduled to be planted approximately 50 to 60 cm into the soil to maximise water and nutrient retention as well as ensure a good clean seed bed, using a subsoiler.

Stay tuned on the project social media, website, and future newsletters for upcoming project results!

Insight from the Agri-Food Biosciences Institute (AFBI)

EU-BioWILL is seeking to explore the salicin content of fast growing willows bred specifically for bioenergy. To date, a report has been compiled which explains the methodology for selecting material that was incorporated in the trials located in Northern Ireland, Ireland, and France.

This AFBI led Work Package, in conjunction with their sub-partner Crops for Energy, has developed and identified from scientific data bases the willow varieties with high salicin content in the bark. This progressed to an assessment of willow varieties & genotypes that exist between collections at AFBI and National UK Collection at Rothamsted as well as contacting other plantations for progeny from new breeding and genetic techniques. This activity has led to and completes the following deliverables:

A) A report on highest yielding salicin willow varieties for Northwest Europe – Optimum (30+ Clones / Varieties for growth trials) varieties/genotypes of willow determined).
B) Report on new breeding programs targeting salicin - Highlighting breeding programs that are selecting for new genotypes which will provide higher salicin yield in future

Furthermore, this report also includes the compilation of activities which include the undertaking and setting up of field trials. This required the collection of planting materials (Fig 1.) of selected willow varieties and planting on sites in Ireland, UK and France (Fig 2).

Fig 1. Willow cuttings taken from willow propagation field sites

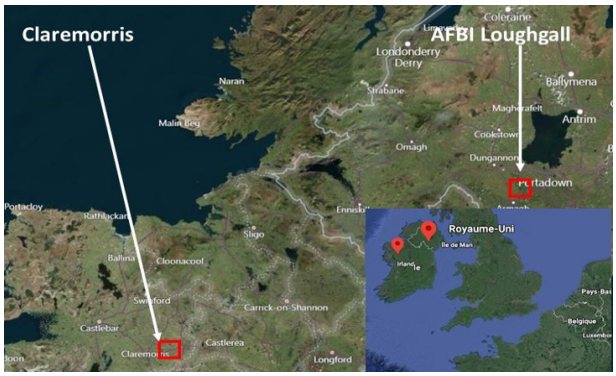


Fig 2a. Planting sites - Geographical locations of the trial sites at AFBI Loughgall, Co Armagh (UK) and at Claremorris Co Mayo, Republic of Ireland (University of Limerick)

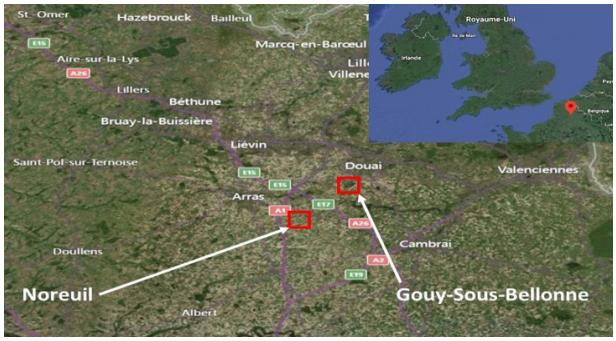


Fig 2b. Planting sites - Geographical locations of the trial sites at Agril- and Noreuil and Gouy-Sous-Bellonne

Identical plantations have been set-up in order to examine effects of different climates and soils. These plantations will be used to assess rotation length and harvest time.

It is hoped that Partner meetings can be held in the vicinity of these planting sites in the coming quarters, COVID-19 allowing. This activity has led to and completes as far as possible (COVID-19 restrictions) the following deliverables:

A) Report on planting of willow varieties. Small scale plantation trials will be set up by AFBI, Crops for Energy, and Agri-land and the varieties planted, planting density, soil types will be recorded.
B) Report on visits to each other sites 1. All partners including associated partners will visit the sites to determine survival rates and observe response of different varieties to soil type, climate and local environment –only performed by local partners due to COVID-19 restrictions however survival rates and responses assessed and recorded (Fig 3.)

Going forward, it is very much hoped that we can hold a number of open days for potential willow growers and other interested stakeholders, organised at these to showcase the crop and highlight potential for cultivation in conjunction with a number of the other partners to illustrate the BioWILL downstream processing intentions.

Fig 3b. Planting and establishment phases at AFBI Loughgall, Co Armagh (UK) - Site with grass 'burned off' May 2020

Fig 3a. Planting and establishment phases at AFBI Loughgall, Co Armagh (UK) - Site prepared for the 3 replicated blocks of the planting trials at AFBI Loughgall, Co Armagh.

Fig 3c. Planting and establishment phases at AFBI Loughgall, Co Armagh (UK) - Early establishment mid-June 2020

Fig 3d. Planting and establishment phases at AFBI Loughgall, Co Armagh (UK) - End November 2020 Block 1

Fig 3e. Planting and establishment phases at AFBI Loughgall, Co Armagh (UK) - Notice at site