Te Maramatanga o Te Tipuranga

Te maramatanga o Te Tipuranga

Literally translated means 'understanding' (Maramatanga) of 'growth' (Tipuranga). The concept applies to the trees themselves, as well as the learning for both Maori and for Forest Research scientists.

Dedicated to the memory of Eria Moke
(Ngati Taeotu, Ngati Hurungaterangi, Ngati Kahuupoko),
in appreciation for strengthening the relationship between
Forest Research and Tangata Whenua.

"He mana ano to tena to tena"
"Each man is unique and integrity is an action."

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The purpose of this document is to convey the results of Forest Research's first year of field trials of genetically engineered trees. This information was put together on behalf of the mandated representatives of the Tangata Whenua and we invite your feedback.

Mihi

E nga mana! E nga reo! Tena koutou!
He mihi poto tenei mai nga kairangahau o tenei pukapuka kia koutou i runga i te ngakau aroha.
Ko te tumanako ma tenei pukapuka hei whakapakari ai i nga hapu i nga iwi hoki i te mahi o Forest Research e pa ana ki te whakatipu rakau rereke mai tawahi.
Kaore e kore he take tenei i te tupato no reira koina te take e ahua ata haere te tipu ranga. He tupato i te ao pütaiao. He tupato hou hoki i te ao Maori.
Noreira, panuitia nga tipuranga o enei rakau i te tau kua pahure ake nei.
Kati ake – ma te rangahau tätou e whakamarama.

Tena koutou katoa!

Foreword

We recognise that Forest Research's field trial of GM trees is likely to be of interest to the local Tangata Whenua since it is planted within the rohe (area) of the three hapu. The main focus of this panui (booklet) is to inform hapu and iwi of Forest Research's mahi (work) on the results of the field trial of genetically modified Pine and Spruce trees. Never before has such an issue been so actively debated and some have concerns about using plant gene technologies. For these reasons, we are proceeding with caution and the results are being evaluated by Forest Research scientists as well as monitored by the mandated representatives from local Tangata Whenua (Ngati Hurangaterangi, Ngati Te Kahu me Ngati Taeotu o Whakaue)

SUMMARY

This field trial is designed to answer questions about the interaction between genetically modified (GM) trees and the environment. It allows scientists to study potential risks and to understand how genes are expressed in the living trees. The trial is part of a long-term kaupapa (plan) aimed at improving the value of Tane (trees) to forest growers.

The local Tangata Whenua have been involved in the field trial from the beginning. This field trial idea was presented to the Maori community as early as 1999 through Hui, which were set up by Kaumatua Ben Hona (Ngati Taeotu, Ngati Hurungaterangi and Ngati Te Kahu). These Hui provided an opportunity to discuss and evaluate concerns surrounding plant gene technology, such as genetic modification or Genetic Engineering (GE), as it is also known.

With permission of the Environmental Risk Management Authority (ERMA), and blessing from Eria Moke (following endorsement from Ngati Taeotu, Ngati Hurungaterangi and Ngati Te Kahu), Forest Research planted Radiata pine and Norway spruce trees, which have been genetically modified with genes known as “reporter genes”. These introduced genes produce special signals that allow their behaviour to be traced by scientists as the trees grow.

Naturally, biotechnologies are associated with risk and Forest Research has developed contingency plans to deal with emergencies related to the field trial. This is designed to avoid any biological threat, particularly with regard to concerns about environmental impact. The field trial is also monitored quarterly by a consultation process between key members of the Cellwall Biotechnology team at Forest Research and mandated Tangata Whenua representative, Penengaru Moke.

We have started to collect some scientific data and so far we can say that:

- The Genetically engineered trees have adapted well to the field conditions and are growing just like the non-GM trees planted in the trial.
- The reporter genes are behaving as expected and can be measured through specific tests. Just like “normal” genes their expression fluctuates with seasonal variation. This is shown by an increase in protein production from the GM genes during summer and a decrease as the seasons get colder.
- Research is still being conducted on the possibility of any gene transfer from the GM trees into bacteria in the soil. AgResearch is conducting this research and results to date, show that the inserted gene is not transferred - i.e. no evidence of Horizontal Gene Transfer (HGT).

All the information and results about the field trial will be published and made available to the public. Anyone interested in the field trial or any issues surrounding it can contact Forest Research directly. Contact details are at the back of the booklet.

What are reporter genes?

Reporter genes (*npt*II and *uid*A) have been transferred into trees, and produce unique proteins that are found only in the field trial GM trees. These proteins are measured, and the amounts of protein produced allow researchers to monitor behaviour of genetically modified trees in the environment.

No human genes or genes from native plants or animals have, or will be used in this study.

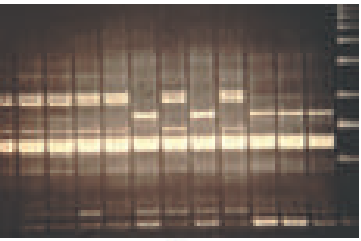
Genetic Engineering

To understand genetic engineering (also called genetic modification), it is essential to understand DNA (Deoxyribonucleic acid), and how genes work.

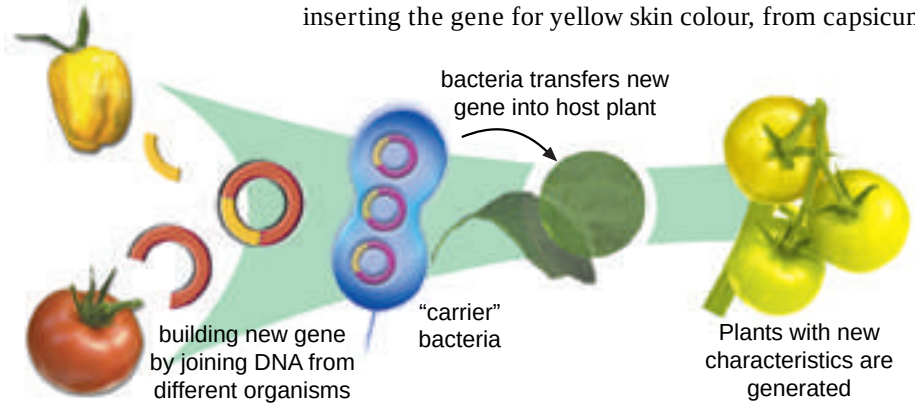
Just as a building might be made up of individual bricks, living organisms are made up of individual cells. The information that is required to make each of these cells is stored in a molecule called DNA.

The information stored in DNA determines the way in which a cell, or indeed the whole organism behaves and what it looks like. The DNA in a cell is made up of specific pieces of information and these are called genes. Each gene contributes to specific characteristics of an organism, for example the way in which an organism behaves, or if it is small or large, hairy or bald.

Thus DNA can be likened to “words on a page,” while genes give the DNA meaning, like “whole sentences”. The letters of the alphabet that make up “sentences” can be read by all organisms so, in other words the code in DNA is universal. Genes are put together in a specific way to make a unique product.



Genetic engineering is simply adding or altering one or more genes (just like adding or removing sentences on a page and this changes the message that is read). Genetic engineering is most commonly used to add a gene to an organism in order to give it a new characteristic (such as producing yellow tomatoes by inserting the gene for yellow skin colour, from capsicum).



Important points to know:

- DNA is a molecule that contains a certain meaning, like words on a page.
- Genes are specific pieces of DNA that convey a message (like sentences on a page). They are also responsible for the way an organism behaves and how it looks. Every gene also has a specific role, for example determining eye colour.
- The genetic makeup of an organism, the so-called "genome", is the entire complement of genes it has (i.e. an entire book).
- Genetic engineering is the adding or changing of genes in an organism. This gives the organism a new or altered characteristic.
- Although the explanations here have been simplified, GE is seen as an important and potentially powerful technology to manipulate plants and other organisms.

Potential Benefits of Genetic Engineering to Maori

Senior scientists of Forest Research, and in particular those in the Cellwall Biotechnology Centre, believe that there may be several benefits of genetic engineering to the Maori community. One of these scientists, Phillip Wilcox (Rongomaiwahine me Ngati Kahungunu) says "Maori ownership of New Zealand's plantation forests are forecast to increase to as much as 36% of the total resource. As key stakeholders in commercial forests, iwi/hapu are well placed to directly benefit from modern biotechnologies". Such benefits could include economic and environmental gains, social and cultural benefits.

Economic benefits due to trees having superior qualities:

Genetically improved trees will enhance the position of New Zealand forests on the international market, and will maintain the competitive advantage currently held in plantation forestry via:

- Faster growth
- Superior wood properties
- Improved pest and disease resistance
- Herbicide resistance (the cost to establish trees would be reduced).

Social and Cultural Benefits:

- An opportunity for Maori to become part of the technology revolution in plantation forestry and be part of the driving force implementing and controlling new technologies, rather than leaving control to others, i.e. enhancing rangatiratanga autonomy of specific iwi and/or hapu.
- An opportunity to learn and become fully informed and familiar with modern forest biotechnologies.
- An opportunity to drive science and the application of modern forest biotechnology into a direction that is in agreement with Maori customs and belief.
- An opportunity for young Maori scientists to participate in science and technology, creating a pathway between te ao Maori and science.

Environmental Benefits:

- The development of processes that are environmentally more acceptable than current practice. For example, reducing the amount of chemicals used to remove lignin (a glue-like substance that binds wood fibres together) for pulp and paper production, ultimately reducing the pollution of the environment.

Some Challenges and Issues

- We recognise that forms of genetic engineering may not be consistent with Tikanga.
- Genetic engineering is expensive at the research stage.
- Not all risks have been fully assessed, and while the technology is widely used in agricultural crops overseas, there are few commercially planted forests with genetically engineered trees.
- The wero (challenge) is to involve Maori in the decision-making process and together decide when GE is acceptable.
- We need to make sure that Maori can participate in and gain substantial benefits from biotechnology research.

Specific Benefits of this Field Trial for Tangata Whenua

- Flow of information between Forest Research scientists and hapu representatives, Tangata Whenua and the whole community.
- Providing access to ideas and technological advances as well as specific advice in key areas of forestry.
- Increased strategic importance of the Tangata Whenua to Forest Research, as part of a developing relationship between these groups, providing a pathway for an ongoing relationship between FR and Tangata Whenua, and other hapu/iwi as well.

The government funds Forest Research to conduct scientific experiments to answer concerns, quantify risks and communicate issues to the public. They recognise that many of the concerns about genetic engineering relate to the impact on the environment. These risks include cross-fertilization, the threat of a genetically modified super-plant or super-weed establishing itself and the (theoritical) risks of horizontal gene transfer.

Although the probability of harmful effects occurring in the trial is small, the effect of genetic engineering on the environment must be studied. This is so the potential risks of genetic engineering can be quantified. The most frequently identified risks for any genetically engineered field trial are:

1. Will Genetically Modified (GM) trees cross breed with other trees outside the field trial?

   The problem of cross-fertilization by pollen between plants and non-GM trees is one of the major concerns of releasing GM plants into the environment. In this trial, the development of pollen will be prevented. Trees are monitored weekly for development of structures bearing pollen and these will be removed long before pollen can mature.

2. Will GM plants lead to “super-weeds” and be impossible to control?

   There is some evidence that GM plants will not survive or be as strong as “normal” plants. Recent results from a study in the UK evaluated the survival

of GM plants adjacent to the non-GM crops. They found after a 10-year period that the GM crops died out prior to the non-GM crops and all but the non-GM plants were overgrown within four years. Included in this trial, Forest Research has non–GM Radiata pine and Norway spruce trees, which will be used to compare the performance of all trees planted. We are of course hopeful in this case, that the wood properties of these GM trees will be at least as good as the non-GM trees. It is unlikely that any of these genes would create a 'super–tree', as these studies are not designed for that purpose, nor are the genes used likely to be able to create such a tree.

3. What about the persistence of the genetically modified genes in the environment?

Every living cell of every living organism contains genes, and the natural environment has ways of breaking down and recycling these compounds. There is no scientific evidence to indicate that inserted genes (such as those introduced by GE) would behave any differently to any other DNA in the cell. Another concern is the spread of an engineered gene into the natural environment, for example into the bacteria that live in the soil. To date, studies suggest that if genes were to spread, it would be extremely infrequent and only parts of the inserted gene would be transferred (not enough to cause the new characteristic to be transferred). The transfer of GM genes to other species is being studied in detail in New Zealand as well as overseas. For this reason the reporter genes used in this field trial were obtained from bacteria living in the natural environment. This means that they are already present naturally and an accidental transfer from the field test would not add any new genes to the environment.

The Field Trial

With permission of the Environmental Risk Management Authority (ERMA), and blessing from the late Eria Moke (following endorsement from Ngati Taeotu, Ngati Hurungaterangi and Ngati Te Kahu), Forest Research has planted genetically modified Radiata pine and Norway spruce on a site located within the rohe of the three hapu. Field trials are an intermediate stage between the production of a Genetically Modified Organism (GMO) in the laboratory and commercial forest plantation. Therefore they provide an opportunity to undertake a full environmental risk assessment of the genetically engineered trees, while they are in a contained environment, but one that is similar to a natural forestry setting. This contained field trial is designed to study the effects of genetically engineered Radiata pine and Norway spruce on the environment. Since this field trial will exist for 9-20 years, it is important to measure and understand all of the risks of the field trial, over a long period of time.

The approved organisms within the trial are Radiata pine and Norway spruce, which have mainly been genetically engineered with reporter genes, however some trees also contain genes for herbicide resistance and genes involved in reproductive development. No human genes have, or will be used in this study.

Reporter genes produce proteins which scientists at Forest Research are able to measure. Monitoring the amount of protein produced by these genes (over a long period of time), and comparing it to data from control plants that have not been genetically modified, allows Forest Research to measure the behaviour of the GM trees, compared to “normal trees”. The names of the reporter genes that have been inserted into the trees are *npt*II and *uid*A. They were derived from the natural environment where they are present in bacteria living in New Zealand soils. This is an important safety mechanism, which makes sure that no new DNA sequences are released into New Zealand’s environment.

Forest Research also has approval from ERMA to plant GE trees containing herbicide resistant genes and genes that may affect reproductive development.

This work has not yet started, but Forest Research plans to do so in the future. Currently the main focus is on the environmental risk assessment of GM trees using reporter genes.

History of the Field Trial

1995

Forest Research consulted with Maori on its genetic engineering (molecular biology) research. The Korero included discussions with the late Mr Te Kuru o Te Marama Waaka and Mr Rangipuawhe Maika, where they recommended to Te Arawa and Mataatua Forestry Accord that the field trial go ahead.

1997

Genetically engineered lines of Radiata pine and Norway spruce trees were developed. These lines contained the reporter genes *npt*II and *uid*A.

The early consultation and engagement with Maori in 1995 resulted in a letter from Te Arawa and Mataatua Forestry Accord, indicating their consent to the intended field trial.

1998

Between the end of 1997 and the beginning of 1998 GM Radiata pine and Norway spruce trees were placed in the Forest Research Containment Glasshouse.

September 1998: Forest Research established the Forest Research/Maori Consultative Group. Various hui were held to discuss the proposed field tests. The group was made up of six representatives from the local iwi.

1999

Forest Research consulted with Te Arawa Maori Trust Board prior to the field trial application being lodged.

18th June 1999: The application for the field trial was lodged

2000

Hui were held to present proposals to the Tangata Whenua and to evaluate concerns that were specific to Maori.

- 17th September Hui: Hurungaterangi Marae.
- 28th October Hui: Apumoana Marae.

1-3rd November 2000, a hearing was held in Rotorua to inform and consult with the public of Rotorua and New Zealand.

20th December 2000, ERMA approved the planting of the field trial.

History of the Field Trial

2001

The genetically modified Radiata pine trees were relocated to Tree and Technology's containment Facility in Te Teko.

2002

9th December 2002: Forest Research set up Te Aroturuki, a consultative group that was designed to ensure that areas of concern to Maori surrounding plant gene technologies are recognised, discussed and addressed.

Mid December 2002: Eria Moke blessed the field trial.

2003

7th January 2003: Norway spruce preliminary tests to measure the amount of the reporter proteins were performed in the containment glasshouse.

22nd January 2003: Radiata pine trees were transported to the field trial.

17th March 2003: Reporter protein levels were measured in selected Radiata pine trees at the field trial site.

19th-20th June 2003: Radiata pine trees were planted at the field trial site.

5th July 2003: Norway spruce trees were transported to the field trial site.

25th July 2003: Norway spruce trees were planted.

2004

Continuation of research to understand gene expression and potential risks to the environment. Monitoring of plants to remove developing pollen and ongoing monitoring with Tangata Whenua until the end of the field trial.

2020

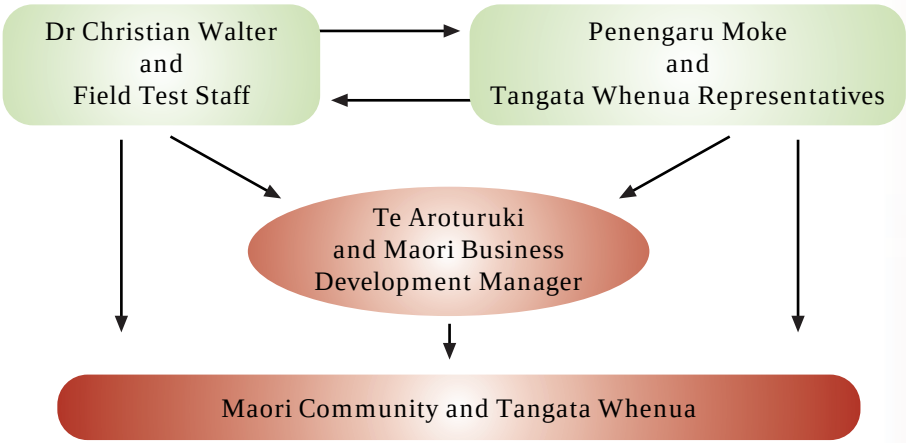
Field trial ends and plants will be removed and disposed of by incineration.

Tangata Whenua Involvement

Monitoring of the Field Trial

Consultation with Maori was seen as an essential part of the process and Forest Research made a commitment to engage with the local Tangata Whenua. For this reason we involved the Tangata Whenua in the field trial right from the beginning. The field trial idea was presented to the community as early as 1999 through Hui, which were set up by Ben Hona. There were two Hui held, the first on the 17th of September 2000, at Hurungaterangi Marae, and the second on the 28th of October 2000 at Apumoana Marae. At these meetings concerns surrounding genetic engineering were discussed and hapu consent was given to the planting of the field trial.

Consultation Structure



Currently the field trial is monitored quarterly by a consultation process between key members of the Cellwall Biotechnology team at Forest Research and Penengaru Moke. The late Eria Moke brokered the arrangement for the monitoring of the field trial on behalf of local Tangata Whenua, and Penengaru Moke has taken over this task as a mandated representative. Penengaru meets regularly with Forest Research staff to discuss any areas of concern to Maori that relate to the field trial. He is in contact with the field trial's principal investigator Christian Walter, who informs him of any processes or issues concerning the trial. Penengaru also reviews data from experiments relating to the field trial.

Penengaru Moke (Tangata Whenua representative).

Forest Research has been involved with Tangata Whenua in a number of other ways, some examples of this are:

1. Forest Research recognised that it was important to strengthen ties with Tangata Whenua, particularly with issues surrounding biotechnology. In late 2002, the Cellwall Biotechnology Centre formed a national Maori consultation group, called Te Aroturuki. Its objective is to enhance relationship with Maori and develop better research outcomes and to ensure that areas of concern to Maori surrounding plant gene technologies are recognised, discussed and addressed. It also provides direct access back to local iwi.

2. In February 2003 Eria Moke and Ben Hona, local Kaumatua (elders), and Henare Kani worked together with Forest Research scientist Christian Walter, to put together powhiri (welcoming ceremony) and Hui relating to the cultural aspects of a transfer of genetically modified pine trees to Hort Research in Auckland. The Kaumatua accompanied the trees to Auckland and were welcomed by Ngati Whatua in Auckland. The purpose of the transfer was to enable the investigation of the effects that genetically engineered trees might have on New Zealand's natural flora and fauna.

3. Another very positive way in which Forest Research has been building relationships with Maori is through the sponsorship of Erina Hingston (Ngati Manawa, Ngati Porou, Tuwharetoa and Te Arawa), a recent graduate from Waikato University. Forest Research recruited Erina over the summer vacation (2003/2004), to compile this communication document on genetic engineering and the progress of the field trial. With the support of Forest Research, Erina will continue with her studies in science, beginning a Masters in Science and Technology.

4. Forest Research recently appointed Tupara Morrison (Ngati Whakaue) as the Maori Business Development Manager. His role is to help identify and develop business opportunities and to facilitate the representation of Maori views in research programmes. In consultation with Ben Hona, a committee consisting of mandated representatives of the Tangata Whenua has been formed to address issues of interest to Tangata Whenua.

Results of the Field Trial

The environmental risk assessment research to understand gene expression and the potential risks of Genetically Modified (GM) trees, is part of a long-term research project. This work is at an early stage and only preliminary data has been collected. All current work on the field trial is centred on assessing environmental risk. This is why Forest Research is currently analysing the field trial trees to see how their inserted genes are behaving. It is also why Forest Research is looking into any possibility of Horizontal Gene Transfer (the possibility that the GM genes will be transferred to other organisms in the environment).

Preliminary experiments in collaboration with AgResearch scientists have showed that none of the genes have been transferred into bacteria, at a level they can detect. Further work on determining if genes are transferred into some of the organisms in the found in the soil (Horizontal Gene Transfer) is underway.

Although it's early days, the data so far supports the following general conclusions:

- The genetically engineered trees, when compared to non-genetically engineered trees, have adapted well to the field conditions and are growing as expected.
- The reporter genes are being expressed and the quantity of proteins is measurable. The measurements taken record how much protein each inserted gene produces.
- The genes are behaving as expected and just like "normal" genes their expression fluctuates with seasonal variation and environmental changes. This is shown by an increase in protein production from the inserted genes during summer and a decrease as the seasons get colder.
- There does not appear to be any Horizontal Gene Transfer (HGT). Research has and is still being conducted on the possibility of any gene transfer from the GM trees into bacteria in the soil. AgResearch is conducting this research and results to date show that the inserted gene is not transferred.

How are the reporter genes doing?

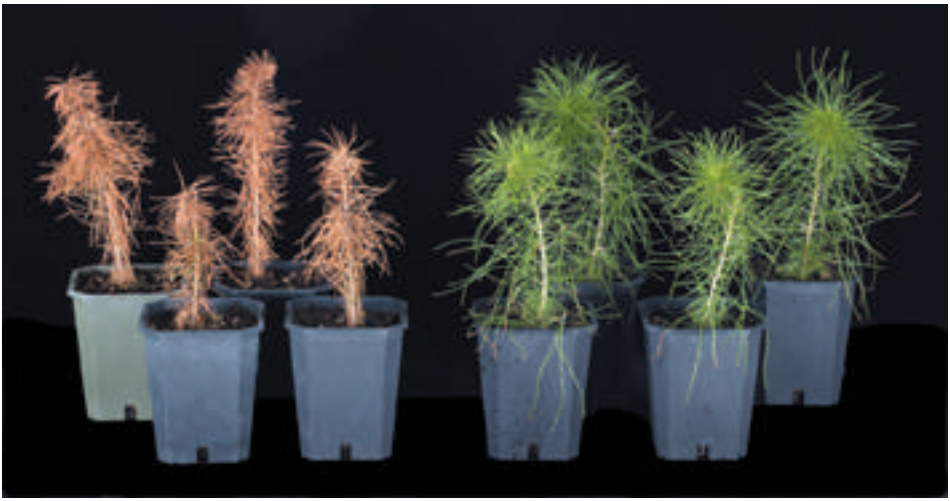
Forest Research scientists have monitored the expression of the reporter genes in 52 transgenic Radiata pine trees and 16 Norway spruce trees, and have started to understand more about how these 'transgenes' are behaving in GM trees over time.

In the first of these studies, four-year-old transgenic Radiata pine trees containing the *npt*II gene were relocated from the GMO glasshouse in Te Teko, to the field trial in January 2003. For approximately half of the trees, the level of NPTII protein was measured for about five months, at weekly intervals. As expected, the level of *npt*II varied between the different transgenic lines. For many of the plants, the level of *npt*II appeared to be affected by the transfer of the trees from pots into soil. It was also around this time that there were heavy frosts. It is normal for gene expression to respond to environmental conditions such as changes in temperature, insect feeding, or physical manipulation.

Furthermore, through monitoring of the *uid*A gene in transgenic Norway spruce trees from April 2003, through to February 2004 Forest Research scientists have obtained valuable data on expression of genes over a much longer period of time. It includes data from when the plants were in the glasshouse, when plants were acclimatising in the field trial, and after planting. The results show that *uid*A expression appeared to be fairly consistent in the constant conditions of the GMO glasshouse. In contrast, *uid*A expression fluctuated much more in the natural environment, probably in response to the changing temperatures of winter, spring and summer.

Future Work

Forest Research has approval from ERMA to undertake research concerning the reproductive development and herbicide resistance of trees in the field trial. Work on the reproductive development and herbicide resistance of GM trees has not begun as yet, but Forest Research plans to do so in the future. Forest Research's main focus at present is on the environmental risk assessment of GM trees.



Trees genetically engineered with herbicide resistance genes (right) were resistant to potent levels of the herbicide Buster, while non-genetically engineered plants (left) died.

Once the field-testing has been completed, all the GM trees present will be removed and destroyed by incineration. The results from the field will be published and made available to the public. Parties interested in the field trial or any issues surrounding it, can contact Forest Research directly. The contact details are in the key staff section at the back of this booklet.

Risks and Contingency Plans for the Field Trial

Forest Research has developed contingency plans to deal with emergencies related to the field trial. Naturally security is a high priority so the field trial is surrounded by a 3 m electronically monitored and electrified fence, with a further 2 m of fence buried beneath the ground.

In case of emergencies, the following action will be taken:

1.The accidental release of plants outside the containment fence:

The site in which the accidental release occurred will be searched for any plant material. This material will be removed and transported back into the containment facility or field test site. The site will also be sprayed with a suitable herbicide and will be monitored for a period of two years, for any growth.

2. Natural Disasters; for example flooding and wind break within the field trial:

In the case of any natural disasters, an experienced, authorised staff member will visit the test site, and the principal investigator will be notified. Trees will be checked for damage and recorded in a log. Dr Walter would then decide on a course of action. A complete inspection of the surrounding fence to ensure its integrity would be performed. Depending on the natural disaster, there is specific criteria that will be referred to. This is set out in the field trial manual and staff are trained to be able to follow the procedures.

3. Vandalism/Removal of trees by unauthorised persons:

If Vandalism is detected the following procedure will be taken:

All the key people involved in the trial will be notified; this includes ERMA and the Ministry of Agriculture and Forestry (MAF), the Police and Forest Research management. Any damage to the fence and containment area will be inspected and rectified. All plants will be inspected, counted and the results compared to the test log.

Key Staff

Forest Research Staff involved in the field trial and production of this document:

Erina Hingston (Ngati Manawa, Ngati Porou, Tuwharetoa and Te Arawa)
Erina produced this booklet for Forest Research as part of her University programme. It was part of a three month University of Waikato work placement.

Dr Julia Charity
Julia is a Research Scientist at Forest Research who has been developing genetic engineering technologies for Radiata pine. Julia has supervised the production of this booklet.

Dr Christian Walter
A Senior Scientist at Forest Research, Christian has developed genetic engineering technologies for conifers and is the principal investigator of the field trial.

Dr Phillip Wilcox (Rongomaiwahine me Ngati Kahungunu)
A Senior Scientist at Forest Research, Phillip established Te Aroturuki (a national Maori consultation group), and assisted in the production of this booklet.

Lynette Grace
Lynette is a vital part of the research team and regenerated all of the plants from genetically modified embryogenic tissue.

Parties interested in the field trial or any issues surrounding it, can contact Dr Christian Walter directly.

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Sala Street
Private Bag 3020, Rotorua
New Zealand.

Telephone: +64 7 343 5899
Facsimile: +64 7 343 5444
Email: christian.walter@forestresearch.co.nz
www.forestresearch.co.nz

Forest Research had a number of its staff working on the field trial. Their expertise was invaluable.

Grant Holden

Grant has been involved in the planting and maintenance of the field trial.

Tomoko Pearson

Tomoko inserted the genes into Radiata pine tissue using the gene gun. She has also been involved in the analysis of the Radiata pine trees in the field trial, collecting samples and performing tests to quantify the expression of the genes. Tomoko is also involved in the regular monitoring of the trial.

Nicola Moore

Nicola quantified the level of *npt*II and *uid*A on a regular basis and collected most of the data used to evaluate how the inserted genes are behaving.

Susan van der Maas

Susan planted and cared for the transgenic plants in the GMO glasshouse.

Mandated Tangata Whenua Representatives:

Ben Hona (Ngati Taeotu, Ngati Hurungaterangi, Ngati Kahuupoko)

A key advisor to the CEO of Forest Research on Tikanga, Kaura and Maori values.

Penengaru Moke (Ngati Taeotu, Ngati Hurungaterangi, Ngati Kahuupoko)

A member of Te Aroturuki who consults with the Cellwall Biotechnology Centre about issues which concern Maori. These include those that surround plant gene technologies. Penengaru monitors the field trial quarterly with Forest Research staff.

Contact Details: Penengaru@hotmail.com

Maori Consultants:

Henare Kani (Rangitane, Ngati Kahungunu)

Henare was one of the initial Maori consultants for the field trial. He co-ordinated the transfer of GM trees from Tree Technologies in Te Teko, to the Forest Research field test site. He also helped Forest Research establish contacts with the Tangata Whenua and is a member of Te Aroturuki.

For generic information on genetic engineering, see:

www.gm.govt.nz
www.ermanz.govt.nz
www.bioethics.org.nz
www.mfe.govt.nz/publications
www.ibac.org.nz

Glossary and Abbreviations

Biotechnology: The exploitation of biological processes for industrial and other purposes, esp. genetic manipulation of an organism.

Cell: The smallest structural unit of living organisms that is able to grow and reproduce.

Clone: A group of genes, cells or organisms that have come from a common ancestor, which are genetically identical. As a verb: to generate replicas of DNA sequences or whole cells.

DNA: Deoxyribonucleic acid. The molecule that carries the genetic information for most living systems.

ERMA: The Environmental Risk Management Authority

Exotic Species: An organism that is not native to a country.

Gene Expression: A characteristic that is specified by a gene.

Gene: The units of heredity. They are defined lengths of deoxyribonucleic acid (DNA) measured in base pairs and occupy a specific positions or locus within a chromosome of an organism.

Genetic Engineering: A technology used to alter the characteristics or traits of an organism by deliberate manipulation of the genetic material of living cells. Genetic engineering bypasses the usual processes of sexual and asexual reproduction. Also known as; Genetic manipulation and Genetic Modification.

Genome: The total hereditary material of a cell, comprising the entire chromosomal set found in each nucleus of a given species.

GMO: Genetically Modified Organism.

Horizontal Gene Transfer (HGT): Natural and non-sexual transfer of DNA between organisms of the same, or different species.

In vitro: Literally 'in glass'; performed in a test tube or other lab apparatus.

In vivo: Within an organism.

MAF: Ministry of Agriculture and Forestry

Non-GM: A Non genetically modified organism, is an organism that has not been genetically modified.

npt II: Reporter gene that has been inserted into the Radiata pine and Norway spruce trees in Forest Research's field trial and can be easily monitored. This gene provides resistance to the antibiotics kanamycin and geneticin, allowing scientists to distinguish the genetically modified tissue from tissue that was not modified.

Phenotype: Observable characteristics of an organism - produced by its genetic makeup.

Promoter: A DNA sequence located at the front of a gene and controls gene expression.

Protein: A molecule composed of small building blocks called amino acids. There are many different types of proteins which carry out a number of different functions within a cell.

Quantitative Test: A test performed to accurately determine the amount of specific material. For example the ELISA test accurately determines the amount of NPT II protein produced.

Restriction enzymes: Enzymes that cut DNA molecules at specific recognition sites. Also know as restriction endonucleases.

Risk: The likelihood of a negative event multiplied by the magnitude of that event.

Transformation: Change in the genetic structure of an organism by the incorporation of foreign DNA. It is used to describe genetic engineering, and is often used interchangeably.

Transgene: the gene that has been transferred to a genetically modified organism.

*uid*A: Reporter gene that has been inserted into the Norway spruce trees in the Forest Research field trial. The *uid*A gene is an important "visual" marker, since genetically engineered cells containing the protein product of *uid*A turn bright blue, when exposed to a reactive substance.

Wild type: The form of an organism that occurs most frequently in nature.

COMMONLY USED MAORI WORDS

hapu: sub-tribe, pregnant
hui: gathering
iwi: tribe
karakia: prayer
kaumatua: elder, elders
kaupapa: agenda, cause
kia ora: greeting
korero: speak, talk
koutou: all of you
mahi: work, job
mana: power, prestige authority
marae: ancestral meeting ground
matauranga: knowledge
mauri: life force
mihi: greeting
powhiri: ceremony of welcome
rohe: tribal area
tangata: person/people
tangata whenua: people of the land
tapu: sacred
tikanga: course, reason, meaning
wananga: course, school
wero: challenge
whanau: family
whakapapa: cultural identity or relationships

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