Tree Improvement Research in North Dakota

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Organized forestry activities began in 1908 in North Dakota when the Dakota National Forest was established, with headquarters at Amidon. Forestry research was launched in 1931 when the Denbigh Experimental Forest was established. Since 1956, forestry research in North Dakota has been centered at U.S. Forest Service laboratory and office facilities on the North Dakota State University - Bottineau Branch Campus. Tree improvement research programs, to develop adapted species for northern Great Plains shelterbelts, have been emphasized since 1956. Past tree improvement research activities are described, along with current research programs in Scotch pine, ponderosa pine and green ash.

Forestry programs came early to North Dakota, about as early as anywhere west of the Mississippi. By 1908, the Dakota National Forest, headquartered at Amidon, was administering federal land in southwestern North Dakota. Although little research, as it is presently understood, was carried on then, the National Forest did contain a small nursery. The nursery produced ponderosa pine seedlings for experimental plantings which were intended to increase the stands of pine in the Badlands of the Little Missouri river.

Planting success was apparently not as good as had been hoped for, however. Perhaps economic conditions associated with World War I were involved in the rather short life of Dakota's first National Forest. Whatever the reason, the Dakota National Forest was discontinued in 1917 because of the "high cost of administration."

Denbigh Experimental Forest

Federally funded forestry and research by the Forest Service were nearly at a standstill for 14 years after 1917. In 1931, however, the Denbigh Experimental Forest was established on a full section of land in McHenry county near the town of Denbigh. U.S. Senator Gerald P. Nye from North Dakota was instrumental in arranging for the appropriation which established the forest on 40 acres of land deeded to the federal government by McHenry county commissioners for building purposes, and 600 acres leased from the state.

It was here that tree improvement research had its first firm beginnings. More than 40 tree species, more than half of which were conifers, were established in blocks on 270 acres before operations were suspended during World War II. The trees were planted to test the hardiness and usefulness of different species for large block plantations and for shelterbelts. Some species, such as ponderosa pine and juniper, were already recognized as good prospects. Plantations of these species, representing a number of geographical origins, were established to determine the best seed sources for use in North and South Dakota.

Along with the species trials, another avenue of research was being followed. Techniques of planting and the culture of trees during the establishment period were being tested. The idea was that results of these silvicultural tests could be combined with growth and survival data from trees of the various seed sources. Then foresters could make specific recommendations for large block plantations or windbreak plantings.

Stoeckeler Memorial Arboretum

In addition to the early block plantings, an arboretum was established during 1940-42 on what had formerly been a nursery site. The arboretum contained a wide variety of native and exotic trees which were to be used for breeding and instruction. Among the 29 species represented now are some little-known exotics such as Chinese red pine, Manchurian ash, Chinese juniper and Siberian larch. Also included are some of the more familiar native and exotic species of pine, cottonwood, boxelder and spruce.

The arboretum on the Denbigh Experimental Forest was dedicated in 1969 as the Joseph H. Stoeckeler Memorial Arboretum (Fig. 1). Stoeckeler was an eminent researcher and prolific writer in the Lake States and Great Plains regions. He was one of the first researchers at Denbigh, continuing work begun by Paul O. Rudolph and Harold F. Scholz on the Denbigh Dunes, as the vicinity of the experimental forest is sometimes called.

The sandy soil in and around the experimental forest is also well suited to production of tree seedlings. A small nursery was established on the forest to grow seedlings to test in the experimental blocks, and for planting elsewhere. It operated for

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Figure 1. Information sign at the entrance to the Joseph H. Stoeckeler Arboretum. Joel Stoeckeler stands by the sign marking the memorial to his father.

a few years, but production was discontinued in 1939.

The U.S. Forest Service selected another nursery site at nearby Towner, intending to produce seedlings for the Souris and Sheyenne Purchase Units. Actually, stock from the nursery was planted only at Denbigh. Later, the nursery produced some trees for the large-scale shelterbelt plantings of the Prairie States Forestry Project. Now the nursery is one of two managed by the North Dakota Forest Service.

Limited activity in research, including tree improvement, characterized the period following plantings on the Denbigh Forest. Research administration was headquartered at St. Paul, Minnesota. Most of North Dakota was far from any of the Lake States Experiment Station field offices, and no full-time Forest Service research was conducted in the northern Great Plains from 1942 to 1956.

Forest research in the northern Great Plains gained new impetus in 1956 when the Bottineau Research Center began operations, coinciding with the celebration of the 50th anniversary of the North Dakota School of Forestry at Bottineau. The center was made possible through the efforts of North Dakota Senators Milton R. Young and William Langer, with aid from Congressmen Usher L. Burdick and Otto Krueger. Paul Slabaugh, a well-known scientist from East Lansing, Michigan, was reassigned to Bottineau to head up the new research center. His leadership role and research in shelterbelt silviculture and tree improvement made him known and respected throughout the northern Great Plains. He served as head of the research laboratory for 17 years until he retired in 1973.

The Bottineau Research Center was enlarged and improved in 1961. Congress provided $130,000 for construction of a research laboratory, and the North Dakota Board of Higher Education leased 3.22 acres of state-owned land to the federal government for the facility on the North Dakota State University - Bottineau Branch campus. Finally, on September 5, 1963, the new Shelterbelt Laboratory (Fig. 2) was dedicated by Senator Young,

Figure 2 The U. S. Forest Service Shelterbelt Laboratory on the North Dakota State University—Bottineau Branch campus.

who consistently maintained his interest in housing a research unit in North Dakota, and who had been instrumental in seeing that the Bottineau unit became a working reality.

In 1966, administration of the laboratory was changed from the Lake States Forest Experiment Station in St. Paul to the Rocky Mountain Forest and Range Experiment Station in Fort Collins, Colorado. No major changes were made in the research program, but now both Great Plains research field offices—Bottineau and Lincoln, Nebraska—were under administration of a single experiment station.

Personnel

Through the years, many silviculturists and tree improvement scientists have worked with distinction at the Shelterbelt Laboratory. Their studies have done much to solve the difficult problems associated with growing and maintaining effective wind barriers on the northern Great Plains. In addition to Slabaugh, these scientists included David Dawson, Howard Phipps, Albert Clegg, Walter Davidson, Robert Hill and Richard Cunningham. The present staff at the laboratory includes one entomologist, Mary Ellen Dix, while the timber management project consists of Richard Tinus and James Van Deusen. Tinus serves as leader for the laboratory, in addition to developing techniques for accelerating the growth and development of nursery stock under greenhouse conditions.

Scientists at the Bottineau Shelterbelt Laboratory have carefully investigated which species of trees are likely to perform best in shelterbelt and other plantings on the Prairie-Plains. Dawson and Read (1964) developed guides for selecting superior trees, and discussed and illustrated desirable characteristics such as growth rate, crown form and resistance to diseases of 17 tree species. Other guides helpful in selecting trees and shrubs for roadside beautification were written by Davidson and Dawson (1968) and Davidson (1970). They recommended tree and shrub species for roadside and screen-type plantings on various soil types for all areas of North and South Dakota. They also made suggestions for location, establishment and maintenance of plantings, along with choices of species.

Trees are long lived; before they attain maturity they encounter a wide variety of climatic conditions in the Prairie-Plains. Throughout the winter, soil moisture is frozen to depths of four feet or more and thus is unavailable to the trees. An unusually long period of exceptionally warm and windy days will sometimes cause considerable moisture loss through the needles of conifer trees. If that moisture cannot be replenished from the soil, part or all of the tree may die.

Some tree species, and even certain seed sources, appear to be more resistant to winter injury than others. For example, larch is unlikely to sustain much winter burn because of its characteristic needle shedding each fall. Winter hardiness should be considered when selecting trees, but for most species it is a trait expressed only when environmental conditions are right to create the necessary stresses.

Stoeckeler and Rudolf (1949) examined plantings of various tree species for winter injury, and compiled reports of others from a number of upper-midwest areas. They found that, in north-central North Dakota, highly resistant species included Black Hills spruce, blue spruce, Scotch pine (Finnish origin), and some sources of Rocky Mountain juniper and eastern redcedar. In the Black Hills of South Dakota, even the native ponderosa pines sometimes have winter injury, but it is localized and not serious.

Tree Improvement Studies

Tree improvement research is now being conducted on both conifers and hardwoods. Scotch pine, Russian species of larch, ponderosa pine and green ash are currently receiving the most research emphasis.

Growth form of Scotch pine varies a great deal among trees from different seed sources. A few unfortunate choices of sources were made for some of the early-day Dakota plantings. Seeds from some European sources grew into twisted, poorly-formed trees that were ill-suited to purposes for which they were planted. Cunningham (1973) recommends areas of central Russia, the Ural Mountains and central Siberia as good seed sources for windbreak trees in the Dakotas.

Scotch pine, although reputed to be less drought-hardy than ponderosa pine, has made better growth than ponderosa pine when grown together on similar sites in North and South Dakota. One of those locations is the Denbigh Experimental Forest, where selected outstanding Scotch pines have been carefully pollinated for the past three years (Fig. 3). Test trees will be grown from these seeds when enough seeds are available. Variations in growth, crown shape and needle color which have developed over the first 13 to 15 years of the parent trees' lives indicate that parents are available to produce offspring adapted to most northern Great Plains needs.

Plans for Scotch pine research include specialized graft tests with branch tips (called scions) from superior trees in plantations in Richland and

Figure 3. Conelet high on a superior Scotch pine tree receives pollen produced by male flowers on another superior Scotch pine. Protective plastic bag which surrounds the branch tip and receptive conelet prevents unwanted windborn pollen from reaching this flower.

Ransom counties in North Dakota, as well as from Nebraska, Wisconsin and Canada. These scions will be grafted onto Scotch pine rootstocks and transplanted into an arboretum on the Denbigh Experimental Forest. The grafted scions (or ramets) will develop into trees containing the identical genetic makeup of the tree from which the scion was collected. Since all the ramets will be growing in a "common garden" situation, the effects of environment will be neutralized, and any differences among trees should be the result of inherited tendencies. With all the ramets together in one area, the best new trees can easily be cross-bred by controlled pollination.

In an earlier test of eight ponderosa pine seed sources at the Denbigh Experimental Forest, Conley, Dawson and Hill (1965) indicated that sources from eastern Montana may be best adapted to a northern Great Plains environment. These results may be confirmed, along with the probable addition of other well-adapted sources of pine, by a current, much larger study. Eighty ponderosa pine seed sources are being compared in test plantings to determine those that will produce pines well-adapted to Great Plains windbreak use (Dawson, 1965).

Green ash, a hardwood, already is a promising component of windbreaks, provided the individuals are fast growing, have compact crowns and maintain good height growth. Superior ash trees have been selected in North Dakota and South Dakota, and additional specimens are being sought. Scions from these outstanding trees are grafted to green ash rootstock (Fig. 4) and planted on a leased portion of the Bottineau Nursery near the Shelterbelt Laboratory. Pollen from selected male trees will be hand collected and applied to receptive female flowers when the trees begin flowering in a few years. Seeds from these controlled pollinations will begin the development of improved green ash trees that incorporate desirable windbreak traits of their parents.

Several other coniferous species have been tested to a limited extent to determine sources of seed from which trees suited to northern Great Plains windbreaks can be grown. They include eastern redcedar, Rocky Mountain juniper, Norway spruce, Siberian larch, white spruce and blue spruce.

In a five-year evaluation of seven seed sources of blue spruce, Dawson and Rudolf (1966) found one source that appeared to be best suited to the Denbigh test site in terms of survival, height, crown diameter and relative freedom from damage by late spring frosts. Those seeds came from northern mountain slopes of the Ashley National Forest in Wyoming and Utah. A more comprehensive test

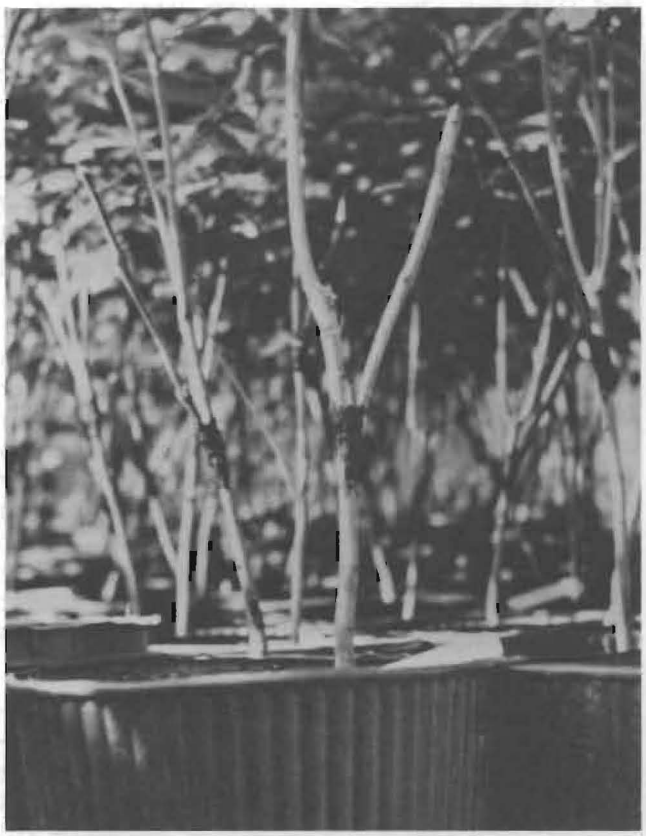

Figure 4. A view of newly grafted, potted green ash rootstocks on a greenhouse bench in February. Rootstocks are in full leaf, but the scions have not broken dormancy. Ramets with successful grafts will be field planted in May.

of some 150 families of blue spruce was started on the Denbigh Experimental Forest in the spring of 1975. More and better-defined geographical origins from which to grow blue spruce trees well suited to northern Great Plains environments will come from this test.

In a small-scale, 10-year test of six seed sources of Siberian and Dahurian larches, two origins were suggested by Cunningham (1972) as suitable for windbreak plantings in the northern Great Plains. Larch is a unique tree in that it is an "evergreen" that loses its needles each year, just as the hardwoods lose their leaves each fall.

Seed Certification

One problem encountered by nurserymen and others who grow trees from seed is the lack of accurate information about the source and capabilities of seeds they receive. No seeds that can be certified as to origin are currently available for many tree species. Such certified seed is essential to a viable program of improving trees for windbreaks or other purposes.

The North Dakota State Seed Department has developed general seed certification rules to help define and standardize seed certification in the state. Siberian larch and blue spruce trees at the Denbigh Experimental Forest are producing seeds that can be certified under North Dakota regulations as "select" seeds. The seed trees have been rigorously selected from plantations of known provenance, but no progeny tests have yet been made. Trees in one Scotch pine plantation are on the threshhold of meeting the requirements for "select" seed production.

The time is coming soon when we can recommend with assurance the best possible trees to provide shelter and beauty on the northern Great Plains.

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Farmstead Planning Handbook Available

The advancement of coal development in North Dakota will likely produce further changes in land use and development. In addition to industrial land site requirements and spoil bank reclamation, there may also be a need for farmstead relocation.

The objectives of planning in farmstead relocation include expansion, improved performance, higher capacity, and better use of labor. Accomplishing these objectives requires in-depth planning that encompasses reviewing the present, assessing the near future, and providing for the more distant future. It means an objective look at the entire farm business as a whole unit.

A successful farmstead development or relocation must consider four critical factors throughout all stages of planning. Water availability, drainage, production volume, and off-farm factors can impose crucial limitations on the success of a farmstead where they occur.

Further information discussing these concepts and other related topics, including development, planning factors, activity centers, and planning services, may be obtained by sending $2.00 to the Extension Agricultural Engineer, NDSU, Fargo, ND, 58102. The handbook, "Farmstead Planning," was compiled by the Midwest Plan Service of which NDSU is a cooperating member.