Precise record keeping: The Minnesota system

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Abstract. Tree improvement programs are often regional in scope. Sharing of genetic material among programs is necessary to fully utilize the variability which is available. While providing benefits, this sharing of material also produces difficulties due to differing record keeping systems employed by various programs. As programs move into advanced generations and as more and more genetic material is shared, the chances for unknowingly using related material increases. More precise record keeping systems would greatly reduce the possibility of such errors occurring.

The Minnesota Tree Improvement Cooperative has developed a record keeping system to eliminate problems of unclear identity. The four main characteristics of the system are 1) simplicity, 2) maintenance of lineage through generations, 3) unique identities for each tree in the program, and 4) keylists which catalogue every tree and seedlot in the program.

The record-keeping system is described and the necessity for precise record keeping is emphasized.

Keywords: tree improvement, genetics, record keeping

Development of a long term record keeping system is a necessity for any successful tree improvement program. The record keeping system must maintain accurate information on both individual tree identity and lineage. This must be done without being cumbersome or complex. In a region where genetic material is shared among improvement programs, additional burdens are placed on record keeping systems so the identity of material is not lost, and so that related material is not inadvertently used. Such a system has been developed by the Minnesota Tree Improvement Cooperative (MTIC) and is offered as a model of a precise record keeping system.

The cooperative has been in existence for six years. It is built upon substantial tree improvement work done in the North Central region, such as the NC-51 provenance tests dating from 1960 (Wright 1964) and other tests from earlier years. The tree improvement program has grown in size and complexity, and the potential for errors in record keeping has increased as well. This problem is exacerbated by the sharing of genetic material with other programs in the region. Before the problem got completely out-of-hand, and prompted by a few difficulties in determining the identity of material, it was decided

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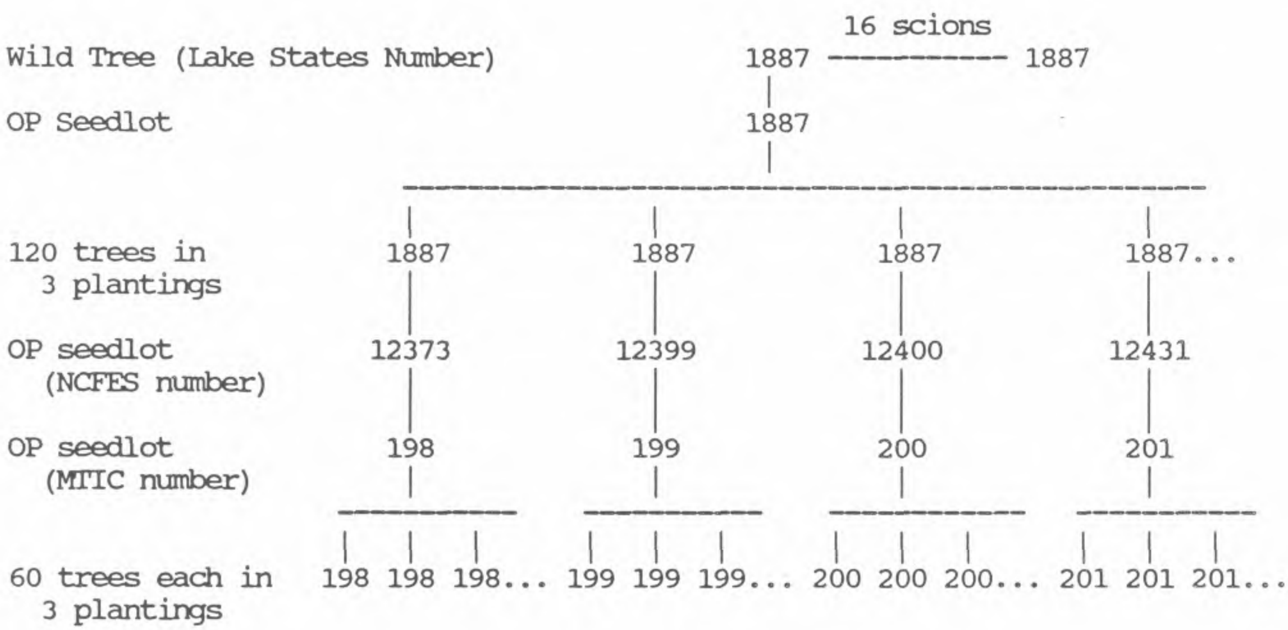
that the existing Cooperative record keeping system should be modified to ensure accuracy in material identification.

An example of the difficulties encountered with the old system is illustrated in Figure 1. It traces the history of a white spruce tree which was first included in a tree improvement program in 1959.

Figure 1. Records for white spruce tree 1887. (OP = open-pollinated, NCFES = North Central Forest Experiment Station, U.S. Forest Service)



Tree 1887 was a white spruce growing in Menominee County, Wisconsin. Open pollinated seeds were collected from it in 1959 by the U.S. Forest Service for use in a test to compare growth of Lake States and Ontario sources of white spruce (Jeffers 1970). The test included three plantings with 40 progeny from each selected tree in each planting. All trees in the test were labeled using the same number as the one assigned to the parent tree (1887).

The offspring of tree 1887 were good growers, and seed from four of them from one of the plantings were provided for use in a white spruce progeny test currently underway in Minnesota. When seeds were collected from each of the four trees, they were assigned seedlot numbers 12373, 12399, 12400, and 12431 by the North Central Forest Experiment Station. These seedlots were given MTIC numbers 198, 199, 200, and 201, respectively, to conform to a record keeping system already in use. Without extensive records and considerable personal communication, it is not at all obvious that all the trees grown from these four seedlots are "grandchildren" of the original parent tree.

To further complicate the records, scions from tree 1887 were grafted in 1959 as part of a study to determine potential seed production from white spruce clonal seed orchards (Nienstaedt and Jeffers 1970). While probably not used any further in the genetics program, all ramets were also assigned number 1887 (Figure 1). Except for good memories (which seem to deteriorate with time) and some written descriptions of the source of the material, the identification numbers cannot be used to distinguish between the ramet 1887 and the progeny 1887. Examples similar to this also exist in Minnesota Tree Improvement Cooperative records for material which has always resided within Minnesota.

THE NEW SYSTEM

A decision to revamp a record-keeping system is not made lightly. All old records must be converted to the new system, and all old documentation resting in the hands of cooperators must be replaced with new documentation. The new system should be "perfect," or nearly so, to avoid the difficulties associated with converting old records more than once.

A number of characteristics were identified as desirable in developing the "ideal" record keeping system; 1) keep it simple, 2) maintain some indication of parentage in identification numbers, 3) provide a unique identification number for every tree, and 4) create "keylists" for each species which would catalogue every tree and seedlot in the program. The Cooperative record keeping system was modified using this wishlist of desirable characteristics.

Figure 2 shows a hypothetical set of material generated from a single wild tree. Throughout the example, it is assumed that collection of three types of propagules could be made from any tree, namely vegetative propagules, open pollinated seed, or control pollinated seed. Inter-specific crosses are not considered in this example, although a record keeping system for them could easily be developed using the same rules as applied to intra-specific controlled pollination. Circled letters on the figure are referred to in the text. The structure of the data files used for each of the keylists is shown in Table 1.

Wild trees

Every wild tree selected for use in the MTIC program is given a family number. Within each species, the numbering begins with 101 and continues consecutively. In Figure 2, the wild tree has been given number 123 (letter a). This family number serves as the backbone of the record keeping system and is used to trace lineage of individual trees. One keylist for each species is maintained for wild trees which have been selected. Information kept on wild trees includes legals, latitude and longitude, state, county, and date the tree was selected.

Table 1. Structure of keylist data files.

Wild Trees	Halfsibs	Fullsibs	Seedlots
Family	IDhalf	IDfull	IDseed
Alias	Seedlot	Seedlot	Female
State	Planting	Planting	Male
County	Rep	Rep	Collectdate
Township	Set	Set	Location
Range	Position	Position	Seedonhand
Section	Row	Row	Other
Forty	Dead	Dead	
Latitude			
Longitude			
Selectdate			

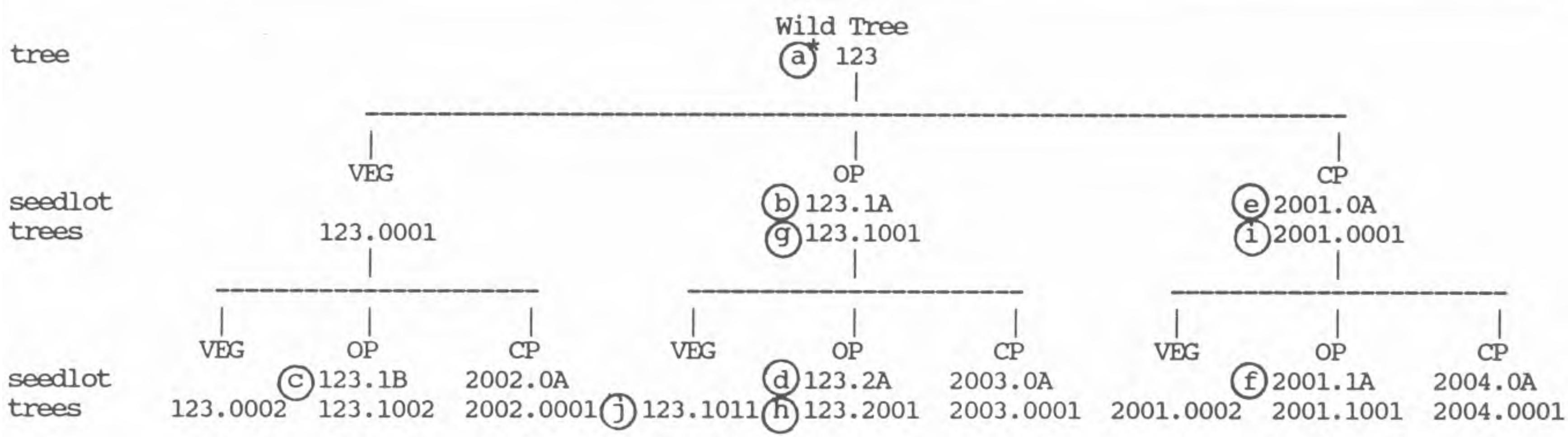
Seedlots

All seedlot records are kept separate from tree records. All seedlots from a single species, whether open or control pollinated, are placed in a separate data file on a computer. Information in the file on each seedlot includes male and female parent, seed on hand, date collected, and other available information (e.g., germination rate, storage location, etc.).

Open pollinated seedlots (letter b) are given an alpha-numeric identification which includes the family number of the parent tree (123) , a number designating the number of generations from the wild tree or a clone of the wild tree (.1) and a letter indicating specific collections (A). Putting the entire number together yields 123.1A, which is interpreted as the first open pollinated seedlot collected from tree number 123, or a clone of tree 123. Seedlot number 123.1B would represent a different collection of open pollinated seed from the same tree or a clone of that tree (letter c). Letters progress sequentially to identify different collections from the same tree or a clone. An open pollinated seedlot collected from a tree grown out of seedlot 123.1A would be labeled 123.2A (or some other letter) (letter d).

Seedlots arising from controlled pollination are also given alpha-numeric identification numbers. To distinguish them from open pollinated seedlots, control pollinated seedlots begin with the number 2001 and proceed consecutively with no upper limit. In a controlled cross, the generation designation is 0 (zero) and as with open pollinated seed, letters beginning with "A" are used to designate different iterations of the same cross between two trees (letter e) . Therefore, seedlot number 2001.OA represents the first set of seeds collected from an intra-specific controlled pollination. Seedlot number 2001.0B represents seeds from the same cross made in a different year, or perhaps made in the same year between clones of the parents of seedlot 2001.OA. The seedlot data file would be consulted to determine the difference between seedlots 2001.OA and 2001.0B.

Figure 2. Identification numbers for an hypothetical set of genetic material generated from a single wild selected tree. (VEG = vegetative propagule, OP = open-pollinated offspring, CP = control-pollinated offspring).



*a - wild selected tree
b - open pollinated seedlot from wild tree
c - open pollinated seedlot from clone of wild tree
d - second generation open pollinated seedlot
e - control pollinated seedlot
f - open pollinated seedlot from full-sib tree
g - half-sib tree from open pollinated seedlot
h - half sib tree from second generation open pollinated seedlot
i - full sib tree from control pollinated seedlot
j - vegetative propagule from half-sib tree from open pollinated seedlot

Labeling of an open-pollinated seedlot collected from a tree grown from seedlot 2001.OA would revert to the system described above, and thus would be identified as 2001.1A (letter f).

Half-sibs

Half-sib trees (those originating from the same female parent, regardless of seedlot) are identified using the family number, the generation designation from their seedlot number, and a unique tree number beginning with . 001 and proceeding to .999 (letter g). Thus, trees grown from seedlot 123.1A and/or seedlot 123.1B would be numbered beginning with 123.1001 and continue consecutively up to 123.1999, if needed. Trees grown from seedlot 123.2A would be numbered beginning with 123.2001 (letter h). Records for all half-sib trees in each species are maintained in a half-sib keylist which contains information on parentage and field planting location.

Full-sibs

Full-sib trees are labeled in a manner similar to half-sib trees. The identification number consists of the full-sib family number, the generation number, and a unique tree number beginning with .001. Trees grown from the seedlot 2001.OA would be numbered from 2001.0001 through 2001.0999 (letter i). Records for full-sib trees in each species are maintained in a full-sib keylist.

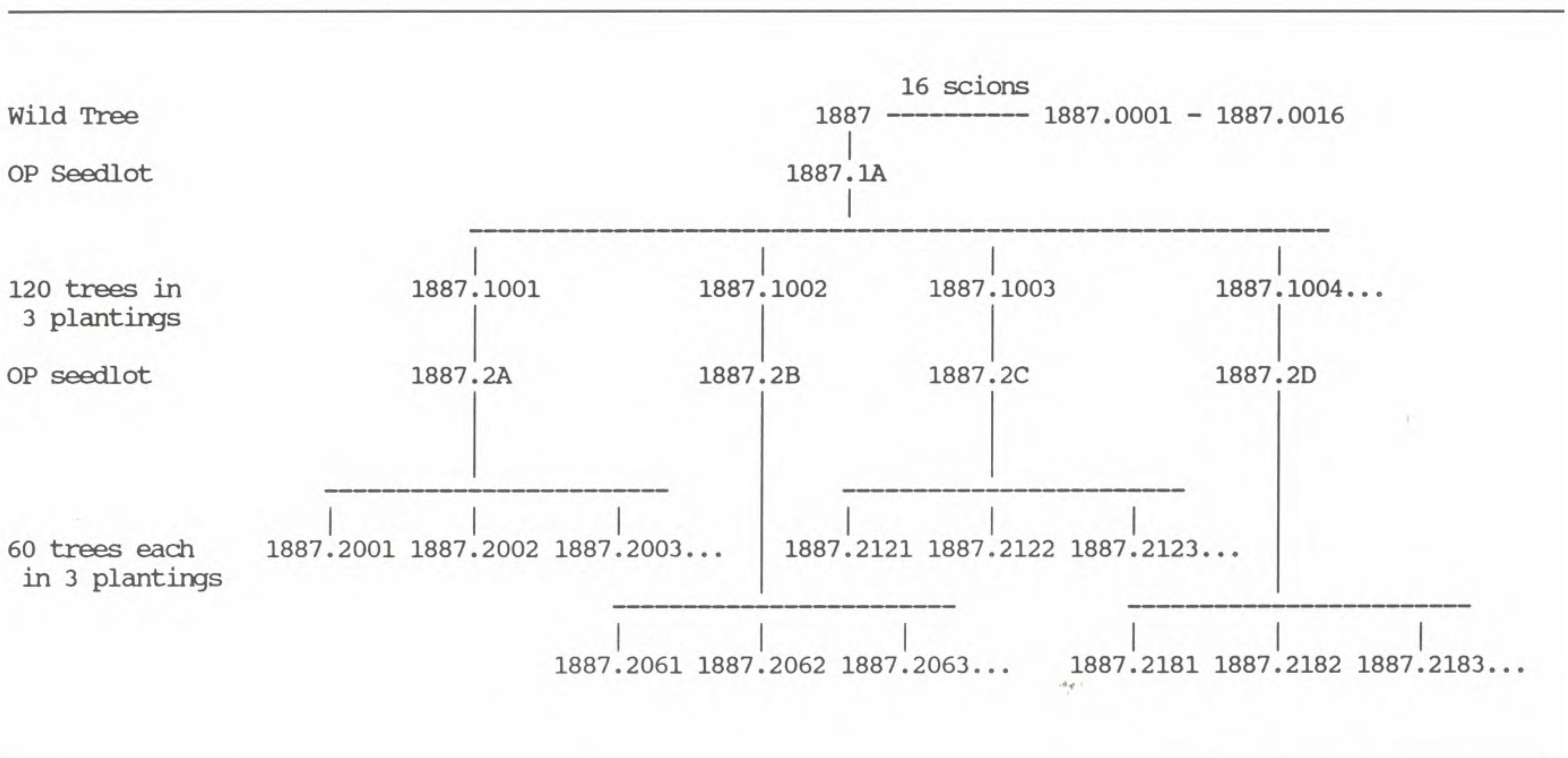
Vegetative propagules

Vegetatively reproduced trees are labeled using the family number, the generation designation of the parent, and a unique tree number. Although genetically identical to the tree from which it is taken, this unique tree number is necessary for distinguishing seedlots taken from various ramets of the same clone. In this case, the tree number is assigned starting with the last tree number in that group, plus .001. For example, assume ten half-sib trees are grown from seedlot 123.1A. They would be assigned numbers 123.1001 through 123.1010. The first tree vegetatively propagated from one of these half sibs (for instance 123.1004) would be labeled 123.1011 (letter j). In the half-sib keylist, the seedlot would be listed as 123.1004, indicating that 123.1011 is a clone of 123.1004. Trees propagated vegetatively from full-sibs would be labeled in the same manner and records would be maintained in the full-sib keylist.

NEW RECORDS

The records as they would appear under the new system for white spruce tree 1887 (used as an illustration in Figure 1) are shown in Figure 3. The ability to recognize relatedness and the unique designation of each tree are evident in the example.

Figure 3. Records for white spruce tree 1887 as they would appear using the new system. (OP = open-pollinated)



One of the major criteria of the new system was that it must be simple enough to avoid a large number of recording or clerical errors. With the increased number of digits in the identification number it appears on the surface that the new system is much more complicated than the old system. However, the last three digits of the number, the unique tree number, can be added after plantings are completed. Therefore, there is no need to include these digits on labels applied to seedlings when plantings are established, which eliminates the need to record them when a planting is mapped. The use of a computer can ease the process of adding this tree number considerably. Also, the entire unique tree identification number can easily be printed on a computer generated map.

REGIONAL IMPLICATIONS

Few people favor regional record keeping because of the massive change in old records that would be required by most organizations. In lieu of that, it is critical that all programs be able to provide accurate pedigree information. A system proposed by Riemenschneider (1983) could then be used to keep track of aliases.

All tree improvement programs in the North Central region have developed record keeping systems which work, at least for themselves. The systems vary considerably and problems with material identification and ancestry have occurred, both within programs and when material has been exchanged among programs. Adoption of more precise systems, such as the one described here, would assist in reducing errors.

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