The USDA Forest Service National Seed Laboratory

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Introduction

The USDA Forest Service National Seed Laboratory has provided seed technology services to the forest and conservation seed and nursery industry for more than 50 years. This paper briefly traces the lab's evolution from a regional facility concerned principally with southern pines to its newest mission as a national facility working with all native U.S. plants and serving national and international needs.

History

Civilian Conservation Corps (CCC) camps operated forest tree nurseries to supply trees to their own reforestation crews. Philip C. Wakely of the USDA Forest Service Southern Research Station in New Orleans conducted germination tests of the seeds used in those CCC nurseries in the south. This early effort to evaluate the seeds sown in the nursery demonstrated to nursery managers in the south the benefits of a seed laboratory. Knowing how well the seeds would germinate removed a great deal of the uncertainty in producing a crop of seedlings. Testing by the Southern Research Station stopped with the outbreak of WWII and the end of the CCC. The effort was revived in 1952 at the USDA Forest Service Ashe Nursery in Brooklyn, Mississippi. In 1953, the testing service was offered to all nurseries in the southern region. During these first two testing seasons (fall 1952 through spring 1954), the lab was called the Ashe Nursery Seed Laboratory.

In 1954, the lab was moved to the Georgia Forestry Center near Macon, GA, and began testing services that November. This move was made in cooperation with the Georgia Forestry Commission (GFC) who had a strong need for seed work. The GFC provided a building, business support services, and a technician. Under this arrangement, more nurseries were encouraged to use the laboratory because testing fees were set in advance and not determined on a prorated basis at the end of the season. The 1954 fiscal year laboratory report states that Federal fiscal regulations made advanced prediction of testing fees impossible. With the move to Georgia, the laboratory name was changed to the Region 8 Seed Testing Laboratory to reflect the region-wide mission. Seed testing occupied approximately half the work year from fall to early spring. The balance of the year was spent on seed research. By fiscal year 1956, this research was formally supported by the Georgia Forest Research Council, another agency of the State of Georgia, and supervised by the USDA Forest Service Southeastern Forest Experiment Station.

Early Growth

In spring 1957, the seed laboratory building was expanded to accommodate more testing. By 1958, a totally new building was needed to meet the needs of the soil bank program, which was converting marginal farm land into forests, and other programs working to reforest millions of acres of abandoned farmland across the south. The number of tests was now exceeding 1,000 per year at a cost of U.S. $9.87 per test. (Compare that price to U.S. $54 per test in 2005.) Over 20 species per year were tested, mostly conifer. Test samples began to come from the northern parts of the eastern U.S. In recognition of this widening area of service, the lab was renamed the Eastern Tree Seed Laboratory in 1961. The expanded facilities met the needs of the program until the late 1970s. The laboratory had engaged in technical assistance with western nurseries, which led them to submit test samples in significant numbers. The seed exchange program with international forest researchers that had been added to the lab in 1972 was also growing. Hundreds of seedlots were being sent out of the country in support of research efforts. New services for evaluating seed orchard management also added a large number of seed tests. The lab was physically too small for the amount of work to be done. With these expanded efforts, the lab had clearly reached a major developmental stage.

Emergence of a National Laboratory

With the program now at a national and international level, the name was changed to the National Tree Seed Laboratory in 1979. A major program review conducted in 1980 led to national funding for the lab by the USDA Forest Service, with the National Forest System, Research and Development, and State and Private Forestry each contributing one-third of the budget. Seed testing receipts remained a significant source of revenue. In light of the importance of the national and international components of the program, the State of Georgia felt the program had reached a point were it could no longer legitimately provide financial support. Therefore, they stopped providing business support functions, technicians for the lab, and research funding. Desiring to maintain the long-term cooperation with the USDA Forest Service, the State leased the existing building and some land to the Forest Service for 99 years for the much needed modernization and expansion of the laboratory. The formal mission was now to provide seed testing services in forestry, to serve as a Federal standard to resolve seed testing disputes among non-Federal labs, to supply research seed samples to other countries, and to serve as a center for seed technology support to State, private, and Federal forestry organizations.

The Widening Need

The main focus through the 1980s was still on conifer species. The Conservation Reserve Program was requiring historically high numbers of pine seedlings to restore highly erodible farm lands back to forests. In 1988, 3.4 million ac (1.4 million ha) were reforested, which was the largest tree planting program in U.S. history. Two billion seedlings were required that year, and the Flint River Nursery in Georgia set a record by lifting and packing 1 million trees in a single day. Timber programs on the National Forests were large and required many conifer seedlings to reforest harvested lands. However, by 1990, habitat restoration was becoming a broader issue. Conifer seedlings were no longer enough. Previously less-favored species, such as longleaf pine *(Pinus palustris)* and hardwoods, were in growing demand. Endangered plants, grasses, and forbs were receiving increased attention in conservation efforts. The term native plant became increasingly important as society tried to retrieve a fast disappearing heritage and confront a growing menace of exotic invasive plants. Some State nurseries were converting part or most of their production into native grass and forb production. Private nurseries were formed to do the same. In response to these changes, the seed lab began to develop expertise with nontimber native plants. At the same time, much of the original mission of making conifer seedling production successful had been accomplished. Although ongoing work with conifers had to be continued and improvements made, the needs of society were changing. By the end of the decade, the seed lab was again at a crossroads.

Beginning in 2003, the mission of the National Tree Seed Laboratory was reviewed with a hard look into the future. Both public and private sectors of the conservation and forest nursery industry were involved in this review process. The findings of the review were basically that the previous needs of nurseries still existed, but the broader range of plants now needed and used in conservation work required a broader mission for the lab. Many seed issues blocked the use of nontimber native plants. However, the half century of applying and developing seed technology for timber trees had well prepared the lab to solve these seed problems and train the new personnel that were involved in the new era. The native nontimber species had all the same problems of seed dormancy, seed zoning, periodic seed production, and seed cleaning that the timber species have. The skill sets and basic technologies were in place to do the job. The end result of the review process was the Chief of the Forest Service announcing a new mission for the lab in June 2005.

The 2005 Mission

The new mission included many of the elements of the old mission: seed testing services for nurseries and seed dealers, international seed exchange for research, technology development, technology transfer, and training. These elements now applied to all native plants, not just trees. To reflect the inclusion of all native plants, the word Tree was removed from the name in order to be inclusive. The USDA Forest Service National Seed Laboratory (NSL) emerged as the newest iteration of the lab. One very exciting new dimension was added, which was long term seed storage for preserving genetic resources. Each of these mission elements is described in more detail in the following paragraphs.

Seed Testing Services

Seed testing is the fee-for-service work that began in the 1950s and has become an integral part of the forest and conservation seed and nursery industry. Customers are located throughout the country and come from all ownership types. Tests provided are germination, purity, seed weight (for example, seeds per pound), seed moisture content, X-ray analysis, tetrazolium tests, and excised embryo tests. The latter two tests are quick tests of viability used predominately for species with deep and variable dormancies for which germination is impractical. This service is the backbone of most other services, as all others involve some sort of seed analysis work. It also provides the laboratory and nursery/seed personnel around the country with a direct link in daily operations, which in turn opens up close communications for technology transfer and technical assistance work. The laboratory views this service as very important in establishing and maintaining a cooperative and integrated relationship with those who are served. The NSL is the only U.S. laboratory that is accredited by the International Seed Testing Association to test forest seeds. The number of clients served and the number of seed samples received in the 50 plus years of service testing exceeds 300 and 60,000 respectively. In the very near future, clients will be able to interact with the seed lab over the internet to receive test results almost as rapidly as they are completed.

Technology Development

Seed collection, cleaning, testing, and storage protocols are desperately needed for nontimber native plants. Therefore, the lab is running as many trials as possible to assist in this effort. Germination trials with and without light, with and without stratification, and at differing temperatures will lead to at least initial germination prescriptions and, eventually, Association of Official Seed Analysts rules for some species. An extensive collection of seed cleaning equipment at the lab allows for rapid development of cleaning protocols. Storage studies, by their very nature, will take more time to complete. In general, dry seeds will likely be found to store well in freezing temperatures; testing the species for desiccation tolerance will, therefore, be the first step. Work will also continue with tree species as needed.

Technology Assistance and Training

Any time there is a seed problem, the laboratory staff is available by phone, e-mail, U.S. mail, fax, or onsite visit. A Web site at http://nsl.fs.fed.us provides contact information and many useful references on seeds and the services available from the lab. Workshops are provided several times per year on a full range of seed topics. These workshops are small groups, not to exceed 20 to 25 persons, and are largely hands-on and tailored to meet the needs of the attendees.

Gene Conservation

This service is a major expansion of the laboratory mission. Long term seed storage requires totally pure seeds of high viability. Its maintenance requires seed testing facilities. Therefore, this work is a very natural companion to the developmental work on native plant protocols performed at the lab and the seed testing services. Seeds are not stored for 100 years for some abstract value. Therefore, collections will be made available for research, both domestically and internationally, as much as possible. This is a logical extension of the work done to this point through the seed bank to meet research requests from outside the country. A cooperative agreement has been signed between the Forest Service (FS) and the Agricultural Research Service National Center for Genetic Resource Preservation (NCGRP) at Fort Collins, Colorado. The Forest Service will receive seeds from FS units and FS cooperators, test the seeds, package the seeds, and send them to NCGRP for storage in their disaster proof vaults. The different types of materials currently envisioned to enter into the program are presented in the next section.

Categories of germ plasm collections (table 1).

- Threatened, sensitive, and endangered species. Threatened, sensitive, and endangered species were identified as highest priority to enter into the collections because these could be totally lost in the wild. Stored seeds could be used to replace lost populations.
- Forest health collections. When a species is fast being lost from the landscape due to an insect or disease infestation, it would be wise to make seed collections in advance of the epidemic to have materials to work with in subsequent restoration efforts. Current examples are white pine blister rust *(Cronartium ribicola)* in whitebark pine *(Pinus albicaulis),* emerald ash borer *(Agrilus planipennis)* in all native ash *(Fraxinus* spp.) species, and woolly adelgid *(Adelges tsugae)* in hemlocks *(Tsuga* spp.).
- Early tree improvement selections. As tree improvement programs advance, it becomes more difficult and costly to maintain clone banks of early selections. Some collections are lost or are threatened with loss as programs end and personnel retire. These collections, however, represent substantial financial, scientific, and intellectual investments. Seeds and tissues of these early selections could economically be stored in the NCGRP. These resources would then be available to check past historical work, renew programs that were temporary halted, take breeding programs in new directions without redoing the original work, or be able to take programs in new directions that would have been lost as the process of selection and domestication progress.
- Provenance collections. The geographic genetic variation of many forbs, grasses, shrubs, and hardwood tree species have not been adequately studied. Work is beginning with many species under varying initiatives. The collection of seeds is expensive and time consuming. Portions of the samples gathered for provenance and common garden studies could be preserved for future reference and study. This would allow for continuity among subsequent studies of a given species and facilitate additional work as resources and opportunities become available.
- Fine hardwoods. Fine hardwoods are those that bring premium prices for lumber and veneer and are very important in manufacturing high value-added products such as furniture, paneling, and flooring. They usually require sites of highest quality and, therefore, are often in competition with agriculture or housing developments for space. Additionally they are under heavy harvest pressures because of their value. These factors together threaten the amount of genetic variation available to researchers for expanding and preserving this valuable economic resource.

Table 1—Eligibility of seedlots for distribution and routine monitoring

Type of collection	For distribution	Monitor viability
Threatened, sensitive, and endangered	No	No
Forest health	Yes	Yes
Tree improvement	No	No
Provenance/common garden	Yes	Yes
Fine hardwoods	Yes	Yes
Small populations	No	Yes
Special	Determined case by case	Determined case by case

- Small populations. Many major tree species that are not, on the whole, threatened do have small unique populations included in their geographic range. Longleaf pine in the State of Virginia has few natural trees left. Logging, naval stores industry, and agriculture have almost eliminated the species at its most northern extremes. Sitka spruce *(Picea sitchensis)* in the Puget Sound area has been greatly reduced in numbers due to housing developments. Yet this is a valuable seed source for plantings not only in that area but also in Europe. These marginalized populations represent unique germ plasm and would be worth preserving.
- Special collections. Without doubt there will be collections that do not fit into the above categories. These, for now, will be placed in the category of special collections.

Conclusion

Every 20 to 25 years, a major evolution has occurred at the USDA Forest Service National Seed Laboratory. All steps have been in direct response to the conservation challenges of the day. The current changes at the NSL are the most recent actions to meet the needs of the 21 st century and beyond.

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