Forest Nursery Production in the United States and Mexico

John G. Mexal and Richard Phillips
Forestation Center for the Americas, New Mexico State University, Las Cruces, New Mexico 88003

Rosalia Adela Cuevas Rangel
Instituto Nacional de Investigaciones Forestales y Agropecuarias (CENID-COMEF), Av Progreso No. 5, Coyoacan, C P 04100 D.F., Mexico

INTRODUCTION

Timber harvests in the United States have increased 57% over the last 40 years without a loss in timber growth. In fact, timber growth has increased 45% in the same period. In contrast, timber harvests in Mexico have declined 29% in the last 5 years because of deforestation, resulting in the closure of mills and the loss of jobs (Anon., 1994). Both countries have a large forested land base covering 30% to 40% of the country. Mexico has 0.58 ha forest land/person, while the United States has 0.75 ha forest land/person. The United States has reforested at least 200,000 ha every year since 1950 (Fig. 1). Mexico reforested 100,000 ha for the first time in 1991 (Fig. 1). Consequently, deforestation is claiming over 400,000 ha/year. Before the forest industry of Mexico can recover, deforested lands must be replanted and reforestation must become part of the land use plan. The objective of this paper is to compare the forest nursery production systems in the United States and Mexico.

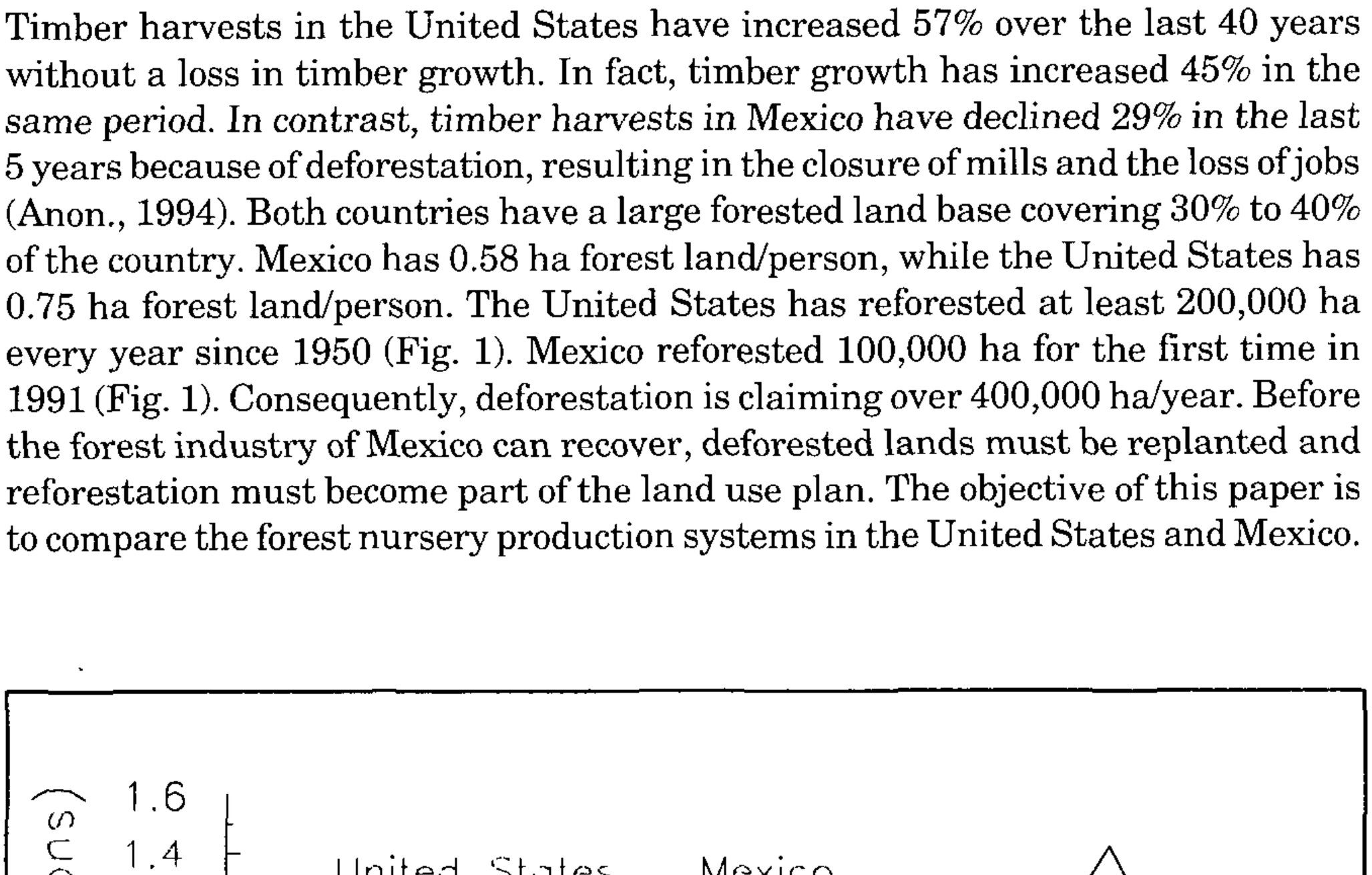

Figure 1. Reforestation in Mexico and the United States (Mangold et al., 1991; R. Sanchez, pers. comm.).

BACKGROUND

The United States has two major forest production regions: the southeast and the northwest. These two regions account for 87% of the nearly 2 billion seedlings planted annually (Mangold et al., 1991). Reforestation occurs primarily during the rainy season of winter to early spring. The primary species in the southeast are *Pinus taeda, P. elliottii*, and *P. palustris.* The major species in the northwest are *Pseudotsuga menziesii* and *Tsuga heterophylla.* Most of these seedlings are hand-planted on forest lands that have been clearcut and site-prepared. The rotation age varies from 20 to 60 years depending upon site quality, desired end product, and ownership.

Mexico has three regions of forest production: the tropical rainforest, coniferous forests, and oak/conifer woodlands. However, the coniferous forests account for 85% of the wood product production. Reforestation occurs during the summer monsoon season (July-October). The major species include: *P. montezumae, P. pseudostrobus, P. ayacahuite, P. oocarpa, P. michoacana,* and *P. durangensis.* However, Mexico has over 50 species of pine, many of which have economic importance (Perry, Jr., 1991). Seedlings are planted following fires, on abandoned farmland, and in forested areas that have been selectively thinned. Mexican forest laws require 10 seedlings be replanted for each m^3 harvested. The rotation age will vary with the shortest rotations in the tropical and central regions.

NURSERY PRACTICES

The United States relies on the forest industry to produce most of the forest tree seedlings. Forest industries operate 22% of the nurseries, but produce 53% of the seedlings (Mangold et al., 1991). State nurseries produce 29% of the seedlings and the federal nurseries produce only 7%.

The dominant production system is the bareroot nursery. Over 99% of the seedlings in the southeast and 82% in the northwest are produced as bareroot seedlings (Anon., 1987). The remaining percentage is seedlings produced in fixed geometry containers. Bareroot nurseries are highly mechanized and, as a consequence, tend to be large. The average industry nursery produces 16 million seedlings/year, and nurseries with capacities of 40 million are common. More efficient operations produce about 4 million seedlings per permanent employee. Temporary or contract laborers are used during the lifting and packing season. The increase in reforestation and concomitant increase in nursery production has been, in part, due to supportive research. There has been a tremendous effort in improving nursery productivity and seedling performance (Duryea and Daugherty, 1991; Duryea and Landis, 1984). One result of this research has been a better understanding of the parameters governing seedling survival and growth. It is likely that future developments from research will continue to improve nursery productivity and seedling performance.

Mexico relies on state and federal nurseries to produce most of the forest tree seedlings. State and federal governments operate 87% of the nurseries in Mexico. There are over 450 government nurseries with a capacity of about 500 million seedlings. This compares to about 110 nurseries in the United States with a capacity of over 700 million seedlings. Industry, usually pulp mills, operate only 13% of the nurseries in Mexico.

The dominant production system in Mexico is the polybag-container nursery. However, there are small bareroot nurseries and a few fixed-geometry-container nurseries. Mexico's nurseries are labor intensive. The average nursery produces about one million seedlings/year, with an average productivity of about 300,000 seedlings per permanent employee. This is less than one-tenth the productivity of the United States.

Forest soil is used as the medium for the polybag system. Typically, this medium is heavy, tends to compact and drains poorly. Nevertheless, one large nursery uses 35,000 m^3 forest soil/year at a cost of \$13/m^3. The bags are filled by hand and either direct seeded or transplanted with germinants. Seedling age at time of transplanting may range from 4 to 14 months. depending on availability of labor and seed. Weeding and fertilization are manual. One of the inherent problems with the polybag system is the lack of pruning of the root system. The seedlings with the best quality shoots have roots growing out of the bag and into the nursery bed. At lifting, most of the root system is left in the nursery; resulting in poor root : shoot ratios. This can be a major deterrent to high survival. Once lifted, the polybag trees are usually transported in open trucks to the planting site or holding area. The polybags offer no structural support and the heavy medium and harsh handling contribute to further root damage. There is little interaction between the nursery production scheme and the needs at the reforestation sites.

OPPORTUNITIES IN MEXICO

Opportunities for improving reforestation activities will require additional research to define target seedling characteristics and site specific requirements (Mexal and Landis, 1990). This will require cooperation among nursery managers, reforestation foresters, and forestry researchers. Specific nursery practices that could contribute to improved seedling quality would include modification of current practices in seed handling, media formulation, fertilization, irrigation, root pruning, and seedling handling.

Currently, seed is collected from natural stands for immediate use in the nursery. They lack the facilities and equipment to test and store seed. Seed germination testing should be initiated as a routine component of the crop growing process. Testing would help identify seed quality problems, conserve scarce seed, and define sowing requirements.

Opportunities exist to improve growing media with locally available material such as bark, compost, and scoria. This would preserve not only irreplaceable forest soil, but also conserve a usually sparse nursery budget. Current practices contribute to problems of drainage, weed populations, disease, and handling during transport. Alternative media could be developed that provide good drainage, high CEC and moisture-holding capacity, and low weight.

Fertilization and irrigation practices are inadequate. Many nurseries use high-priced special formulations of fertilizer. Agricultural fertilizer could be used at 1% of the cost of current materials. Irrigation uniformity is often poor. Training and testing of current equipment could improve the current system. Capital investments in new equipment should be made only after current systems have reached maximum efficiency. Virtually all training manuals in polybag nurseries stress the need to root prune the seedlings regularly. However, this is not a standard practice in Mexico's nurseries. Pruning at time of harvest creates a serious

imbalance in the root : shoot ratio and may help explain the high mortality in plantations. The nurseries also need innovations in the shipping and handling of seedlings from the nursery to the plantation. The current system causes extensive root damage and contributes to planting failures.

Nurseries, particularly federal and state nurseries, are viewed often as employment centers. Thus, the introduction of new technology may be met with resistance if it results in a net loss of jobs. However, technologies exist that improve productivity without a loss of jobs. For example, most nurseries lack the labor resources to hand weed in a timely fashion. Thus, weeding is often late, resulting in decreased growth from competition and damage and even mortality from weeding. Herbicides would reduce weed populations and the damage to seedlings caused by late or no weeding. At the very least, these types of technologies could double productivity with no increase in cost and no change in labor or capital investment (Fig. 2).

Future quality and production gains can be made by implementing a second level of technology that would include converting from polybag systems to fixed geometry (containerized) or expanding the bareroot nursery system. These systems provide increased opportunities to mechanize operations and increase productivity. However, the technology must be appropriate for the region or nursery and nursery managers must have the opportunity to become familiar with these systems prior to converting their nurseries.

Mexican nursery managers do not have easy access to a supportive research program. Certainly, there is nothing similar to the forest nursery cooperatives at Auburn University and Oregon State University. Instituto Nacional de Investigaciones Forestales y Agropecuarias (INIFAP) has good researchers, but

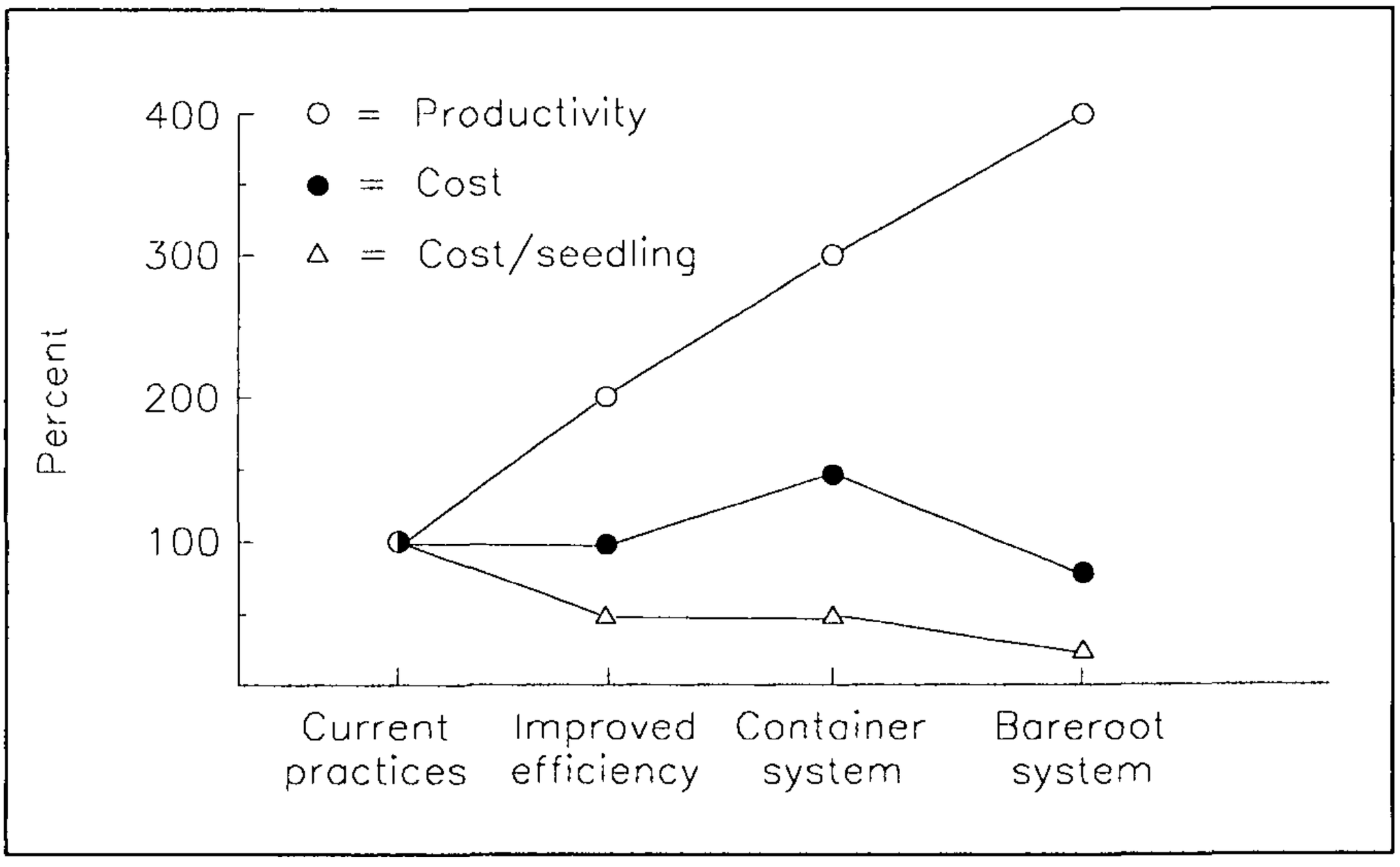

Figure 2. The hypothetical effect of changes in technology on the productivity, costs, and capital investments in nursery systems (opportunities for improving nursery production in Latin America).

little funding to develop technology. Industrial research programs are almost non-existent. Since 1991, New Mexico State University's Forestation Center for the Americas (CEFORA) has worked with over 80 Mexican nursery and reforestation foresters to improve forest nursery production. In 1994, CEFORA in conjunction with Programa Nacional Reforestacion (PRONARE), INIFAP, and the U.S. Forest Service conducted a 3-week training course in central Mexico. This training opportunity along with limited in-country short-term programs are the only programs available to Mexican forest nursery managers. Future improvements in Mexico's forest nurseries will, in part, depend upon developing a strong forest nursery research program and developing a communication network between nursery research and nursery management.

LITERATURE CITED

Anon. 1987. Directory of forest tree nurseries in the United States. Amer. Assoc. Nurserymen.

Anon. 1994. Memoria estadistica 1993 Camara Nacional de la Industria Forestal.

Duryea, M.L. and **T.L. Landis** (eds.). 1984. Forest nursery manual. Production of bareroot seedlings. Martinus Nijhoff/Dr. W. Junk.

Duryea, M.L. and **P.M. Dougherty** (eds.). 1991. Forest regeneration manual. Kluwer Academic Publishers.

Mangold, R.D., R.J. Moulton and **J.D. Snellgrove.** 1991. Tree planting in the United States. 1990. USDA Forest Service, State and Private Forestry.

Mexal, J.G. and **T.L. Landis.** 1990. The target seedling concept-height and diameter, p. 17-36. In Proc. 1990 Joint Western and Intermountain Nursery Conf., Roseberg, OR. USDA Forest Service. Gen. Tech. Rep. RM-200.

Perry, Jr., J.P. 1991. The pines of Mexico and Central America. Timber Press, Portland, OR.