DYNAMIC PROGRAMMING FOR OPTIMIZATION OF FORAGE AND WOOD FIBER PRODUCTION

K. Riitters and J.D. Brodie
School of Forestry
Oregon State University
Corvallis, Oregon 97331

SUMMARY

Given economic and biological models for forage and fiber production, dynamic programming is an alternative to simulation to find optimal joint production strategies. The methodology allows the comparison of single- and multiple-product strategies under present and future projections of value. Dynamic programming also can provide useful insights into joint production strategies that are not apparent in simulation studies.

INTRODUCTION

Optimization analyses of the independent production of forage or wood fiber are readily available in the literature. Joint-production strategies have been compared in simulation studies; in such analyses, the "best" solution often is the most complex in terms of management activity. A joint optimization framework is more efficient and more flexible but usually is analytically complex. Dynamic programming is a simple optimization algorithm that provides insights and useful solutions to joint-production problems.

MATERIALS AND METHODS

Joint optimization of forage and fiber production requires:

1. economic information and assumptions;
2. biological models of forage and fiber production and interactions, and;
3. an optimization framework.

The dynamic programming optimization framework is described in elementary operations research texts (Hillier and Lieberman, 1974).

When coupled with economic models and with biological models of forage production (Jameson, 1967) and of wood fiber production (Hann, 1980), dynamic programming can be used to solve the joint-production problem (Riitters et al., 1982). Comparison of optimal single- and joint-product strategies under alternate economic projections can be made in this optimization framework. The analysis can be expanded to include additional outputs.

RESULTS AND DISCUSSION

Depending on relative prices and discount rate, maximum site expectation is achieved by producing either forage or wood fiber alone, or by an optimal schedule of joint production. When joint production is optimal, forage revenues predominate early in the rotation, when forage and fiber production are least competitive. Massive relative forage price increases are required to justify forage production later in the rotation, although fiber rotations are shortened due to the impacts of early grazing revenues (Brodie et al., 1978). Projected increases in relative forage prices will shift solutions towards the forage-only alternative, because fiber production ultimately restricts forage production. With increasing fiber prices, however, joint production remains optimal because forage production occurs during the tree stand establishment period when forage production is essentially non-competitive with fiber production. When forage production and stand establishment are highly competitive, the present algorithm allows the comparison of alternate stand establishment strategies.

LITERATURE CITED

Brodie, J.D., D.M. Adams, and C. Kao. 1978. Analysis of economic impacts on thinning and rotation for Douglas fir, using dynamic programming. For. Sci. 24:513-522.

Hann, D.W. 1980. Development and evaluation of an even- and uneven-aged ponderosa pine/Arizona fescue stand simulator. USDA Forest Ser. Res. Pap. INT-267. Intermt. For. & Range Exp. Stn., Ogden, Utah. 95 pp.

Hillier, F.S., and G.J. Lieberman. 1974. Operations Research. Second Ed. Holden-Day, Inc., San Francisco, California.

Jameson, D.A. 1967. The relationship of tree overstory and herbaceous understory vegetation. J. Range Manage. 20:247-249.

Riitters, K., J.D. Brodie, and D.W. Hann. 1982. Dynamic programming for optimization of timber production and grazing in ponderosa pine. For. Sci. 28:517-526.