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Abstract.--Research was initiated in 1936 to produce container-grown conifer stock for planting in the northern Great Plains. Containers evaluated were oil and beer cans, and aluminum foil, tar paper, and wood veneer pots. The tar paper pots and oil cans were the most satisfactory. Information is presented on 17- to 37-year-old conifers that were grown in containers before planting.

Research on improving tree and shrub species, methods of growing and maintaining them, and planting of trees for windbreak purposes on the northern Great Plains was begun in 1915 by the United States Department of Agriculture at the Northern Great Plains Research Laboratory, Mandan, N. Dak. Trees for farm windbreaks were grown at Mandan and shipped bare-rooted in the spring in accordance with a planting plan prepared after inspection of the site the previous summer. Many of the farmers lived far from express and post offices that had no rural delivery systems. Lack of delivery systems frequently meant delayed pickup by the addressee and unsuitable storage of the tree shipment. As a result, conifer survivals were very poor and often a complete loss. Handling of conifers had to be improved if they were to be used in the Great Plains tree-planting program.

In 1936, research on growing conifers in containers was begun in an effort to increase survival of field-planted stock. Conifer seedlings were transplanted from seedbeds into quart or gallon oil cans that had one end removed and drain holes punched in the other end. A blowtorch was used to clean the containers of residual oil. Many trees started in such containers were planted in permanent plantings the next year with 100 percent survival (fig. 1). Trees in gallon containers were planted after removing only the bottom of the can. Quart containers were removed before the trees were planted. Although high survivals could be ob-

tained by planting containerized stock, the transportation problem could not be readily solved. Each quart container weighed 3 or more pounds, and when a large number of trees had to be shipped, transportation costs became prohibitive.

Further studies to increase survival and to reduce transportation cost were conducted during 1941-46. The following methods were used: undercutting 2-1 stock during midsummer before lifting the next spring, spraying or dipping the tops in various wax emulsions, and removing all of the needles. Undercutting in the nursery row gave very satisfactory results and was used as a practical method until the farm tree-planting program was discontinued in 1949. Some of the wax emulsion treatments gave good survivals, others were definitely harmful. Deneedling gave good survivals but the method was not practical for use on large numbers of trees.

Despite the fair to good success obtained with the methods described, container-grown stock had the highest potential for establishing good stands. A study in which smaller and lighter containers were used was begun in 1955. Three species of conifers were planted in 5-inch beer cans, 5- and 7-inch aluminum-foil containers, 7-inch tar paper and 7-inch wood-veneer containers. All fabricated containers were 2 x 2 inches in cross section. Conifer stock was transplanted in the containers in 1955 and field planted in test plots in 1956. Trees planted in beer cans had the lowest survival and also the poorest growth and vigor, possibly because of some toxicity related to the can-tinning process. Trees in aluminum-foil containers had high survival and greater growth and vigor. Trees in tar paper and wood-veneer containers gave good survival and normal growth. Many of the trees

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Figure 1.--Tree-plantings made in 1937 with containerized stock. (A) Block planting of 2-1 ponderosa pine (*Pinus ponderosa*) grown in gallon-can containers the year before planting and planted after the bottoms of the cans were removed. (B) Windbreak row of 2-1 ponderosa pine grown the year before planting in quart-can containers and planted after removal of the can. First-year survivals were 100 percent, and only a few suppressed trees have since been lost in block planting A.

Figure 2.--Tree-plantings made in 1957 with containerized planting stock. (A) Windbreak row of 2-2 ponderosa pine grown for 2 years in tar paper containers and planted without removing the containers. (B) Block planting of 2-2 ponderosa pine and Rocky Mountain juniper (*Juniperus scopulorum*) grown for 2 years in aluminum-foil containers which were removed before permanent planting. First-year survivals of 100 percent have been maintained.

in this test were dug the following spring and planted in permanent plantings. All survived (fig. 2). All containers except those of tar paper were removed at the time of planting. The tar paper containers were in good condition and well penetrated by tree roots.

The North Dakota Farm forestry Committee has been intensely interested in, and has encouraged the use of containerized conifer planting stock for the past 20 years. In 1954, the committee endorsed the use of containerized stock as the surest method of establishing conifers in the state. Minutes of the Farm Forestry Committee meetings in 1954, 1955, and 1957 show the Soil Conservation Service Plant Specialist had 20,000, 10,000, and 7,500 containerized plants, respectively, for district plantings. A report on the 3 years' results showed that the use of containerized stock had little advantage in the eastern one third of North Dakota because of the higher precipitation. In the remainder of the state that has a

much lower precipitation, container-grown stock gave much higher survival than bare-rooted trees. Even with the exhibited success, the demand for container-grown trees was very low because of their high cost and transportation problem. The 1960 minutes of the North Dakota Farm Forestry Committee Meeting state "Until there are further improvements in potting methods and in the problem of transporting stock, practical use of potted conifers will not be possible". However, it now appears that, through extensive research, most of the early problems encountered in producing and transporting containerized stock have been overcome as evidenced by reports presented at this Symposium. Present and future technological developments will undoubtedly contribute greatly to the chances of obtaining high survival rates for field-planted conifers in the Great Plains. Such developments will be welcomed in North Dakota which usually leads the nation in the miles of windbreaks planted each year.