TWENTIETH-YEAR RESULTS FROM A PLANTATION GRAZING STUDY

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Our long-term study of an experimentally grazed forest plantation on the Hall Ranch of the Eastern Oregon Agricultural Research Center is providing new insights into agroforestry. Measurements of tree and cattle responses and changes in vegetation have continued throughout the study. At the conclusion of data collection in fall 1983, the plantation completed the first phase of the study and thinning of the resultant stands was implemented.

One objective of this study was to determine the feasibility of interim grazing of forested land from immediate post-logging to tree canopy closure and the effect of such grazing on survival and growth of forest regeneration from planted coniferous tree stock.

EXPERIMENTAL PROCEDURE

A 30-acre tract of mixed coniferous forest, predominately grand fir (Abies grandis) was clearcut in summer 1963 and broadcast burned in summer 1964. Residual cull logs were oriented perpendicular to the prevailing slopes. Within this tract, three 5-acre pastures were fenced to exclude cattle.

In fall 1964, all three pastures were seeded to grass utilizing a split-plot design (seeded vs. unseeded) on a random basis. Each plot was 0.5 acre and oriented perpendicular to the slope. Forage species were seeded on the lower half of each treatment at a rate of six pounds per acre with a mixture including orchardgrass (Dactylis glomerata), tall oatgrass (Arrhenatherum elatius), timothy (Phleum pratense), smooth brome (Bromus inermis), and white clover (Trifolium repens). The upper half of each plot designated for seeding was further divided longitudinally into two equal subplots, one seeded to blue wildrye (Elymus glaucus) and the other to mountain brome (Bromus marginatus) at the rate of eight pounds per acre.

In the spring of 1965, coniferous seedlings (2-0 and 3-0 stock) from the U.S. Forest Service Nursery in Coeur d'Alene, Idaho, were planted in each pasture on a random block basis at the rate of 1,000 trees per acre (Figure 1). Species planted were: ponderosa pine (Pinus ponderosa), Douglas-fir (Pseudotsuga menziesii), western larch (Larix occidentalis), and western white pine (Pinus monticola). Spacing was six feet within rows with rows oriented across the slopes and seven feet apart.

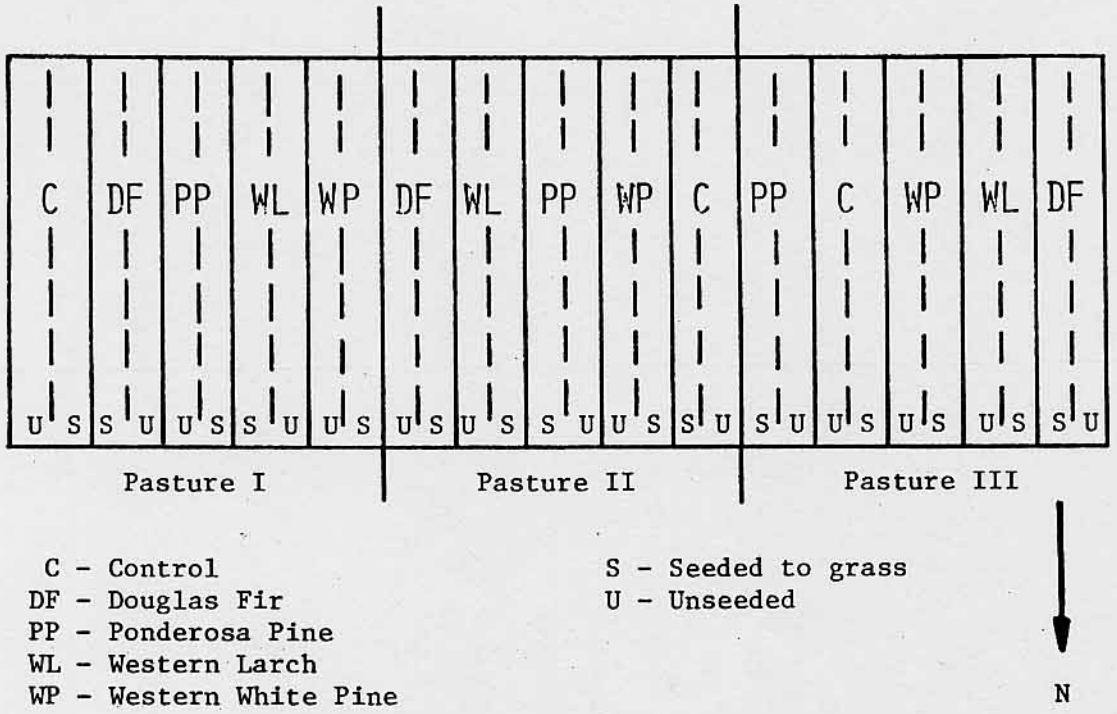

Figure 1. Field design of tree plantations on the Hall Ranch of the Eastern Oregon Agricultural Research Center.

Cattle grazing was initiated in July 1966 with the introduction of five yearling heifers annually in each pasture until 1972 when cattle grazing in Pasture III was discontinued. Grazing was continued in Pastures I and II on an annual basis through 1983. Therefore, grazing treatments were: Pasture I grazed by cattle, Pasture II grazed by cattle and game, and Pasture III grazed only by game. Cattle dispersion was affected by development of the water source at the ridge top and placement of salt blocks at the base of the slope. Cattle entry into the pastures was timed with the phenology of forage and tree species -- varying from June 15 to July 15 each year. Cattle remained on pasture for approximately one month.

Records of survival and height growth of planted coniferous seedlings were tallied twice annually - before and at the conclusion of grazing -- from 1966 through 1978 and in fall 1983 after grazing. In 1983, diameter at breast height (dbh) was also measured for each species. In addition, evidence of seedling damage and probable causes of mortality were recorded from the time of planting (1965) to 1978.

RESULTS AND DISCUSSION

Survival was unchanged from 1977 levels (Krueger and Vavra 1983). Ponderosa pine and Douglas-fir had the best survival ranging from 55 to 62 percent. Survival of western larch and western white pine ranged from 22 to 36 percent. Mortality stabilized the fourth year after planting. Trampling by cattle accounted for 8 percent of mortality (less than 5 percent of planted ponderosa pine and Douglas-fir). Big game and rodents caused 18 percent of mortality. The rest of the mortality was caused by a variety of factors and drought was assumed to be the major problem. There were no significant differences in survival or growth between plots seeded to grass and those unseeded.

In all cases, maximum growth of planted trees was attained in the pasture grazed by both cattle and big game (Table 1). In an operational sense, we would not expect to control access of big game to a plantation, so the comparison of results from the pasture grazed by cattle and big game with that grazed by game only simulate the choices a land manager would face. When this comparison was made, the trees grown in the pasture grazed by cattle and game were taller and larger than those in the pasture that excluded cattle use (Table 2). The lowest response was for ponderosa pine and the greatest response was for western larch. The benefit to tree growth from cattle grazing was surprisingly large for western white pine and western larch. However, because of lower survival, these stands were stocked at about 250 to 300 trees per acre. These open stands provided more forage and, especially in recent years, concentrated grazing in those parts of the pasture. The added benefit to tree growth from cattle grazing was probably caused by a number of factors; among those should be improved moisture relations from grazing of the understory and a fertilizer effect from cattle urine and dung. These effects would obviously be exaggerated where cattle grazing was most intense.

The treatment design allowed us to evaluate the basic effects of adding cattle grazing when big game grazing was present or adding big game grazing when cattle grazing was present. The addition of cattle grazing to pastures grazed by big game generally increased tree growth much more than the addition of big game to pastures grazed by cattle. Big game grazing was nearly as effective as cattle grazing for increasing growth of Douglas-fir. Big game were about half as effective as cattle for increasing growth of ponderosa pine and added very little to enhance growth of western white pine or wester larch. The synergistic effect of grazing cattle with big game did produce the largest growth response in planted conifers and that response as not equal to adding of individual grazing effects.

Table 1. Height and diameter (dbh) growth of planted conifers in 1983, 18 years after planting.

Species	Cattle & Game Grazing		Cattle Only		Game Only	
	Height (ft)	Diameter (inches)	Height (ft)	Diameter (inches)	Height (ft)	Diameter (inches)
Ponderosa pine	19.9	4.8	18.6	4.6	17.6	4.4
Douglas fir	25.5	4.4	21.7	3.7	21.6	3.5
Western white pine	24.0	3.9	22.4	3.9	16.7	2.5
Western larch	29.2	5.0	28.6	4.5	21.2	3.1

Table 2. Percentage increase in growth for trees in pastures grazed by cattle and big game compared to trees in pastures grazed by game only.

	Ponderosa pine	Douglas-fir	Western white pine	Western larch
DBH	9	26**	56*	61**
Height	13*	18^{+}	44*	38**

t Statistically significant at $P \leq .10$

* Statistically significant at $P \leq .05$

** Statistically significant at $P \leq .01$

The first phase of this study has been completed. It is clear that under the management applied to these experimental pastures, grazing by both cattle and big game enhanced the productivity of trees in the plantation. Seeding of the plantation to forage species under this system had no effect on tree growth. However, forage seeding will enhance the forage supply and should make management easier on large plantations. The potential for development of this agroforestry practice is good since it provides income from cattle production in the short term while improving growth of trees. We will continue these studies after the plantation is thinned to provide information on these cattle-timber-big game relationships for the growing forest.

LITERATURE CITED

Krueger, W. C. and M. Vavra. 1983. Responses of herbaceous vegetation planted trees and cattle on a forest plantation. IN: Research in Rangeland Management. Oregon State University, Agricultural Experiment Station. Special Report 682, pp. 41-45.