1993 Project Abstract
For the period ending June 30, 1995
This project was supported by the Minnesota Future Resources Fund (MS 116P.13)

TITLE:	Development of Tree Seed Orchard Complex
PROGRAM MANAGER:	Lawrence K. Miller
ORGANIZATION:	Minnesota Department of Natural Resources-Division of Forestry
LEGAL CITATION:	M.L.93 Chpt.172, Sect.14, Subd.5(a)
APPROPRIATION:	$ 80,000

Statement of Objectives

To develop the seed orchard complex physical plant for the efficient maangement of the site, to establish and intensively manage a northern red oak seed orchard for the production of genetically improved seed for the state forest nursery program and, to establish and intensively manage a black spruce seed orchard for the production of genetically improved seed for the state forest nursery program.

Overall Project Results

In 1992, an abandoned farm site located near Moose Lake, MN was acquired by the DNR-Forestry at no cost. This site was needed to further the goals of the DNR Tree Improvement Program. Unneeded buildings on the site were removed and the site was cleaned of residual farm debris. The site was fenced and the pole building was modified to provide secure storage for equipment and supplies at the seed orchard complex. Electrical service was restored and the well was rehabilitated so that workers now have a ready source of water necessary for chemical mixing and rinsing, irrigation, and fire control. Equipment was purchased and an employee hired to provide daily maintenance of the site. Two seed orchards were established; a second generation black spruce orchard and a first generation northern red oak orchard. These orchards will produce genetically improved seed for the state nursery program.

Project Results Use and Dissemination

The Split Rock Tree Improvement Center currently contains a black spruce and a northern red oak seed orchard. These orchards will produce genetically improved seed for the state nursery program. Seedlings derived from improved seed will be superior in one or more traits, including growth rate, form, wood quality, and pest resistance. The site also contains a blister rust tolerant white pine clone bank, and a hyrid poplar trial coordinated by the US Forest Service. In 1997, a 1.5 generation white spruce seed orchard will be established. This orchard will provide genetically improved seed capable of increasing growth rate by about 25 % over woods run sources. Overall, the Split Rock Tree Improvement Center provides a consolidated area where intensive tree improvement program activities can be conducted in an efficient manner. Information and data generated from both empirical and controlled studies on the center are shared with members of the Minnesota Tree Improvement Cooperative, and tree improvement practitioners and forest geneticists nationwide.

Date of Report: July 1, 1995

LCMR Final Work Program Update Report

I. Project Title: 5(a) Development of Tree Seed Orchard Complex

Program Manager: Lawrence K. Miller
Agency Affiliation: DNR - Forestry
Address: General Andrews Nursery
P. O. Box 95
Willow River, MN 55795
Phone: (218) 372-3183

A. Legal Citation: M.L.93 Chpt. 172 , Sect. 14 , Subd. 5(a)

Total Biennial LCMR Budget: $80,000

Balance: $15,000*

* A final accounting will be made when all invoices have been processed.

Appropriation Language as drafted 7/27/92: 5(a) Development of Tree Seed Orchard Complex. This appropriation is from the future resources fund to the commissioner of natural resources for the production of genetically improved forest tree seed.

B. LMIC Compatible Data Language: Not applicable

C. Status of Match Requirement: Not applicable

II. Narrative: In 1991 the DNR acquired an FmHA foreclosed farm by fee title transfer for the purpose of developing a seed orchard complex. New seed orchards will be established on this site, and managed intensively to produce genetically improved seed for the state forest tree nursery program. Planting genetically improved tree seedlings can significantly increase the productivity of Minnesota's forests. Improved seed increases forest growth and resistance to insects and disease.

III. Statement of Objectives:

A. To develop the seed orchard complex physical plant for the efficient management of the site

B. To establish and intensively manage a northern red oak seed orchard for the production of genetically improved seed for the state forest nursery program

C. To establish and intensively manage a black spruce seed orchard for the production of genetically improved seed for the state forest nursery program.

IV. Objectives

A. Title of Objective: Development of Orchard Complex Physical Plant

A.1. Narrative: For the efficient production of genetically improved forest tree seed, seed orchards must be intensively managed. Intensive management will be simplified by developing the orchard complex physical plant. Site improvements will be directed toward making the complex self supporting and secure. Planned site development includes secure storage for equipment and supplies, fencing, electrical service, an office, a weather station, a road system, repair of drainage ditches, and upgrading the water system. These improvements will allow workers to carry out their tasks in an efficient manner, leading to early and abundant production of genetically improved seed.

A.2. Procedures: Planned development of the seed orchard physical plant will include the following:

a. *site cleanup*

Although the farm contains a number of buildings in relatively good condition, the cost of long term maintenance dictates that uneeded structures be removed. The house, barn, garages, granary, and shed are planned to be disposed of prior to July, 1993. All that will remain are the metal pole building, the pumphouse, the metal shed, and the silo. After these structures are removed, the site will require cleanup of any remaining debris.

b. *perimeter fencing and gates*

To exclude wayward livestock and off-road vehicles, a three-wire barbed wire fence will be constructed around the perimeter of the orchard complex. Gates will be installed on the main driveway and on the driveway to the old homesite.

c. *internal road system*

To improve access to different orchard areas, roads will be constructed as shown in Figure 1.

d. *security enclosure*

The existing pole building will be retained on the site for equipment storage and to house a field office. As such, the area will have to be secured. Plans are to erect a chain link fence around the building, including a locking vehicular gate.

e. *electric service*

At present, the farm is still connected to the Carlton County Cooperative Association, although the power has been turned off. Electrical service is needed to run the well pump and to provide electricity to the pole building.

f. *weather station*

Seed orchard management often relies upon the application of certain practices at precise stages of plant and/or pest development. Plant and pest development is closely related to heat accumulation. Accurate rainfall records are also needed to help quantify growing conditions. Relative humidity is important to the development of fungal diseases. A computerized weather station will be set up deploying a temperature recorder, a tipping bucket rain gauge, and a relative humidity sensor. The weather station will be set up on a tower inside the fenced security area. Hardware necessary to read collected data and transfer it to computer files will also be obtained.

g. *field office*

There are many occasions when office work is interspersed with field work. Rather than make the drive back to General Andrews Nursery, it would be much more efficient to do the work right on the site. A corner of the pole building will be developed into a field office where maps can be updated, tags made, and weather calculations completed.

h. *upgrade existing ditches*

The soils on the Split Rock Seed Orchard Complex are classified as Autumba fine sandy loam. Drainage is slow, a fact the original farmer did not overlook. At one time ditches were dug to help speed the drainage of surface water. These ditches need to be dug out to improve the movement of surface water.

i. *upgrade water system*

Although the well, pump, and pressure tank are in good working order, there is currently no way to obtain water. The well house will need to be plumbed so that water can be obtained for the mixing of chemicals and for fire control.

j. *equipment and supplies*

The following list outlines the planned purchases of equipment and supplies needed to support seed orchard management activities.

Equipment

flail mower	tractor mounted sprayer
fertilizer spreader	4-wheeler and accessories
backpack sprayers	

Supplies

tree shelters	fertilizer
pesticides	fuel
cable ties	aluminum tags
mulch materials	

A.3. Budget: $ 8,000

A.4. Timeline:

	7/93	1/94	6/94	1/95	6/95
Site cleanup	xxxxxxxx				
Fencing and gates	xxxxxx				
Road system	xxxxxxx				
Security enclosure	xxxxxxx				
Ditch upgrade	xxxxxxx				
Weather station			xxxx		
Electric service			xxx		
Water system			xxx		
Field office				xxxxx	
Equipment:					
flail mower	xxx				
tractor sprayer	xxx				
backpack sprayer	xxx				
4-wheeler			xxx		
fertilizer spreader			xxx		

A.5. Status: The following implements have been acquired:

fertilizer spreader	flail mower 4 wheel ATV
tractor mounted sprayer	ATV trailer
automated weather station	laptop computer

Development of the seed orchard complex physical plant is essentially

complete. All equipment needed to manage the orchard has been acquired, and most site improvements were made as planned. Personnel are able to work in the seed orchards and have all equipment needed safely stored on site. Plans to install a security fence around the pole buildng were modified to make the pole building secure without the fence. This change saved the project about $3000. The planned field office was not completed, but this is not considered a significant concern. Field ditches were not cleaned out because of the difficulty in hiring heavy equipment for a small project. Site drainage is an infrequent problem associated with excessive rain. When precipitation patterns are more "normal", drainage is not a problem. Overall, the key elements of this objective were successfully completed.

A.6. Benefits: The following benefits will be realized from completion of this objective.

a. An abandoned farm will be transformed into a working seed orchard complex.

b. Workers will be provided with the equipment and supplies necessary to conduct intensive seed orchard management.

c. New DNR - Forestry seed orchards established on the site will produce genetically improved seed at an early age and in abundance.

B. Title of Objective: Establishment and Management of a Northern Red Oak Seed Orchard

B.1. Narrative: The DNR-Forestry has had an applied forest tree improvement program since the mid 1970's. The program has progressed to the point where new seed orchards are needed to take advantage of the increased genetic gain available from proven selections and to replace older orchards that are becoming obsolete. Because seed orchards can only be successful when intensively managed, it is prudent to concentrate orchards on a single site. As outlined in the Tree Improvement Plan for the Minnesota DNR, it is now time to develop a first generation northern red oak seed orchard. Orchard stock will be produced by grafting. The trees will be planted and managed intensively to encourage early and abundant seed production. Small scale applied studies in seed orchard management are also planned in conjunction with regular orchard operations.

B.2. Procedures: Completion of this objective involves three stages: a) production of grafted orchard stock, b) orchard planting, and c) orchard management.

a. *Production of orchard stock*

In the late fall and over the winter, high quality red oak stands

will be systematically searched, and plus trees selected. A plus tree is one that is superior in appearance, and thus *might* be genetically superior. Traits of importance in red oak include stem straightness, branch angle, crown form, and growth rate. In late winter, scions will be collected from the plus trees by shooting a branch out of the top of the tree with a rifle. The scions (small twigs used for grafting) will then be placed in cool storage until they can be grafted.

Two years old red oak seedlings will be used as rootstock. These seedlings will be obtained from General Andrews Nursery in late February - early March. The seedlings will be potted up and placed in a warm greenhouse (75 degrees). In about two weeks the seedlings will begin to flush and can be grafted. Red oak grafts very easily using the modified side graft method. Scions begin to break bud about a week after grafting, and most grow vigorously thereafter in response to regular watering and fertilization. Successful grafted stock will then be moved outside at the end of May and grown under shade for the rest of the summer. The following spring it will be planted in the seed orchard. Thus, grafts made in March, 1994 will be planted in the seed orchard in May, 1995.

b. *Orchard planting*

Selection of red oak plus trees, scion collection and grafting are currently underway. There will be grafts made in March, 1993 (before the start of this project) that will be planted in May, 1994. A second crop will be available for planting in May, 1995. These plantings will expand the orchard area to 5 acres. Figure 1 shows the location of the red oak orchard on the orchard complex.

Prior to planting, the site must be laid out and prepared. Seed orchards are commonly planted at wide spacing to allow full sunlight to reach the crowns. Full sunlight encourages healthy growth and more importantly, increased flower and seed production. The spacing chosen for the red oak orchard is 20 x 25 feet. The site will be laid out by marking each planting position with a flag. In late August, the site will be prepared by applying herbicides in a four feet wide band down each row. The tank mix of glyphosate and sulfometuron methyl (Roundup + Oust) at the rate of 1.5 qts + 1 oz per acre provides excellent season long control of most broadleaf weeds and grasses. The treated bands can be planted immediately or the following spring.

The orchard will be planted according to a design that randomizes the planting positions of the different clones, maintaining a certain minimum distance between ramets of the same clone to minimize selfing. Such a design will be computer generated by a software package called Somad.

Deer browsing is a constant and frustrating problem for forestry in Minnesota. Given the high value of each individual grafted tree, it will be necessary to protect newly planted orchard trees from deer depradation. This may involve the use of plastic tree shelters or cages made of hardware cloth. Such tree protectors will be placed on the grafted stock immediately after planting.

The maintenance of an accurate map is another important aspect of seed orchard establishment and management. Orchard maps will be kept in computer files and a separate hard copy kept in the nursery files. Each tree will also be tagged with a permanent aluminum tag containing the clone number. These tags will be placed on the grafts immediately after planting.

c. *Orchard management*

Orchard management during the establishment phase will be directed toward encouraging vigorous growth and healthy trees. If the trees get off to a good start, they will produce seed earlier and in greater abundance. Management practices will include fertilization, weed control, animal control, and mowing between the rows of trees. These practices are absolutely necessary to ensure the high survival and rapid growth of high value seed orchard trees.

During 1992, the soils on the orchard complex will be systematically sampled to make an accurate soils map and to determine base fertility levels. This information will be used to develop fertilization recommendations. Fertilizer will be applied as needed.

After the first year, it will be necessary to re-apply herbicides in the bands running down each row. Maintenance of a weed free band will eliminate competition for nutrients and water. It will also discourage rodents from entering the area around the trees. Finally, the bare ground will serve as a "mini-" firebreak around each tree.

In grassy areas populations of rodents such as meadow voles and white-footed mice are common. Girdling by these animals can be very destructive. If maintenance of a weed free zone around the trees is unsuccessful because of high populations, it may be necessary to employ other control strategies. Construction of raptor perches and kestrel boxes will help build and maintain populations of predatory birds. As a last resort, bait stations would be distributed across the site.

The orchard site will also be regularly mown between the rows. This will maintain the orchard's appearance, reduce the fire hazard, and reduce rodent habitat.

During the establishment phase, red oak grafted stock must be

routinely checked to monitor their growth and development. Red oak is particularly prone to adventitious sprouting from the rootstock below the graft. These sprouts must be rubbed off so that growth is directed to the graft. If tree shelters are being used, it will be necessary to lift the shelter from each tree to check for adventitious sprouts. Sometimes, tree shelters lean over in the wind and must be straightened. Thus, a considerable amount of time is required during the growing season just caring for the grafts.

Although much is known about successful seed orchard practices for northern forest species, research in this area has essentially ceased in recent years. The primary source of new information on seed orchard management comes from continuing work done in the southeastern US on southern pines. Techniques and practices shown to be successful in southern pine seed orchards will be tested at the Split Rock Orchard Complex as a part of regular orchard management.

Over the two years of this project, every effort will be made to produce and plant high quality grafted stock, and to care for that stock to encourage rapid early growth. Grafted seed orchard trees are very expensive, so it is critical that every means necessary be used to get the trees off to a good start. Well established orchard trees will yield early and abundant seed crops, thereby increasing orchard and program profitability.

B.3. Budget: $ 5,000

B.4. Timeline:

	7/93	1/94	6/94	1/95	6/95
Red oak grafting		xxx			xxx
Red oak orchard planting			xx		xx
Seed orchard management	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx				

B.5. Status: The northern red oak seed orchard for the Department of Natural Resources Region 3 has been established, and is being managed intensively to encourage early seed production. Excessive precipitation and cool weather in 1992-93 killed some trees and resulted in reduced growth of the survivors. Additional grafting and replanting has been necessary to more fully develop the orchard. Establishment of hardwood seed orchards typically requires several years, because the trees simply grow slowly above ground while they are developing a good root system. Excessive moisture in the first two years caused extensive mortality and slowed tree growth, extending the establishment period by several years. There was no way to avoid this weather caused situation. Now that more "normal" precipitation patterns have returned, the surviving orchard trees

are beginning to grow vigorously.

Over the next several years, additional grafts will be planted in the orchard to replace those lost to flooding, and to expand the orchard to a final area of five acres. At that time the orchard should contain about 400 trees.

B.6. Benefits: The following benefits will be realized from the completion of this objective.

a. A first generation northern red oak seed orchard will be established.

b. The seed orchard will be intensively managed.

c. The DNR-Forestry Nursery Program will receive genetically improved red oak seed by the end of the 1990's.

d. Future Minnesota forests planted with seedling stock derived from this seed orchard will be more productive.

e. Cooperative tree improvement programs in Minnesota and the north central region will share information and improved plant materials developed in these orchards.

C. Title of Objective: Establishment and Management of a Black Spruce Seed Orchard

C.1. Narrative: This orchard represents the direct application of over 10 years of forest genetics research in black spruce. In the mid-1970's, 300 black spruce plus trees were selected from Minnesota forests. Cones were collected from each tree, and seedlings grown at General Andrews Nursery. After three growing seasons, a progeny test of the best 200 families was planted on three sites. The test was periodically measured and the data statistically analyzed. These analyses were used to thin the progeny test sites for conversion to seedling seed orchards, and to rank the over 12,000 trees based on their performance. The black spruce orchard will contain the best 20 unrelated clones from the progeny test. Genetic gain in volume is estimated to be 9 %.

C.2. Procedures: Completion of this objective involves three stages: a) production of grafted orchard stock, b) orchard planting, and c) orchard management.

a. *Production of orchard stock*

Production of black spruce grafts for the seed orchard was begun

in 1990. Spruce grafting takes three years to produce a healthy, transplantable tree. First of all, rootstock must be potted up and grown for a full year prior to grafting. Thus, rootstock grafted in the winter of 1990 was potted up in May of 1989. During the first year after grafting, spruce grafts grow slowly, and are generally considered to be too small to be transplanted in the orchard. In the spring of the second year (1991), the grafted stock is transferred to a larger pot and grown for another summer. During the second year, black spruce grafts respond well to fertilization and irrigation. Rootstocks are pruned back in the fall and the grafts are overwintered under the snow. Essentially all grafts will be ready to transplant the following spring (1992). Spruce grafted stock can also be planted in the late summer/early fall.

The first group of black spruce grafts for the seed orchard was planted in 1992. There are currently about 120 more younger grafts the require one more years growth before they can be transplanted. At this time there are no plans to do any additional grafting.

b. *Orchard planting*

The black spruce seed orchard site location is shown in Figure 1. The site was laid out and prepared just prior to planting in May, 1992. Each planting position was marked with a flag at a spacing of 15 x 20 feet. A tank mix of Roundup (1.5 qts) + Oust (2 oz) per acre was applied in four feet wide bands over the top of each row of flags. The first group of 125, two years old grafts were planted on May 26 according to randomized orchard design generated by the computer program, Somad. A slow release fertilizer tablet was placed in each planting hole to provide season long feeding.

A second group of grafts was planted in the late summer/early fall of 1992. Fall planting of spruce is a good choice for several reasons. The soil temperature is still warm enough to promote vigorous root growth, but there will be no top growth because of the shortening photoperiod and decreasing air temperatures. Thus, the grafts get firmly established without the risk of drought or frost damage. No fertilizer will be given to the fall planted grafts so that they will harden off properly. These trees will be ready to get off to a quick start in the spring of 1993. Fertilizer will be added at that time.

The final group of grafts will be planted in the fall of 1993, during the first year of this project. This will increase the number of trees in the black spruce orchard to 350, and the area to three acres. Immediately after planting, aluminum tags stamped with identifying clone numbers will be attached to all trees with reversable cable ties. A map will be made and kept in computer and office files.

c. *Orchard management*

Management of the black spruce orchard during the establishment phase will be similar to the red oak orchard. All activities are designed to promote the development of healthy, vigorous trees. This appears to be particularly important for black spruce. Studies have shown that tree height is more important than age in determining whether or not a tree will flower and produce seed. Management practices to encourage rapid height growth will be rewarded with earlier seed production. Planned management practices include fertilization, weed control, animal control, and mowing.

With the soils information obtained in 1992, fertilization recommendations will be developed. Because the root systems of newly planted orchard trees are small, fertilizers will be applied in a circle around each tree.

The herbicide bands running down each row of trees will be kept weed free with repeated applications as needed. This will eliminate competition for nutrients and moisture. It will also eliminate rodent habitat around the trees.
Black spruce is not a favored browse species for white-tailed deer, so no extra protection will be needed. Rodents will be controlled by elimination of habitat, encouraging raptor use of the area, and with baiting if necessary.

The black spruce orchard will be mown regularly between the rows to keep a short sod cover. This will improve the trafficability of the site, reduce rodent habitat, reduce fire hazard, and improve the overall look of the orchard.

Small scale trials of seed orchard management techniques will be integrated with regular orchard practices. This will help refine orchard management, making operations in the future more effective and efficient.

The newly planted black spruce orchard trees will require less care than the red oak grafts. During the first two years, remaining rootstock branches will be gradually pruned leaving only the graft. Any plagiotropic grafts will be staked to promote vertical growth.

C.3. Budget: $2,000

C.4. Timeline:

	7/93	1/94	6/94	1/95	6/95
Black spruce planting	xx				
Seed orchard management	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx				

C.5. Status: This orchard is now established and is being managed intensively to encourage abundant cone and seed production. Black spruce typically flowers early and often, and many of the older grafts planted in 1992 are already producing small numbers of cones. The orchard trees must still grow for several more years before they attain sufficient size to produce a collectible cone crop. Several grafts will be added to the orchard in 1996, but the orchard is essentially complete at this time.

C.6. Benefits: The following benefits will be realized from the completion of this objective.

a. A black spruce seed orchard will be established.

b. The orchard will be intensively managed.

c. The DNR-Forestry Nursery Program will receive genetically improved black spruce seed by the end of the 1990's.

d. Future Minnesota forests planted with seedling stock derived from this orchard will be more productive.

e. Cooperative tree improvement programs in Minnesota and the north central region will share information and improved plant materials developed in this orchard.

V. Evaluation: According to the Minnesota Forest Resources Plan (MFRP), the goal of the DNR-Forestry Nursery and Tree Improvement Program is to "economically produce forest regeneration material of the highest genetic and biologic quality needed for environmental programs". Given the current level of funding for the Tree Improvement Program, this goal cannot be accomplished. At the present time, DNR-Forestry seed orchards are located on widely scattered sites across the state many miles from General Andrews Nursery, the base of operations. Equipment must be hauled by trucks and trailers from the nursery to accomplish management objectives. Manpower availability is frequently limiting. This project will provide the funding necessary to properly manage future DNR-Forestry seed orchards.

The seed orchards planned for the project period should be the best established to date. Intensive management will encourage high survival and healthy, vigorous trees. Such trees are better able to withstand bad weather, and can recover more quickly from damage. The best measure of the success of this project however, will not be seen until the trees begin to produce seed, or by the late 1990's. By the early part of the 21st century, the red oak and black spruce orchards should be producing regular crops of genetically improved seed for the state nursery program. Future Minnesota forests planted with improved seedlings will be more productive.

Development of the orchard physical plant will facilitate the development

of additional seed orchards in the future. At this time, a white spruce seed orchard is planned for establishment about 1996. This orchard will provide the next increment of genetic gain over and above the current improved source now being used by the DNR-Forestry Nursery Program.

VI. Context: The DNR-Forestry is an active member of three tree improvement cooperatives, as listed below:

- The Minnesota Tree Improvement Cooperative (1981)
- The North Central Fine Hardwoods Tree Improvement Cooperative (1986)
- The University of Minnesota/Institute of Paper Science and Technology Aspen and Larch Genetics Cooperative (1988)

Cooperative tree improvement is the vehicle by which most organizations participate in applied forest tree improvement. A tree improvement cooperative comprises like-minded forestry organizations that work together to achieve genetic improvement of selected species. The tree improvement workload is usually too burdensome for a single organization to bear. Members of the cooperative share the workload, and reap the collective benefits. The DNR-Forestry has an obligation to the other cooperative members to carry it's share of the workload. The tree improvement cooperatives listed above therefore, all have a stake in the Split Rock Seed Orchard Complex.

A. The process of genetic tree improvement is essentially open-ended. As a group forest trees contain more genetic variation than most other higher life forms. The presence of considerable genetic variation means that trees can be improved, or domesticated for many generations without serious loss of genetic variation. Thus, when a tree improvement program is started, sooner or later the current population will be replaced by a newer, more improved group of trees. The DNR-Forestry Tree Improvement Program is at this point with black spruce. A population better than the one currently in use is available. The black spruce orchard will capture the next available increment of genetic gain.

In the case of the red oak seed orchard, this program is clearly demand driven. Ten years ago, the Nursery Program produced only about 50,000 red oak seedlings per year. Today, with ever increasing pressure on the red oak resource, annual seedling demand is nearly one million seedlings. It was clear with this tremendous increase in demand that the DNR-Forestry should be developing a genetically improved seed source. Of equal importance was the need to save valuable genetic resources in the face of mounting harvest pressure. This project will accelerate progress toward these two objectives.

As previously noted, the current Tree Improvement Program budget is inadequate to accomplish the program goal as stated in the MFRP. The current budget would not allow the DNR to take advantage of the Split Rock Township site, a property that was

acquired at no charge. This project will provide the funding necessary to accelerate program progress. Development of the physical plant will not only benefit the orchards planned for the project period, but also orchards planned several years in the future.

B. The red oak and black spruce seed orchards are currently being established. This work will continue in the absence of this project. However, the orchards will not be cared for properly. Lack of good orchard management would result in higher mortality and reduced growth, leading to an overall reduction in the production of genetically improved seed. Simply stated, this project will significantly accelerate progress in the DNR-Forestry Applied Tree Improvement Program.

C. The current Tree Improvement Program is working on the following species:

red pine	jack pine	white pine
scots pine	white spruce	black spruce
red oak	black walnut	aspen

The program has been funded since it's beginning in the mid 1970's by either General Fund appropriations or by a surtax on seedling sales (1984 to present). The FY 92 budget was $93,000, most of which is taken up by salary and Cooperative dues. The annual operations budget is about $20,000, not nearly enough to take care of nine species programs. The result is that current seed orchards and progeny tests cannot be properly managed. Inadequate management is evidenced by increased mortality, reduced growth, and reduced and delayed production of genetically improved seed.

At the end of the project period (6/95), management of the Split Rock Orchard Complex will be funded by the Nursery and Tree Improvement Program, and other internal DNR-Forestry sources.

VII. Qualifications:

1. Program Manager

a. May, 1985 to present. Tree Improvement Specialist, Minnesota DNR-Forestry. Responsible for the planning and implementation of DNR-Forestry Tree Improvement Program.

October, 1980 to October, 1983. Tree Improvement Specialist, Ontario (Canada) Ministry of Natural Resources. Developed and began implemetation of tree improvement programs for three major forest species.

b. Master of Science in Forestry, Genetics Minor

North Carolina State University, Raleigh. 1980.

Bachelor of Science in Forest Management, University of Maine, Orono. 1977.

2. Cooperators/Other Investigators

Not Applicable

VIII. Reporting Requirements: Semi-annual status reports will be submitted not later than January 1, 1994, July 1, 1994, January 1, 1995, and a final status report by June 30, 1995.

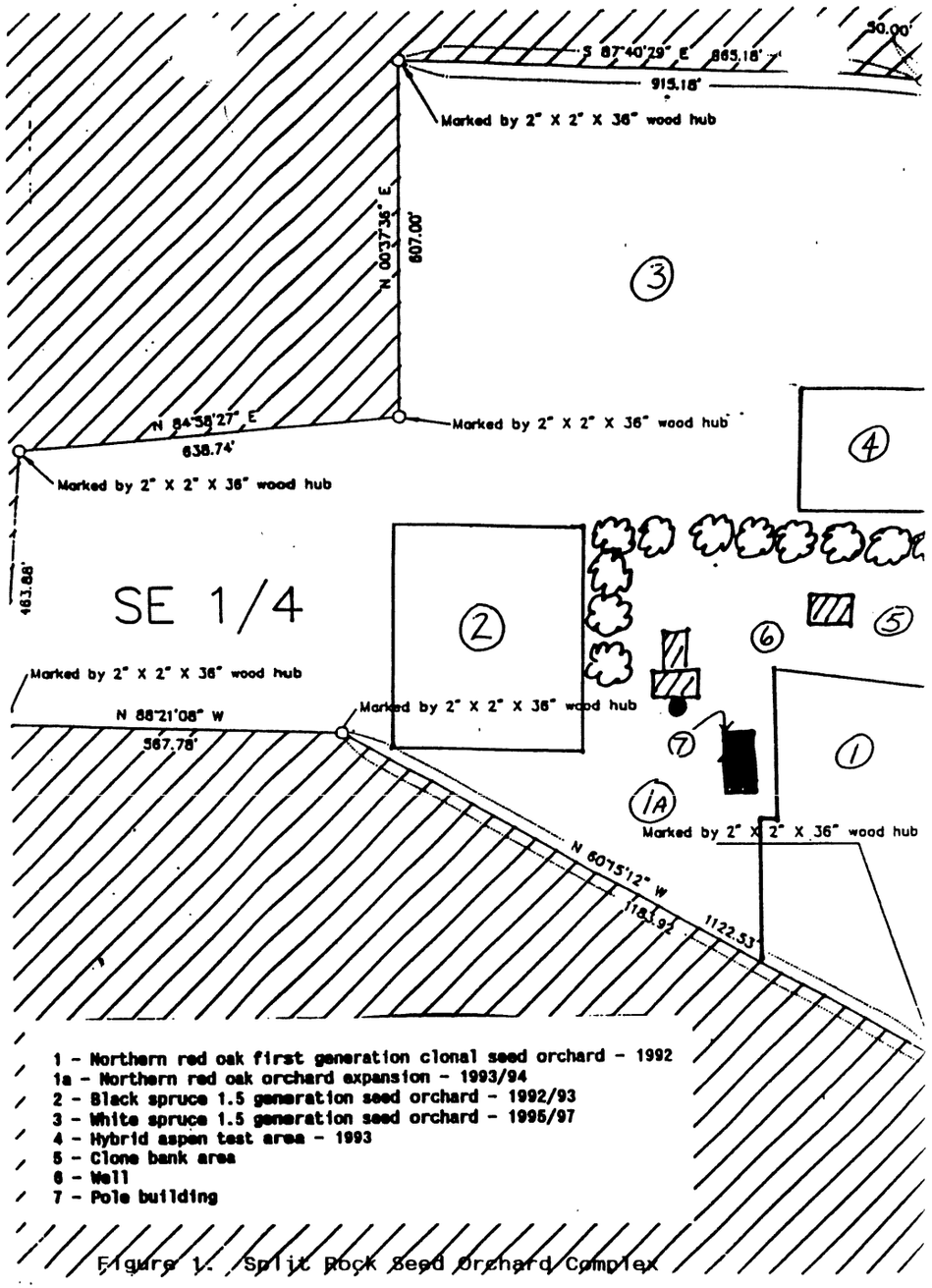

Figure 1. Split Rock Seed Orchard Complex