PROC. SYMP. on Management of Young Pines. Alexandria, La. Oct. 22-24, 1974
and Charleston, S. C. Dec. 3-5-, 1974. 1974. p. 307-309.

IMPLICATIONS OF YOUNG STAND DEVELOPMENT FOR SHORT ROTATION SILVICULTURE

William R. Harms[1/]

Abstract.--A brief discussion of the importance of stand density to growth and yield as it relates to rotations of 15 years or less.

Additional keywords: Stand density, mortality, competition.

The production of wood on short rotations with complete utilization of the tree is an attractive option that may some day render more efficient the business of meeting the ever increasing demand for fiber (Ribe, 1974). The silage sycamore system introduced by McAlpine et al. (1966), and the complete tree concept of Young (1964) have given impetus to research and development of alternatives to the pulpwood production systems now in general use. However, a management system incorporating short rotations, say less than 15 years, and the complete tree has not yet, to my knowledge, been put together. There are still too many biological, technical, and economic unknowns to be worked out before such a system can become operational.

One of the more important of the biological aspects is the optimal density for young stands that will maximize the yield of useable fiber for a desired age or rotation length. Stand density is important because short rotation silviculture requires that a site be completely occupied with trees as soon as possible after the stand is established. The object is to get full production quickly so as to produce an economically harvestable crop in the shortest possible time. To get full production at young ages requires that the stand be started with a much larger number of trees than is normal for a pulpwood rotation. Instead of starting with 800 to 1000 trees per acre it may be necessary to start with 2000 to 4000 or more. We must know, therefore, what initial density is required because the fast growth of young trees causes rapid and significant changes in stand structure. Even a small departure from optimum density can be costly. If too few trees are started, the rotation age may have to be extended. If too many are started, early onset of competition can result in unplanned growth losses and mortality.

The forester requires knowledge of how stands of the desired species develop during the time span of a short rotation. Unfortunately, past experience and research offer little specific guidance. It is possible, however, to describe in general terms how young stands develop and to reason what factors and relationships need to be studied in order to develop a system of management that is biologically sound.

1/ Principal Plant Physiologist, Southeastern Forest Experiment Station, USDA Forest Service, Charleston, S. C.

Growth and development of a stand are inseparably related to stand density--the number of stems per unit area--by the factor of competition for growing space. At any particular time in the development of a stand, the survival and growth of individual trees depend on how successfully they are able to compete with each other for light, water, and nutrients. As long as the trees are free to grow, their size and rate of growth are independent of density. This is the normal situation the first few years following stand establishment. However, as the trees extend their roots, and increase in height, and in width of crown they begin competing with each other for a share of the growing space. If the supply of growth factors is less than that required by the stand there will be a reduction in rate and total amount of growth of individual trees, and in their ability to survive. The reduction in growth is a plastic response whereby trees adjust their size (diameter and height) to the share of growth factors available to them. If a species is not able to adjust sufficiently to the space available, the smaller and weaker individuals die--the stand thins itself.

The competition-density effect can be generalized as follows: In stands that are in the process of self-thinning, the plastic response of the survivors tends to keep rate and amount of growth in balance with the loss of trees so that at any given time the residual density tends to approach the maximum number of trees that a site can support. It follows that this density will also produce the maximum yield. In fact, any stand undergoing self-thinning should be yielding its maximum volume and dry matter. However, the nature of yield-density curves indicates that a maximum yield at an age can be had over a range of densities. Loblolly pine data shown at this stop indicate that the density range for such an asymptotic yield response depends on the interplay between self-thinning and growth of the residual trees.

Self-thinning is evident in the densest stands shortly after establishment. Mortality among young trees tends to be high, and adjustment to changing growing space is rapid. Competition begins progressively later and operates more slowly at lower initial densities. Because of the longer time it takes trees at low densities to occupy the site to the point of self-thinning, such stands also approach maximum density more slowly. In a density series on the same site then, stands of differing densities will begin self-thinning at different ages, so that at any one age there can be a range of densities that are undergoing self-thinning, with the initially densest stand approaching the maximum density for the age and site. The standing or net yield of these stands should be the maximum for that age and should approach the same level over the range of densities.

The significance of these relationships for short rotation silviculture is that maximum yield for a density will occur shortly after competition first initiates self-thinning. The age and rate at which the maximum is approached depends on initial density, but the magnitude of the yield and its quality will depend on the age of the trees, site quality, and species. It is obvious that as rotation ages are lowered greater attention must be given to obtaining the proper balance between number of trees at time of stand establishment, growth rate, and the desired tree size and yield of harvest.

The principles discussed above were illustrated with data that showed the development of young naturally regenerated loblolly pine stands grown at densities of 1000, 2000, 4000, 8000, and 16,000 trees per acre. A manuscript[2] discussing these data in detail has been submitted for publication in Forest Science.

LITERATURE CITED

Ribe, J. H. 1974. A review of short rotation forestry. Life Sci. & Agric. Exp. Sta., Univ. of Maine at Orono. Misc. Rep. No. 160. 52 p.

McAlpine, R. G., C. L. Brown, A. M. Herrick, and H. E. Ruark. 1966. "Silage" sycamore. Forest Farmer 26: 6-7.

Young, H. E. 1964. Complete tree utilization: A challenge and an opportunity. Proc. Soc. Amer. For. Ann. Mtg., Denver, Colo.

2/ The Development of Loblolly Pine in Dense Stands, by William R. Harms and O. Gordon Langdon.