THE U.S. FOREST SERVICE GENETICS RESEARCH PROGRAM: ITS FUTURE

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INTRODUCTION

With the rapid changes that forest genetics research programs and tree improvement activities are now undergoing it would be most appropriate at this time to consider what the future may hold. In order to do this it is necessary to briefly review the past, evaluate current programs and speculate as to future requirements of a modern society for goods and services from their natural resources, and the role that forest genetics might play.

Most of my experiences have been with the U.S. Forest Service. All of my planning activities have essentially been associated with strengthening existing research or developing new initiatives in forest genetics in the federal sector. For these reasons I will for the most part concentrate my attention on the Forest Service activities, not forgetting the major and essential role that the university and industrial scientists have played, are playing and will play in the future of our sciences. Many of the programs are now interrelated and there remains a critical need for better coordination and cooperation in the future.

EARLY HISTORY

USDA Forest Service research from its modest beginning at the turn of the century to its current basic research initiatives have played a major role in advancing modern forest genetics and tree improvements. It would be useful to review briefly the early history of forest genetics research in the U.S. Forest Service in order to better appreciate how the past is now influencing the present program and shaping the future of this science.

Forestry research had its beginning in 1876 with the establishment of the Division of Forestry. Its principal task was to study the forest and forestry methods. Division of Forestry greatly expanded its activities after the appointment in 1898 of Gifford Pinchot. At the turn of the century, there was no science of forest genetics; yet in 1899 a tree species introduction and testing center was established in south Florida. At this first "forest" tree testing center a number of Eucalyptus species were screened. The scientists were seeking fast growing hardwood species. A few years later a similar research testing center was established in southern California. Both centers lasted about 10 years; but sudden low winter temperatures abruptly ended the wide use of Eucalyptus at the time. About every 10 to 15 years since, we keep relearning these early experiences with Eucalyptus in southern U.S. and California. We are still seeking a cold hardy Eucalyptus. These first organized attempts at enriching the forest germplasm in the United States was a reflection of the European concept on the use of exotics for special conditions. To a limited degree we have continued our search for useful exotic germplasm, especially for treeless areas of the United States. It should be noted at many locations in eastern United States the early settlers

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brought with them seeds and trees from their communities in Europe. A practice that lasted many years in the settling of the midwestern states and to a limited degree in the Great Plains.

Individual silviculturists within the U.S. Forest Service were also beginning to explore population differences. About 1912 a major Douglas-fir population study was established and shortly after other Forest Service scientists were studying Jack pine and southern pine variation. These early population studies were the forerunners of the very large population variation studies of the late 1950's and 1960's. In these early investigations emphasis was placed on population not individual tree differences, nor was the seed source always clearly defined.

It was during the 1920's that forest genetics as a distinct science got its start with a series of concurrent investigations on the southern pines, poplars and the western pines. Even in this case, the studies were still being carried out by silviculturists; but this new generation of scientists had been influenced by the expanding investigations in Europe and the great expansions of modern agriculture in the United States. For example, Cieslar (Austria) was publishing on larch and oak provenances in 1904 and in the next year 1905 Engler (Switzlerland) was reporting on elevational differences in fir, pine, spruce and maple. While that same year, Dengler (Germany) was conducting provenance tests with fir and spruce. The general concept of the provenance was developed by forest researchers. Poplar breeding in Europe was already well underway with the stress on "superior" hybrids especially those between the old and new world poplars. Much of this poplar improvement strategy was continued in the U.S. by Schreiner. He first started research about 1922 with forest industry and then joined the U.S. Forest Service for the next 40 years. S. Larsen (Denmark) in 1930's and onward provided valuable direction to forest genetics in Europe especially his zeal to get research into practice. His ideas greatly influenced this new generation of forest geneticists in the United States.

In the 1920's modern forest genetics was becoming of age. For the first time forest genetics research was being recognized as a distinct science. Individual research programs were being established. In 1925 the first forest genetics institute in the world was established at Placerville, California with private funds. This Institute became part of the U.S. Forest Service in 1932. Other programs were being developed in the South, Lake States and Northeast. The main goals of these early programs included developing trees with faster growth, disease and insect resistance, and improved adaptability. For some programs improved wood quality was the objective or useful secondary products; i.e., gum naval stores. In addition, these early programs had to develop new breeding technology and field designs to meet their individual condition. It was during this period that the initial breeding technology for forest trees was developed and tested. Major species population studies were installed employing the current agriculture statistical designs.

MODERN ERA

These early attempts at developing the new science established a reasonable base for greatly expanded programs following World War II. In the 1950's tree planting finally became an important element in forest management and as such the value of forest genetics took on a new meaning and importance. This was especially true in the South. But it should also be noted that

active research programs were established in the Pacific Northwest, Northeast, Lake states and even in the Great Plains. Major university programs were now making their appearance in the university - industrial cooperatives were being established, first in the southern states and eventually in all regions of the United States.

By the late 1960's and early 1970's Forest Service programs had reached their peak in terms of staffing and budgets. The research objectives had been expanded to include the identification of superior populations, developing inter and intraspecific breeding strategies and multi-trait breeding programs. A number of basic physiological and biochemical studies were initiated in support of the genetics effort. During their same period we saw the growth of industrial forest genetics research and the establishment or expansion of tree improvement activities. A number of universities were by now providing courses in forest genetics and initiating new research. By the end of the 1970's the majority of the forestry schools had genetics programs or at least introductory courses.

A survey of the this period demonstrated the extent of forest genetics research and development in the United States. Sixty-five private companies had or were part of tree improvement programs. Twenty-two state organizations had what could be identified as tree improvement programs. In all of the forest regions managed by the U.S. Forest Service, there were active tree improvement programs. Approximately 122 tree species were receiving some degree of genetics improvement or at least being studied. Most forestry organizations considered tree improvement activities as a regular part of their management responsibilities. By the early 1980's forest genetics and tree improvement activities had come of age. These programs were no longer protected from budget reductions. These programs were now beginning to be reduced with the lower forestry budgets then available. Except for support in selected cooperatives many forest industries closed or at least reduced their investment in genetics research. The U.S. Forest Service saw an annual reduction of some 5 percent in their project funding and this has been reflected in the closing or at least major reductions in 5 genetics projects. In fact some areas such as the northeast no longer has an individual genetics research unit, although some studies are still being maintained. Major reductions in staffing has also taken place in the South, and in the north central area. There has also been a shift in research priorities.

This shift in research priorities should not have surprised anyone. We had reached a stage where for the most part species and seed sources could be recommended for most sites. The level of actual improvement could be predicted with a degree of success. We had an array of provened seed orchard ,designs for various levels of improvement. To be sure, we had a number of important but unanswered questions to be resolved. Yet, in my opinion much of our research effort in forest genetics was to a large degree "reinventing the wheel" not addressing the major issues that were constraining the advancement of the science. Forest tree improvement is expensive and it was no longer being competitive with other management practices for the limited funds available. We had not broadened adequately the scientific base of forest genetics in order to respond quickly to changing management strategies or priorities of society. Furthermore, we had been dependent on the more basic sciences i.e., plant genetics and physiology, to provide our basic science information. There had been a further shift in the basic sciences from the more complex systems; i.e., trees to a greater emphasis on single cell

systems. Much of the current basic research in non-forestry institutions was of only limited value to forestry.

THE FUTURE

In my opinion, we have now reached the limit of the budget reductions. And we need to consider what type of new programs we should develop. We need to identify the skills needed and the type of organization that will be most productive. There will still be regional research programs addressing local and regional operational needs, although I suspect these regional programs will be structured somewhat different from today's projects. In the past, each Forest Service unit was to be an essentially complete research team with all of the necessary skills at one location. This may not be necessary nor needed in the future. We have started the development of several national genetics research resource centers. Such centers would have a critical mass in terms of scientists and budget. The research undertaken would be national or at least widely applicable over a large regional area. Such centers would have highly specialized skills available as a core team; but in order to stay current in terms of their science would be strongly supported by current post-graduates. The research would be aimed in a more basic direction, and would include more high risk science. Such a program would be like our current biotechnology effort which is located at only three locations. The aim of these programs is to test, develop and exploit the new technology to solving problems not easily done or possible by the traditional forest genetics approaches.

It is the aim of the new biotechnology program to accelerate genetic improvement by bypassing sexual contraints common to forest trees. It is by developing new methods of gene transfer that such difficult problems as disease and insect resistance breeding will be accelerated. We have an opportunity to explore stress resistance by the use of stress genes from other organisms. And for the first time we have a realistic opportunity to identify and locate useful tree genes by the use of DNA probes. To be sure this is high risk research, but the payoffs are well worth the investments. Already some of the improved techniques associated with the new biotechnology, such as somaclonal screening i.e. poplar resistance to leafspot, is already demonstrating its value.

The new genetic centers or projects would be interdisciplinary in composition. The critical core team may well not be permanent. With the rapid information production common to science it will be essential that the team composition constantly change to reflect the research needs for new disciplines or skills. Such a center could address for example, quantitative genetics issues nationally, as well as provide some scientific foundation for addressing the biological diversity issues now being raised by the environmental community or the impact of traditional management or air pollution on genetic structure of natural forests. These questions are of some importance to future generations. Such centers are not unlike the Biological Centers now being propsoed by NSF, DOE and USDA. The basic goal is to try to maintain a high level of current scientific skills in order to address more complex issues facing forestry.

A major need is still more basic physiological studies directed toward understanding of flowering and on how a tree grows both as an individual tree but also as part of a complex system. We can expect some concentration on a

series of model systems i.e. pines, poplars, Douglas-fir. Such information is essential in providing more direction to the breeding programs.

From a practical point of view more research is needed in clonal forestry. Its role needs to be better defined and the costs of establishment needs to be greatly reduced.

Finally, there is one serious role that the U.S. Forest Service should and must continue to play; the U.S. Forest Service must continue to support and maintain long term field studies in support of forest genetics, especially long term population studies. A recent review has shown that because of reduced funding and for other reasons many long term studies are being closed by forest industries and at some universities. Even some U.S. Forest Service field studies are threatened by reduced budgets. We will continue to make every effort to maintain priority field studies, and I encourage other organizations to work with us in maintaining an invaluable resource for future generations.

It should be obvious that I have no crystal ball to predict what the future research programs will be. What I have attempted to accomplish is to give you at least my opinion of the changes ahead. Personally, I am looking forward to these changes and a rebuilding and strengthening of our science. I feel strongly that we have a bigger role to play in forest and natural resource management. But we must demonstrate that we are, in fact, problem solvers now and in the future.