Procedure for Including a Timber Enterprise in a Programming Evaluation of River Basin Development

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Wood products are included as competing enterprises in a model used as an aid in evaluating the need for land and water resource development. The procedure for developing linear programming data inputs for veneer, sawtimber, cordwood, and "other" enterprises is presented. Detailed land use was developed from secondary sources. Data for enterprise budgets were developed mainly from experience on publicly owned land. The river basins examined were found to be capable of meeting food and fiber needs for the next 50 years, although improved woodland management is necessary. An increase in woodland acreage is needed to meet wood product demands after 1980.

Key words: Enterprise budgets, linear programming, resource development, resource use, river basin planning, timber resource planning, woodland clearing.

All areas of our Nation have been scheduled to undergo a comprehensive investigation of their land and water resources. Some areas have been, and others will be, investigated more than once under various types of river basin studies. Such studies usually involve a detailed analysis of the land resource's capability to meet the projected demand for non-wood products, but few have placed more than minor emphasis on wood products.

Woodland is a major land use in the two river basins we investigated, and we wanted to know some of the possible effects that resource development would have on timber production in the basins. Since we were using linear programming to analyze possible economic effects of resource development on crop production, we decided to include forest production activities in the same model. In this paper we discuss (1) some of the problems of including wood products in the evaluation, (2) our approach to wood products as a crop competing with other crops for the available land resource, and (3) some preliminary findings. We are not providing numeric estimates of other inputs or outputs of the model because we feel they are not germane to this discussion of procedure. Though input needs are specific, we feel that the results should be viewed as indicating direction rather than absolute outcomes.

Comprehensive Timber Resource Planning

Timber as a natural resource has both stock and flow resource properties (4). The forest's growing stock provides an annual flow and a reservoir of timber which can be harvested, maintained, or expanded. Within given climatic zones the timber reservoir can be moved from one place to another, that is, from bottomland to upland or vice versa, or from drainage area A to drainage area B. However, a considerable period of time is involved in such a movement.

National timber supplies have been projected, but little effort has been devoted to planning ways of increasing national production beyond that which will occur naturally through the actions of thousands of independent land managers. This is partly because annual forest growth in this country has exceeded annual cut over the past 30 years. Such a situation is not expected to continue. The total volume of growing stock is increasing, but so is the total demand for wood products. Also, some specialty woods are becoming scarce. A report by the Forest Service projects sawtimber cut to exceed growth in the Southern States by

1 Underscored numbers in parentheses indicate items in the References, p. 111.
If this happens, some segments of the timber industry could be completely disrupted. Some land and water resource development projects affect the timber resource. Flood protection and drainage projects often result in a change in land use, including clearing, and may reduce the long-run supply of timber products. Clearing of woodland capable of producing sawtimber and veneer, and putting the land in crops, may be imprudent, considering that (1) agricultural crops are in surplus, (2) sawtimber and veneer woods may become scarce, (3) cost-reducing technology for making wood substitutes is uncertain, and (4) several decades are required to produce trees for sawtimber and veneer.

Land use planning, including comprehensive river basin planning, should integrate the planning for various major land uses. Investigation of current and future production capabilities of the timber resource needs to be undertaken in conjunction with the other productive uses of farmland. The importance of such an investigation becomes apparent when it is realized that decisions made in the forest industry today may influence the supply of timber as much as 50 years hence.

This report is only concerned with appraising the economic contribution of the forest toward meeting expected future food and fiber needs. Such information would be helpful in formulating long-run policies of timber-management—both public and private—as well as in establishing type, scale, location, and priorities for planning natural resource development needs.

The Programming Model

Land use shifts and resource development are dynamic processes. Linear programming is often used as a tool of comparative statics to help establish optimum land use and evaluate resource development needs. Such a tool was used in this analysis for future years—1980, 2000, and 2020. The basic inputs are production requirements, land resources, production costs, yields, current land use, and constraints on shifts in land use.

The future levels of basic inputs were estimated aside from the model. The object of the analysis was to estimate least cost patterns of land use to achieve the production requirements established for the basin under various assumptions, including levels of resource development.

The production requirements were estimates of the future quantity demanded from the basin at existing price levels. They merely served as planning goals. The land resource was classified into soil productivity groups based upon resource problems and production potential.

Production costs included only on-farm costs. Group-action project costs were not included. Yields were expressed on an annual per acre basis. Current land use and constraints on shifts in land use were used in developing future land use by restricting the shifts in land use implied by production cost differentials alone.

The general model was not originally devised to include forestry as a competing enterprise. Several basic differences between the production of timber and conventional crops present problems in identifying the inputs for wood products. Characteristics of timber production which present problems are (1) the relatively long production cycle of wood products—10 to 50 years, and (2) the fact that various products—such as veneer, sawtimber, cordwood, poles, posts, and firewood may come from the same acre of woodland.

Detailed Land Use

In estimating the detailed use of woodland, a specific acre could not be considered as producing a single product. In this study, four product groups were established to represent the numerous products that could be obtained—veneer, sawtimber, cordwood (including pulpwood and fuelwood), and “other.” A priority rating based on the length of the growth cycle for the product group was established. This rating also corresponded to the economic value of the groups. First priority was given to veneer, which has the highest per unit value and can only come from superior logs. Sawn lumber, which has the second highest per unit value and can come from veneer or sawtimber logs, was ranked second. Pulpwood has a per unit value less than veneer or sawtimber and can come from veneer logs, sawtimber, or pulpwood. It was ranked third. All of the remaining products, including wood chips, charcoal, and posts, were grouped into the last product group. These products could be made from poor quality timber not in the other three groups as well as from timber in these groups. Per unit value of these products varied by product but was generally lower than veneer, sawtimber, or pulpwood.

A composite woodland cropping pattern was developed by establishing the maximum percentage of timber growth that could be harvested for each wood product in order of its priority rating. For example, a composite might have 10 percent of all growth available for veneer; half of the remainder, or 45 percent of the total, available for sawtimber; three-fourths of the residual available for cordwood; and the portion left available for “other” products (fig. 1). This relationship of products is referred to as the product mix.
Woodland characteristics for each soil resource group were based on an analysis of the individual soils and forest type represented. The current capacity to support growing stock, growth rates, and the product mix assigned to each soil resource group was based on studies of site index and woodland growth, and on data collected from production of wood products on various forest types.

Through better management and the application of known technologies, the existing situation on a plot of land could be improved. The potential for a desirable change in the characteristics was examined by soil resource group for each projection period—1980, 2000, and 2020. The maximum possible change in annual growth and product mix, assuming 100 percent effectiveness of all practices, was developed. Since these practices would not be expected to be 100 percent effective, a 70 percent effectiveness level was arbitrarily assumed.

The mix of wood products varied by resource groups and future time periods. However, the bottomland sites represented a relatively high proportion of veneer hardwoods and sawtimber. Poor upland sites, where quality hardwoods could not grow, had a high proportion in pulp and "other" wood. Sites in between were assigned pro rata shares, based on soil productivity and known adaptability of forest types.

Clearing was evaluated by providing a transfer activity from unharvested woodland to other crop uses. Based on the assumed excess of growth over cut, future yields were developed for all periods under consideration before any runs were initiated. Later, it was realized that this should be a step by step process, and yields should be developed for the next time frame after the feasible clearing was established. Then, the clearing of unharvested woodland could influence yield projections for future periods.

Enterprise Budgets

Adequate secondary information was not available for production costs and yields of woodland on privately owned lands, where the major part of production occurs, and funds were not available to collect such data. Therefore, many of the basic data were derived from experience gained by Federal managers and supervisors. Studies conducted by industry, universities, and the Southern Forest Experiment Stations were also utilized (1, 3, 6). The available data imply a somewhat higher level of management and technology than would be likely to exist under private ownership. The possible bias toward public woodland was recognized but no adjustment was made in developing the enterprise budgets.

The budgets include those costs which can be associated with woodland enterprises including machinery and equipment depreciation, labor, and interest on capital for operating expenses. Overhead costs, such as interest on investment in land, building maintenance, motor vehicle expenses, insurance, and real estate taxes, are not included.

The exclusion of these overhead costs is one reason the production cost indicated in computer solutions cannot be viewed as the total farm production cost. However, the solutions can be utilized to make comparisons of costs with and without resource development. Although some of these overhead costs might increase with resource development, yields will also increase and the overhead cost per unit of product would be practically unchanged. Furthermore, these overhead costs are a small cost item in relation to total production cost.

Production costs were broken down into three components—annual maintenance costs, per unit preharvest costs, and harvest costs. Annual maintenance costs included such items as fire protection and disease and insect control, and these costs were a constant charge for all acres within a soil resource group. The cost of maintaining the unharvested woodland was allocated proportionately to the product groups harvested. Costs attributable to a specific product were established and classified as harvest or preharvest costs. These costs were aggregated by product group and converted to per acre costs, representing the cost of producing the equivalent of one acre's growth in the form of one of the four products. These budgets were developed for each product in each soil resource group. Such per acre costs do
not reflect composite acre costs or costs of actual harvest. For example, per acre costs of producing veneer in a soil resource group with a composite acre reflecting 10 percent veneer could be viewed as having three components: (1) Annual maintenance costs of 1 acre of woodland, (2) annual preharvest costs associated with veneer production on 10 acres of woodland, and (3) annual costs of harvesting a quantity of veneer equal to 1 acre’s total growth from 10 acres of woodland.

In developing projected yield, a given level of management and technology is implicitly assumed. In the two basins studied, forest composition with respect to tree size and number does not presently provide for maximum increase in the volume of growing stock. The management level assumed included the maintenance of timber growth in excess of cut. This allowed a shift toward improved forest composition and yields over time, obviously at the expense of current production.

The proportion of woodland acreage reflecting the excess of growth over cut was maintained as unharvested woodland. In a situation where demand could not be met, the assumed level of growth over cut could be reduced but this would affect future yield projections. If cut and growth were assumed to be equal, only minor yield increase could be anticipated. When cut in excess of growth is necessary to meet demands, yields would remain constant and the woodland resource base would be reduced for future time periods.

Yields which reflect per acre total growth were used for each wood product. The calculated yield by soil resource group was based on the selected management level and two specific assumptions relating to management. One assumption was that timber would be harvested for the highest priority product possible, if needed. That is, a tree suitable for veneer or sawtimber would be cut for pulpwood only if it were not required for the higher priority products. Demands in the lower priority groups could be satisfied by cutting trees in the higher priority groups. The other assumption was that the volume of growing stock would increase through better management practices.

Changes in Woodland Use and Production

The constraints placed on woodland use in the two basins varied by product group and soil resource group. The composite acre represents maximum use of the resource for veneer and sawtimber. For example, the product shares of 10 percent veneer and 45 percent sawtimber illustrated in figure 1 present maximum per acre production in a particular time period, and are structured into the model as upper acreage limits. In the event that veneer and/or sawtimber demands cannot be met, additional woodland acreage would be required. However, such a situation prescribes that trees must be planted some 20 to 50 years before the timber is needed.

The part of a composite acre established for cordwood and “other” wood represented the portion of growth which was not of a size or species suitable for veneer or sawtimber. Actually, the major part of total growth could be harvested for cordwood and “other” wood. Therefore, 34 percent cordwood and 11 percent “other,” as reflected in figure 1, were established as lower limits, and the upper limits were left open. This allowed for some of the sawtimber and veneer acreage to be used for cordwood or “other” products if they were not needed for the higher priority uses.

Minimum levels of production of wood products were established for the basins by allocating a share from preliminary projections for the lower Mississippi Water Resource Region. This allocation was on a land area percentage basis. An allocation based upon present production would have been more desirable but the necessary data were not available. The projections were based on a percentage allocation of the national projections for wood products (7). They could be interpreted as the necessary increase in production of wood products so that this area could maintain its relative share of expected national wood product production.

Concluding Remarks

Several land resource use solutions were analyzed. Woodland clearing and flood protection were both considered. In the two basins studied, the land resource was found to be sufficient to produce its share of national demand for food and fiber, including wood products. The present woodland acreage base is sufficient to meet future veneer, sawtimber, and “other” wood product demand. However, to meet expected pulpwood demand, additional acres of woodland would be needed. In these basins the additional resource base needs to be established immediately for expected future production.

The provision of flood protection was found to affect timber resource use in two ways: (1) The location and scale of feasible clearing varied between solutions with and without flood protection, and (2) the location of the additional woodland needed varied with and without flood protection. This was because the better land was needed to meet the pulpwood demands without development. However, with development the stress on the land resource was diminished and the pulpwood was shifted to less productive acres.
Model adaptation, as discussed, is not the only problem in including wood products with crops in the evaluation. There are several areas where more basic information is needed. Budgets were developed mainly from experiences and costs on publicly owned land. More information is needed to determine the acceptance rates for new technology that can be expected from the private sector. Little is known about the actual effects of various development activities on the production of wood products. For example, beneficial or detrimental effects of flood protection were not included in the wood product budgets because of the lack of research in this area.

Future demand for wood products is an important factor in this analysis. Additional research in this area would be helpful.

A 50-year growing cycle for some wood products, e.g., veneer, means that we estimate now the harvest needs for 50 years hence, and dedicate some land to their production. Our experiences indicate that such harvest needs can be evaluated by including wood products as well as crops in the conventional linear programming models. We feel this is a step in the right direction and hope that we have generated enough interest for this approach to be further investigated.

References


