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SCION
Next generation biomaterials

NEWSLETTER
Biomaterial Futures

Oil wells of the future

BIOMASS COULD SUPPLY FUTURE FUEL NEEDS

In 2007 the Prime Minister made a speech to Parliament that outlined a vision for New Zealand to become carbon neutral in its economy and way of life. Two studies recently completed by Scion show the role that sustainably managed forests can play in realising this ambitious goal.

Scion Chief Executive Dr Tom Richardson says that by utilising planted forests as energy crops, New Zealand could ultimately meet its heat and transport fuel needs without relying on fossil fuels.

"It is possible for New Zealand to be self-sufficient in terms of heat energy and liquid fuels by using sustainably managed forests planted on marginal land. Along with the energy will come ancillary benefits of forests on the landscape including flood mitigation, improved water quality, erosion control and carbon sequestration," Tom explains.

This important finding arises from a study undertaken by Scion as part of the EnergyScape programme, a collaboration between Scion, NIWA, CRL, Industrial Research Limited and GNS. This major research programme is aimed at finding ways for the New Zealand Government to meet its targets of sustainable, carbon neutral energy by 2050.

The study shows that even with existing technologies, if New Zealand were to harvest around 125,000 ha of purpose-grown forests per annum, the resulting biomass could be used to meet all of New Zealand's projected needs for transport fuels and heat.

These results come at the same time as another feasibility study published by the New Zealand Lignocellulosic Bioethanol Initiative that found bioethanol, a 1st generation biofuel produced from wood and wood residues, is currently New Zealand's best option for transport fuels.

Tom says the two studies highlight the important role that forestry and biomass can play in helping New Zealand meet the Government's targets of sustainable, carbon neutral energy. This newsletter provides an overview of the concepts provided in the recent reports.

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Inside this issue

Scion has mapped out a viable plan of action that would enable the country to meet Government targets of sustainable, carbon neutral energy by 2050

Find out about it on Page 2.

A VISION FOR SUSTAINABLE ENERGY

"Biofuels can replace diesel or petrol, and reduce our greenhouse gas emissions. With domestic production they can also be positive for the current account."

- Helen Clark, February 2007

Scion has mapped out a viable plan of action that would enable the country to meet Government targets of sustainable, carbon neutral energy by 2050. Author of the plan, Peter Hall, says this study highlights the important role biomass can potentially play in New Zealand's future energy supply.

"Biomass is available from a range of sources including forestry, agriculture, horticulture and municipal wastes. All of these resources can be used to produce energy in different ways.

"Biomass can be used to produce a diverse range of energy products including heat, power and liquid biofuels, and energy carriers like gas, chars, and chemicals. It has advantages over other sources of fuels or energy forms because it is renewable, easily produced in New Zealand and carbon-neutral when based on sustainable crops, forests or residues."

In other parts of the world, grain and sugar crops are increasingly used to produce bioethanol. This practice can create conflict between food and energy production where arable or high quality pastoral land is at a premium.

"Purpose-grown forestry crops on marginal lands offer the most practical means of producing a large enough volume of biomass to meet New Zealand's transport fuel and heat energy needs on a national scale, without compromising food production."

Peter says the key is to utilise large areas of marginal land, often erodable hillcountry, that are available in this country, thereby making best use of available resources.

"Estimates show that around 8.7 million hectares of medium and low quality grazing land are available in New Zealand. Purpose-grown energy forests could be established using at most 37% of this area, amounting to around 3.5 million hectares of new forest.

"These forests have the potential to meet the New Zealand Government's goal to be one of the world's first carbon-neutral economies. It would be difficult for New Zealand to produce enough biomass by any other means to service the future energy demand," Peter explains.

To view a copy of the report, "Bioenergy Options for New Zealand" see www.scionresearch.com

Establishing energy forests in New Zealand

The recently released Bioenergy Options report estimates that a forest resource capable of supplying New Zealand's energy demands will take around 25 years to establish. This can be achieved by planting forests of various species at a planting rate of around 100,000 ha/year.

An initial regime could be 30,000 hectares of short rotation coppice (e.g. willows or poplars) on the 'low-slope' land, 20,000 hectares of medium rotation crop on steeper land and 70,000 hectares of radiata on steep hill country land.

"New Zealand is currently facing a Kyoto liability of several hundred million dollars. In addition to providing a renewable energy option, planting forests would protect against this and other potential liabilities," says Scion CEO, Tom Richardson.

The Ministry for the Environment's recent Environment New Zealand 2007 report highlights how high-country hill erosion continues to cost the country an estimated $100-150 million a year, but in those areas where the land had been converted to either exotic forestry or reverted to scrub, the erosion has eased.

"A bioenergy approach based on sustainable forestry crops would enable sustainable economic growth while providing other wood-based products and a range of environmental benefits, such as greenhouse gas reduction, erosion control and improved water quality.

"To put it simply, these biofuel opportunities will enable New Zealand to meet our sustainability goals and our energy targets," Tom says.

CARBON TRADING – CREATING A NEW ECONOMY

As the Government and forestry companies move to develop carbon-trading systems, questions are being raised about how a carbon economy will work. A new project funded by the Ministry of Agriculture and Forestry will enable Scion to fill in the blanks.

Scion economist, Dr James Turner says that current forestry management practices are focused on maximising profits from timber and fibre sales through the control of variables such as rotation length, silvicultural regimes and species choice.

"With the introduction of an official carbon market in New Zealand, an incentive has been created for forest owners to effectively manage their plantation estates for carbon production as well, not just wood products.

"This means that forest managers are faced with new opportunities and challenges when including carbon in the products they produce from their forests."

Managing a forest for maximum carbon stocks is similar to managing it for growing timber. However, decision making is complicated by tradeoffs between carbon and timber management and the current uncertainty of carbon prices.

James says that while the basic principles of carbon trading are reasonably straightforward, the legislative and forest management implications are far from it. A new MAF-funded research programme is aimed at clarifying how New Zealand forest management practices can be modified to balance wood production and carbon sequestration.

"Many of the questions surrounding the impact of carbon trading on forest management can only be answered through quantitative economic analysis. Economic analysis will allow the sensitivities around such factors as carbon and timber prices to be explored.

"Our aim is to identify and address knowledge gaps so forest managers can have the information they need when making decisions that affect non-timber values."

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The New Zealand Government has established a Biofuels Sales Obligation (BSO) of 3.4% transport biofuels by 2012. Currently, more than 50% of New Zealand's energy use is fossil fuel based, with the country consuming more than 3 billion litres of petrol annually. An ethanol facility located in the Central North Island producing 90 million litres of ethanol per annum from forests and biomass, could fulfil the petrol component of the Government's BSO by supplying E10 to the North Island.

TURNING WOOD INTO LIQUID FUELS

As the costs and consequences of using oil increase, the spotlight is on technologies to produce renewable liquid fuels. While ethanol made from corn or sugar cane is already used as a transport fuel in many parts of the world, the clear next step is to move towards using non-food resources, such as trees and grasses.

A feasibility study completed by Scion, AgResearch, Carter Holt Harvey and US-based Verenium, reviewed the infrastructure, technology and economics of a transportation biofuel industry in New Zealand. This study showed no major technical or input barriers to producing large volumes of ethanol from New Zealand-grown wood and plant waste.

Scion CEO, Dr Tom Richardson says that science and technology development around biofuel development is truly global and many contributors are required to solve the challenges faced by New Zealand. He sees the rapid progress now being made to bring cellulosic biofuels (or 2nd generation biofuels) towards commercial reality as exciting.

"Technologies driven by massive investment for row crop application overseas will be rapidly transferable to forest trees. This is particularly true for plant and industrial biotechnologies and frameworks for end-to-end sustainability certification of bio-based products, including biofuels.

"This will also be true for other conversion technologies like gasification and pyrolysis and other biofuels, such as biobutanol. These technologies will enable the conversion of forest tree biomass to biofuels in ways analogous to other cellulosic feedstocks."

Medium to long rotation forests differ from most other feedstock options in that they create an energy store that can be harvested as required, or alternatively processed into other valuable products.

"Compared to most other feedstocks, these forests are very attractive with regard to net energy efficiency, GHG mitigation, end-to-end life cycle analysis, biodiversity retention, and the provision of other environmental and social benefits. We need to find better ways of quantifying these benefits and then rewarding them in our policy settings," Tom concludes.

ENSURING THE SUSTAINABILITY OF A BIO-ECONOMY

As New Zealand looks to develop a stronger bio-economy, there is increasing pressure to ensure our natural resources are not depleted over time. If large areas of forest are grown specifically for energy production, how long can this type of production be sustained?

Scion has established trials across New Zealand to identify key indicators of forest productivity for New Zealand. These indicators are now available to forest managers, enabling the sustainability of planted forests to be quantified and monitored for the first time. By regularly measuring these indicators on any given site, it will be possible to see whether the productive capacity is being maintained by management options, or is declining.

Senior soil scientist Dr Peter Clinton says the key soil indicators of productivity for radiata pine are: soil carbon to nitrogen ratio (CN ratio); total soil nitrogen and total soil phosphorous and; depth of top soil. The key soil physical property is porosity. The key environmental variables are air temperature and root zone water storage.

"Measuring and recording data on these indicators is likely to become a standard practice for forestry companies whether they are growing for timber, fibre, or any other purpose," Peter explains.

"This information will allow forest managers to develop site-specific silvicultural regimes that ensure the productivity of the soil is not depleted. Our research shows that there's no reason why you can't continually grow trees on appropriate sites, as long as important soil functions are properly managed."

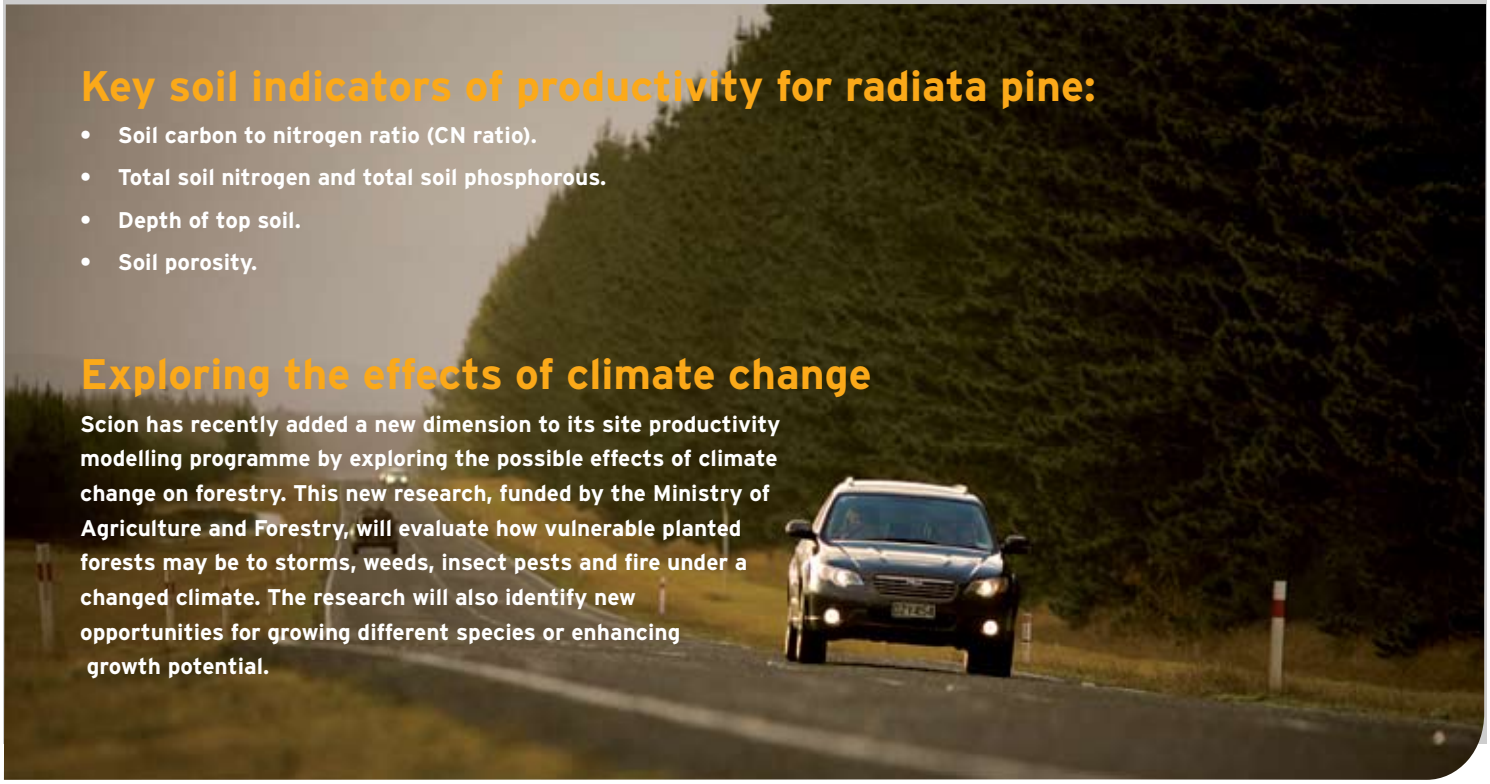
Unlike arable crops or intensive agricultural grazing, forests do not require high applications of fertiliser. Nutrients are generally applied only once for each crop of trees, and only to overcome inherent site nutrient deficiencies such as nitrogen, phosphorous, and boron.

The need for productivity indicators arose from New Zealand's commitment to developing sustainable forest management practices. This commitment is realised through Government involvement in international forestry agreements such as the Montreal Process, and the forestry sector's adoption of forest certification mechanisms.

Peter says the more intensively a forest resource is managed, the more important these indicators will become.

"For example, if short-rotation forests are grown for energy, we can monitor the productivity indicators over time. If changes are found to be occurring in the soil, then management regimes can be changed to maintain the productive capacity of the site."

Scion will be running workshops starting in June 2008 to provide forest managers with information about how to monitor and apply these indicators. If you are interested in attending a workshop, contact Peter Clinton at peter.clinton@scionresearch.com



Key soil indicators of productivity for radiata pine:

- **Soil carbon to nitrogen ratio (CN ratio).**
- **Total soil nitrogen and total soil phosphorous.**
- **Depth of top soil.**
- **Soil porosity.**

Exploring the effects of climate change

Scion has recently added a new dimension to its site productivity modelling programme by exploring the possible effects of climate change on forestry. This new research, funded by the Ministry of Agriculture and Forestry, will evaluate how vulnerable planted forests may be to storms, weeds, insect pests and fire under a changed climate. The research will also identify new opportunities for growing different species or enhancing growth potential.

MEASURING FOOTPRINTS ON THE ENVIRONMENT

As people look for solutions to growing environmental problems, it is becoming important to know how much energy, water or chemical has gone into manufacturing a product and what greenhouse gas or other emissions have been released in the process. This information can be gained using Life Cycle Assessment (LCA), a method that is now being used to calculate the environmental impact of different building materials in New Zealand.

Scion is undertaking a research project, funded by the Ministry of Agriculture and Forestry, to develop datasets for New Zealand building materials using LCA studies of timber and other types of construction.

Project leader, Dr Barbara Nebel, says the results of this project, in combination with greenhouse gas footprinting research for the forestry sector, will lay the basis for fair comparisons of different building materials, such as timber, steel, concrete, and plasterboard.

This information will be valuable for a range of purposes, including research, policy analysis and building code development. The research will also identify LCA "hotspots", which are key processes that cause the highest impacts on the environment.

In future, limits pertaining to carbon dioxide emissions and embodied energy could potentially be included in the New Zealand Building Code, creating the need for reliable and scientifically-robust data that is specific to our environment.

Barbara says the current focus of the project is on improving, updating and extending existing New Zealand information with overseas data.

"International databases for Life Cycle Assessment studies already exist and these provide comprehensive information on all greenhouse gas emissions, detailed energy information and information on other environmental impacts, such as ozone depletion. However, these international databases do not take into account the New Zealand specific context, such as the electricity mix."

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