CANADIAN TREE IMPROVEMENT ASSOCIATION/
ASSOCIATION CANADIENNE POUR L'AMÉLIORATION DES ARBRES

Tree Seed Working Group

NEWS BULLETIN

No. 43 June 2006

INFORMATION MANAGEMENT

THIS ISSUE AT A GLANCE

CHAIR'S 'ARMCHAIR' REPORT

Hello, I hope everyone is having a good spring. The monsoons seem to have finished on the west coast and it looks like summer is finally here. Most of our current activities in BC are focused on mountain pine beetle and lodgepole pine – planning for future seed needs, increasing yields and seed quantities from our orchards, increasing seed-use efficiency, and dealing with a very large increase in cone collections. This past year in BC, we have seen twice as many cones processed compared to the 10-year average! It is June, we are still processing cones and foresters are still collecting. Many of you have heard about the mountain pine beetle and its impact – it certainly is a strong focal point for almost all of our current activities related to reforestation.

I'm very much looking forward to heading back east for the CTIA meeting and associated Tree Seed Workshop in Charlottetown, PEI (http://www.gov.ns.ca/natr/forestry/ctia/). The theme of the Tree Seed Workshop is "Appreciating, Quantifying, and Utilizing Family Differences" and this will be presented from both the technical and operational levels. I think this is an extremely important topic in the delivery of the genetic gain we have worked so hard to breed and select for. I think the topic also fits very well with this News Bulletin's theme of "**Information Management**" which I will say a few words on below. The other exciting east coast adventure will be the IUFRO Tree Seed Symposium in Fredericton, NB (http://www.tss2006.org/). This is a great opportunity to listen, learn, and exchange ideas with some of the most distinguished tree seed researchers from throughout the world. Hope to see you there.

I'd like to thank everyone who has contributed to the News Bulletin. It is great to see some new names attached to articles, but I'm especially indebted to those who continually support the working group through their contributions – Thank You!

Information Management is an important topic that we all engage in daily. If one Google's Information Management you get 2.7 Billion hits on the internet! The whole area of certification under schemes like ISO 9000 is a good example of the importance placed on information management. Most of the News Bulletin contributions have focused on the area of managing data. This is extremely important and most jurisdictions have systems to track seed inventories and assist with distribution of seed to production facilities. Many orchards have systems to aid with their crop monitoring, data collection requirements, and mapping functions. Most also have some method of capturing environmental data, although this is an area that I believe data are being underutilized. Hopefully someone can provide a good example to adjust my thinking on this topic as I think these data provide a good opportunity to better understand environmental cues to bud differentiation, crop development, and insect population dynamics. Processing facilities also require information systems to keep track of activities performed, yields obtained, and comments related to insect and fungal pest occurrence as well as other unique attributes of each seedlot. There is a great appreciation for the need to manage the data we obtain in our operational and scientific endeavours.

Information management goes beyond managing data. We all manage the background information that is critical to our jobs whether it be legislation, scientific reports and papers, the masses of e-mails we accumulate, and the working files we manage on our computers. We often talk about something being based on the "best scientific information", but how is this information managed? The transition from data to information often involves statistics that are intended to translate the raw data into information that is useful to us. Unfortunately, statistics is a discipline most people are not comfortable with or interested in improving their abilities in. I'm not sure if this is because of the awesome powers of computers (and choices of statistical methods), the basic fear of statistics (and statisticians ☺), or the lack of resources to assist in statistical inquiry?

Most facilities are engaged in some form of continuous improvement efforts based on operational trials. These may or may not be replicated, may or may not follow the principles of experimental design, but they do provide specific data on a specific question of direct interest to that facility. Different facilities may be asking the same question using a different design and coming up with different conclusions. How do we combine the data from a variety of trials into some useful information? The term meta-analysis is relatively new to me, so I was surprised to learn that this was first performed in 1904, although analytical techniques became more sophisticated in the 1970's[1]. The current co-operative collection of lodgepole pine cone crop data in BC across orchard sites is a good example of what we should be doing more of. I find it ironic that the practitioners who are closest to the problems and who require the most assistance with statistical "methodology" are the ones who often do not have access to this expertise. I believe that there is a lot of valuable data out there at operational facilities that never gets converted to information or knowledge.

Last, but not least (and maybe most important) is the information management that occurs with extension. The conversion of research to application is an important and to me clearly an underappreciated part of our business today. Extension specialists were a common element in the past for many of our programs. I think we need to be going back to a model of having individuals dedicated to extension before we can move forward. Does any of this resonate with anyone else? The News Bulletin is also a place to voice your opinion on the topics we raise, besides our contributors – Is anyone out there? In addition to all your opinions, the next News Bulletin will have "**Seed Dormancy**" as its theme. Have a great summer!

Dave Kolotelo
Chairperson

EDITOR'S NOTES

We are constantly being bombarded by information and we continually generate information at work. It is important and usually necessary to create information but it is only useful to us and others if the data are stored properly and can be efficiently retrieved and manipulated to serve our needs now and/or in the future. With the common use of computer technology storage, retrieval, and manipulation of data are relatively easy. A number of software packages exist that the user can set up to do what needs to be done or consultants hired to create custom applications. There is an excellent variety of articles in this issue outlining how and why information is stored and the means by how it is managed.

[1] From Wikipedia, the free encyclopedia (http://en.wikipedia.org/wiki/Meta-analysis)

A number of us are intimately involved with organizing the IUFRO Tree Seed Symposium being held in Fredericton July 18–21 as well as the Canadian Tree Improvement Association meeting and associated Tree Seed Workshop taking place in Charlottetown July 24–27. I know a number of you are planning to attend one or both of these events. I look forward to seeing you.

If you are unable to attend, I hope you have a great summer and I will talk to you again in December.

Erratum: Please note in the last News Bulletin, a correction should be made to the author's name of the first two papers under 'References' on page 14 – ' Èermák ' should be ' Ĉermák '.

Dale Simpson
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Comments, suggestions, and contributions for the News Bulletin are welcomed by the Chairperson and Editor.

DATA MANAGEMENT USING MICROSOFT EXCEL

Western Forest Products has been using Microsoft Excel to manage orchard data as well as field research data of all kinds. This software has many tools for data management, summarization, and analyses. Frequently used tools include the look-up and 'if' functions, pivot tables, random number generation, sort, and subtotals. Basic data analysis tools are also available, including single and two factor analysis of variance, t-tests, and others.

Orchard layouts can be developed using the random number generator tool. This can be done by listing all replicates of the ramets to be included in the orchard in the first column, or if designing a clonal row orchard list each of the clonal identification numbers once for each clonal row. In the next column the random number function is deployed and copied down to all listed ramets. Convert these random number calculations to fixed numbers (copy and then paste special – values). Sort the two columns by random number, and then assign the orchard position by row in the next column, and by tree in row in the fourth column. If adjacency is a concern, check by entering a subtraction calculation in the next column(s). Using the 'if' function, only differences that are equal to zero can be specified. Various sort and subtraction calculations may be desired depending on species and design adjacency concerns. Remember to adjust the outcomes to fixed numbers prior to re-sorting, as results will change, based on the sorting. Manual adjustments to the layout can address adjacency concerns.

The look-up function is useful to link clonal attributes to multiple listings of ramets in an orchard. With a list file of the ramets in an orchard and a list file of the parent trees and their attributes, one can use the look-up function to add the specific attributes of each clone to the orchard listing of ramets. This is frequently used in the preparation of seedlot parental contribution estimates and summary data.

Reproductive bud surveys, phenological surveys, ramet health surveys, insect surveys, and any other orchard surveys or inventories are recorded in data files and summarized using the pivot table function. Pivot tables allow one to summarize data by multiple classifications and the layout of the summary table is flexible. Using the row and column positions of an orchard list file, an orchard map may be generated using the pivot table function. Maps can be customized to include a restricted subset of the ramets or clones in the orchard by selecting based on listed attributes in the data file. For example, if a person had surveyed an orchard for the incidence of spider mites and intended to treat only trees where the incidence rating score for a ramet was greater than one, this could be selected, mapped, and provided to the pesticide applicator.

These tools are useful for the manager who is not comfortable with using a black box to generate data summaries but wants to understand and confirm that the methodology deployed is as defined. Microsoft Excel macros are used by many data managers. Additionally, this software may be used in conjunction with Microsoft Access for improved data presentation.

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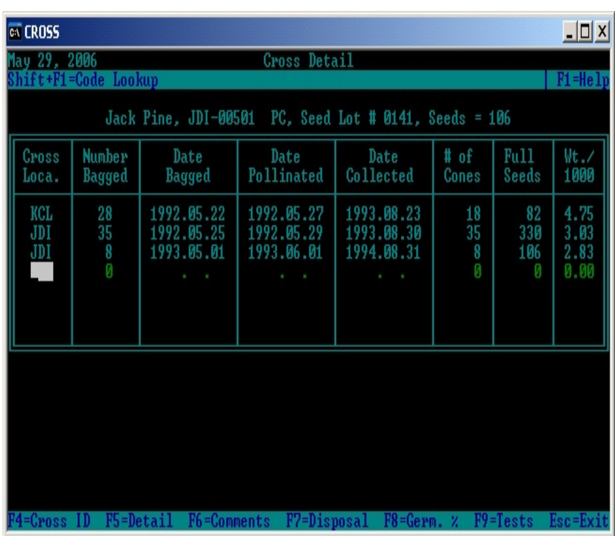
INFORMATION MANAGEMENT AT NEW BRUNSWICK-DNR TREE IMPROVEMNT

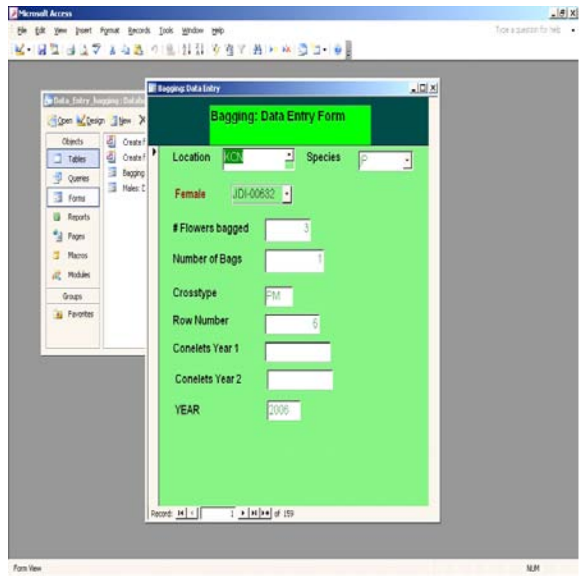
The Tree improvement program at NB-DNR will be celebrating its 30th year in 2006. Over the years, information management methods have changed dramatically with the use of computers. There are many areas of information that we track so I will break it down.

Breeding Information

In 1989, a program was developed in-house to collect all cross-pollination information and enable us to track a cross from its inception to its eventual establishment in field tests. The data entry screen allows you to enter seedlot numbers and generate a number of reports that allow you to check the status of the crosses.

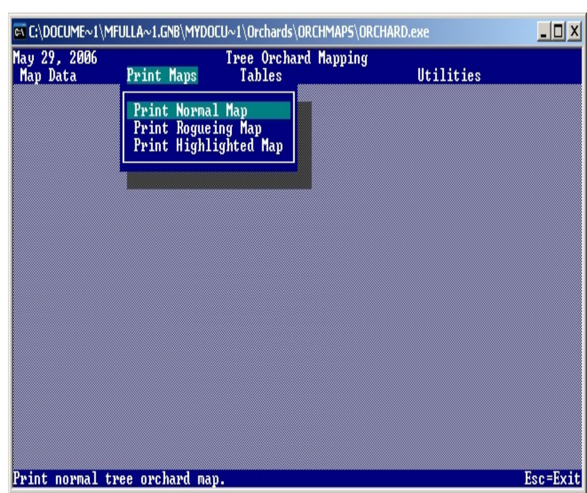


These databases are also used in MS Access where custom reports can be generated that combine bagging information for the current year and bagging information by sub-line can be automatically generated, saving duplication of data-entry. Screens have also been designed that check against a master inventory list so that a bogus number cannot be entered. There is also an Access database of all stored pollen that can be queried for reports that will sort by sub-line and species so we can fine-tune our breeding efforts before going to the field.



Orchard Mapping

Another program allows you to enter orchard maps by row/column and you can generate maps for various activities by highlighting particular clones for cone collection, $GA_{4/7}$ injections or rogueing.

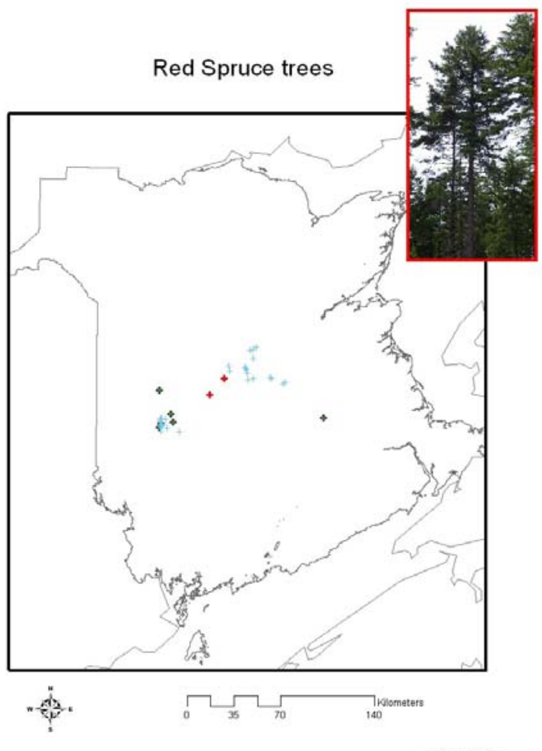


Grafting

MS Access is used to create a database containing all grafting details. There are forms to allow easy entry of cull information as the grafts flush. A final report can be produced with the total number of grafts by clone and species to be used for spring out-planting in the seed orchards and clone banks.

ARCMAP/GPS Technology

We started using this software in 2005 to generate maps of orchards, building locations, drain-tile locations, test areas, etc. We are currently tracking red spruce plus tree selections with a GPS and producing a layer for plus-tree origins in wild stands.



Data Collectors

We are currently using DAP's and a Palm Pilot to measure both field and nursery tests. The measurement screens include historical data so that the operator will be able to check whether or not he/she is in the right plot. If trees are dead or missing previously, they should remain so. Also, a tree should not be shorter than its previous measurement. It is critical that the same tree is measured in successive years or the data will not be valid.

The advantage of using computers is that errors in the data will be minimized. A number of checks can be set up on the data entry screens. Once the data are entered, it is easily transferred or manipulated.

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PROVINCIAL-LEVEL INFORMATION IN SUPPORT OF OPERATIONAL TREE IMPROVEMENT AND SEED SUPPLY

British Columbia is large and ecologically diverse, with over 20 indigenous tree species under management across a wide variety of climatic variants. Annual planting averages about 230 million trees per year, with 2006 sowing requests reaching 275 million. Provincial objectives set by the multi-stakeholder Forest Genetics Council of BC (FGC) call for 75% of planting to be derived from genetically selected sources (seed orchards or superior provenance - not genetically modified) by 2013 (about 49% in 2005), and for the average level of improvement (described as genetic worth for stem volume per hectare (GWg)) to reach 20% by 2020. Merely stating these objectives implies a series of coordinated processes and information systems capable of developing and tracking the required data. Such systems exist and include the following: 1) standard protocols for estimating breeding values for selected parent trees, 2) standard protocols for estimating parental contributions and the genetic worth of orchard crops, 3) a common provincial seed database that covers all owners, 4) tracking of seedling orders and seed use for all users, and 5) data systems that link seedlot number with a range of information on the seedlot, including genetic worth.

A number of highly developed information systems aid operations, while maintaining and allowing access to data. These include SPAR (Seed Planning and Registration system) and CONSEP (Cone and Seed Processing System). Larger companies also maintain their own systems for tracking seed use.

At the provincial level, there is a need to synthesize and present information that will aid with: 1) monitoring progress to provincial objectives as set by the FGC, 2) setting program spending priorities among species and seed zones, 3) facilitating discussion and interaction among those involved in all aspects of gene resource management and in operational silviculture, 4) planning for orchard developments, 5) identifying gene conservation issues and needs, and 6) operational seed acquisition. In support of these needs, the FGC and it's advisory committees lead the development of "Species Plans" as part of the annual business planning process. The remainder of this article will describe the purpose, information sources, and information presented in Species Plans.

A FGC-led analysis of provincial priorities is based on Seed Planning Units (SPU). A SPU is a unique combination of species, seed zone, and elevation band. Each SPU forms the basis for a tree breeding and seed orchard program. Seed from an orchard is planted only within a specific SPU (e.g., western larch in the Nelson seed zone between 700 and 1200 m). An analysis of provincial priorities for tree improvement investment previously considered over 80 SPUs, of which 50 SPUs are deemed economically significant enough to warrant some level of investment in tree breeding, seed orchards, and/or genecology research (genecology research often encompasses areas outside the 50 priority SPUs).

A species plan is developed for each of the 50 priority SPUs. Each species plan contains seven sections: 1) SPU description, program priority category, and a brief strategy statement, 2) a summary of progeny testing information, with a 20-year projection of parents in test at various pedigree levels (open-pollinated, clonal, F1, F2, etc.), 3) 20-year seed production forecast for each orchard targeting the SPU, 4) 20-year GW forecast for seed flowing from each orchard targeting the SPU, and 5) gene conservation status and statistics, 6) orchard size needs and a listing of current orchard status in terms of the number of ramets planned and established, and 7) a summary of total seed use in the SPU since 1995, as well as current seed in storage by GW class.

Information for species plans is derived from a variety of sources: 1) tree breeding programs led by the Ministry of Forests and Range (MoFR), 2) orchard managers from private and MoFR orchards, 3) the Centre for Forest Gene Conservation at the University of BC, 4) all provincial seedling requests (SPAR), and 5) all seed in storage at the Provincial Tree Seed Centre (from CONSEP).

Information for each SPU is synthesized and presented in a two-page format known as a Species Plan. The Species Plan format is consistent from year to year and among the 50 SPUs tracked through the FGC planning process. The following two pages show a species plan for lodgepole pine in the Bulkley Valley seed zone between 700 and 1200 m elevation. Species plans are published annually as an appendix to the annual Business Plan of the Forest Genetics Council of BC.

What have we learned? Presentation of information in a consistent and reliable format will lead to increased use of the information. In addition, when those involved in gene resource management, including orchard managers, tree breeders, and seed users, have an easily accessed information source, discussion is facilitated and each component of the program becomes more familiar with other components. Ultimately the operational stream of activities improves with better overall program delivery. Maintaining and developing the information, however, requires cooperation and consistent effort by many people to ensure its veracity and to simply get it done every year.

Planning and communication are keys to program success and monitoring progress is key to continued improvement. Thanks to the effort of many people in BC, we have been able to develop the information management and presentation systems that allow detailed business planning, program delivery, and monitoring.

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ORCHARD DATA MANAGEMENT SYSTEM

Vernon Seed Orchard Company recently embarked on the creation of an orchard data collection system. The system will help seed orchard technical staff to upload and download field data in a more timely and error-free manner. Seed orchard staff require accurate data collection in order to license seedlot information.

How does it work? There are three main components of this system:

1) A hand held bar code reader scans the tag and enters the type of survey. The operator simply scans the bar code, enters the amount or particular survey figure he/she is taking and moves on to the next tree. The tag will have tree location, clone number, orchard number, bar code, and key id number on it.

SPU # 17	Interior Lodgepole Pine	Bulkley Valley	700 - 1200m

Seedling need (million): 16.4

Program category: Advanced-generation

filename: 17 Pli BV low Jun.10.05

STRATEGY

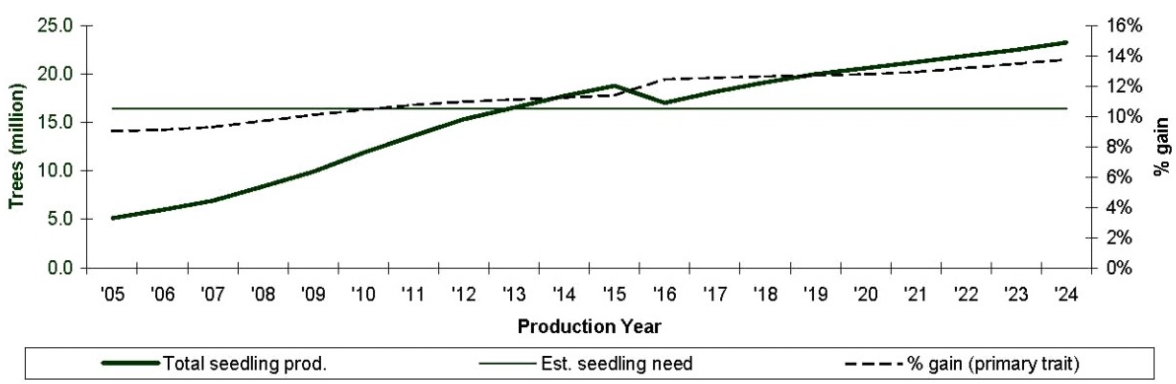
Selection of parent trees in wild stands. Open-pollinated progeny tests on multiple sites. Selection for seed orchards of best parents and offspring, with a focus on stem volume and form. Second generation breeding will focus on volume and wood density.

TRAITS — **Primary:** Stem volume — **Secondary:** Wood density

TESTING AND PRODUCTION	Production Year (July 1 to June 30) -- (Cone harvest year shown)																			
	'05	'06	'07	'08	'09	'10	'11	'12	'13	'14	'15	'16	'17	'18	'19	'20	'21	'22	'23	'24
Parents in progeny test:																				
Open pollin.	296	296	296	296	296	296	296	296	296	296	296	296	296	296	296	296	296	296	296	296
Polycross																				
Clonal																				
F1	130	130	130	130	130	130	130	130	130	130	130	130	130	130	130	130	130	130	130	130
F2																				
F3																				
Production forecast (million plantables)																				
Orchards (#, owner)																				
219 VSOC (Vernon)	3.1	3.7	4.2	5.0	5.7	6.8	7.7	8.5	9.1	9.6	9.8	9.8	10.0	10.0	10.1	10.2	10.2	10.2	10.2	10.2
228 MoF (PGTIS)	2.0	2.3	2.5	2.6	2.8	2.8	2.8	2.8	2.8	2.8	2.8	Retire orchard								
234 VSOC/SelectSeed	0.0	0.0	0.2	0.5	0.9	1.4	1.8	2.2	2.5	2.9	3.3	3.9	4.4	4.8	5.1	5.3	5.4	5.4	5.4	5.4
240 Sorrento/Selectseed	0.0	0.0	0.0	0.2	0.5	0.9	1.3	1.8	2.2	2.5	2.9	3.3	3.9	4.3	4.8	5.0	5.3	5.3	5.3	5.3
2nd generation replacement													0	0	0	0.1	0.3	0.9	1.5	2.25
Vegetative prod.:																				
Phase 1																				
Phase 2																				
Estimated gain in primary trait																				
Orchards (#, owner)																				
219 VSOC (Vernon)	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%	11%
228 MoF (PGTIS)	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%									
234 VSOC/SelectSeed	14%	14%	14%	14%	14%	14%	14%	14%	14%	14%	14%	14%	14%	14%	14%	14%	14%	14%	14%	14%
240 Sorrento/Selectseed	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%
2nd generation replacement													23%	23%	23%	23%	23%	23%	23%	23%
Vegetative prod.:																				
Phase 1																				
Phase 2																				
Total Production	5.1	6.0	6.9	8.4	9.9	11.9	13.6	15.3	16.5	17.7	18.8	17.0	18.2	19.2	20.0	20.6	21.2	21.9	22.5	23.2
Total gain	9%	9%	9%	10%	10%	10%	11%	11%	11%	11%	11%	12%	13%	13%	13%	13%	13%	13%	13%	14%

Estimated orchard gain and production

SPU 17 Pli BV 700-1200m



Seed production estimates are subject to change. When using this information for silviculture planning or timber supply analysis, contact the Tree Improvement Branch of the Ministry of Forests to confirm data. See SeedMap on www.for.gov.bc.ca/hti/seedmap for current inventory by Seed Planning Unit

17 Pli BV low Jun.10.05

Interior Lodgepole Pine Bulkley Valley 700 - 1200m

SPU #17

Conservation -- Seed Orchards -- Seedling Use

GENE CONSERVATION STATUS

Conservation statistics

Seed planning unit (SPU) area	**3,442,345**	**ha**
Area protected within SPU	**516,127**	**ha**
Percentage of SPU area protected	**15%**	
Estimated genetic reserves with >5000 mature trees based on botanical sample data	**>2**	
Confirmed genetic reserves with >5000 mature trees based on forest inventory data	**28**	

Conservation status

Current in-situ protection status: **Well protected**

Probability of maintaining > 3 protected areas with adequate population size given natural disturbance regimes: **Very high**

For further information visit http://www.genetics.forestry.ubc.ca/cfgc/

ORCHARD STATUS

Orchard location	Orchard number	Number of parents	Mean BV	# of ramets currently established	# of ramets planned for final orchard size	Target Seed production kg/y at maturity	Total Seedling Prod. million seedlings
VSOC (Vernon)	219	71	11%	5,691	5,850	44.1	8.78
MoF (PGTIS)	228	40	6%	1,554	1,600	12.0	2.40
VSOC/SelectSeed	234	91	14%	2,876	3,000	22.6	4.50
Sorrento/SelectSeed	240	77	15%	2,980	3,100	23.3	4.65
			Total ramets	**13,101**	**13,550**	**Total production**	**20.33**

Vegetative propagation	**Stecklings/Emblings**	**0.0**
	Total production	**20.3**

Seed and Nursery Factors

Expected annual average seedling production per ramet =	**1,500**
Seed weight (seeds/gram) =	**249**
Seedling recovery factor (seedl./seed) =	**0.80**

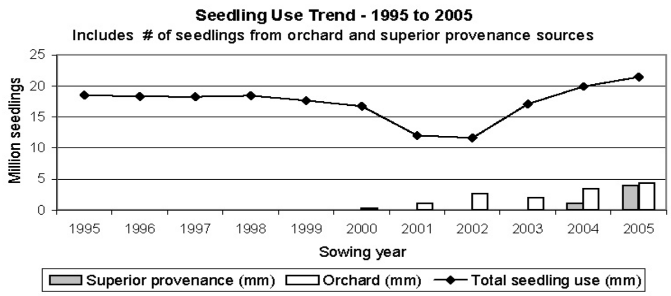
Estimate of Required Orchard Capacity

Annual planting (million seedlings)	**16.4**
Planned over-production factor	**1.3**
Ramets required	**10,935**
Ramets required with over-capacity	**14,215**
Projected necessary expansion	**665**

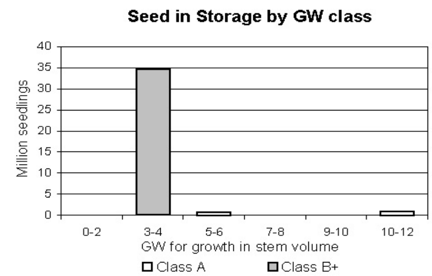
SEEDLING USE AND SEED IN STORAGE

Average 5-year seedling use from SPAR (2001 - 2005) **16.4** **million**

Estimated years of class-A seed in storage **0.1** **years**



Notes:
- Seedling use data prior to the 2000 sowing year are estimated from old seed planning zones and are approximate.
- Seedling use data include 1/2 of adjacent overlap zones, where applicable
- Sowing year: July 1 to June 30 (i.e. 2003 sowing year starts July 1, 2002)



Notes:
- Seed held in both "reserve" and "available" status in the Seed Planning and Registration (SPAR) system is included
- Seed inventories change with new orders. Data presented here are based on an April 2003 sample.
- For up-to-date information use SPAR, or contact the Tree Improvement Branch of the Ministry of Forests

Seed production estimates are subject to change. When using this information for silviculture planning or timber supply analysis, contact the Tree Improvement Branch of the Ministry of Forests to confirm data. See SeedMap on www.for.gov.bc.ca/hti/seedmap for current inventory by Seed Planning Unit

2) A Brady tag printer can print roughly 1500 tags per hour. The key performance of the printer is downloading the orchard to be printed directly from the computer file to the printer. When compared to our old inscribing method of 50 tags per hour, this new system creates huge cost and labour savings to the company and decreases the onerous task of previous tag making methods.

3) The Microsoft Access program allows for the information taken from the field to be automatically downloaded into a database.

We have now created a system that allows us to print maps, do reports such as clone summary and cone history, do individual clone selection and mapping, deleting and adding clones. In addition, this system records a host of other vital data linked to orchard management data collection.

The following people have contributed to this system's development:

- Tim Lee and Dan Gaudet articulated the system requirements and parameters,
- Len Ingram of Len Ingram InfoSystems built the system, using Access,
- Tia Heeley provided Access support, and
- Chris Walsh provided computer knowledge and support.

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INFORMATION MANAGEMENT !!!

What thoughts come to mind when you think of Information Management? Each of us has different expressions for what information management is.

We could be thinking about navigating the "Information Highway", Newsletters, Quarterly Journals subscribed to, Reference Literature, project records we keep for our needs and then information to share with others along the way, or Membership Groups we're a part of. It just keeps on growing and then how do we keep it all together so we don't get buried or confused in this fast paced society.

It was once stated that **"It is desirable, at intervals to reduce life to it's simplest of terms if we are to remain healthy minded individuals in the midst of a society that is rapidly going MAD" (**Pete McConville, 1880-1959).

Information Management transcends many categories. You might think of it only in terms of Reports and Reference materials. Maybe you think about it in terms of people you interact with frequently or infrequently or how you share your knowledge, your individual gifts or skills with others.

So lets think about the **people,** the people you meet along the way.

What about the people we meet and know? How do they influence us in the management of information? Do they play mentorship roles? Are they people you gravitate to, based on a need or purpose, people you know about or people you want to know more personally not just gather data about.

People come into your life for a ***reason, a season*** or ***a lifetime***. When you know which one it is, you will know what to do for that person.

When someone is in your life for a ***REASON***, it is usually to meet a need you have expressed. They have come to assist you through a difficulty, to provide you with guidance and support, to aid you physically, emotionally or spiritually. They may seem like a godsend and they are. They are there for the reason you need them to be. Then, without any wrongdoing on your part or at an inconvenient time, this person will say or do something to bring the relationship to an end. Sometimes they die. Sometimes they walk away. Sometimes they act up and force you to take a stand. What we must realize is that our need has been met, our desire fulfilled, their work is done. The prayer you sent up has been answered and now it is time to move on.

Some people come into your life for a ***SEASON***, because your turn has come to share, grow or learn. They bring you an experience of peace or make you laugh. They may teach you something you have never done. They usually give you an unbelievable amount of joy. Believe it, it is real. But only for a season!

LIFETIME relationships teach you lifetime lessons, things you must build upon in order to have a solid emotional foundation. Your job is to accept the lesson, love the person, and put what you have learned to use in all other relationships and areas of your life. It is said that love is blind but friendship is clairvoyant.

Always give thanks for the part that people have played in your life, whether they were a ***reason,*** a ***season*** or a ***lifetime.***

So lets now give some thought to the **Paper Side** of things.

Reports and reference materials on the other hand can end up as a bulking mass. Over time they can occupy more and more space and end up collecting dust because the material becomes out-dated or is not used. Is this true? First ask yourself, How old is old? Do we replace our record/reference information because it's not trendy anymore or do we just keep adding to it?, thereby compounding our paper or cyber collections creating a categorical maze.

If you decide to do 'an out with the old and in with the new' how are you going to decide that the new is reliable and accurate? What judgements or precautions do you exercise when proceeding along this avenue? "Trendiness" or "Hype" can cloud an issue in something that has been rooted and proven for many years. Something that comes to mind at this point in thinking about what I just wrote, is the Da Vinci Code, which presently is creating a hype and flurry as the movie is just released. Reliability and accuracy are creating global discussion forums.

In all that we do we need to know what is reliable and know what is not. Don't disregard the older research materials, ensure you give them a full evaluation before moving on. Personally we are finding that some very basic techniques and protocols in seed cleaning and handling have either been brushed aside or forgotten about for whatever reason. Each lab season serves others and assists in helping to resolve many practical issues.

In summary to all of this, try to attend **one or two** specific topical meetings, talk to people, personally discuss and share thoughts/ideas. Remove the apprehensions and barriers to communication between people. We're all busy but maybe we need to think more about why we're so busy. Is it the kind of busyness? or are there just too many things out there that we think we need to be involved with or concerned about? Focus on what's important and always keep a good balance to life. We all need stability of the body, mind and spirit. It leads to more humane living, it's richer and simpler, and it is enlightened by joy and freedom.

Have a great summer from all of us at Nature's Common Elements.

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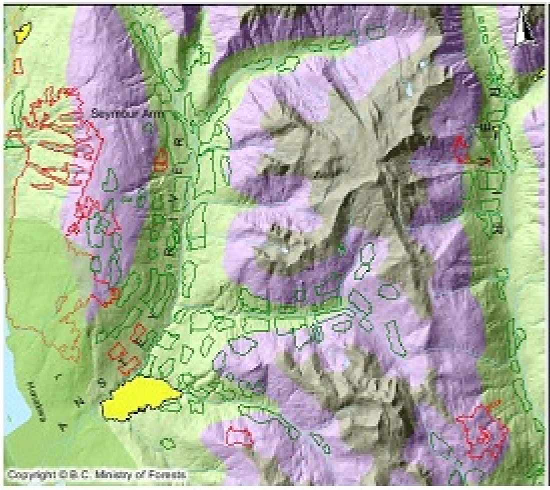
MANAGING GENE RESOURCE INFORMATION IN BRITISH COLUMBIA

In British Columbia, gene resource information management plays a significant role in meeting the province's stewardship mandate for forest tree genetic resources. Gene resource information management projects support the development of gene resource management (GRM) registries, gene resource information management systems (including spatial data sets), land-based GRM and seed planning decision support tools, strategic planning and analysis, forest genetic modelling (including timber supply analyses), and effectiveness monitoring.

A provincial resource strategy for forest tree genetic resources is currently being developed to meet seed use requirements and genetic resource stewardship objectives identified under the new Forest Practices and Range Act (FRPA), strategic planning and seed mitigation needs in response to the Mountain Pine Beetle epidemic, and to address emerging issues such as climate change. An effectiveness evaluation report is also underway to benchmark genetic diversity levels pre-FRPA implementation. Summary information is captured through the reporting of regeneration systems (natural and artificial), genetic source, and the tracking of seed deployed through reforestation activities (planting) along with associated genetic quality attributes.

Gene resource information management programs are sponsored through the Ministry of Forests and Range (MoFR) and the Forest Genetics Council of British Columbia. Funding is shared between the MoFR (Tree Improvement Branch, Forests For Tomorrow, and Forest Resource Evaluation Program) and the Forest Investment Account.

Please read the following article for more information about SeedMap.



Seedlot tracking by silviculture opening in SeedMap – MoFR

Seed deployment (Silviculture Openings with Planting); SeedMap screen capture

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GENE RESOURCE INFORMATION MANAGEMENT IN BRITISH COLUMBIA

Information management technology has evolved in leaps and bounds over the past twenty years. The British Columbia Ministry of Forests and Range (MoFR) has been developing and enhancing its tree seed information management systems as technology has evolved. MoFR currently has three applications that share data and work together to provide clients with current tree seed information and a myriad of information to enable clients to establish free growing stands on crown or private land. These applications are Seed Planning and Registry system (SPAR), the Cone and Seed Processing system (CONSEP), and a web-based mapping tool, SeedMap.

Seed Planning and Registry system (SPAR)

Background

Twenty years ago, British Columbia had a Tree Seed Registry system that was housed on a mainframe computer. Access was limited to a small number of staff at the Tree Seed Centre who entered data and produced reams of paper reports on seedlot information to distribute to clients. The information on test results and seed quantities would be out of date soon after the reports were printed.

In 1991, the BC Ministry of Forests Silviculture Branch embarked on a major project to develop the Seed Planning and Registry system (SPAR). This original SPAR system resided on the Government IBM VM network and was coded in CSP (an IBM mainframe language). SPAR was built to provide ministry and non-ministry clients with on-line access to current seedlot information and an on-line facility for entry of seedling requests. Current information could be viewed on-line or printed in a variety of reports. Ministry of Forests staff, forest licensees, seed dealers, seed orchards, and nurseries accessed SPAR via mainframe terminal emulation software such as Rumba or FTTerm. However, user access software, printing on mainframe-connected printers, and cumbersome procedures for downloading reports caused regular problems for some users.

In 1998, the Tree Improvement Branch was formed and gained responsibility for the Tree Seed Centre, the MoFR seed orchard program, and SPAR.

By 2001, internet information technology had evolved to the point where the next logical step for SPAR was to convert to a proven web-based framework. In August 2002, SPAR was released as a web-based application, using technologies such as Oracle, Java, IIS, SQL, and Crystal Reports. A complex security framework provides access to BC MoFR staff via their government ID and to external clients via their BC electronic ID (BCeID) with one of several levels of security access.

SPAR Functions

The basic functions in SPAR have been in place since the original system was implemented in 1992. Enhancements to SPAR have been ongoing since it was released as a web-based application in 2002.

The seedlot data available in SPAR includes:

- Collection and extraction information such as dates and agencies involved.
- The genetic class, which indicates if a seedlot source is a seed orchard, natural stand or superior provenance stand.
- The seed orchard and parent trees that contributed to a seedlot, if applicable. The breeding values of the parent trees determine the genetic worth of a seedlot.
- The geographic location, including latitude, longitude, elevation range, seed planning zone, and biogeoclimatic zone of the collection site for natural stand collections.
- The area of use where a seedlot can be transferred, which includes seed planning zones and elevation range for seed orchard collections and additionally BEC zone, latitude range, and longitude range for natural stand collections.
- Results of tests performed at the Tree Seed Centre on a seedlot over time, including moisture, purity, germination capacity, peak value, seeds per gram, fungal assays, etc.
- Original balance and ownership details, as a seedlot can have multiple owners.
- Details of seed withdrawals for seedling requests and other transactions. The balance of a seedlot changes as requests are made against the seedlot.

Seedlot registration on SPAR includes:

- A new Application for Seedlot Registration function became available in September 2005. Seed orchards and natural stand cone collectors now enter all the information required by the Forest Range and Practices Act (FRPA) Chief Forester's Standards for Seed Use using this function. The screen layout differs for Class A (seed orchard collections) and Class B (natural stand collections) seedlots. Required orchard data include cone and pollen counts for all the parent trees. SPAR then calculates effective population size (Ne) and Genetic Worth (GW) for a seedlot.
- Parent tree data are entered in SPAR with test results determined by the MoFR Research Branch Forest Genetics group. The Breeding Values (BV) are used to calculate the GW of the seedlot.

The request functions in SPAR include:

- Seedling requests, where a client enters information that will initiate withdrawal of seed from storage, seed preparation and shipment to a nursery, sowing at the nursery, and production of seedlings for reforestation. The information required in a seedling request includes: planting site geographic parameters, forest licence and tenure information, seedling quantity required, nursery, seedling stocktype, and stock age information. These parameters are run through complex queries to determine suitability of seedlots based on the FRPA Chief Forester's Standards for Seed Use, availability of seedlots based on ownership, and seedlot quantity required to fill the order based on sowing guidelines.
- Cone and seed processing requests.
- Direct withdrawal of seed for purposes other than producing seedlings for establishing a free growing stand.
- Seed sale requests, where ownership of all or a portion of a seedlot it transferred between agencies.

Nursery specific functions include:

- Latest sowing date table where nurseries enter their sowing dates for specific species, container type, planting year/season combinations. These sowing dates then trigger 'recommended action dates' for the Tree Seed Centre to withdraw the seed from storage, stratify, and prepare for shipment to the nursery.
- Nursery gram adjustment function where nurseries can list several seedling requests on one screen and reduce the grams of seed required to sow the request.

Reports in SPAR are created by entry of parameters on a report submission form. Most reports are created as Adobe Acrobat pdf files. Other reports create data extracts in MS Excel format. SPAR reports include:

- Seedlot listing or search reports with one line of information per seedlot, seedlot detail report with options for all information for each seedlot, seedlot ownership by agency report, seedlot usage report, and seed orchard reports.
- Parent tree reports, listing the parent trees produced by breeding programs.
- Seedling Request listing or search reports with one line of information per seedling request, seedling request confirmation report, and seedling request status report.
- Nursery reports with seedling request information pertinent mainly to a nursery, such as sowing guidelines and sowing dates.
- Inventory reports that summarize quantity of seed available for specific areas.
- Seed use and genetic gain reports that summarize quantities of improved or natural stand seed used in seedling requests. These reports are important for incorporating genetic gain in timber supply analyses.
- Data extracts, that provide seedlot, parent tree or seedling request data in a spreadsheet format that can be sorted or manipulated by the user.

The Tree Seed Centre and Tree Improvement Branch headquarters staff has several administrative and approval tasks in SPAR.

- Table maintenance including test grams, test frequency, seed price, sowing rule factors, transfer limits, etc.
- Approval and completion of seedlot registration when all the requirements of the Chief Forester's Standards for Seed Use have been met and testing completed.
- Approval of parent tree registration and BVs.
- Monitoring and approval of seedling requests where privately owned surplus seed has been selected. This requires authorization by email from the seedlot owner.

SPAR Business Cycle

There are normally specific times of the year when there is heightened activity for the SPAR functions listed above. Seedlot registration depends on species-specific timing of cone collections. For example, most seed orchard collections occur between August and October. Most seedling requests are entered in the period from September to December. Seed withdrawal, preparation and shipments to nurseries for sowing happens between December and June, depending on the seedling request stock age and stock type.

During the slower period of the cycle from May through August each year, SPAR enhancements are developed and released. Maintenance of the application and database is ongoing all year as required. In 2006 there are some major infrastructure and security changes occurring during the slower period. Enhancements include a new online Vegetative Lot registration process and enhancements to existing reports.

SeedMap

SeedMap is a web-based mapping tool that provides clients with direct online access to maps and reports for gene resource management planning.

Until the 1990s, paper maps were used to display information on seed planning zones (SPZ), seedlot sources, etc. Geographic Information Systems (GIS) development then allowed for the creation of digital map files that could be created and viewed with GIS software. Tree Improvement Branch then moved into the world of internet-based GIS mapping technology with the development of SeedMap.

Data terminology distinguishes between 'attribute data' (e.g., collection information and seedlot test data stored in SPAR) and 'spatial data' (e.g., digital mapping of a seed planning zone polygon). Attribute data originate and are stored in an Oracle database from applications such as SPAR. Spatial data are produced using GIS applications and are centrally stored in the Land and Resource Data Warehouse (LRDW).

SeedMap is built on an Internet Mapping Framework (IMF) that allows users to view spatial data from the LRDW in a web browser. This makes gene resource management spatial data available to anyone, without requiring GIS software on their workstations. In SeedMap a user can select one or many layers to view at one time. Layers are equivalent to transparent overlays on a paper map.

SeedMap includes the following digital map layers:

- Genetic resources including GRM seed planning zones, natural stand seed planning zones, seed planning units, and seedlot sources (natural stand).
- Silviculture openings, activity treatment units regeneration strategies.
- Biogeoclimatic zones and subzones.
- Vegetation cover.
- Forest health – pest infestations since 1999.
- Bbase map data (land and water features, elevation, BC geographic system grid, NTS grid).
- Administrative boundaries (timber supply areas, tree farm licences, forest districts, watershed boundaries, parks).

Map tools available in SeedMap include: zoom in to a larger scale, zoom out to a smaller scale, select a specific area, identification of the attributes of a feature, drill-down identification of multiple attributes, text markup, point markup, polygon markup, pinpoint location, measure distance, measure area, save session, and print to pdf.

Using the layers and tools described above, SeedMap can be used for tasks such as:

- Viewing map layers to determine the seed planning zones and digital BEC zone/subzone for a planting site latitude and longitude or UTM.
- Viewing natural stand seedlot sources.
- Seedlot deployment history.
- Creating custom pdf maps with seed planning zones overlaid on BEC zones timber supply areas, or other features.

A link to look-up maps in ready-to-print pdf format for the following themes is also available from SeedMap:

- Natural Stand SPZs.
- Gene Resource Management SPZs.
- Gene Resource Management SPUs.

Together, SPAR and SeedMap provide the tools for a range of silviculture and forest management activities, including:

- Registration of seedlots and vegetative lots.
- Seed needs analysis and planning.
- Seedling request entry to meet reforestation obligations.
- Compliance & Enforcement audits of free-to-grow declarations, seedlot transfer and use.
- Incorporation of genetic gain in Timber Supply Analyses.
- Reporting on genetic gain and seed use for several monitoring and evaluation programs, including the BC FRPA Resource Evaluation Program, Criteria & Indicators for the Canadian Council of Forest Ministers and State of the Forests.

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CONE AND SEED PROCESSING SYSTEM (CONSEP)

CONSEP is the data management system used by BC's MoFR Tree Seed Centre. CONSEP and SPAR function together to operate as a "just in time" inventory, processing, invoicing, and decision management system for cones and seed. Seedlot Registration and Seedlot Action Requests are entered via SPAR and the data and information related to activities such as scheduling, processing, testing, preparation, and shipping are managed by CONSEP. CONSEP is organized into two main components, an Online Application for the entry and reporting of Data and a Batch component for the transfer of data to and from SPAR.

History

In the early 1990s, while SPAR was being developed as an IBM mainframe application, the Tree Seed Centre staff were managing data using a number of separate applications such as Tree Seed Register, Lab Control System, Sowing Request Action, and Import/Export Data to TSR/SPAR. A project was initiated to integrate all of the separate Tree Seed Centre systems and provide a better linkage to the corporate database (SPAR). This project included data modelling, business process modelling, documenting the business rules, and developing the tables, data entry screens, and reports – CONSEP is the end result. Since its initial development the principles of Continuous Improvement have been applied and CONSEP is updated and maintained as needed. Maintenance tasks are performed by both in-house staff and external contractors.

Technology Platform

Before CONSEP, the Tree Seed Centre applications were developed using DBASE/Clipper and basic LAN technology. CONSEP version 1.0 was developed as a Microsoft Access 1.1 application. This first version was functional but had its bumps and warts. CONSEP was soon retooled to use Microsoft Access 2.0 as the front-end application with an Oracle backend database. The current 2006 version of CONSEP still uses a MS Office Access/Oracle platform. As a Microsoft Office Application, most CONSEP screens and reports allow the user to copy/paste details to MS Excel or MS Word, this is a useful feature for ad-hoc sorting and reporting.

CONSEP Modules

CONSEP Online data:

- Seedlot Details – data reporting and links to Seedlot Storage, Testing, Processing, and Ownership.
- Cone and Seed Processing Requests – reporting and data entry screens for Cone and Seed Processing activities.
- Withdrawal Requests – reporting and data entry screens for activities related to Seed Withdrawal Requests, mainly Sowing Requests.
- Shipping Waybills – reporting and data entry for seed distribution activities at the Tree Seed Centre.
- Seed Sale and Transfer – reporting and data entry related to Seedlot Ownership transfer.
- Seedlot Testing – reporting, data entry, complex calculations and tolerance requirements, and management of activities for Seedlot Testing such as germination, moisture, purity, and seed weight.

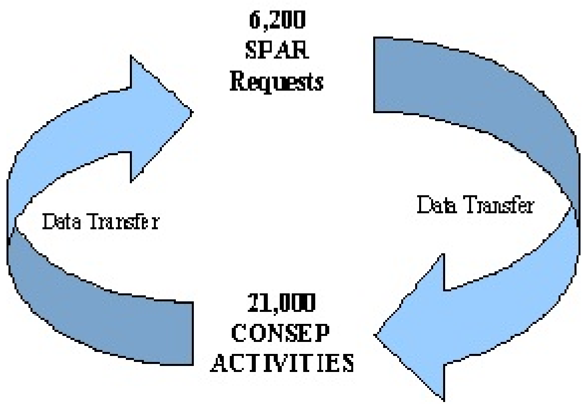
- Extension Services – reporting and data entry for activities such as publications requests and Tree Seed Centre Tours.
- Client Data – reporting and data entry for Tree Seed Centre clients.
- Administration and Table Maintenance – data entry screens for maintaining activity and workplan tables.
- Invoicing and Forecasting – invoice reporting and financial forecast reporting.
- Ad-hoc reporting for technical/operational requirements such as seed supply and demand analysis.

CONSEP Batch Data Transfer

CONSEP and SPAR both include batch data transfer modules that facilitate a nightly 2-way data exchange between the two applications. Features of these Batch Modules include:

- Scheduling batch jobs as daily, weekly, monthly, and adhoc.
- Pulling data to CONSEP from SPAR, the modules take the higher level seedlot and request data to generate and schedule the appropriate workplan and activities required to complete the requested action such seed withdrawal, stratification, and shipping.
- Pushing data from CONSEP to SPAR, the modules summarize the detailed seedlot and request data into the desired format such as key activity completion dates, seedlot test result data, and original seedlot balance.
- Batch processing of seedlot and request data such as generating germination retests, request status updates, and request activity invoicing.
- Batch reporting of seedlot and request activities such as seedlot registration and new/updated Seedling requests.

The following graphic illustrates the relationship between the number of activities recorded on CONSEP and the SPAR requests that generate those activities. 2003 request season data are shown.



Business Concepts

Workflow in CONSEP is based on the operational business concepts used at the Tree Seed Centre and includes the following:

- Workplan – requests are assigned a workplan that includes all the activities needed to complete the request. Workplans are assigned based on request type, species, nursery, and test type. For example, to complete a Seedling Request, the following activities are in the workplan: withdrawal from storage, seed stratification or pellet, ship to nursery. A Cone Processing Request include activities such as cone receipt, kiln loading, cone kilning, tumbling, screening, blending, moisture, purity, seed weight, germination testing, original seed balance (weight).
- Inhouse Inventory – request activities that can be grouped together with a common species schedule, and destination nursery are assigned to an inhouse inventory. This is a physical and logical grouping that simplifies the management of the thousands of activities.
- Germination Trays – Seedlot Germination Tests that have a common start schedule and stratification regime are grouped together and tracked via germination trays.
- Germination Count Estimate – prediction model used to capture future workload in the Tree Seed Centre lab.
- Seedlot Retest Schedule – generate Seedlot Retest requests based on current test age, species, seedlot inventory, and seedlot use history.

Future thoughts and possible improvements of CONSEP include integrating RFID (Radio Frequency Identification) technology and other plant floor integration such as the kiln process controller.

Summary

CONSEP is the data management tool used at the BC MoFR Tree Seed Centre to provide and capture:

- Chain of custody data for cones and seed,
- Reduction of employee effort and human error,
- Management of large information datasets,
- Moving from information to knowledge,
- Change management for processes and data,
- Seed processing and delivery with a "just in time" model,
- Process control and resource levelling, and
- Inventory management for cones and seed.

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INFORMATION MANAGEMENT OF ALBERTA'S REFORESTATION SEED

The Alberta Tree Improvement and Seed Centre (ATISC) is responsible for the registration, storage, and distribution of forest tree seed to be used for public land reforestation. ATISC manages the records for about 1800 registered seedlots and stores over 42 000 kg of seed. Eighteen species are represented in storage but the bulk of the provincial inventory is comprised of white spruce, lodgepole pine, black spruce, and jack pine seed.

All reforestation seed activities are documented with forms which are maintained for all registered seedlots, active or depleted, and include origin and collection information, processing and cleaning data, seed test data and results, and seed deployment information. Duplicate paper records are also maintained on all active and depleted seedlots and contain origin and collection information, seed test results, withdrawal request information, and current inventory balances. These duplicate records are kept in a different building location.

The Seed Information Management System (SIMS) database was developed to manage operational seed information in a comprehensive manner and became operational in the early 1990s. The Microsoft Access database is internal to ATISC and was recently updated and expanded to include seedlot information now required by the new Standards for Tree Improvement in Alberta implemented in 2003.

In SIMS, seedlot administrative information includes seedlot owner(s), registration category, and collection type (wild or improved). Seedlot origin is documented with species, elevation, seed zone, four latitude and longitude coordinates of the most north, south, east, and west perimeter points of the collection area, and a legal land description of the centre of the collection area using the Alberta Township System. Collection and processing information includes collection method and dates, number of parent trees, cone volume, processing facility, date of processing, and amount of seed received for storage. The system calculates the seed yield (g/hL) based on the hectolitres of cones collected/processed and kilograms of seed cleaned. Raw data are entered and results are calculated for moisture content, germination, and purity tests. One thousand seed weight results are entered directly into SIMS but seed testing facilities are required to provide the data to ATISC for review. Cold storage bay and shelf locations of all seedlots are also tracked in SIMS. Seed transactions are documented with transaction date, amount of seed, and purpose of withdrawal. If the withdrawal purpose is seedling production then the nursery and the number of seedlings to be grown are entered. SIMS automatically credits or debits a seedlot's inventory with the amount being added or withdrawn.

Reports most frequently requested are easily generated through a SIMS report function and include client inventories, inventories with seed test data, individual seedlot registrations, company or seedlot transaction histories, seedlot cold storage bay and shelf locations, and annual seed use summaries.

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ONTARIO TREE SEED PLANT INFORMATION MANAGEMENT EXPERIENCES

Some History

The Ontario Tree Seed Plant has a long history of meticulous record keeping. In the early days several staff were devoted to maintaining "the ledgers" with particular focus on yield, viability, and purity data. Cone collection details and seed shipping records were also kept. We are fortunate to have occupied the same location since 1923 which has helped preserve records. Staff continuity has played a significant role. The Seed Plant has a history of staff remaining in their positions for at least 20 and often over 30 years with a deep rooted culture of good record keeping. We simply don't throw anything out!

As the paper records grew to a nearly unmanageable proportion a decision was made to move to microfilm technology which was leading edge at the time. We now have fairly complete records on microfilm for the period from 1923 until 1995.

In the early '90's everyone realized that some sort of electronic data management tool was the way of the future. A number of small spreadsheets and databases were tried, fortunately the paper based system was never abandoned.

By 1995 a few key data management products were emerging that appeared to have the power and longevity to be appropriate to our program. As a government organization there were guidelines about what products could be used for programs which would become "corporate application".

After much discussion and consideration Microsoft Access was chosen and a local consultant was hired to produce what would become known as "Tree Seed Database" or TSD.

TSD Now

TSD has become the backbone of all operations within the Seed Plant. From the time cones arrive, through processing, testing and storage, all operational, scientific and administrative information regarding a seedlot is entered and available in TSD.

All workstations are networked to have access to TSD, which is actually located on a common, central drive. Technicians have access to the program in their work areas and are able to enter information about a seedlot as it changes through processing, testing, and storage. Administrative staff can generate reports on the status of seedlots, enter requisitions for seed orders, and generate invoices.

Technical information such as source, yield, total viability, germinative energy, and purity is all available through TSD.

The Future

We now have over 10 years of experience with TSD and have become very dependant on it. During that time the TSD program has seen some minor upgrades and adjustments but has served us well. The greatest difficulties have been during major systems upgrades. Newer, faster equipment does not always result in better operation of an existing program and database. Upgrades to Microsoft Access have also been problematic, however the original consultant author of TSD has supported the program through these upgrades. Having survived both hardware and software upgrades TSD has been quite stable for a few years now. As technology advances, it is imperative to budget for the additional costs of program and database conversion to ensure continuity of the records.

Looking ahead, we are exploring how to best integrate our pre-1996 records into digital format. The microfilm continues to serve us well but with increasing interest in our historical records from scientists and other agencies there is need to fully integrate the records.

Whether records are paper, microfilm, or digital their long-term accessibility, storability, and durability are all factors which must be considered as part of any data management program. The decisions can be difficult and costly but the data we are entrusted with are irreplaceable.

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DATA MANAGEMENT AT THE NATIONAL TREE SEED CENTRE

The National Tree Seed Centre (NTSC) was established in 1967. Management of data through database applications was initiated in the early 1980s when the records were entered in INGRIS which was a commonly used database at the time. INGRIS was run from a SUN station which users accessed via a local area network (LAN). One major disadvantage with INGRIS was that it required a trained individual to manage the database. A set of queries and reports were developed and if any modifications or additional queries or reports were needed, the database manager was the only person who could do it. In 1996 the NTSC was relocated to the Atlantic Forestry Centre and a decision was made to move the database from INGRIS to MS Access. The transfer of data was accomplished by converting all of the tables to text files, importing them into MS Access, and formatting them to suit the appropriate fields. MS Access was able to do this with very few problems.

The NTSC database contains records for almost 30 000 seedlots from over 450 species. Queries are easy to create (thanks to the Wizard feature) and allow the operator to select criteria in several fields and instantly view all relevant records. MS Access also has an easy-to-use HELP function that will guide you through a step by step scenario for solving challenging problems.

Each NTSC seedlot is assigned a unique number which also serves as one of the primary keys in the database. Information recorded on each seedlot consists of: date of collection, single tree or bulk collection, provenance, province, country, latitude, longitude, elevation, quantity of seed, and information on various tests such as moisture content, 1000-seed weight, and germination or viability.

Client information and seedlots sent are also kept in the database. The data entry form used for Client Information contains a toggle button that allows seed quantities to be updated (removes the quantity shipped from what is stored for the seedlot). A separate toggle button will print a report for the client of the seedlots being sent, along with all pertinent information on the seedlot including the most recent test information.

MS Access is compatible with MS Word and MS Excel. Information from a query can be sent to MS Excel to take advantage of the spreadsheet capabilities to further analyse the data or to send a data file to a colleague or client. Reports can be sent to MS Word for publication or editing

This past winter, the database tables were transferred to ORACLE to allow for internet access. The tables reside in Oracle but the platform on the PC is still MS Access. One major advantage of this for clients is that the status and information about each seedlot will always be current. An additional feature will allow seedlot locations to be plotted on an overlay of a species range map. This will provide the user with a visual display of the distribution of seedlots throughout a species' range in Canada.

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ORCHARD INFORMATION SYSTEM IN BRITISH COLUMBIA

The Orchard Information System (OIS) was developed under contract for the BC Ministry of Forests and Range to handle seed orchard data and mapping. In its first incarnation (ca. 1985) it ran in PC-Focus. The software was installed at all Ministry orchard sites and also supplied to most private seed orchards. Training sessions were held and the Ministry provided ongoing support. Functions included maintenance of data on orchard parents and individual orchard trees and maintenance of survey and treatment data. The system provided for data collection by hand-held data loggers. Various reports were available, including summary of tree survey data by clone. Most useful was the mapping function, where orchard maps could be produced, based on selection criteria querying tree, survey, or treatment data.

In the mid-1990's the Ministry contracted with the same developer to move the OIS to a Windows-based platform, FoxPro for Windows. Several enhancements were made at this time while the basic database architecture remained the same. The Ministry continued to support the private orchard sites in their use of the system but this support ended some time around 2001 when a shortage of resources compelled the Ministry to concentrate on core functions only.

The OIS is still being used at all Ministry orchard sites and some private sites. Most new orchard operators are using Microsoft Excel for their mapping and data handling needs. Excel is capable of filling all orchard data management needs but requires a reasonably advanced level of Excel literacy for effective use. A few private seed orchards have developed their own information systems, incorporating bar-code label printers and readers.

At Kalamalka we continue to use the OIS as the basis for our data management. However, we've added many enhancements to its functionality, most notably in the mapping output. Map files are imported into Excel where they are superimposed on templates and scaled to produce very effective maps which highlight tree locations based on user-specified selection criteria. We think that the mapping is the most useful function of any orchard data system. For instance, from a ripeness survey we will have a list of clones that are ready to be picked. It's a simple matter to produce a map which identifies the locations for all ramets of those clones that have a minimum number of cones. The map allows the pickers to move through the orchard in the most efficient way possible. Other improvements to the basic OIS include routines to allow data updating from Excel files and the use of a better data logger program which permits scrolling through a virtual map of an orchard on the data logger when recording survey values.

Although we remain quite happy with the OIS, it is mostly the enhancements we've added over the years that are still making it useful. For anyone shopping for an orchard data system I would recommend trying Excel, or perhaps investigating the availability of the systems recently developed by private orchards.

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THE PRT SEED CENTRE

The PRT Seed Centre is located at PRT Prince Albert Nursery situated near Prince Albert, Saskatchewan. PRT (Pacific Regeneration Technologies) consists of a network of nurseries located throughout Canada and the United States providing quality nursery products and services for reforestation. Collectively, these nurseries produce in excess of 220 million forest tree seedlings per year. PRT offers a wide range of seed services, starting with seed orchard production at PRT Armstrong and cone collection provided by PRT Frontier.

The Seed Centre at Prince Albert is a modern, full service seed processing facility with services including seed extraction, seed testing, upgrading, and storage. The Seed Centre staff is fully trained in all aspects of seed processing. The Seed Centre provides seed services to PRT's customers and is also the centre for PRT's internal seed processing and testing needs.

The seed plant was built in 1980 while the nursery was a provincial government run bareroot conifer nursery. After privatization in 1997, PRT assumed control of the nursery and the seed plant and, with the construction of nearly 300 000 square feet of greenhouse space, converted the nursery into a container growing facility.

Bags of cones delivered to the Seed Centre are placed in a fully ventilated cone shed. Cones that arrive at the Seed Centre "green" (immature) such as white spruce are placed on racks that allow for post-harvest curing.

The seed extraction facility features twin, side-by-side cone kilns. Each kiln contains two screened, rotating drums. The drums are filled to half capacity with cones and then kilned at the appropriate temperature and length of time according to the protocol for a particular species. Half filling the drums allows space for the opening cones to expand and to properly release their seed when tumbled. The drums rotate for 1 minute every half hour. Most species' cones are kilned for 24 hours at temperatures ranging from 45° to 65°C. The winged seed falls from the cones and is directed to a vibrating conveyer situated below the kiln drums that directs the seed into holding bins. The gathered seed is then de-winged and cleaned using specialized equipment. Depending on the amount of debris within the cone bags when received and the amount of pitch on the cones, the seed may need to be cleaned more than once to assure that the seedlot is at least 99% pure. Various methods of seed cleaning are used including screening, air separation, and water separation. When the seed has been fully cleaned it is either dried to between 5 and 9% moisture content and placed in freezer storage or soaked and stratified (if needed) in preparation for seeding. A small sample of the seedlot is withdrawn at this time for seed testing purposes.

The most common species extracted at the Seed Centre are jack pine, lodgepole pine, white pine, red pine, white spruce, black spruce, Douglas-fir, and various *Abies* species. Black spruce is an especially challenging species to extract due to its' tendency to remain tightly closed and to close back up once the cones have cooled. Black spruce requires multiple kilning periods. The cones are soaked in water between these kiln periods to allow the cone scales to flex open more easily and more effectively release their seed. For these reasons, black spruce is more costly to extract than other species. White pine and *Abies* species are also challenging due to the tremendous amount of pitch that can accompany these cones.

Of extreme importance in regard to seed extraction (and all seed processing work) is a thorough quality control program as well as exceptional organization and precise record keeping. All seed extraction and processing equipment is thoroughly cleaned between cone batches to prevent cross-contamination of seedlots or species.

Seed testing is performed on individual seedlots and consists of germination, number of seeds per gram, purity, and moisture content. Accurate, up to date seed tests are important for determining the amount of seed required by a nursery to successfully produce the seedling numbers required for an order. The seed lab performs seed testing on newly extracted seedlots as well as older seedlots. Seed tests are normally done on seedlots where no information is available or where the information is outdated. A new germination test is normally done every three years for older seedlots in storage at the Seed Centre. Seed testing is done in accordance with the International Seed Testing Association (ISTA 1999) protocols. Again, strict adherence to cleanliness and sanitation is an extremely important part of seed testing. All seed testing equipment is sanitized between tests. Germination tests are run in ConViron growth chambers. Seed upgrading is also done in the seed lab. In seed upgrading, the overall germination potential of a seedlot is improved by systematically removing empty or non-viable seed from the seedlot. This is normally done using air or water separation techniques.

Conifer seed that has a moisture content of between 5 and 9% can be placed in long term storage at -18°C. PRT Prince Albert has two seed storage facilities which are fully alarmed to protect our customer's valuable seed.

The bulk of the Seed Centre's extraction work is done for Saskatchewan and Ontario customers, but it also does extraction work for British Columbia companies (with permission from the Ministry of Forests and Range Chief Forester) and is certified by the Alberta Tree Improvement and Seed Centre for seed extraction for Alberta customers.

For more information concerning seed processing services offered by PRT, please contact Grant Harrison or your local PRT Customer Support Representative. The regional representatives can be located on PRT's web site at www.prtgroup.com.

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NATIONAL TREE SEED CENTRE

Single-tree black ash (*Fraxinus nigra*) seed collections were made in September/October 2005 at three locations in northern New Brunswick, one location in the Gaspé region of Québec, and a partial collection along the Saguenay River in Québec. These collections supplemented those made in 2004 as part of a project to conserve ash germplasm before it is destroyed by the Emerald Ash Borer and to allow for the evaluation of genetic variation within black ash. Seed quality is determined by viability testing because germination tests require about 12 months of warm and cold treatments in order for the embryo to complete elongation and dormancy to be alleviated. To test for viability, the seed is separated from the samara and soaked in water for 120 hours at 3°C. Embryos are carefully removed and placed on VersaPak™; 3 replications of 25 embryos each. Any dead or decayed embryos are noted and are included in the tally of the 75-seed sample from each seedlot. The germination boxes are placed in a germinator for 14 days set at a constant temperature of 25°C with 8 hours light per 24 hours. After 14 days the embryos are assessed. A viable embryo is one which has either remained as it was when excised or has developed chlorophyll in the cotyledons and/or the hypocotyl or radicle has started to elongate. The degree of embryo development varies among seedlots and is an indication of the degree of dormancy. Results from viability tests on 82 seedlots showed the average viability was 68% and ranged from 12 to 96%. This large range indicates tremendous variability in seed quality among seedlots. Viability percentages in the 80s and 90s are incredible especially since the seed cannot be processed to remove dead, damaged, empty or partially filled seed.

Germination testing was completed on 340 tamarack (*Larix laricina*) seedlots. Most of this seed was collected in the late 1970's and early 1980's for a range-wide provenance trial coordinated by the former Petawawa National Forestry Institute. Some of this seed had been tested in the mid 1980's. Germination averaged 40% and ranged from 0 to 98%. Generally, seedlots that had high germination in the 1980's still had high germination 20 years later. All seed was stored at -20°C.

An undergraduate forestry student at the University of New Brunswick completed a thesis on white spruce (*Picea glauca*) seed storage. Darren Hayes (2005) evaluated germination and moisture content of seed from several provenances and combined these data with those obtained from a single provenance several years ago. Seed was collected in 1974 to be used in a range-wide provenance coordinated by the former Petawawa National Forestry Institute. In 1978, samples of seed were removed from many of the individual tree collections and placed in storage at 4°C and -20°C. There were 36 seedlots from 5 provenances which had moisture content and germination data from late 1974 or early 1975. The original moisture content and germination was 4.5% and 94.5%, respectively. After about 28 years in storage at 4°C, average seed moisture content was 7.8% and germination was 24.7%. The same seedlots stored at -20°C averaged 6.0% moisture content and 94.1% germination. Moisture contents greater than 8.5% had a noticeable negative impact on germination of seed stored at 4°C. It is not obvious how the seed stored at 4°C gained moisture but nonetheless the combination of moisture and temperature were detrimental to seed survival in contrast to storage at -20°C where germination remained unchanged.

Hayes, D. 2005. Effect of storage temperature and moisture content on germination of Picea glauca seeds. Unpubl. BScF thesis, Univ. New Brunswick. 24 p + App.

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INTERIOR SPRUCE CHEMICAL TREATMENT TRIAL

An investigation into the use of a variety of chemical seed treatments was conducted to determine if improvements could be made to the germination characteristics of interior spruce (*Picea glauca*, *P. engelmannii*, and hybrids). Five different chemical treatments and a control were applied to samples of 20 seedlots of interior spruce. The 20 seedlots were comprised of ten operational seedlots, five half-sib family lots and five operational sowing requests that had been stratified, dried back to storage moisture content (approximately 8%) and stored in a freezer (-18 C) for between 6 and 9 months. Treatments were conducted in four 'Rounds' of five seedlots to enable one person to perform all counts on peak days (i.e., the ten operational seedlots were divided into two rounds of five seedlots). The seed treatments are presented below.

T1 – Control – The seed was soaked for 24 hours and placed into cold stratification for 21 days.
T2 – Seed Flow Lubricant – The seed was soaked for 24 hours and surface moisture removed from the seed coat. The seed was then placed in a small ziplock bag and 1 magic scoop[2] of seedflow lubricant (0.135 g) added and the bag agitated for 30 seconds. The seed was then stratified for 21 days.
T3 – Early Harvest TST - The seed was soaked for 24 hours and surface moisture removed from the seed coat. The seed was then placed in a small ziplock bag and add 1 magic scoop[1]of Early Harvest TST (0.100 g) added and the bag agitated for 30 seconds .The seed was then stratified for 21 days.

[2] A magic scoop is the code word for a McDonalds' coffee stirrer spoon volume

T4 – Early Harvest PGR - The seed was soaked for 24 hours in a 500 ppm solution of Early Harvest PGR. No rinsing performed. The seed was then stratified for 21 days.
T5 – Gibbex - The seed was soaked for 24 hours in a 500 ppm solution of Gibbex. No rinsing performed. The seed was then stratified for 21 days.
T6 – Hydrogen Peroxide - The seed was soaked for 24 hours in a 3% hydrogen peroxide solution. No rinsing performed. The seed was then stratified for 21 days.

Germination testing was conducted using four replicates of 100 seeds. Tests were conducted using a germination dish containing one piece of 22-ply Kimpak, 50 ml of water and one piece of filter paper upon which the seeds were placed. Testing was conducted for 21 days under the 30:20 temperature regime specified by ISTA (ISTA 1999). Seed was considered germinated when the radicle was 4X the length of the seed coat. Counts were performed on Monday, Wednesday, and Friday allowing for determination of the germination capacity (GC) as well as the germination rate. Germination capacity is defined as the percentage of seeds that germinated normally during the 21-day test period. Peak value (PV) is the variable used to describe germination rate. It is the maximum number obtained by dividing the cumulative germination at day x by day x (Czabator 1962).

Analysis and Results

Although unconventional, I will discuss the statistical results prior to discussing the raw data. The data were first analyzed with all Rounds combined as a split-plot design (the 'Round' effect restricts the randomization of seedlots). The Round and Treatment were considered fixed effects and seedlot a random effect (nested in round). Although the Round term was considered non-significant ($P>F = 0.97$), the Round*Treatment interaction term was significant and one should not draw conclusions about a main effect if any interaction with it is also significant. Therefore this analysis, which I haven't provided for brevity, indicates that the effect of seed treatment on both GC and PV is dependent on the round, or seedlots, used. Examination of residuals (actual – predicted) showed no deviations from normality or unequal distribution of variance.

To further investigate the data, analyses were performed separately by round. The model of the subdivided analysis was a simple factorial experiment crossing seed treatment and seedlot. For all four rounds and for both GC and PV the interaction term was again statistically significant indicating the effect of the treatment was dependent on the seedlot it was applied to. Examination of residuals (actual – predicted) showed no deviations from normality or unequal distribution of variance. The results of GC and PV for each round are displayed in Table 1 illustrating that treatments T2 and T3 averaged above the control for both variables and the remaining three treatments fell below the control.

The germination curves for the six treatments averaged over all seedlots are presented in Fig. 1. The curves for treatments 2 and 3 are nearly identical and illustrate that by day 9 these treatments have an 18% advantage in GC over the control.

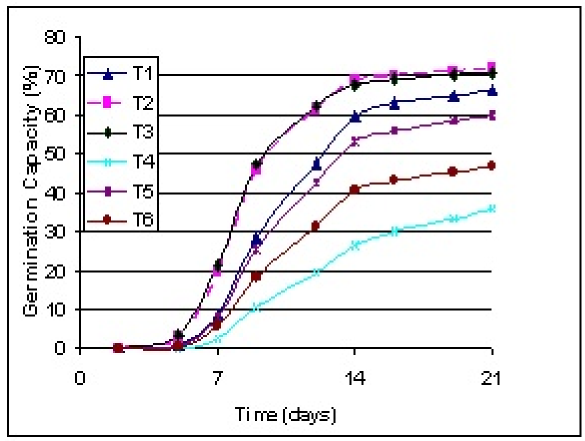

Figure 1. The average germination curves for the six seed treatments.

Discussion

The statistical analysis indicated that the effect of the treatment was dependent on the seedlot it was applied to. In a purely statistical sense one cannot conclude that treatments had a consistent effect across all seedlots. Are there still some reasonable conclusions that can still be drawn from this data set? I'm convinced that there are.

Two of the treatments (T2 and T3) consistently performed better than the control for both GC and PV. Treatment 2 produced the highest GC and PV for 11/20 seedlots examined in this study. Treatment 2 is an interesting surprise, as we did not think it would have any effect on germination characteristics. The Seed Flow Lubricant (powdered graphite) is being used at some BC nurseries to facilitate mechanical

Table 1. The average and round response in germination capacity (GC) and peak value (PV) to the six seed treatments.

	Treatment					
Round/Variable	T1	T2	T3	T4	T5	T6
R1 / GC	68	70	71	42	62	46
R1 / PV	4.7	5.5	5.6	2.5	4.2	3.1
R2 / GC	61	68	67	29	63	41
R2 / PV	4.6	6.1	6.6	1.8	4.4	2.6
R3 / GC	64	75	75	38	67	37
R3 / PV	4.5	6.4	6.4	2.1	4.5	2.3
R4 / GC	70	74	70	34	48	63
R4 / PV	4.4	5.3	5.2	1.7	3.0	4.0
Overall GC	66	72	71	36	60	47
Overall PV	4.6	5.8	6.0	2.0	4.0	3.0

sowing. We wanted to confirm that it had no detrimental effect on germination characteristics, but were surprised by the consistent improvement in germination characteristics exhibited. The Early Harvest TST (Talc Seed Treatment) also outperformed the control and produced the best GC in 7/20 seedlots and the best PV in 9/20 seedlots. This talc mixture contains small quantities of cytokinin, indolebutyric acid and gibberellic acid.

Results were even more consistent at the poor end of the scale. Treatment 4 was the worst treatment for GC in 12/20 seedlots and produced the slowest germination (PV) in 15/20 of the seedlots. This solution also contained cytokinin, indolebutyric acid, and gibberellic acid but in slightly higher percentages by weight than the talc seed treatment. The hydrogen peroxide treatment also did poorly, as it was the worst treatment in 7/20 seedlots for GC and 5/20 seedlots for PV. This treatment was perhaps extreme as hydrogen peroxide was substituted for water in seed hydration. Hydrogen peroxide is still considered a good treatment for seed sanitation following seed imbibition. The final treatment (T5) was inferior to the control and produced the worst GC and PV for one seedlot. This solution contained gibberellic acid as the active ingredient.

While the statistical results may be inconclusive this trial has identified two treatments (T2 and T3) that should be evaluated further. I suggest that the significant Treatment*Seedlot interaction term is caused by rank changes in the middle of the results profile, but the best and worst treatments are fairly consistent across seedlots. The two best treatments appear to improve both the germination capacity and germination rate of interior spruce. With the desire to be more efficient with seed use an increase of even 6% in germination capacity equates to almost a 10% increase relative to the mean. Increased germination capacity results in a need for less seed. Increased germination rate indicates that the window for pests attacking succulent germinants will be narrower, the energy required to complete germination will be less and a grower will have a more uniform crop from the outset. All of these attributes are worth pursuing and we will be looking at the effect of the Seed Flow Lubricant and the Early Harvest Talc seed treatment with other species to determine if these benefits are universal. Supplier contacts for the two ‘superior’ treatments are given below:

Seed Flow Lubricant, Distributed by: CASE Corporation, 700 State St., Racine, WI 53404 USA

Early Harvest TST, Mark Crawford, Griffin L.L.C., 2509 Rocky Ford Rd., Valdosta, GA 31601 USA

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HIGH-RESOLUTION MRI IN CONIFER SEEDS

Magnetic resonance imaging (MRI) is a superior non-invasive diagnostic tool widely used in clinical medicine, with more than 60 million MRI tests performed each year worldwide (http://nobelprize.org/medicine/laureates/2003/press.html). The important characteristic of MRI, whether applied to produce images of human or animal organs, or images of plant tissues, is the resolution it can provide, which for most imagers is specified per pixel, similar to digital photography. The spatial resolution of a standard medical MR imager is about 1x1 mm^2 per pixel, which is adequate for most clinical applications. Consider using the same medical MRI machine for smaller objects, like tree seeds. If a pine seed is about 5 mm long, the resulting MR image would consist of only 5 pixels per seed, hardly sufficient for any practical use.

For these reasons, specialized high-resolution MRI systems have now been developed, capable of 100 to 1000 times higher resolution than the typical "whole body" medical MRI systems. Such highly improved resolution allows the study of samples of interest in great detail and in a nondestructive manner. Thus, the method is often called MRI microscopy, or μ-MRI. One unfortunate "trade-off" of the high-resolution MRI systems is limitations on the size of the sample, which normally cannot exceed 25 mm diameter, but luckily this is not an issue for most tree seeds. MRI microscopy is used primarily in material science, but has gained in popularity in plant physiology (Chudek and Hunter 1997; Ishida et al. 2000; Köckenberger 2001). MRI provides a wealth of information on the internal anatomy of plants *in vivo*; similar studies have just begun in seeds (Terskikh et al. 2005; Manz et al. 2005; see references therein).

An additional limitation is that there are only a few high-resolution MRI machines available worldwide. One of the best-known to plant scientists is located here in Canada, in Saskatoon, in the Plant Biotechnology Institute of National Research Council, PBI NRC (http://pbi-ibp.nrc-cnrc.gc.ca/en/research/nmr.htm). For those who are familiar with the subject, this MRI system is based on the 360 MHz Bruker Avance WB NMR spectrometer, equipped with a Bruker microimaging unit. The system is well-maintained and routinely produces a resolution of 20x20 μm^2 per pixel, or even better when longer acquisition times are used, depending on the nature of the seed material. At PBI, MRI is mostly used to image seeds of crop plants, such as canola or barley, as well as to study whole plants or plant tissues. Recently their MRI has been used to study whole intact cones of several conifer species at different stages of development.

In many respects, MRI of plant seeds provides information similar to that derived from X-ray radiography (Kolotelo et al. 2001), although the origin of the contrast in the two techniques is different. X-ray radiography generally provides images of hard tissues, while MR images originate from soft tissues and liquid-like components. For example, the seed coats of dry seeds, solid fats of some seeds, and the protein and carbohydrate storage reserves are not detected by MRI. In medicine, the two techniques, X-ray and MRI, are often used together to complement each other.

In our NSERC (Natural Sciences and Engineering Research Council) strategic grant "Novel approaches for improvement of conifer seeds quality and germination", awarded jointly to SFU (Simon Fraser University) and PBI, we are testing the feasibility of using MRI techniques to address problems related to seed dormancy and seed deterioration in conifer species during storage. Our long-term goal is to develop MRI-based techniques that may help to predict the germination and growth potential of conifer seeds.

A typical high-resolution MRI image of a dry Ponderosa pine (*Pinus ponderosa*) seed (seedlot # 32000) is shown in Fig. 1. In dry conifer seeds MRI images originate from liquid storage oils. Different oil content in different seed tissues provides excellent image contrast, so that the internal anatomy of seeds can be studied in detail. The oil concentration in this MRI image is color-encoded according to a color-bar provided. Areas with the highest oil content are white, while areas containing no oils are black. In Fig. 1, the shrunken (dry) embryo in the embryo cavity surrounded by the megagametophyte is readily discerned. Note the fine anatomical details of the embryo and the megagametophyte.

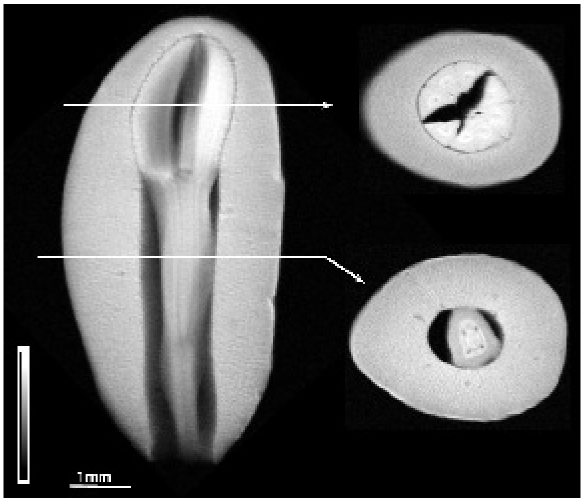

Figure 1. MRI of a dry Ponderosa pine seed (resolution 20x20 μm^2).

Unlike X-ray radiography, the MRI operator is free to choose any orientation of the plane of view, taking virtual "slices" through the seed to image its detailed anatomy (see axial images through the cotyledons and the hypocotyl in Fig. 1). Three-dimensional MRI reconstruction is also possible (Terskikh et al. 2005). MRI can be applied to rapid screening of conifer seeds, providing information on insect or mechanical damage, poor seed fill or embryo abortion, and other developmental problems (Fig. 2).

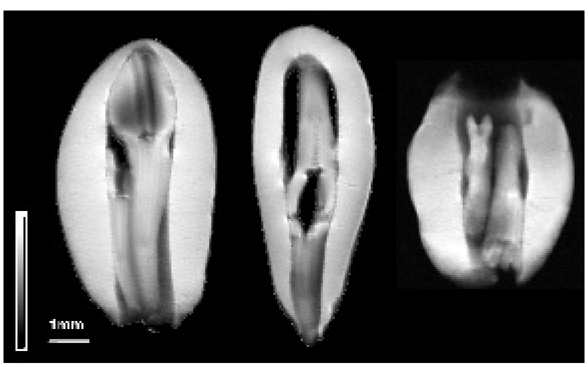

Figure 2. Polyembryony in Ponderosa pine seeds (MRI).

As has been mentioned, in dry conifer seeds the only liquid component detectable by MRI are the storage oils. During imbibition, however, seeds absorb considerable amounts of water; thus water uptake and distribution can also be monitored with MRI. In imbibed seeds it is possible to simultaneously record two separate MRI images: one of oil distribution and the other of water distribution (Figure 3). As MRI images can be considered maps of intensity or concentration, it is straightforward to obtain numerical values for water and oil content in different seed tissues *in vivo*, i.e., without destroying the seed or altering it in any way. There is presently no other technique capable of performing such measurements *in vivo*. We are using this approach to study imbibition kinetics in conifer seeds as related to seed viability (for more details see Terskikh et al. 2005) and most recently have used this method to monitor the *in vivo* changes in water and oil distribution in germinating seeds, i.e., consumption of storage oils in young seedlings during post-germination reserve breakdown.

Figure 3. MRI images for oil and water recorded simultaneously in the same imbibed Ponderosa pine seed.

Similarities between X-ray and MRI are illustrated in Figure 4 for western white pine (*Pinus monticola*) seeds (seedlot # 08006). Twelve dry seeds were assembled on a plastic plate with double-sided adhesive tape. The X-ray image was taken at the Tree Seed Centre (Surrey, BC) and the MRI image of the same seed assembly was taken at PBI. In both images, empty seeds are readily seen. Close inspection of both images reveals many other interesting complementary anatomical features. Note that the seed coats in dry seeds are visible only in the X-ray image and not in the MRI (hard vs. soft tissues).

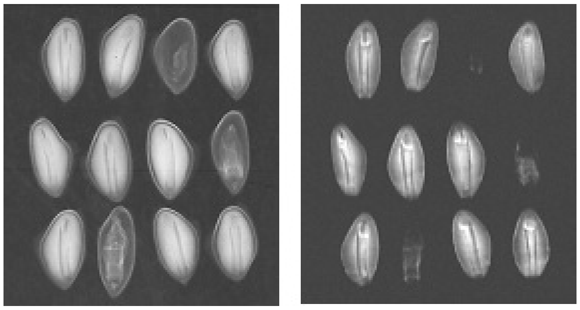

Figure 4. X-ray (left) and MRI (right) for the same set of western white pine seeds.

In a similar fashion, seeds from five seedlots of western redcedar (*Thuja plicata*) were assembled on a plastic plate, and X-ray and MRI images were taken (Figure 5, bottom to top: seedlot # 27153 – germination 86%; # 09035 – 24%; # 08484 – 0%; # 20202 – 0%; # 04790 – 0%). Even though visual inspection or X-ray images show no significant differences in these five seedlots, the germination tests revealed very different viability. The germination data correlate well with the MRI results: non-viable seedlots show very weak or no MRI signals (Figure 5). Reduced MRI signals in poorly performing seedlots are due to lack of storage oils, the major nutrient reserve in conifer seeds that supports early post-germinative seedling growth. This could be due to developmental problems or environmental stress during seed fill or it may be related to deterioration during seed storage. Based on these and other NMR spectroscopic results, we have demonstrated that the deterioration of western redcedar seeds in storage is accompanied by, and most likely caused by, the oxidation of storage oils and seed proteins (Terskikh et al. unpublished). This last example shows certain advantages of MRI over X-ray analysis; however, the two techniques can be used to supplement each other in assessing the internal anatomy of seeds and in predicting *viability* of seeds non-invasively and non-destructively.

We presently have an extended collection of high-resolution MR images of seeds of many different conifer species, including western white pine, Ponderosa pine, lodgepole pine, loblolly pine, stone pine, white spruce, western hemlock, Pacific silver fir, yellow-cedar, and western redcedar. This collection is destined to grow with our experience and continuing interest in the subject.

We encourage you to think about possible applications of MRI in your practice, whether it is fundamental seed science or applied seed technology. You may address your questions and suggestions to Allison Kermode of SFU (conifer seed dormancy and quality), or to Sue Abrams or Brock Chatson of NRC-PBI (MRI technology). The modern NMR/MRI facility at PBI is available to third-party clients on a fee-for-service basis or for collaborative research projects.

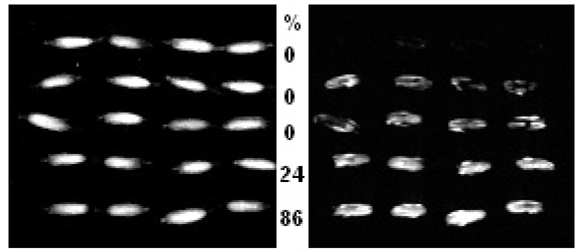

Figure 5. X-ray (left) and MRI (right) for five different western redcedar seedlots (germination capacity is shown for each seedlot).

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Further Reading

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NEW INTERIOR CONE AND SEED PEST MANAGEMENT BIOLOGIST

On 23rd May 2006, Jim Corrigan took over the reins of the BC Ministry of Forests & Range's "Interior Seed & Cone Pest Management Biologist" position based out of the Kalamalka Forestry Centre in Vernon. Jim comes to us following a successful and interesting career in teaching and applied environmental biology in and around Ontario. He holds a BSc in Agriculture from the University of Guelph, a BEd in Biology & Environmental Science from the University of Western Ontario, and a MSc in Entomology from Rutgers University. He has over 25 years of experience in pest management, teaching, and extension work. His combined understanding of research, operational pest management (including relevant legislative issues), and the real value of extension education and training led us to offer the Pest Management Biologist position to him.

Most recently, Jim led the highly successful Ontario program to control the invasive wetlands plant Purple Loosestrife. This program (considered to be one of the best examples of successful classical biological control) was a complex blend of operational pest management activities built upon existing research knowledge and incorporating a large extension, training, and public education component.

Jim can be contacted at the Kalamalka Seed Orchards site by phone (250 549-5696) or E-mail jim.corrigan@gov.bc.ca .

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DIGITAL SEED ATLAS

The new Digital Seed Atlas of the Netherlands will appear in May 2006. It consists of digital photographs, made with the help of a microscope, of the seeds and fruits of over 1800 native plants, adventive plants, and naturalized cultivated plants.

The atlas will consist of a book and a website. The book will be in full colour and hardbound, in A4 size. Each page has 9 colour photographs of seeds and fruits, with a total of c. 3800 colour photographs. The introduction is in both English and Dutch, and at the back of the book are indexes of the Dutch and the scientific names of the plants.

Purchase of the atlas gives you the right to access the website, which will be managed by the Library of the University of Groningen. Private individuals will have access to the website by means of a user name and password, institutions through IP address authentication so that all staff will automatically have access to the website without further identification.

For more detailed information – e.g., a full colour pdf file in English with an example of the page lay-out, examples of photographs on a larger resolution, and an order form – I refer you to the website of the Groningen Archaeological Studies (GAS) at http://www.gas.ub.rug.nl

If you have any further questions, please feel free to contact the undersigned (subject: Digital Seed Atlas or DSA), who is one of the authors of the atlas.

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UPCOMING MEETINGS

AOSA/SCST/AOSCA Joint Annual Meeting
June 3–8, 2006 Indianapolis, IN
www.indianacrop.org/2006isc.htm

ISTA Annual Meeting
June 26–29, 2006 Zurich, Switzerland
www.seedtest.org

IUFRO Seed Physiology and Technology
July 18–21, 2006 Fredericton, NB
cfs-IUFRO@nrcan.gc.ca

30th Canadian Tree Improvement Association
July 24–29, 2006 Charlottetown, PEI
http://www.gov.ns.ca/natr/forestry/ctia/

ISTA Forest Tree and Shrub Seed Seminar
Sep 12–15, 2006 Verona, Italy
www.seedtest.org

Forest Nursery Association of BC Annual Meeting
Sep 18–20, 2006 Penticton, BC
Gary.deBoer@tolko.com

28th ISTA Congress
May 5-11, 2007 Iguassu Falls, Brazil
www.seedtest.org

Seed Ecology II
Sep 9–13, 2007 Perth, Western Australia
www.seedecology2007.com.au

Carrefour de la recherche forestière
Sep 19–20, 2007 Québec City, QC
http://www.mrn.gouv.qc.ca/carrefour/

IUFRO Larix Symposium
Sep 16–21, 2007 Québec City, QC
http://www.mrn.gouv.qc.ca/carrefour/larix.asp

Canadian Poplar Council
Sep 16–21, 2007 Québec City, QC
http://www.mrn.gouv.qc.ca/carrefour/populus.asp

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An especially diverse set of selected references for your enjoyment, courtesy of Dave.

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