

# **An INVESTMENT GUIDE for Cooperative Forest Management in Pennsylvania**

**by Robert S. Manthy**



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## Introduction

**A**DMINISTRATORS of the Federal-State Cooperative Forest Management (CFM) program need sound investment guides for monitoring the efficiency of their program activities. This study, undertaken by the Northeastern Forest Experiment Station in cooperation with the Pennsylvania Department of Forests and Waters, provides CFM program administrators with a portion of the data they need to insure that their program and its adjunct, the Agricultural Conservation Program (ACP), are functioning in a manner that will produce maximum benefits for the dollars spent.

Nearly 76 percent of Pennsylvania's 16.7 million acres of commercial forest land is owned by 300,000 private individuals, institutions, and non-wood-using industries. In fiscal-year 1965 the Federal Government and the Commonwealth of Pennsylvania invested \$264,000 in the CFM program and in ACP cost-sharing payments to assist these owners in the management of their forest lands.

Public funds are invested in CFM and the ACP as a means of encouraging Pennsylvania's private forest landowners to manage their land holdings so they will contribute more actively to current and future social welfare.

Sponsored activities are assumed to be economically sound. ACP subsidized planting, timber stand improvement, and other forestry practices are justified in terms of soil and water conservation benefits produced by these practices (*Agricultural Stabilization and Conservation Service* 1963). The assumed economic justification of CFM program activities is that the public benefits derived from the increased supply of timber, wildlife, water, and forest recreational facilities as a result of the program will equal or exceed the costs of obtaining these benefits.

But despite these assumptions, ACP and CFM administrators know relatively little about the costs and benefits of sponsored forestry practices. To estimate the relative and absolute profitability of sponsored practices, they must have detailed records of

program inputs and potential outputs. On the input side, they need measurements of the actual costs of obtaining practice accomplishments. Such data are not available. And on the output side, they require measures of the increased amounts and probable worth of the timber, wildlife, water and other claimed outputs that will be available in the future as a result of current activities. Currently available measures of output are annual records of the physical size of program accomplishments.

Four types of information are provided in this report. First, the public, private, and total direct costs of undertaking all the major CFM-sponsored forestry practices in various parts of Pennsylvania are given. For those practices for which ACP subsidies are available, separate cost data are given for CFM-sponsored practices that are undertaken with and without ACP cost-sharing payments.

Second, the procedure by which cost data were collected is presented. This procedure is recommended to program administrators as an inexpensive and easily implemented means of monitoring program costs.

The third type of information makes up the major portion of this report. This is a measure of the relative and absolute profitability for timber production of the State-wide weighted average investment in tree planting and associated site preparation and fencing, and investments in hardwood timber stand improvement (TSI). Together, these practices account for virtually all the total acreage of CFM-sponsored landowner forestry-practice accomplishments in Pennsylvania. Estimates of returns are based on projected stumpage values for the maximum possible gross volume of future timber crops produced by planting and TSI. Possible benefits arising from increased production of wildlife, soil and water conservation, forest recreation facilities, and other benefits occasionally claimed to arise from forestry activities are not considered. However, should reliable methods of estimating the size and worth of these claimed benefits become available in the future, such data can be easily incorporated.

Finally, an estimate of the uncertainty associated with investments in subsidized forestry practices is provided, and a number

of recommendations are made regarding the implications of this uncertainty for efficient program management.

### **Forest Practices Considered**

The forestry practices for which cost data are given are classified into two groups, based on the nature of public assistance received by the private landowners. One group, "ACP-CFM-supported" practices, includes practices for which private landowners have received both cost-sharing assistance through ACP and technical assistance from the CFM service forester. The second group, "CFM-supported" practices, is composed of those practices undertaken by private landowners with technical assistance from the CFM program. Thus, a given forestry practice may be considered under both "ACP-CFM-supported" and "CFM-supported" practices. The practices considered are:

#### **ACP-CFM-supported:**

1. *Planting* forest trees on farmland, farm woodlots, or woodlands for reasons other than prevention of wind or water erosion.
2. *Site preparation* necessary to permit planting of trees or to facilitate natural reseeding.
3. *Fencing* to protect plantations from destructive grazing.
4. *Timber stand improvement* of (a) an immature poletimber stand of forest trees on farmland by thinning and cull tree removal, or (b) (TSI) of a seedling-and-sapling stand by removing or killing competing and undesirable vegetation.
5. *Pruning* crop trees.
6. *Fencing* to protect natural stands from destructive grazing.

#### **CFM-supported:**

1. Except for pruning, each of the practices listed above.
2. Marking and other technical service or assistance given to landowners for timber sale or harvesting activities.

### **Study Areas**

Cost data were collected in six sections of the State (fig. 1). Each study area is a CFM Project Area or District served by a single service forester. Study areas were selected in different parts

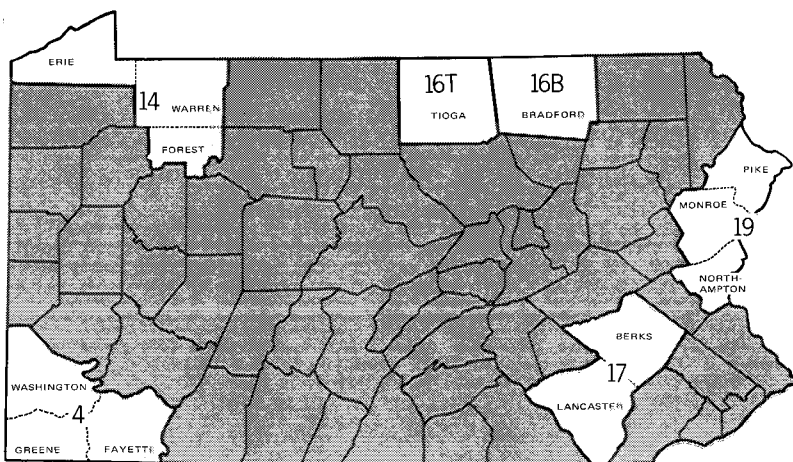


Figure 1.—Each study area is a CFM district or project served by a single service forester. Study areas are identified by their CFM project number designation.

of the State to account for possible regional variations in the costs of providing forestry assistance, and to provide for a comparison of the public costs of ACP-CFM-supported and CFM-supported forestry practices as the relative level of ACP-CFM activity varies. In fiscal year 1964, service foresters in Districts 16B and 16T received more than 100 requests for ACP assistance per county; foresters in Districts 19, 14, and 4 received an average of 24 requests per county; and the forester in District 17 received an average of 5 requests per county.

Districts avoided were: (1) areas where the normal activities of the CFM forester are carried out by state forest-management personnel and (2) areas where the local service forester has been operating for less than 2 years. In the first instance, state forest-management personnel commonly have little time for assistance to private owners. The extent and nature of their CFM activities are quite different from those of the regular, full-time, service foresters. In the second instance, a new service forester spends a greater proportion of his time on general promotional and administrative activities than the more established forester does.

## **ACP & CFM Programs in Pennsylvania**

### **CFM — THE COOPERATIVE FOREST MANAGEMENT PROGRAM**

Under the provisions of the 1950 Cooperative Forest Management Act and enabling state legislation, the U.S. Forest Service cooperates with the Secretary of the Department of Forests and Waters to provide private landowners and primary wood processors in Pennsylvania with free technical advice and assistance for managing, harvesting, marketing, processing, and utilizing forest products. Forest Service cooperation takes the form of partial financial support to the Department. In fiscal-year 1965, the Forest Service paid 40 percent of total CFM expenses.

On-the-ground technical services are normally provided by state-employed CFM or service foresters. In areas of the State where most of the forest land is in state ownership, CFM assistance is provided by Department personnel whose principal responsibility is the administration of state forests or other state-owned lands.

Upon an owner's request for technical forestry advice, the service forester recommends needed forestry measures and advises or assists landowners in carrying out these practices. Up to 5 days per year of free assistance is given for such operations as timber harvesting, planting, thinning, pruning, and protection from fire, insects, diseases, and grazing.

Although the service forester is nominally an employee of the CFM program, he is actually the agent who transmits nearly all public forestry programs directed at owners of small woodlands. Frequently the non-CFM programs administered by the service forester are complementary to the objectives of CFM. The forestry aspects of ACP are an example of this complementary relationship. CFM administrators view ACP as an adjunct to their program, and capitalize upon it as a means of stimulating landowners to undertake forestry practices. ACP and CFM are so mutually interdependent that forestry accomplishments ob-

tained under ACP are classified as CFM accomplishments by both the Pennsylvania Department of Forests and Waters and the U.S. Forest Service.

In fiscal-year 1965 there were 33 service foresters in Pennsylvania. Technical assistance was given to 3,250 landowners, 60 percent of whom had not previously used the services of a CFM forester. Planting accomplishments under the program amounted to 4,464 acres; TSI accomplishments, 3,380 acres.

## **ACP — THE AGRICULTURAL CONSERVATION PROGRAM**

Cost-sharing financial assistance for conservation practices through ACP was authorized by the Soil Conservation and Domestic Allotment Act of 1936 (Agricultural Stabilization and Conservation Service 1963). The stated purpose of ACP is to protect the public's interest in the Nation's soil and water resources. Under ACP, landowners are helped to carry out socially desirable conservation practices that would not be undertaken if the total costs had to be assumed by the landowner.

In Pennsylvania, cost-share payments for approved forestry practices account for 2.8 percent of total ACP cost-share payments. The forestry practices that are approved for cost-sharing and the maximum allowable cost-share payment for such practices are established by the State ACP Development Group, a committee whose membership includes a U.S. Forest Service representative.

ACP is administered by county ACP committees through county Agricultural Stabilization and Conservation Service (ASCS) offices. County ACP Development Groups recommend to the county ACP committees which state-approved conservation practices are needed in their respective counties, the funds that should be allocated to these practices, and the cost-shares that should be allowed. County Development Groups may recommend all, some, or none of the practices approved by the State Development Group; and they may suggest maximum allowable cost-share payments below those approved by the State Development Group. The cost-share rate for any given ACP practice is supposed to be

the minimum required to induce increased performance of the practice.

The U.S. Forest Service is responsible for developing technical specifications for approved forestry practices and for providing necessary technical forestry assistance to ACP cooperators. In Pennsylvania, field administration is delegated to the Department of Forests and Waters. The CFM service forester is the field-level administering agent. His duties include: (1) determining the need for and the practicality of a specified forestry practice on the ACP cooperator's property, (2) developing technical specifications under which the practice should be carried out, and (3) certifying that the practice has been performed according to specifications. In return for these services, ACP regulations provide for payment of 1 percent of each county's budget to the Department of Forests and Waters for reimbursement of assumed costs. County reimbursements have not been requested by the Department.

In 1964, Pennsylvania landowners received \$128,880 in ACP cost-share payments for forestry practices. ACP forestry accomplishments were:

| <i>Practice</i>                  | <i>Extent</i>      |
|----------------------------------|--------------------|
| Planting                         | 3,412 acres        |
| Fencing plantations              | 2,902 rods         |
| Timber stand improvement         | 3,467 acres        |
| Fencing natural stands           | 663 rods           |
| Erosion control on logging roads | 15,000 linear feet |

## **Costs of Accomplishments**

The total cost of establishing a forestry practice on an acre of privately owned land under ACP or CFM is the sum of the costs incurred by government agencies plus those incurred by the subsidized private landowner. In this study, acreage accomplishment and private and public costs per acre of accomplishment were obtained from records kept by service foresters in the study areas. Data were collected for fiscal-year 1965 (1 July, 1964 to 30 June, 1965).

Acreage accomplishments recorded during the study period do not necessarily correspond to actual on-the-ground-accomplish-

ments for the study period. Completed ACP-CFM and CFM practices were recorded as accomplishments only when the service forester certified an ACP practice as completed or when he definitely knew that a CFM practice for which he had advised a landowner had been completed. A portion of the accomplishments reported at the beginning of the study period was actually completed by landowners before 1 July, 1946. Similarly, practices actually completed by landowners near the end of the study period were not reported as accomplishments until after 30 June, 1965.

### ACREAGE ACCOMPLISHMENTS

ACP-CFM- and CFM-supported practice accomplishments in the six study areas during fiscal-year 1965 are shown in table 1.

Table 1.—ACP-CFM and CFM-supported practice accomplishments in fiscal year 1965, by district  
(In acres)

| Practice                 | All districts | District |     |     |                 |                  |     |
|--------------------------|---------------|----------|-----|-----|-----------------|------------------|-----|
|                          |               | 19       | 16B | 16T | 14              | 4                | 17  |
| ACP-CFM-supported:       |               |          |     |     |                 |                  |     |
| Planting                 | 917           | 43       | 151 | 83  | 116             | 498              | 26  |
| Site preparation         | 56            | 1        | —   | 10  | 3               | 42               | —   |
| Fencing plantations      | 161           | —        | 2   | 44  | —               | <sup>1</sup> 115 | —   |
| Timber stand improvement | 600           | 220      | 127 | 180 | 37              | 33               | 3   |
| Pruning                  | 31            | —        | 7   | 24  | —               | —                | —   |
| Fencing natural stands   | 133           | —        | 75  | 58  | —               | <sup>1</sup> —   | —   |
| Total                    | 1,898         | 264      | 362 | 399 | 156             | 688              | 29  |
| CFM-supported:           |               |          |     |     |                 |                  |     |
| Planting                 | 399           | 212      | —   | 15  | 45              | 40               | 87  |
| Site preparation         | 82            | —        | 12  | —   | —               | 66               | 4   |
| Fencing plantations      | 25            | —        | —   | —   | <sup>1</sup> 25 | —                | —   |
| Timber stand improvement | 67            | —        | 2   | 45  | —               | 17               | 3   |
| Fencing natural stands   | 21            | —        | 16  | 5   | <sup>1</sup> —  | —                | —   |
| Total                    | 594           | 212      | 30  | 65  | 70              | 123              | 94  |
| Harvesting assistance    | 622           | 26       | 31  | 37  | 325             | 93               | 110 |
| Total                    | 1,216         | 238      | 61  | 102 | 395             | 216              | 204 |
| Total accomplishments    | 3,114         | 502      | 423 | 501 | 551             | 904              | 233 |

<sup>1</sup>Accomplishments for fencing plantations and natural stands are combined.

ACP-CFM-supported accomplishments were obtained from ACP performance reports (ACP Form 247). Non-ACP-supported CFM accomplishments (here called "CFM-supported" accomplishments) were obtained by subtracting ACP-CFM accomplishments from the CFM Progress Report record of total ACP-CFM and CFM accomplishments. Excluding the 622 acres of general harvesting assistance, 2,492 acres of accomplishments were reported in the study areas. Tree planting was the most popular practice, accounting for 53 percent of the total. This was followed by timber-stand improvement practices (27 percent) and fencing (14 percent). Site preparation was important only in the southwestern part of the State. Pruning, which accounted for 1 percent of accomplishment, was usually undertaken in conjunction with thinning and cull-tree removal operations.

The average size of ACP-CFM-supported accomplishments per landowner for all practices was 7.9 acres. The average size of planting was 6.4 acres; TSI practices averaged 10.2 acres per landowner (table 2).

ACP supported planting is the most popular practice.—Three-fourths of the total acreage of landowner accomplishments were ACP-supported. By practice, landowners received ACP cost-sharing payments for 70 percent of the planting, 41 percent of the site preparation, 86 percent of the fencing, and 90 percent of the TSI undertaken.

Table 2.—Average acreage accomplishments per owner for  
ACP-CFM-supported practices, fiscal year 1965  
(In acres)

| Practice                 | Weighted<br>average | District |      |     |     |      |      |
|--------------------------|---------------------|----------|------|-----|-----|------|------|
|                          |                     | 19       | 16B  | 16T | 14  | 4    | 17   |
| Planting                 | 6.4                 | 3.3      | 4.2  | 5.9 | 7.7 | 7.9  | 13.0 |
| Site preparation         | 4.7                 | 1.0      | —    | 5.0 | 3.0 | 12.1 | —    |
| Fencing <sup>1</sup>     | 16.3                | —        | 19.3 | 5.7 | —   | 16.4 | —    |
| Timber stand improvement | 10.2                | 14.7     | 8.5  | 9.0 | 7.4 | 11.0 | 3.0  |
| Pruning                  | 3.1                 | —        | 3.5  | 3.0 | —   | —    | —    |
| All practices            | 7.9                 | 9.1      | 5.5  | 7.8 | 7.4 | 8.7  | 9.7  |

<sup>1</sup> Includes fencing both plantations and natural stands.

Although there is no doubt that ACP encourages planting, the comparison of ACP-CFM and CFM planting accomplishments (table 1) may overemphasize the importance of ACP financial assistance as an incentive for tree planting.

The Agricultural Conservation and Stabilization Service, the Soil Conservation Service, and other agricultural agencies that deal with farmers and other small landowners frequently encourage their clients to plant trees under ACP. When this occurs, ACP is likely to be active. In Districts that have an active ACP, the service forester may receive so many requests for ACP technical assistance that he finds it unnecessary, or does not have time, to solicit planting under the CFM program. Also, service foresters nearly always inform a CFM client of the availability of ACP cost-sharing if the practice he is considering is approved by ACP. To the degree that CFM cooperators apply for ACP cost-sharing on the basis of this knowledge, potential CFM accomplishments are traded for ACP-CFM accomplishments.

Tree species planted with financial assistance from ACP are shown in table 3. White and red pine were the most widely planted, accounting for more than half of all planting. Black locust, the only hardwood species extensively planted, was popular with farmers in Districts 16B, 14, and 4 as a future source of fence posts and grape stakes. Landowners who planted more than 5 acres usually planted two or more species, one of which was spruce or larch.

**Market conditions determine the importance of the ACP-supported TSI.**—The relative importance of ACP-CFM-supported TSI practices in Districts 19 and 16T reflect market conditions in these areas. At the time of the study, neither of these areas had a market for the small and cull material that is normally removed in TSI operations. TSI operations did not yield salable products and were therefore eligible for ACP-support payments. In contrast District 14 had an active and readily available market for pulpwood, and noncommercial thinning and cull-tree removal were relatively uncommon in this district.

The presence of active timber markets in District 14 also

**Table 3.—Tree species planted with ACP cost-share payments in the study areas, fiscal year 1965**

| Species       | Percent |
|---------------|---------|
| Austrian pine | 5       |
| Red pine      | 11      |
| White pine    | 41      |
| Other pines   | 1       |
| Larch         | 9       |
| Norway spruce | 10      |
| White spruce  | 3       |
| Black locust  | 8       |
| Not reported  | 12      |
| Total         | 100     |

explains why assistance in harvesting operations is a relatively important CFM activity in this district. More than half of the total acreage of harvesting assistance given landowners by the six cooperating service foresters was in this district.

## PUBLIC COSTS

The social or public costs of CFM-ACP- and CFM-subsidized forestry practices include: (1) the overhead or indirect costs of the programs; (2) direct or variable costs incurred by service foresters in providing solicited technical services; and (3) for ACP-CFM practices, the cost-sharing payment. For planting, an additional public cost is the difference between planting-stock production costs and the price charged private landowners for planting stock.

### Overhead Costs

Overhead costs include the costs of supervision, secretarial services, office facilities, professional tools and equipment, and similar items. Since this study is about the profitability of individual ACP-CFM and CFM practices rather than about the profitability of the ACP and CFM program as a whole, overhead costs were not considered.

DAILY RECORD of S. M. Kurtz for period ending January 20, 1965

PROJECT Braddock #4

| DATE             |                                                                                                                      |     | Hours | Expense | Mileage |
|------------------|----------------------------------------------------------------------------------------------------------------------|-----|-------|---------|---------|
| 7                |                                                                                                                      | CFM | 4     | \$0.60  | 60      |
|                  | Exam of Morris' woodland,<br>3-1/2 hr.                                                                               | ACP | 4     | .60     | 60      |
|                  | Exam planting sites in<br>Wash. Co. 2, ACP A7-1,<br>4-1/2 hr.                                                        |     |       |         |         |
| 8                |                                                                                                                      | CFM | 5     |         |         |
|                  | Office: Planting plans,<br>compute volume of timber<br>marked, correspondence,<br>filling, talk with land-<br>owner. | ACP | 3     |         |         |
|                  |                                                                                                                      |     |       |         |         |
| TOTAL FOR PERIOD |                                                                                                                      | CFM | 47    | \$2.50  | 575     |
|                  |                                                                                                                      | ACP | 31    | 2.20    | 219     |
|                  |                                                                                                                      | #67 | 2     | --      |         |
|                  |                                                                                                                      |     |       |         |         |
|                  |                                                                                                                      | --  | 80    | 4.70    | 794     |

SERVICE FORESTER

Figure 2.—Sample daily record of a cooperating service forester.

### Direct Costs

Three types of direct costs are incurred by the service forester who provided technical assistance to landowners: salary, transportation, and subsistence. Subsistence expenses are almost entirely the cost of meals eaten away from the forester's headquarters. The extent of these direct costs was determined from the service foresters' daily records of the number of hours spent on various professional activities, and the mileage and meals chargeable to these activities (fig. 2).

The amount of salary chargeable to individual practices was obtained by summarizing the daily activities of the cooperating service foresters into three classes:

1. **Recorded ACP-CFM and CFM activities:** Time spent on activities directly related to forestry measures supported by (a) ACP-CFM, and (b) by CFM alone.
2. **Unrecorded activities:** Time spent on activities that may result in on-the-ground accomplishments of practices not classified under or related to "recorded activities". These activities include: (a) insect and disease survey and control, (b) fire prevention and suppression, (c) forestry activities on State-owned lands, (d) and forestry work undertaken on PL-566 watersheds. Many of these activities are undertaken by service foresters but are not legitimate CFM functions. The State therefore does not charge the costs of the activities to the CFM program.
3. **Supporting activities:** Time spent on activities that do not directly result in on-the-ground accomplishments but are necessary for accomplishment of "recorded" and "unrecorded" activities. Five classes of supporting activities are recognized:
  - Assistance to landowners that is not related to a specific practice.
  - CFM records and administrative duties.
  - Official meetings other than CFM meetings.
  - Information and education activities (I&E).
  - Vacation and other paid leave.

The proportion of total time spent by cooperating service foresters on each of these three classes of activities is given in table 4. Time charged to recorded activities includes both the time spent servicing clients who actually undertook forestry practices and time spent servicing those who did not. In some districts, the time spent visiting landowners who had considered, but did not undertake, forestry practices represents a substantial part of total time. In at least one district, more than half of the ACP-referred landowners contacted by the service forester did not complete a forestry practice (table 5).

In total, cooperating service foresters visited 365 ACP clients

**Table 4.—Time spent by cooperating service foresters, pursuing different classes of activities, fiscal year 1965**  
(In percent)

| Activity                | Weighted average | District |     |     |     |     |     |
|-------------------------|------------------|----------|-----|-----|-----|-----|-----|
|                         |                  | 19       | 16B | 16T | 14  | 4   | 17  |
| Recorded activities:    | 30               | 39       | 34  | 32  | 23  | 18  | 35  |
| ACP-CFM practices       | 20               | 29       | 25  | 21  | 11  | 6   | 29  |
| CFM practices           | 10               | 10       | 9   | 11  | 12  | 12  | 6   |
| Unrecorded activities   | 14               | 15       | 7   | 16  | 5   | 27  | 11  |
| Support activities:     | 56               | 46       | 59  | 52  | 72  | 55  | 54  |
| General assistance      | 10               | 5        | 13  | 8   | 17  | 10  | 9   |
| Administrative          | 21               | 15       | 27  | 22  | 28  | 14  | 17  |
| Meetings                | 6                | 7        | 5   | 4   | 7   | 5   | 6   |
| Information & education | 6                | 8        | 2   | 2   | 5   | 13  | 4   |
| Paid leave              | 13               | 11       | 12  | 16  | 15  | 13  | 18  |
| All activities          | 100              | 100      | 100 | 100 | 100 | 100 | 100 |

in fiscal-year 1965. One-third of these landowners failed to complete the forestry practice they applied for. For individual practices, the following percentages of landowners failed to complete the practice applied for:

| <i>Practice</i>          | <i>Percent</i> |
|--------------------------|----------------|
| Planting                 | 12.2           |
| Site preparation         | 40.0           |
| Fencing plantations      | 40.0           |
| Timber stand improvement | 48.7           |
| Pruning                  | 65.5           |
| Fencing natural stands   | 63.5           |

Time associated with recorded ACP-CFM and CFM practices for which there were no on-the-ground accomplishments was charged to practices for which there were accomplishments. Charges were allocated to completed practices in proportion to the acreage accomplishments for these practices. For ACP-CFM practices, time associated with visits to county ASCS offices were charged to the practice the visit was in reference to. If the nature of the practice was not specified, or if the visit was for general administration, time was allocated to individual practices according to the acreage distribution of ACP-CFM practice accomplishments.

**Table 5.—Number of owners applying for and completing ACP-supported forestry practices, by district, fiscal year 1965**

| District | Owners who requested ACP assistance | Owners completing practice applied for |
|----------|-------------------------------------|----------------------------------------|
| 19       | 32                                  | 29                                     |
| 16B      | 97                                  | 58                                     |
| 16T      | 108                                 | 51                                     |
| 14       | 31                                  | 21                                     |
| 4        | 93                                  | 79                                     |
| 17       | 4                                   | 3                                      |
| Total    | 365                                 | 241                                    |

Within each district, the number of hours devoted to supporting activities was prorated to recorded and unrecorded activities according to the percentage of total service-forester time accounted for by these activities. For example, in District 19 the service forester devoted 46 percent of his time to support activities and 54 percent to recorded and unrecorded activities. Of this 54 percent, 28 percent was for unrecorded and 72 percent for recorded activities. Thus, 28 percent of total support time was allocated to unrecorded activities, and 72 percent was allocated to recorded activities.

Support time charged to recorded practices was charged to individual ACP-CFM and CFM practices in proportion to the number of acres of practice accomplishments under these programs. Acreage rather than forester time distributions were used since there was no clear relationship between time spent on a given practice and accomplishments for that practice.

Time data were converted to dollars on the basis of the average salary of cooperating foresters: \$6,100 per year. The results of these allocations are shown in table 6. For all districts, support time allocated to recorded activities accounted for 58 percent of the total salary charged to ACP-CFM practices and 72 percent of total salary costs for CFM practices.

**Mileage and miscellaneous expenses.**—Direct and allocated mileage and miscellaneous expenses are also shown in table 6. Mileage was charged at \$.055 per mile, the rate paid by the

Table 6.—Total costs of recorded activities and allocated support for providing technical assistance to landowners for forestry practices under the CFM program, by study area, fiscal year 1965

| Program<br>and<br>expense | All<br>districts | District |         |        |        |        |        |
|---------------------------|------------------|----------|---------|--------|--------|--------|--------|
|                           |                  | 19       | 16B     | 16T    | 14     | 17     | 4      |
| ACP-CFM-SUPPORTED         |                  |          |         |        |        |        |        |
| Salary:                   |                  |          |         |        |        |        |        |
| Recorded                  | \$ 4,492         | \$1,139  | \$1,157 | \$ 963 | \$ 343 | \$ 172 | \$ 718 |
| Allocated support         | 12,634           | 1,892    | 3,377   | 2,147  | 1,500  | 482    | 3,236  |
| Mileage and other:        |                  |          |         |        |        |        |        |
| Recorded                  | 1,530            | 496      | 320     | 151    | 182    | 38     | 343    |
| Allocated support         | 1,903            | 393      | 643     | 234    | 177    | 87     | 369    |
| Total:                    |                  |          |         |        |        |        |        |
| Recorded                  | 6,022            | 1,635    | 1,477   | 1,114  | 525    | 210    | 1,061  |
| Allocated support         | 14,537           | 2,285    | 4,020   | 2,381  | 1,677  | 569    | 3,605  |
| CFM-SUPPORTED             |                  |          |         |        |        |        |        |
| Salary:                   |                  |          |         |        |        |        |        |
| Recorded                  | 3,335            | 490      | 368     | 616    | 663    | 844    | 354    |
| Allocated support         | 8,820            | 1,252    | 655     | 486    | 3,061  | 2,664  | 702    |
| Mileage and other:        |                  |          |         |        |        |        |        |
| Recorded                  | 643              | 163      | 112     | 62     | 102    | 151    | 53     |
| Allocated support         | 1,737            | 363      | 104     | 59     | 456    | 639    | 116    |
| Total:                    |                  |          |         |        |        |        |        |
| Recorded                  | 3,978            | 652      | 480     | 678    | 766    | 995    | 407    |
| Allocated support         | 10,557           | 1,615    | 759     | 545    | 3,517  | 3,303  | 818    |

Department of Forests and Waters for use of State-owned automobiles.

ACP-CFM mileage and miscellaneous expenses were prorated to individual practices according to the percentage of total ACP-CFM accomplishments represented by each ACP-CFM practice. Non-ACP mileage and miscellaneous expenses were charged to support, recorded, and unrecorded activities in proportion to the time spent on these activities. Expenses thus allocated to support activities were prorated to recorded ACP-CFM and CFM practices according to the percentage of total acreage accomplishments represented by individual practice accomplishments.

**Costs per acre.**—Direct public costs per acre of accomplishment were obtained by dividing the total direct costs by the acreage of practice accomplishments. These data are given in table 7. The average direct cost of providing technical advice and service for all ACP-CFM and all CFM accomplishments other than harvesting assistance was \$10.80 per acre. For all ACP-CFM-supported practices the average for all districts was \$10.83 and for CFM-supported practices it was \$10.68. Costs of providing harvesting assistance to landowners averaged \$12.11 per acre.

For TSI practices, the average cost of providing assistance was \$13.25, per acre, which was \$2.82 greater than the cost of providing assistance for planting. This was expected because the service forester had to take time to teach the landowner proper TSI tree-marking procedures, or do the actual marking job himself. The cost of providing technical advice for each of the practices of site preparation and fencing of plantations was less than for planting.

Technical advice for site preparation and fencing is normally given in conjunction with planting advice. Similarly, advice for fencing natural stands or for pruning is less expensive than that for thinning and cull-tree removal. In general, when two or more practices are undertaken by a landowner, each practice bears a portion of the cost for traveling to the co-operator's woodlands and the cost of time spent in establishing a working relationship with the landowner.

Table 7.—Direct costs per acre of accomplishment for providing technical assistance for forestry practices under the CFM program, by district, fiscal year 1965  
(In dollars per acre)

| District      | Program and weighted average | Landowner accomplishments |          |                  |                     |                          |         |                        |                       |
|---------------|------------------------------|---------------------------|----------|------------------|---------------------|--------------------------|---------|------------------------|-----------------------|
|               |                              | All practices             | Planting | Site preparation | Fencing plantations | Timber stand improvement | Pruning | Fencing natural stands | Harvesting assistance |
| 19            | ACP-CFM                      | \$14.85                   | \$16.45  | —                | —                   | \$14.53                  | —       | —                      | —                     |
|               | CFM                          | 9.42                      | 9.42     | —                | —                   | —                        | —       | —                      | \$10.37               |
|               | Weighted average             | 12.43                     | 10.63    | —                | —                   | 14.53                    | —       | —                      | 10.37                 |
| 16B           | ACP-CFM                      | 15.19                     | 14.56    | —                | \$27.17             | 16.22                    | \$23.79 | \$13.58                | —                     |
|               | CFM                          | 17.21                     | —        | \$15.23          | —                   | 47.97                    | —       | 14.86                  | 23.33                 |
|               | Weighted average             | 15.34                     | 14.56    | 15.23            | 27.17               | 16.71                    | 23.79   | 13.80                  | 23.33                 |
| 16T           | ACP-CFM                      | 8.76                      | 10.45    | 5.88             | 6.64                | 9.10                     | 8.66    | 7.41                   | —                     |
|               | CFM                          | 10.36                     | 13.70    | —                | —                   | 9.32                     | —       | 9.73                   | 14.83                 |
|               | Weighted average             | 8.98                      | 10.95    | 5.88             | 6.64                | 9.15                     | 8.66    | 7.59                   | 14.83                 |
| 14            | ACP-CFM                      | 13.92                     | 13.20    | 18.59            | —                   | 16.60                    | —       | —                      | —                     |
|               | CFM                          | 11.03                     | 12.35    | —                | 18.67               | —                        | —       | 1                      | 10.80                 |
|               | Weighted average             | 13.17                     | 13.00    | 18.59            | 8.67                | 16.60                    | —       | —                      | 10.80                 |
| 4             | ACP-CFM                      | 6.98                      | 6.65     | 6.32             | 6.55 <sup>1</sup>   | 10.19                    | —       | 1                      | —                     |
|               | CFM                          | 5.47                      | 8.07     | 4.05             | —                   | 4.89                     | —       | —                      | 5.94                  |
|               | Weighted average             | 6.58                      | 6.75     | 4.93             | 6.55                | 6.99                     | —       | —                      | 5.94                  |
| 17            | ACP-CFM                      | 26.89                     | 25.09    | —                | —                   | 42.53                    | —       | —                      | —                     |
|               | CFM                          | 18.49                     | 15.81    | 16.96            | —                   | 89.40                    | —       | —                      | 17.55                 |
|               | Weighted average             | 20.47                     | 17.94    | 16.96            | —                   | 65.96                    | —       | —                      | 17.55                 |
| All districts | ACP-CFM                      | 10.83                     | 10.11    | 8.88             | 6.83                | 13.29                    | 12.07   | 10.88                  | —                     |
|               | CFM                          | 10.68                     | 11.17    | 4.05             | 8.66                | 12.94                    | —       | 13.63                  | 12.11                 |
|               | Weighted average             | 10.80                     | 10.43    | 6.55             | 7.08                | 13.25                    | 12.07   | 11.26                  | 12.11                 |

<sup>1</sup>Fencing of natural stands and of plantations are combined under "Fencing plantations."

Differences in average costs between study areas correspond closely to the differences in the level of practice accomplishments. Low costs were experienced when high levels of accomplishment were obtained. And high costs occurred when accomplishments were low. The proportion of the service forester's time specifically devoted to the considered practices was also related to costs: the greater the time spent on a practice, the higher the cost. A comparison of data for Districts 14 and 17 (tables 1, 4, and 7) illustrates these relationships. The forester in District 4 spent less of his total time on the recorded activities than did other foresters, reported more acres of practice accomplishments, and had the lowest costs per acre of landowner accomplishment. The forester in District 17 spent 35 percent of his time on recorded activities, had the lowest record of total accomplishments, and experienced the highest costs per acre. In general, the relationships held, for all study areas.

Sample data indicate that the relationships between per-acre costs, level of accomplishments, and time spent on a practice were mainly the results of the following interrelated factors: (1) differences in levels of ACP activity among study areas; (2) the seasonality of forestry activities (fig. 3); and (3) the efficiency of the individual service forester. It appears that the seasonal nature

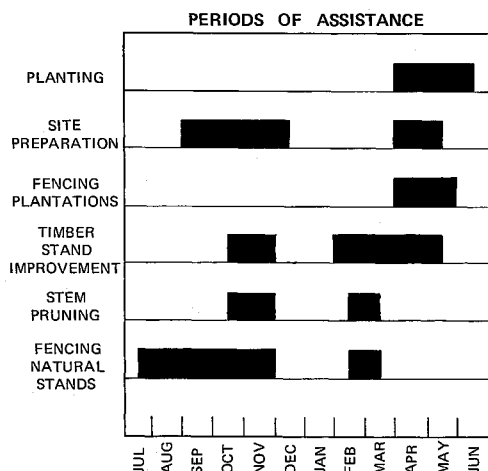


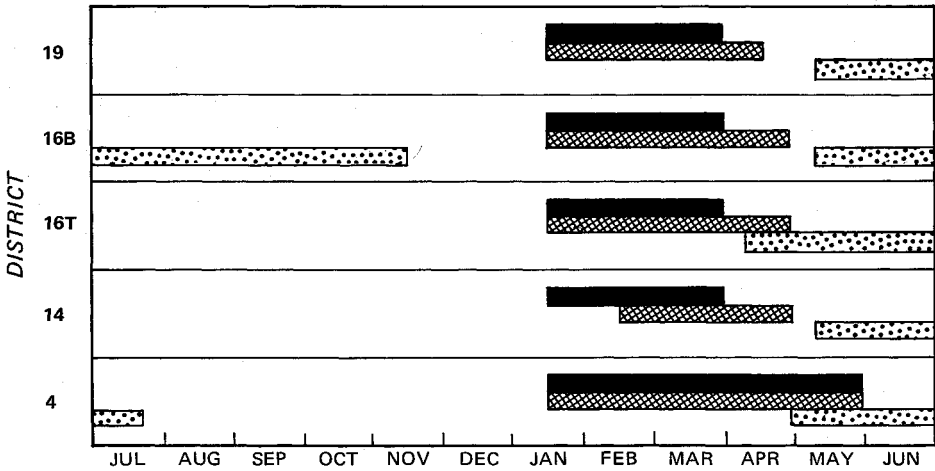
Figure 3. — The time period during which assistance for forestry practices is provided by service foresters in the study areas follows seasonal patterns. Planting and related fencing are normally done in the spring, site preparation in the fall, and TSI activities in early fall and late winter.

of forestry activities and the relative importance of ACP as a vehicle for undertaking forest practices strongly influence the amount of time a service forester spends advising individual landowners. Time devoted to servicing landowners in turn affects the costs of providing assistance on a per-acre-of-accomplishment basis.

For example, most county ASCS offices do not begin to process landowner applications for approval to undertake ACP-supported planting until mid- or late-January. It usually takes the ASCS office 1 to 2 months to process an ACP application and to submit the ACP referral sheet to the service forester determining technical needs. To insure survival, planting must be done before May. Certification of planting accomplishments must be turned into the ACP office in June. This means that the service forester has about 3 months to contact the applying landowners, draw up technical specifications, process orders for seedlings from a State nursery, and certify that planting has been undertaken (fig. 4). During this same 3-month period he must also provide assistance to landowners who intend to plant without ACP support. If the number of ACP cooperating landowners interested in planting is large, service time for other forestry practices (other than site preparation and fencing of plantations) is necessarily postponed until after the planting season. Postponement of nonplanting service activities is made even more necessary if other types of important seasonal activities, such as fire suppression and insect and disease surveys, are also conducted during the planting season. A similar situation occurs for TSI activities during the fall.

In effect then, in areas where there is an active interest in ACP-CFM-sponsored forestry activities, the service forester specializes in providing assistance for different types of activity at different times of the year. He also limits the amount of service he gives individual landowners. And since ACP supplies him with a list of people who have expressed an interest in a particular forestry practice, he spends a relatively small percentage of his time encouraging landowners to undertake forestry practices. Those promotional activities he does undertake are also

## PLANTING



## TIMBER STAND IMPROVEMENT

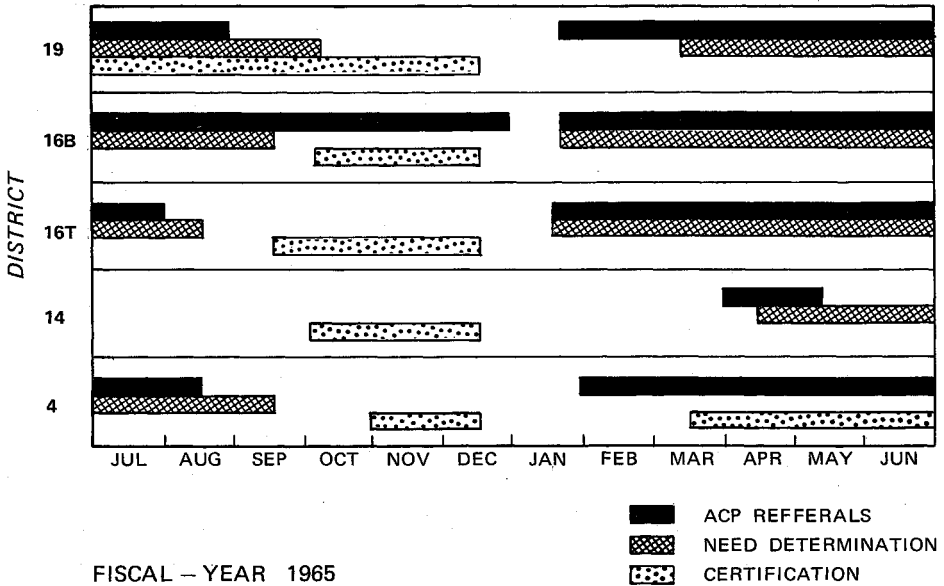


Figure 4.—The time period over which service foresters received ACP referrals, determined practice needs, and certified accomplishments for planting and for TSI practice varied by district.

likely to be relatively successful. Locally favorable attitudes toward forestry practices are generated by ACP and various public agricultural agencies, such as the Soil Conservation Service, that encourage landowners to undertake forestry practices under ACP. As a result, costs per acre are low.

Alternatively, in districts where there is a relatively inactive ACP-CFM program, costs per acre of accomplishment are high. In these districts the service forester does not specialize by season. Accordingly, he spends more time with individual landowners and provides them with more service. And he spends a good portion of his time trying to overcome landowner apathy in forestry practices. Without the deadlines imposed by ACP, service foresters also appear to make less efficient use of their time than do foresters who are actively engaged in ACP-related forestry. District foresters who reported low ACP-CFM accomplishments had larger and more persistent backlogs of unanswered requests for CFM assistance than did the foresters who reported high ACP-CFM accomplishments. If these requests for assistance had been met, accomplishments might have increased and costs per acre decreased.

### **ACP Cost-Sharing Payments**

ACP cost-sharing payments are shown in table 8. The payments shown, ranging from \$1.02 to \$21.88 per acre, are usually the maximum that was allowed. There are two reasons for this. First, when a landowner received tentative approval for a practice, the maximum payment for the number of practice units to be undertaken was set aside by the ASCS office. This was done so that approval would not be given for more ACP practice units than total ACP funds allowed. Since the amount of ACP funds available to a county in the next fiscal-year was based partially on levels of ACP expenditures during the current year, and since the maximum funds had been committed, they were usually paid. Second, landowners knew the maximum cost-share rates and billed accordingly. A landowner will seldom turn in a bill that will not permit him to receive the maximum allowable payment.

In each of the study areas, ACP payments for planting covered

Table 8.—Average cost-sharing payment per acre for ACP-supported practices,  
by study area, fiscal year 1965  
(In dollars per acre)

| Practice                 | Weighted<br>average | District |         |         |         |                   |         |
|--------------------------|---------------------|----------|---------|---------|---------|-------------------|---------|
|                          |                     | 19       | 16B     | 16T     | 14      | 4                 | 17      |
| Planting                 | \$17.32             | \$19.09  | \$17.52 | \$18.22 | \$21.88 | \$15.85           | \$18.28 |
| Site preparation         | 6.03                | —        | —       | 19.00   | 18.31   | 5.00              | —       |
| Fencing plantations      | 3.17                | —        | 16.66   | 8.19    | —       | <sup>1</sup> 1.02 | —       |
| Timber stand improvement | 20.00               | 20.00    | 20.00   | 20.00   | 20.00   | 20.00             | —       |
| Pruning                  | 10.74               | —        | 9.75    | 11.02   | —       | —                 | —       |
| Fencing natural stands   | 3.30                | —        | 2.13    | 4.81    | —       | <sup>1</sup> —    | —       |

<sup>1</sup>Fencing natural stands is included under fencing plantations.

80 percent of the total cost of planting, but not in excess of \$2.50 per 100 trees or \$25.00 per acre, whichever was smaller. Average payments in the individual study areas were calculated on the basis of the number of trees required to plant an acre according to the spacing normally recommended by the local forester.

Cost-share payments for site preparation were also 80 percent of total costs. The maximum payment allowed varied according to the nature of site preparation performed. A maximum of \$5.00 per acre was usually allowed for removal of small ground cover by rotary mowing, \$19.00 per acre for removing competing growth with a root rake, and \$10.00 per acre for girdling, felling, or poisoning of an undesirable overstory. The total acreage for different types of site preparation was weighted by the respective cost-share to determine an average figure for each district.

Cost-share for fencing was 50 percent of total costs, but not in excess of some specific amount per rod of fencing. The maximum amount varied between counties, and within a county by type of fencing. Average per-acre cost-share payments were calculated on the basis of the total rods of fence constructed, total fencing cost-share payments actually paid, and number of acres enclosed by fencing.

The standard payment for improving a stand of forest trees is the smaller of \$20 per acre or 80 percent of the cost. Although different types of TSI operations are undertaken under the ACP and a variety of methods are often used for similar operations (for example, felling, girdling, or chemical poisoning for thinning and cull tree removal), the maximum of \$20 per acre is nearly always paid. This was the rate used in our cost calculations.

Payments for pruning were \$.075 per linear foot pruned but not in excess of 80 percent of costs. Average acre cost-share payments for each district were calculated, using the \$.075 rate and the average number of feet pruned per acre in the district.

### **Planting Stock Production Costs**

Virtually all the seedlings planted by private landowners in conjunction with the CFM program are obtained from nurseries operated by the Pennsylvania Department of Forests and Waters.

Private landowners purchase seedlings from State nurseries at \$7 per thousand, or \$4 for 500 seedlings, delivered to a central point in each county. These prices are considerably below production costs. For purposes of this analysis, we assumed that the public cost of supplying seedlings to private landowners at subsidized prices is \$7 per acre of land planted.

## LANDOWNER COSTS

**ACP-CFM supported practices.**—The initial investment that a landowner makes in an ACP-supported forestry practice is equal to that portion of practice establishment cost not covered by the cost-sharing payment. In theory, this is what is left after the appropriate percentage of total cost has been paid by ACP. In practice, landowners frequently submit bills that have been influenced more by their knowledge of the maximum cost-sharing payments available than by actual costs experienced. Because costs reported by landowners are unreliable indicators of actual costs, local contract rates were used whenever possible.

Contract-rate-based estimates of private investment in ACP-supported planting are given in column (4) of table 9. Contract rates averaged 2c per tree for machine planting and 3c per tree for hand planting, exclusive of the cost of seedlings. Planting costs shown for the individual study areas are for the most common methods of planting and plantation spacing in the area. Private costs were calculated by subtracting seedling costs and contract planting rates from the cost-share payment. Private costs ranged from \$10.92 per acre in District 19 to \$1.46 per acre in District 17.

Local contract rates were also used to calculate private investments in timber stand improvement practices. The difference between contract rates and ACP cost-share payments, which varied from \$10 to \$5 per acre, was the cost to the landowner.

For site preparation, pruning, and fencing, we assumed that the cost-share payments represented 80 percent, 50 percent, and 50 percent, respectively, of total practice costs, and that the landowner absorbed the remainder. These practices are not normally undertaken by contractors.

Table 9.—Public and private costs of an acre of ACP-CFM- and CFM-supported forestry practice accomplishment, by practice and district, fiscal year 1965  
(In dollars per acre)

| District<br>(1) | Practice<br>(2)          | ACP-CFM-supported          |                |              | CFM-supported              |                    |              |
|-----------------|--------------------------|----------------------------|----------------|--------------|----------------------------|--------------------|--------------|
|                 |                          | Public <sup>1</sup><br>(3) | Private<br>(4) | Total<br>(5) | Public <sup>2</sup><br>(6) | Private<br>(7)     | Total<br>(8) |
| 19              | Planting                 | \$42.53                    | \$10.92        | \$53.45      | \$16.42                    | \$30.00            | \$46.42      |
|                 | Timber stand improvement | 34.53                      | 10.00          | 44.53        | —                          | —                  | —            |
|                 | Harvesting assistance    | —                          | —              | —            | 10.37                      | —                  | 10.37        |
| 16B             | Planting                 | 39.08                      | 4.91           | 43.99        | —                          | —                  | —            |
|                 | Site preparation         | —                          | —              | —            | 15.32                      | 23.75              | 39.07        |
|                 | Fencing plantations      | 43.83                      | 4.16           | 47.99        | —                          | —                  | —            |
|                 | Timber stand improvement | 36.22                      | 5.00           | 41.22        | 47.97                      | 25.00              | 72.97        |
|                 | Pruning                  | 33.54                      | 2.44           | 35.98        | —                          | —                  | —            |
|                 | Fencing natural stands   | 15.71                      | .53            | 16.24        | 14.86                      | 2.84               | 17.70        |
|                 | Harvesting assistance    | —                          | —              | —            | 23.33                      | —                  | 23.33        |
| 16T             | Planting                 | 35.67                      | 5.10           | 40.77        | 20.70                      | 23.32              | 42.02        |
|                 | Site preparation         | 24.88                      | 4.75           | 29.63        | —                          | —                  | —            |
|                 | Fencing plantations      | 14.83                      | 2.05           | 16.88        | —                          | —                  | —            |
|                 | Timber stand improvement | 29.10                      | 5.00           | 34.10        | 9.32                       | 25.00              | 34.32        |
|                 | Pruning                  | 19.68                      | 2.75           | 22.43        | —                          | —                  | —            |
|                 | Fencing natural stands   | 12.22                      | 1.20           | 13.42        | 9.73                       | 6.01               | 15.74        |
|                 | Harvesting assistance    | —                          | —              | —            | 14.83                      | —                  | 14.83        |
| 14              | Planting                 | 42.08                      | 6.00           | 48.08        | 19.35                      | 27.88              | 47.23        |
|                 | Site preparation         | 36.90                      | 4.58           | 41.48        | —                          | —                  | —            |
|                 | Fencing                  | —                          | —              | —            | 8.67                       | <sup>a</sup> 11.20 | 19.87        |
|                 | Timber stand improvement | 36.60                      | 7.00           | 43.60        | —                          | —                  | —            |
|                 | Harvesting assistance    | —                          | —              | —            | 10.80                      | —                  | 10.80        |

|     |                          |       |                   |       |       |                    |        |
|-----|--------------------------|-------|-------------------|-------|-------|--------------------|--------|
| 4—  | Planting                 | 29.50 | <sup>4</sup> 3.12 | 32.62 | 15.07 | 18.97              | 34.04  |
|     | Site preparation         | 11.32 | 1.25              | 12.57 | 4.05  | 6.25               | 10.30  |
|     | Fencing <sup>5</sup>     | 7.57  | .26               | 7.83  | —     | —                  | —      |
|     | Timber stand improvement | 30.19 | <sup>4</sup> 5.00 | 35.19 | 4.89  | 25.00              | 29.89  |
|     | Harvesting assistance    | —     | —                 | —     | 5.94  | —                  | 5.94   |
| 17— | Planting                 | 50.37 | 1.46              | 51.83 | 21.81 | 19.71              | 42.52  |
|     | Site preparation         | —     | —                 | —     | 16.96 | <sup>3</sup> 10.00 | 26.96  |
|     | Timber stand improvement | 62.53 | 5.00              | 67.53 | 89.40 | 25.00              | 114.40 |
|     | Harvesting assistance    | —     | —                 | —     | 17.55 | —                  | 17.55  |

<sup>1</sup>Includes the ACP cost-share payment, the direct costs of providing technical assistance, and the planting stock production cost subsidy.

<sup>2</sup>Includes the costs of providing technical service, and the planting stock production cost subsidy.

<sup>3</sup>Estimate.

<sup>4</sup>Assumes a contract rate of \$25.00 per acre.

<sup>5</sup>Includes fencing both plantations and natural stands.

**CFM-supported practices.**—Data describing the private costs of undertaking CFM-supported forestry practices without ACP assistance were not collected. We derived the estimates of private costs shown in column 7, table 8. These costs were assumed to be equal to the sum of ACP cost-share payments (table 8) and the private investments for identical practices undertaken with ACP support (column 4, table 9).

For CFM harvesting assistance, a practice for which there is no ACP-CFM counterpart, private costs per acre were assumed to be negligible.

### **TOTAL COSTS PER ACRE**

Total costs of ACP-CFM- and CFM-subsidized forestry practices in the individual study areas are shown in columns 5 and 8, table 9. For comparable practices, costs ranged from a high of \$114.40 per acre for non-ACP-supported TSI in District 17 to a low of \$7.83 for ACP-CFM fencing in District 4. Because private cost estimates for CFM practices are based on private costs for ACP-CFM practices, differences between total costs per acre for any given ACP-CFM-supported practices and identical CFM-supported practices within a given district are entirely due to the differences in the costs of providing technical advice and service.

The explanations of differences in practice-accomplishment costs between study areas have been noted in previous sections dealing with the components of total costs. Briefly, in districts where total ACP-CFM accomplishments are high, average cost per acre of all ACP-CFM-supported and all non-ACP-supported accomplishments are low. Alternatively, low levels of ACP-CFM accomplishment lead to high costs per acre of accomplishments.

Average cost data for all study areas are shown in table 10. Excluding harvesting assistance to landowners, total average cost for all ACP-CFM practices (\$34.30) was \$3.31 less than the total cost for comparable CFM practice accomplishments (\$37.61.) As expected, significant differences occurred in the incidence of accomplishment costs. For all ACP-CFM practices, public costs were 87 percent of total cost. For comparable non-ACP-sup-

ported CFM accomplishments, public cost accounted for 41 percent of total costs.

## **Estimating Stumpage Returns from Planting and TSI**

Measurements of profitability of the investment made in establishing a forestry practice require knowledge of both the costs of establishment and the market value of the products eventually produced.

**Table 10.—Weighted average public, private, and total costs per acre  
for practice accomplishments for all study areas, fiscal year 1965**  
(In dollars per acre)

| Item                              | Public  | Private | Total   |
|-----------------------------------|---------|---------|---------|
| <b>ACP-CFM-SUPPORTED</b>          |         |         |         |
| Planting:                         |         |         |         |
| Planting only                     | \$34.43 | \$ 4.28 | \$38.71 |
| With site preparation             | 49.34   | 6.31    | 55.65   |
| With fencing                      | 44.43   | 5.08    | 49.51   |
| With site preparation and fencing | 59.34   | 7.11    | 66.45   |
| Site preparation                  | 14.91   | 2.03    | 16.94   |
| Fencing plantations               | 10.00   | .80     | 10.80   |
| Timber stand improvement          | 33.29   | 6.95    | 40.24   |
| Pruning                           | 22.81   | 2.68    | 25.49   |
| Fencing natural stands            | 14.19   | .82     | 15.01   |
| Total ACP-CFM                     | 29.81   | 4.49    | 34.30   |
| <b>CFM-SUPPORTED</b>              |         |         |         |
| Planting:                         |         |         |         |
| Planting only                     | 18.17   | 26.16   | 44.33   |
| With site preparation             | 24.50   | 35.15   | 59.65   |
| With fencing                      | 26.84   | 37.36   | 64.20   |
| With site preparation and fencing | 33.17   | 46.35   | 79.52   |
| Site preparation                  | 6.33    | 8.99    | 15.32   |
| Fencing plantations               | 8.67    | 11.20   | 19.87   |
| Timber stand improvement          | 12.94   | 25.00   | 37.94   |
| Fencing natural stands            | 13.63   | 3.59    | 17.22   |
| Total                             | 15.38   | 22.23   | 37.61   |
| Harvesting assistance             | 12.11   | —       | 12.11   |
| Total CFM                         | 13.71   | 22.23   | 24.56   |
| ACP-CFM and CFM                   | \$23.52 | \$ 8.72 | \$30.50 |

## RETURNS FROM PLANTING

Estimates of the stumpage output from forest plantations were made for white pine, red pine, larch, and Norway spruce. All together, these four species accounted for at least three-fourths of the total planting undertaken in the study areas (table 3). Published and unpublished yield tables were used to determine possible gross yields. Yield tables and their sources are given in the appendix, tables 16 to 19.

For each species, an attempt was made to provide a comprehensive coverage of possible investment alternatives. Several rotation ages, site conditions, and final products were considered. These are shown in table 11.

Three site indexes were considered for white pine, red pine, and larch; and two for Norway spruce. Site index levels were chosen to conform to the site-productivity classification used by the Pennsylvania Department of Forests and Waters. The analytical procedure described by Webster (1960) was used to equate site indexes and site-productivity classes. In each case, the highest site index corresponded to site-productivity class I, the next highest to a class II site, and the lowest to a class III site.

A minimum of four alternative rotation ages spaced 10 and 20 years apart were considered for each species. Volume of timber that was to be removed during thinnings and final harvest cuttings are shown in the yield tables in the appendix. Timber products to be harvested were chosen on the basis of current and projected market conditions. Sawlogs were assumed to be the most likely product from larch and white pine plantations. For red pine, a market for both pulpwood and sawlogs was assumed. For Norway spruce plantings, a pulpwood market seemed more likely than a sawlog market.

Estimates of future stumpage prices were based on 1965 market prices for softwoods in Pennsylvania and on expected price increases. Because market conditions vary between study areas, two price levels were considered for each species. For sawlogs, prices ranged from \$43.95 to \$30.00 per thousand board feet. Pulpwood prices ranged from \$7.50 to \$3.50 per cord. With the exception of white pine, an annual percentage

Table 11.—*Stocking levels, site indexes, rotation ages, products, and stumpage prices considered for softwood plantations, by species*

| Species       | Stocking level | Site indexes <sup>1</sup> | Rotation ages       | Products | Stumpage price <sup>2</sup> |                 |
|---------------|----------------|---------------------------|---------------------|----------|-----------------------------|-----------------|
|               |                |                           |                     |          | Current price               | Annual increase |
|               | <i>Percent</i> | <i>Feet</i>               | <i>Years</i>        |          |                             | <i>Pct.</i>     |
| White pine    | 90             | 80,70,40                  | 50,60,70,80,100,120 | Sawlogs  | \$43.95                     | 1.1             |
|               |                |                           |                     |          | 30.00                       | .5              |
| Red pine      | 90             | 60,50,45                  | 55,75,95,105        | Sawlogs  | 43.95                       | 1.1             |
|               |                |                           |                     | Pulpwood | 5.50                        | .5              |
|               |                |                           |                     | Sawlogs  | 30.00                       | 1.1             |
|               |                |                           |                     | Pulpwood | 3.50                        | .5              |
| Larch         | 80             | 90,80,40                  | 30,40,50,60,70      | Sawlogs  | 35.00                       | 1.1             |
|               |                |                           |                     |          | 30.00                       | 1.1             |
| Norway spruce | 80             | 80,60                     | 20,30,40,50,60,70   | Pulpwood | 7.50                        | 1.1             |
|               |                |                           |                     |          | 5.50                        | 1.1             |

<sup>1</sup>Site index is the average height of dominant and codominant trees at 50 years of age.

<sup>2</sup>Prices for sawlog stumpage are dollars per thousand board feet; for pulpwood, dollars per cord.

increase in price of 1.1 percent for sawlogs and 0.5 percent for pulpwood was used for both the high- and low-price options. For white pine, an annual price increase of 1.1 percent was applied to the high-price option and 0.5 percent to the low-price option. The lower price growth rate for the low-price option was made under the assumption that there would be comparatively little increased demand for white pine stumpage in those areas of the State where current stumpage prices are lower than the state-wide average.

## RETURNS FROM HARDWOOD TIMBER STAND IMPROVEMENT

The term *timber stand improvement* has been used to cover two silvicultural practices: (1) a combination of cleaning and liberation or cull-tree removal in seedling-and-sapling stands, and (2) precommercial thinnings and cull-tree removal in previously unmanaged poletimber stands. On the basis of Pennsylvania's forest inventory, noncommercial thinnings similar to those subsidized by ACP and CFM are most likely to occur in northern hardwood, oak, or cove hardwood stands. Cleaning and cull-tree removal are most likely to occur in the northern hardwood or oak stands. Typical site indexes and related site-productivity classes for these forest types are shown in table 12. Yield tables

**Table 12.—Stand timber types, site indexes, and site-productivity classes subject to financial analysis for cleaning and cull-tree removal and thinning**

| Stand type<br>description             | Site index corresponding to site-productivity class <sup>1</sup> |               |                |
|---------------------------------------|------------------------------------------------------------------|---------------|----------------|
|                                       | Site class I                                                     | Site class II | Site class III |
| <b>CLEANING AND CULL-TREE REMOVAL</b> |                                                                  |               |                |
| Northern hardwoods                    | 90                                                               | 70            | —              |
| Oak                                   | 80                                                               | 60            | 30             |
| <b>THINNING</b>                       |                                                                  |               |                |
| Northern hardwoods                    | 90                                                               | 70            | —              |
| Oak                                   | 80                                                               | 60            | 30             |
| Cove hardwoods                        | 100                                                              | 80            | —              |

<sup>1</sup>Site index is defined as the average height of dominant and codominant trees at 50 years of age.

for the sites identified in table 12 are given in tables 20 and 21.

Estimates of the physical responses to TSI activities given in tables 20 and 21 are based on the stand-table projections made by Webster (1960). Webster's projections were based on the assumption that cleaning and cull-tree removal (1) will occur in stands between 10 and 15 years of age, (2) will result in an improved species composition and high timber quality, (3) will increase timber yield per acre by permitting commercial thinnings for sawlogs, and (4) will reduce the time required for the stand to reach maturity by 20 years.

For precommercial thinnings in stands that have not received an earlier cultural treatment, Webster assumed that thinnings (1) will occur at stand age 40 in northern hardwood and oak timber types and at age 30 in cove hardwood type, (2) will improve species composition and timber quality, (3) will permit a commercial thinning of approximately 25 percent of available sawlog-sized material 10 years before the final harvest, and (4) will reduce the rotation age by 10 years. The species composition and quality of material removed by the thinning were assumed to be identical to those removed during the final harvest.

The economic response to a TSI activity is the value of the difference between what a treated stand will be worth and what it would have been worth without silvicultural management. For stands that have received a cleaning and liberation cutting, rotations are shorter and total yields are greater than for identical unmanaged stands (table 20). When management begins with a precommercial thinning, the total volume harvested is the same as for unmanaged stands but is of higher quality and is harvested earlier (table 21).

The influence of management upon species composition and timber quality is reflected in the stumpage prices received at the time of harvest. In this study, anticipated future stumpage prices for both managed and unmanaged stands were based on price projections made by Webster (1960). They are shown in table 13. Prices shown, ranging from \$72.02 to \$44.45 per thousand board feet, are the weighted average prices for all species and log grades to be harvested. For treated stands, these were to be

**Table 13.—Estimated future stumpage prices for hardwood sawtimber at harvest for stands that have and have not been subject to a TSI treatment<sup>1</sup>**

(In dollars per thousand board feet)

| Timber type                           | Average future price per thousand <sup>2</sup> |                   |
|---------------------------------------|------------------------------------------------|-------------------|
|                                       | With treatment                                 | Without treatment |
| <b>CLEANING AND CULL-TREE REMOVAL</b> |                                                |                   |
| Northern hardwoods                    | \$72.02                                        | \$63.52           |
| Oak stands                            | 70.44                                          | 70.73             |
| <b>THINNINGS</b>                      |                                                |                   |
| Northern hardwoods                    | 63.10                                          | 44.45             |
| Oak stands                            | 61.92                                          | 52.16             |
| Cove hardwood stands                  | 51.16                                          | 49.89             |

<sup>1</sup>Prices shown are for trees removed during the harvest cutting. Prices for volumes removed during thinnings are 90 percent of final harvest price.

<sup>2</sup>Because species mixture and quality vary by site, and because several sites were considered for each treatment, prices vary within each timber type. Variation is less than 1 percent of the prices shown.

received 40 years after the TSI operation in northern and cove hardwoods, and 50 years after TSI in the oak timber type.

## Financial Yields

The costs and returns associated with planting and TSI practices are used to determine the financial yields of these practices. The financial yield is the compound rate of interest by which future stumpage returns are discounted so as to equal the cost of establishment at the time of practice establishment. Use of the interest rate of return as a measure of financial yields provides a clear means of comparing possible alternative investments. Investments that yield a high rate of interest are preferable to those that earn a low rate of interest.

A modified version of Row's (1963) rate-of-return program was used to calculate financial yields on an electronic computer. And in computing rates of return, we determined the future value of timber yields by multiplying expected physical yields by expected prices. The following assumptions were inherent in this procedure and should be considered in interpreting rate-of-return data:

1. The yield tables (in appendix) are accurate representations of the volumes of timber that will be available for harvest.
2. The entire volume of timber shown in the yield tables will be available for harvest at the specified dates.
3. The available stumpage will be sold at the projected prices at the dates shown in the yield tables.

For planting, four types of establishment activities and associated cost were considered: (1) planting only, (2) planting with site preparation, (3) planting with protective fencing, and (4) planting with site preparation and fencing. Costs used were the weighted averages of direct and private establishment costs in the six study areas (table 10). Accordingly, rate-of-return data are provided for investments in planting, and for investments in planting that require site preparation, or fencing, or both site preparation and fencing. For TSI practices, average TSI cost data shown in table 10 were compared with stumpage returns to cleaning and cull-tree removal, and with stumpage returns from thinning. The use of an identical cost for both these silvicultural operations is in accord with the equality of ACP cost-share payments for these practices.

## FINANCIAL YIELDS OF INVESTMENTS

Detailed financial data for average investments in ACP-CFM- and CFM-supported planting and TSI are given in tables 22 to 27. Tables 22 to 25 provide yield data for plantations by species, and by site productivity class, for the financially optimum rotation ages under the high- and low-price assumptions. Returns to average investments in cleaning and cull-tree removal are given in table 26, and returns to precommercial thinnings in table 27.

In each of the appendix tables, financial yields at the financially optimum rotation age are given for three sources of investment funds—public, private, and total. Public cost is the direct cost associated with establishing a practice. Cost of administrative overhead and other indirect ACP- and CFM-program costs were excluded. Rates of return earned on direct public investments

were determined by comparing these costs with the entire value of stumpage available for harvest at the end of the rotation. The financial yield is therefore one measure of the return to society brought about by public investments in private forestry practices when the objective of these investments is timber production.

Financial yields to private funds represent the rate of return earned by the private landowner on the funds that he invested in practice establishment. Costs associated with holding a stand of timber until harvest were assumed to be equal to the costs of holding land in some other use or condition and therefore were not considered.

Yields to the sum of private and public investments measure the return to the total funds committed by the public and private sectors of the economy in establishing a subsidized practice on private lands. Thus, financial yields to total investments provide a broader measurement of the social return to subsidized forestry practices than is provided by financial yields on the public's investment alone.

A summary of yields to investments in ACP-CFM planting and TSI is given in table 14. Returns to CFM-supported practices are summarized in table 15. In both summaries planting returns are for plantations that did not require site preparation or protective fencing and have been harvested at the financially optimum rotation age.

The summary tables show that, in terms of returns to total establishment investments, it makes little difference if a practice is accomplished with or without financial assistance from ACP. Interest rate returns to total investments in ACP-CFM-supported practices averaged an insignificant 0.3 percent more than returns to total investments in non-ACP-supported CFM accomplishments. Interest returns to public investments in ACP-CFM practices averaged nearly 2 percent lower than investments in CFM practices. Correspondingly, because ACP cost-sharing payments cover 80 percent of private establishment costs, interest returns to private investments in ACP-supported practices averaged 4 per-

**Table 14.—Summary of potential financial yields of ACP-CFM-supported plantings at financial maturity and for TSI practices for public, private, and total establishment investments, by site-productivity class**  
(In percent, compound interest)

| Practice                  | Site I    | Site II   | Site III  |
|---------------------------|-----------|-----------|-----------|
| <b>PUBLIC INVESTMENT</b>  |           |           |           |
| Planting:                 |           |           |           |
| White pine                | 16.9-8.2  | 5.8-7.0   | 3.1-3.9   |
| Red pine                  | 7.3-8.3   | 6.7-7.6   | 6.1-6.9   |
| Larch                     | 8.9-9.4   | 7.3-7.7   | 5.6-5.9   |
| Norway spruce             | 7.8-9.0   | 5.8-6.5   | —         |
| Cleaning and liberation:  |           |           |           |
| Oak                       | 5.4       | 4.1       | 1.0       |
| Northern hardwoods        | 7.3       | 6.3       | —         |
| Thinning:                 |           |           |           |
| Oak                       | 7.9       | 6.0       | 1.0       |
| Northern hardwoods        | 11.1      | 10.2      | —         |
| Cove hardwoods            | 12.2      | 9.9       | —         |
| <b>PRIVATE INVESTMENT</b> |           |           |           |
| Planting:                 |           |           |           |
| White pine                | 11.5-12.9 | 9.6-10.8  | 4.8-5.7   |
| Red pine                  | 12.8-14.1 | 11.9-13.2 | 10.6-11.6 |
| Larch                     | 15.5-17.6 | 13.2-13.7 | 9.6-9.9   |
| Norway spruce             | 15.9-17.1 | 10.6-11.3 | —         |
| Cleaning and liberation:  |           |           |           |
| Oak                       | 8.3       | 7.1       | 3.2       |
| Northern hardwoods        | 10.3      | 9.7       | —         |
| Thinning:                 |           |           |           |
| Oak                       | 12.1      | 10.2      | 4.4       |
| Northern hardwoods        | 16.7      | 15.7      | —         |
| Cove hardwoods            | 18.0      | 15.5      | —         |
| <b>TOTAL INVESTMENT</b>   |           |           |           |
| Planting:                 |           |           |           |
| White pine                | 6.6-7.9   | 5.6-6.8   | 2.9-3.8   |
| Red pine                  | 7.1-8.0   | 6.5-7.4   | 5.9-6.8   |
| Larch                     | 8.6-9.0   | 7.0-7.4   | 5.4-5.7   |
| Norway Spruce             | 7.4-8.6   | 5.5-6.2   | —         |
| Cleaning and liberation:  |           |           |           |
| Oak                       | 5.1       | 3.7       | 1.0       |
| Northern hardwoods        | 7.0       | 5.9       | —         |
| Thinning:                 |           |           |           |
| Oak                       | 7.4       | 5.4       | 1.0       |
| Northern hardwoods        | 10.5      | 9.5       | —         |
| Cove hardwoods            | 11.7      | 9.2       | —         |

<sup>1</sup>The high and low interest rates for planting are rates earned under the high- and low-stumpage price assumptions.

**Table 15.—Summary of potential financial yields of CFM-supported plantings at financial maturity and for TSI practices for public, private and total establishment investments, by site-productivity class**  
(In percent, compound interest)

| Practice                  | Site I               | Site II | Site III |
|---------------------------|----------------------|---------|----------|
| <b>PUBLIC INVESTMENT</b>  |                      |         |          |
| Planting:                 |                      |         |          |
| White pine                | <sup>1</sup> 8.3-9.6 | 7.0-8.2 | 3.9-4.8  |
| Red pine                  | 8.9-9.9              | 8.2-9.2 | 7.4-8.2  |
| Larch                     | 11.3-11.8            | 9.1-9.5 | 6.8-7.1  |
| Norway Spruce             | 10.2-11.4            | 7.2-7.9 | —        |
| Cleaning and liberation:  |                      |         |          |
| Oak                       | 7.2                  | 5.9     | 1.6      |
| Northern hardwoods        | 9.2                  | 8.4     | —        |
| Thinning:                 |                      |         |          |
| Oak                       | 10.4                 | 1.0     | 2.7      |
| Northern hardwoods        | 14.5                 | 13.5    | —        |
| Cove hardwoods            | 15.8                 | 13.3    | —        |
| <b>PRIVATE INVESTMENT</b> |                      |         |          |
| Planting:                 |                      |         |          |
| White pine                | 7.5-8.8              | 6.3-7.5 | 3.4-4.3  |
| Red pine                  | 8.0-9.0              | 7.3-8.3 | 6.6-7.5  |
| Larch                     | 9.9-10.4             | 8.1-8.5 | 6.1-6.4  |
| Norway spruce             | 8.9-10.0             | 6.4-7.1 | —        |
| Cleaning and liberation:  |                      |         |          |
| Oak                       | 6.0                  | 4.7     | 1.0      |
| Northern hardwoods        | 7.9                  | 7.0     | —        |
| Thinning:                 |                      |         |          |
| Oak                       | 8.6                  | 11.8    | 1.0      |
| Northern hardwoods        | 12.1                 | 11.2    | —        |
| Cove hardwoods            | 13.4                 | 10.9    | —        |
| <b>TOTAL INVESTMENT</b>   |                      |         |          |
| Planting:                 |                      |         |          |
| White pine                | 6.3-7.6              | 5.4-6.5 | 2.9-3.6  |
| Red pine                  | 6.7-7.7              | 6.2-7.1 | 5.6-6.2  |
| Larch                     | 8.2-8.5              | 6.6-7.1 | 5.1-5.4  |
| Norway spruce             | 6.9-8.0              | 5.2-5.9 | —        |
| Cleaning and liberation:  |                      |         |          |
| Oak                       | 5.2                  | 3.9     | 1.0      |
| Northern hardwoods        | 6.7                  | 6.1     | —        |
| Thinning:                 |                      |         |          |
| Oak                       | 7.5                  | 5.6     | 1.0      |
| Northern hardwoods        | 10.7                 | 9.7     | —        |
| Cove hardwoods            | 11.9                 | 9.4     | —        |

<sup>1</sup>The high and low interest rates for planting are rates earned under the high- and low-stumpage price assumptions.

cent greater than returns to practices subsidized by technical assistance only.

On site productivity class I and II lands, the most financially desirable practices were precommercial thinning in cove hardwoods and northern hardwoods. Successively less-desirable practices were planting larch or Norway spruce, planting red or white pine, thinning pole-timber-size oak stands, and cleaning and liberating cuttings in northern hardwood and oak stands. On site III lands, planting was more desirable than TSI practices. Practices undertaken on site I lands yielded 0.6 to 2.5 percent more than interest returns to total investments in similar practices undertaken on site II lands. For similar practices, site III lands yielded 0.3- to 10.8 percent less than investments on site II lands.

## UNCERTAINTY AND THE FINANCIAL YIELD TABLES

The principal value of the financial yields given in the appendix is that they provide a means of ranking the relative financial desirability of private and public timber-producing investments. Because of the uncertainty associated with the yield data, absolute levels of the financial yields are of limited value. They are based directly on a number of limiting assumptions—assumptions as to possible yields, stumpage values, expenditures, and probability of harvest. How well these assumptions depict future conditions remains to be seen, although a number of factors indicate that the financial yields shown are very highly optimistic.

Physical yield data employed in the analysis are estimated gross yields. No accounting has been made of the probability of loss of growing stock or of entire stands to planting failures, fire, or insects and diseases. Webster (1960) estimated that the net output of softwood plantations in Pennsylvania varied between 56 and 81 percent of gross output, depending upon the species planted. Volume loss in hardwoods was estimated to range from 12 to 37 percent of gross output for unmanaged stands, and from 7 to 20 percent of gross output for managed stands. The

financial yields given in the appendix would be substantially reduced if these factors were considered.

Another and more important reason for conservative interpretation of absolute levels of financial yields is the basic assumption underlying the financial yields: that the timber produced from program accomplishments will be placed on the market by landowners, and will be purchased and harvested. Data collected during this study indicate that, even if owner objectives are such that they will sell stumpage, a large portion—perhaps a majority—of the net volume of the timber produced as a result of ACP and CFM will not be marketed.

The average size of publicly subsidized planting was less than 7 acres. Landowners who planted more than 5 acres usually planted more than one species. And when more than one species was planted, pines were mixed with spruce or larch. CFM clients occasionally plant a few acres of land for several years in a row, thereby producing a sizable stand of softwoods; but service foresters report that this is not common practice. Given current trends toward capital-intensive high-volume wood-harvesting methods, it does not seem likely that the small and often isolated CFM plantation of mixed species will be attractive to future stumpage buyers. Also, when these tracts are sold, the price received for stumpage may be substantially below the projected market prices. The probability of harvest also is less likely when softwood species, particularly larch and spruce, are planted in a region characterized by hardwood timber types and hardwood timber markets. These species are not widely available in natural stands in Pennsylvania, and it is unlikely that sufficient volumes will become available from plantations to stimulate development of strong markets for them.

The average TSI practice undertaken by CFM clients was about 10 acres in size. Returns to investment for timber very likely would be increased if the average landowner undertook 10 acres of TSI every year for a series of years; but as with planting, this is not common. Since normally only a small portion of the landowner's woodlot is subjected to TSI, there is little effect upon the marketability or value of the stands treated.

## Summary & Conclusions

This study provides the administrators of Pennsylvania's CFM program with data they need to monitor the economic efficiency of their program activities. Public and private costs of establishing major CFM- and CFM-ACP-sponsored forestry practices in different parts of the State are given. The practices considered are planting (including either site preparation or protective fencing, or both), cleaning and cull-tree removal, precommercial thinning, pruning, and harvesting and marketing assistance.

The procedure by which cost data were collected is presented in detail with the hope that program administrators will adopt the procedure as an economical means of monitoring program costs. Average establishment costs are compared with estimates of potential stumpage returns, to provide an investment opportunity guide for planting and TSI practices, excluding pruning. The assumed objective of these investments is profitable timber production. The investment guide is based on the rate of interest earned on the weighted average of public and private establishment costs in six CFM districts. The six areas in which data were collected were chosen to account for regional variations in practice establishment costs and differences in levels of CFM program activity.

In the study areas, 2,492 acres of CFM and ACP-CFM forestry practice accomplishments by private landowners, and 622 acres of CFM harvesting assistance were reported. Planting accounted for 53 percent, TSI practices 27 percent, and fencing 14 percent of total landowner accomplishments.)

Three-fourths of the accomplishments requiring investments by private landowners were subsidized financially through ACP cost-sharing payments. ACP supported 70 percent of the planting, 89 per cent of the fencing, and 90 percent of the TSI. The average size ACP-supported accomplishment was 7.9 acres per landowner. For planting and TSI the averages were 6.4 acres and 10.2 acres, respectively.

Total direct costs of ACP-CFM and CFM accomplishments ranged from \$114.40 to \$7.83 per acre. The average public,

private and total costs for individual practices are shown in table 28. Non-ACP-supported CFM planting with site preparation and fencing was the most expansive practice, averaging \$79.52 per acre. For ACP-CFM practices, the TSI cost (\$40.24), was greater than the cost of planting without site preparation or fencing (\$38.71). But for non-ACP-supported CFM activities the order was reversed: planting costs (\$44.33) exceeded TSI costs (\$37.94). The lowest cost activity was that of providing harvesting and marketing assistance to private landowners. The average cost of this service, born entirely by the public, was \$12.11 per acre.

The average total cost per acre of all ACP-CFM-supported landowner accomplishments (\$34.30) was \$3.31 less than the average total cost of all comparable CFM practices (\$37.61). Significant differences occurred in the incidence of costs. For practices subsidized by ACP cost-sharing payments, public costs were 87 percent of total costs. For comparable non-ACP-supported CFM practices, public costs accounted for 41 percent of total costs.

Costs varied widely between study areas. Non-ACP-supported TSI showed the most variation, ranging from \$29.89 to \$114.40 per acre. Total costs of ACP-CFM-supported planting, the most widely undertaken practice, varied from \$32.62 to \$51.83 per acre. Lowest costs were obtained in districts where the total acreage of ACP-supported forestry accomplishments was large. Conversely, where total ACP-CFM accomplishments were low, costs per acre were high. Sample data therefore indicate that an active ACP program is a prerequisite to low costs. Presumably the same opportunities for efficient operations are available when large numbers of requests for non-ACP-related assistance are received, but these opportunities did not materialize. Service foresters who obtained low ACP-CFM accomplishments had large, persistent backlogs of unanswered requests for CFM assistance. Had the forester been able to honor these requests, accomplishments might have been significantly larger than they were, and costs per acre of accomplishment would have been less.

There may be many reasons why service foresters who had

few ACP-CFM accomplishments also reported relatively small non-ACP-supported CFM accomplishments. One explanation is that the absolute deadlines set by county ASCS offices for certification of ACP practice accomplishments cause the service forester to complete a project quickly. ACP practices must be certified as complete by certain specified dates in order for the landowner undertaking the practice to receive a cost-sharing payment. No deadlines are imposed upon the service forester when he services non-ACP-supported CFM cooperators.

Interest rate yields to average total investments in ACP-CFM-supported practices were found to be an insignificant 0.3 percent higher than returns to average total investments in non-ACP-supported CFM practices. For non-ACP-supported CFM practices, the public portion of total investments earned a higher rate of interest return than public investments in identical practices supported by ACP. This was expected, of course, since under ACP the public pays up to 80 percent of the costs incurred by the private landowner in establishing a practice. Correspondingly, private investments in ACP-sponsored practices returned more than private investments in non-ACP-supported practices.

As would be expected, the relative financial desirability of alternative practices was found to vary with the productivity of the forest site. Any practice undertaken on site productivity class III lands was nearly always less desirable than the same or other practices undertaken on site II or site I lands. On sites I and II precommercial thinning in cove hardwoods and northern hardwoods was the most desirable practice. On site III lands, planting was more desirable than thinning or cleaning and liberation. When successful planting must be preceded by site preparation or followed by protective fencing, the additional costs involved caused the order of desirability to change.

Table 29, shows the rates of interest calculated on total investments in ACP-CFM and CFM practices, by site productivity class.

This study indicates that the social return to public investments in the CFM program in Pennsylvania can be increased. Some improvement can be obtained by emphasizing those practices

that yield high returns. But if timber production is the major goal more immediate and significant improvements can be obtained by curtailing activities in districts where owner accomplishments are small and by discouraging practices that have a high degree of uncertainty of eventual harvest.

Districts that report low levels of accomplishment are districts in which per-acre establishment costs are high. High establishment costs, in turn, lead to low returns. For example, site I red pine plantations established at a cost of \$25 per acre will earn a potential rate of return that is about 20 percent greater than the potential return on establishment investments of \$50 per acre.

Two activities that are likely to produce low timber returns are the typical 10-acre or smaller TSI operation and the 6-acre or smaller plantation of two or more species. Harvesting small acreages of timber is usually more costly than harvesting large tracts of timber and, on the basis of current trends in harvesting methods, will become more so in the future. Even if these small stands will be harvested, stumpage prices very likely will be lower than average. Another practice that is not likely to be profitable for timber production is the planting of softwoods, particularly larch and spruce, in areas where the planted species are not naturally available in volume. Where this condition occurs, markets may not be available for timber that would otherwise be economically mature.

## References

- Agricultural Stabilization and Conservation Service (ASCS).  
1963. THE 1964 AGRICULTURAL CONSERVATION PROGRAM FOR PENNSYLVANIA. Washington: U.S. Dep. Agr., Agr. Stabiliz., and Conserv. Serv. 68 pp.
- Agricultural Stabilization and Conservation Service (ASCS).  
1966. AGRICULTURAL CONSERVATION PROGRAM SUMMARY BY STATES, 1965. Washington: U.S. Dep. Agr., Agr. Stabiliz. and Conserv. Serv. 133 pp.
- Buchman, R. E.  
1962. GROWTH AND YIELD OF RED PINE IN MINNESOTA. U.S. Dep. Agr. Tech. Bull. 1272, 50 pp.
- Lake States Forest Experiment Station.  
1957. YIELD TABLES FOR USE IN STUDY OF THE ECONOMICS OF EASTERN WHITE PINE PRODUCTION. Unpublished manuscript, USDA Forest Serv. Lake States Forest Exp. Sta., St. Paul, Minnesota.
- Marty, Robert J.  
1957. FOREST MANAGEMENT POSSIBILITIES ON IDLE LAND IN POTTER COUNTY, PENNSYLVANIA. Office report, USDA Forest Serv., NE Forest Exp. Sta., Upper Darby, Pa. 59 pp.
- Row, Clark  
1963. DETERMINING FOR INVESTMENT RATES - OF - RETURN BY ELECTRONIC COMPUTER. USDA Forest Serv. Res. Paper SO-6, 13 p. So. Forest Exp. Sta., New Orleans, La.
- Stone, Earl L.  
1957. BRITISH YIELD TABLES FOR EUROPEAN AND JAPANESE LARCHES IN NEW YORK. Cornell Univ. Agron. Paper 397. 4 pp.
- Webster, Henry H.  
1960. AN ECONOMIC ANALYSIS OF CERTAIN STUMPAGE PRODUCTION ALTERNATIVES IN PENNSYLVANIA. Ph.D. thesis, Univ. Michigan. 158 pp.
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# Appendix

## I

### PHYSICAL YIELD TABLES

Table 16.—Yield table for white pine at 90 percent of full stocking,  
site indexes 80, 70, and 40  
(In thousand board feet per acre)

| Age<br>(years) | Site 80                |         | Site 70                |         | Site 40   |         |
|----------------|------------------------|---------|------------------------|---------|-----------|---------|
|                | Thinnings <sup>1</sup> | Harvest | Thinnings <sup>1</sup> | Harvest | Thinnings | Harvest |
| 50             | 3.8                    | 21.3    | 3.3                    | 11.1    | —         | —       |
| 60             | 3.8                    | 28.8    | 3.3                    | 22.2    | —         | 1.3     |
| 70             | 3.8                    | 41.4    | 3.3                    | 32.3    | —         | 2.8     |
| 80             | 5.0                    | 41.1    | 3.6                    | 32.4    | —         | 7.7     |
| 90             | 5.0                    | —       | 3.6                    | —       | —         | —       |
| 100            | —                      | 48.7    | 3.0                    | 40.6    | —         | 14.0    |
| 110            | —                      | —       | 3.0                    | —       | —         | —       |
| 120            | —                      | 55.9    | —                      | 45.8    | —         | 18.0    |

<sup>1</sup>Thinnings at stand ages 50, 60, and 70 apply only to rotation ages 80, 100, and 120.

Source: Yield data were based on *Yield tables for use in study of the economics of eastern white pine production*, unpublished manuscript, USDA Forest Serv. L.S. Forest Exp. Sta., St. Paul, Minn., 1957.

Table 17.—Yield table for red pine, site indexes 60, 50, and 45, based on a basal-area control of 90 square feet per acre

| Age<br>(years) | Thinnings        |              | Harvest          |              |
|----------------|------------------|--------------|------------------|--------------|
|                | Sawlogs          | Pulpwood     | Sawlogs          | Pulpwood     |
|                | <i>M bd. ft.</i> | <i>Cords</i> | <i>M bd. ft.</i> | <i>Cords</i> |
| SITE INDEX 60  |                  |              |                  |              |
| 25             | —                | 8.1          | —                | —            |
| 35             | —                | 10.2         | —                | —            |
| 45             | —                | 11.6         | —                | —            |
| 55             | 6.5              | 1.0          | 18.6             | 2.0          |
| 65             | 6.5              | 1.0          | —                | —            |
| 75             | 6.3              | 1.0          | 21.1             | 2.0          |
| 85             | 5.9              | 1.0          | —                | —            |
| 95             | 5.6              | 1.0          | 22.6             | 2.0          |
| 105            | —                | —            | 23.0             | 2.0          |
| SITE INDEX 50  |                  |              |                  |              |
| 25             | —                | 5.6          | —                | —            |
| 35             | —                | 7.5          | —                | —            |
| 45             | —                | 8.5          | —                | —            |
| 55             | 4.7              | 1.0          | 14.7             | 2.0          |
| 65             | 4.6              | 1.0          | —                | —            |
| 75             | 4.3              | 1.0          | 16.7             | 2.0          |
| 85             | 4.0              | 1.0          | —                | —            |
| 95             | 3.6              | 1.0          | 17.7             | 2.0          |
| 105            | —                | —            | 17.9             | 2.0          |
| SITE INDEX 45  |                  |              |                  |              |
| 25             | —                | —            | —                | —            |
| 35             | —                | 6.4          | —                | —            |
| 45             | —                | 7.2          | —                | —            |
| 55             | 3.9              | 1.0          | 13.0             | 2.0          |
| 65             | 3.8              | 1.0          | —                | —            |
| 75             | 3.5              | 1.0          | 14.7             | 2.0          |
| 85             | 3.2              | 1.0          | —                | —            |
| 95             | 2.8              | 1.0          | 15.5             | 2.0          |
| 105            | —                | —            | 15.6             | 2.0          |

Source: Buckman, R. E. *Growth and yield of red pine in Minnesota*. U. S. Dep. Agr. Tech. Bull. 1272, 50 pp. 1962.

Table 18.—Yield table for larch, site indexes 90, 80, and 40  
(In thousand board feet per acre)

| Age<br>(years) | Site index 90 |         | Site index 80 |         | Site index 40 |         |
|----------------|---------------|---------|---------------|---------|---------------|---------|
|                | Thinnings     | Harvest | Thinnings     | Harvest | Thinnings     | Harvest |
| 30             | 3.0           | 9.0     | —             | —       | —             | —       |
| 40             | —             | 14.0    | 3.0           | 11.2    | —             | —       |
| 50             | 3.6           | 20.9    | —             | 14.4    | 2.5           | 8.5     |
| 60             | 4.4           | 21.3    | 4.6           | 20.2    | —             | 11.6    |
| 70             | —             | 21.8    | —             | 18.6    | 3.6           | 16.8    |
| 80             | —             | —       | —             | —       | —             | 17.2    |

Source: Stone, Earl L. *British yield tables for European and Japanese larches in New York*. Cornell Univ. Agron. Paper 397, 4 pp. 1957.

Table 19.—Yield table for Norway spruce for site indexes 80 and 60<sup>1</sup>  
(In cords per acre)

| Age<br>(years) | Site index 80 |                  | Site index 60 |                  |
|----------------|---------------|------------------|---------------|------------------|
|                | Thinnings     | Final<br>cutting | Thinnings     | Final<br>cutting |
| 20             | —             | 13.3             | —             | —                |
| 30             | 10.5          | 44.1             | —             | 18.9             |
| 40             | 15.6          | 68.5             | 7.8           | 36.5             |
| 50             | 13.0          | 76.0             | 12.2          | 59.2             |
| 60             | 17.3          | 90.6             | 19.2          | 74.2             |
| 70             | —             | 105.6            | —             | 83.3             |

Source: Marty, Robert J. *Office report on forest management possibilities on idle land in Potter County, Pennsylvania*. U. S. D. A. Forest Serv., NE. Forest Exp. Sta., Upper Darby, Pa., 1957.

Table 20.—Yields per acre for hardwood stands that have been precommercially thinned, and for identical stands that have not been thinned, by site-productivity class

| Stand description   | Age at time of precommercial thinning | Thinned stands |                  |              |                  | Yield from unthinned stands |                  |
|---------------------|---------------------------------------|----------------|------------------|--------------|------------------|-----------------------------|------------------|
|                     |                                       | Thinnings      |                  | Harvest      |                  |                             |                  |
|                     |                                       | Age            | Volume           | Age          | Volume           | Age                         | Volume           |
|                     | <i>Years</i>                          | <i>Years</i>   | <i>M bd. ft.</i> | <i>Years</i> | <i>M bd. ft.</i> | <i>Years</i>                | <i>M bd. ft.</i> |
| Northern hardwoods: |                                       |                |                  |              |                  |                             |                  |
| Site I              | 40                                    | 70             | 5.9              | 80           | 17.7             | 90                          | 23.6             |
| Site II             | 40                                    | 70             | 4.5              | 80           | 13.4             | 90                          | 17.9             |
| Oak stands:         |                                       |                |                  |              |                  |                             |                  |
| Site I              | 40                                    | 80             | 5.2              | 90           | 15.6             | 100                         | 20.8             |
| Site II             | 40                                    | 80             | 2.6              | 90           | 7.7              | 100                         | 10.3             |
| Site III            | 40                                    | —              | —                | 90           | 1.5              | 100                         | 1.5              |
| Cove hardwoods:     |                                       |                |                  |              |                  |                             |                  |
| Site I              | 30                                    | 60             | 8.6              | 70           | 25.7             | 80                          | 34.3             |
| Site II             | 30                                    | 60             | 4.3              | 70           | 12.8             | 80                          | 17.9             |

Source: Yields are based on data developed by Webster (1960).

Table 21.—Yields per acre for managed hardwood stands that have been cleaned and liberated at age 10-15 and will be subsequently thinned, and for identical unmanaged stands, by site productivity class

| Stand description   | Yields from managed stands <sup>1</sup> |           |         |           | Yield from unmanaged stands <sup>1</sup> |           |
|---------------------|-----------------------------------------|-----------|---------|-----------|------------------------------------------|-----------|
|                     | Thinnings                               |           | Harvest |           |                                          |           |
|                     | Years                                   | M bd. ft. | Years   | M bd. ft. | Years                                    | M bd. ft. |
| Northern hardwoods: |                                         |           |         |           |                                          |           |
| Site I              | 60                                      | 6.1       | 70      | 18.4      | 90                                       | 23.6      |
| Site II             | 60                                      | 4.6       | 70      | 18.4      | 90                                       | 17.9      |
| Oak:                |                                         |           |         |           |                                          |           |
| Site I              | 70                                      | 5.4       | 80      | 16.2      | 100                                      | 20.8      |
| Site II             | 70                                      | 2.7       | 80      | 8.2       | 100                                      | 10.3      |
| Site III            | —                                       | —         | 80      | 1.6       | 100                                      | 1.5       |

<sup>1</sup>Managed stands are stands that have been subjected to cleaning and liberation cuttings and will be subsequently thinned. In unmanaged stands, no cultural treatment will be undertaken.

Source: Yields are based on data developed by Webster (1960).

## FINANCIAL YIELD TABLES

**Table 22.—Financial yields of white pine plantations grown for sawlogs to the financially optimum rotation age for public establishment costs under high- and low-stumpage value assumptions, by site-productivity class**

(In percent, compound interest)

| Investment                              |                  | High price <sup>1</sup>  |                           |                            | Low price <sup>2</sup>   |                           |                             |
|-----------------------------------------|------------------|--------------------------|---------------------------|----------------------------|--------------------------|---------------------------|-----------------------------|
| Source                                  | Dollars per acre | Site I, 50-year rotation | Site II, 60-year rotation | Site III, 80-year rotation | Site I, 50-year rotation | Site II, 60-year rotation | Site III, 100-year rotation |
| PLANTING ONLY                           |                  |                          |                           |                            |                          |                           |                             |
| ACP-CFM:                                |                  |                          |                           |                            |                          |                           |                             |
| Public                                  | 34.43            | 8.2                      | 7.0                       | 3.9                        | 6.9                      | 5.8                       | 3.1                         |
| Private                                 | 4.28             | 12.9                     | 10.8                      | 6.5                        | 11.5                     | 9.6                       | 6.2                         |
| Total                                   | 38.71            | 7.9                      | 6.8                       | 3.8                        | 6.6                      | 5.6                       | 3.0                         |
| CFM:                                    |                  |                          |                           |                            |                          |                           |                             |
| Public                                  | 18.17            | 9.6                      | 8.1                       | 4.8                        | 8.3                      | 7.0                       | 3.8                         |
| Private                                 | 26.16            | 8.8                      | 7.5                       | 4.3                        | 7.5                      | 6.3                       | 3.4                         |
| Total                                   | 44.33            | 7.6                      | 6.8                       | 3.6                        | 6.3                      | 5.4                       | 2.9                         |
| PLANTING AND SITE PREPARATION           |                  |                          |                           |                            |                          |                           |                             |
| ACP-CFM:                                |                  |                          |                           |                            |                          |                           |                             |
| Public                                  | 49.34            | 7.4                      | 6.3                       | 3.5                        | 6.1                      | 5.2                       | 2.8                         |
| Private                                 | 6.31             | 12.0                     | 10.1                      | 6.2                        | 10.1                     | 9.8                       | 4.9                         |
| Total                                   | 55.65            | 7.1                      | 6.1                       | 3.3                        | 5.8                      | 5.0                       | 2.6                         |
| CFM:                                    |                  |                          |                           |                            |                          |                           |                             |
| Public                                  | 24.50            | 8.9                      | 7.6                       | 4.4                        | 7.6                      | 6.5                       | 3.5                         |
| Private                                 | 35.15            | 8.1                      | 6.7                       | 3.9                        | 6.8                      | 5.8                       | 3.1                         |
| Total                                   | 59.65            | 7.0                      | 6.0                       | 3.2                        | 5.7                      | 4.9                       | 2.6                         |
| PLANTING AND FENCING                    |                  |                          |                           |                            |                          |                           |                             |
| ACP-CFM:                                |                  |                          |                           |                            |                          |                           |                             |
| Public                                  | 44.43            | 7.6                      | 6.5                       | 3.6                        | 6.3                      | 5.4                       | 2.9                         |
| Private                                 | 5.08             | 12.3                     | 10.5                      | 6.4                        | 10.9                     | 9.7                       | 5.5                         |
| Total                                   | 49.51            | 7.4                      | 6.3                       | 3.5                        | 6.1                      | 5.2                       | 2.8                         |
| CFM:                                    |                  |                          |                           |                            |                          |                           |                             |
| Public                                  | 26.84            | 8.8                      | 7.5                       | 4.3                        | 7.5                      | 6.3                       | 3.4                         |
| Private                                 | 37.36            | 8.0                      | 6.9                       | 3.8                        | 6.7                      | 5.7                       | 3.0                         |
| Total                                   | 64.20            | 6.8                      | 5.9                       | 3.1                        | 5.3                      | 4.7                       | 2.5                         |
| PLANTING, SITE PREPARATION, AND FENCING |                  |                          |                           |                            |                          |                           |                             |
| ACP-CFM:                                |                  |                          |                           |                            |                          |                           |                             |
| Public                                  | 59.34            | 7.0                      | 6.0                       | 3.2                        | 5.7                      | 5.4                       | 2.6                         |
| Private                                 | 7.11             | 11.9                     | 10.0                      | 6.0                        | 9.8                      | 8.8                       | 4.8                         |
| Total                                   | 66.45            | 6.7                      | 5.8                       | 3.1                        | 6.1                      | 4.7                       | 2.4                         |
| CFM:                                    |                  |                          |                           |                            |                          |                           |                             |
| Public                                  | 33.17            | 8.2                      | 7.0                       | 4.0                        | 6.9                      | 5.9                       | 3.0                         |
| Private                                 | 46.35            | 7.5                      | 6.4                       | 3.6                        | 6.2                      | 5.3                       | 2.9                         |
| Total                                   | 79.52            | 6.4                      | 5.0                       | 2.9                        | 5.0                      | 4.3                       | 2.3                         |

<sup>1</sup>The high-stumpage value assumption is that the current market price is \$43.95 per thousand board feet, and that it will increase at a rate of 1.1 percent per year over the length of the rotation.

<sup>2</sup>The low-stumpage price is \$30.00 per thousand board feet, with an annual increase of 0.50 percent.

Table 23.—Financial yields for red pine plantations grown for sawlogs to the financially optimum rotation age of 65 years for public establishment costs under high- and low-stumpage value assumptions, by site-productivity class<sup>1</sup>  
(In percent, compound interest)

| Investment                              |                        | High price <sup>2</sup> |         |          | Low price <sup>3</sup> |         |          |
|-----------------------------------------|------------------------|-------------------------|---------|----------|------------------------|---------|----------|
| Source                                  | Dollars<br>per<br>acre | Site I                  | Site II | Site III | Site I                 | Site II | Site III |
| PLANTING ONLY                           |                        |                         |         |          |                        |         |          |
| ACP-CFM:                                |                        |                         |         |          |                        |         |          |
| Public                                  | 34.43                  | 8.3                     | 7.6     | 6.9      | 7.3                    | 6.7     | 6.1      |
| Private                                 | 4.28                   | 14.1                    | 13.2    | 11.6     | 12.8                   | 11.9    | 10.6     |
| Total                                   | 38.71                  | 8.0                     | 7.4     | 6.8      | 7.1                    | 6.5     | 5.9      |
| CFM:                                    |                        |                         |         |          |                        |         |          |
| Public                                  | 18.17                  | 9.9                     | 9.2     | 8.2      | 8.9                    | 8.2     | 7.4      |
| Private                                 | 26.16                  | 9.0                     | 8.3     | 7.5      | 8.0                    | 7.3     | 6.6      |
| Total                                   | 44.33                  | 7.7                     | 7.1     | 6.2      | 6.7                    | 6.2     | 5.6      |
| PLANTING AND SITE PREPARATION           |                        |                         |         |          |                        |         |          |
| ACP-CFM:                                |                        |                         |         |          |                        |         |          |
| Public                                  | 49.34                  | 7.4                     | 6.8     | 6.1      | 6.5                    | 5.9     | 5.3      |
| Private                                 | 6.31                   | 12.9                    | 12.0    | 10.4     | 11.7                   | 10.9    | 9.6      |
| Total                                   | 55.65                  | 7.2                     | 6.5     | 5.9      | 6.2                    | 5.7     | 5.1      |
| CFM:                                    |                        |                         |         |          |                        |         |          |
| Public                                  | 24.50                  | 9.2                     | 8.5     | 7.5      | 8.1                    | 7.5     | 6.7      |
| Private                                 | 35.15                  | 8.3                     | 7.6     | 6.8      | 7.3                    | 6.7     | 6.0      |
| Total                                   | 59.65                  | 7.0                     | 6.4     | 5.7      | 6.1                    | 5.5     | 4.9      |
| PLANTING AND FENCING                    |                        |                         |         |          |                        |         |          |
| ACP-CFM:                                |                        |                         |         |          |                        |         |          |
| Public                                  | 44.43                  | 7.7                     | 7.1     | 6.2      | 6.7                    | 6.2     | 5.6      |
| Private                                 | 5.08                   | 13.4                    | 12.5    | 12.3     | 12.0                   | 11.4    | 10.0     |
| Total                                   | 49.51                  | 7.4                     | 6.8     | 6.1      | 6.5                    | 5.9     | 5.3      |
| CFM:                                    |                        |                         |         |          |                        |         |          |
| Public                                  | 26.84                  | 9.0                     | 8.3     | 7.5      | 8.0                    | 7.3     | 6.6      |
| Private                                 | 37.36                  | 8.2                     | 7.5     | 6.8      | 7.2                    | 6.6     | 6.0      |
| Total                                   | 64.20                  | 6.5                     | 6.2     | 5.8      | 5.9                    | 5.3     | 4.7      |
| PLANTING, SITE PREPARATION, AND FENCING |                        |                         |         |          |                        |         |          |
| ACP-CFM:                                |                        |                         |         |          |                        |         |          |
| Public                                  | 59.34                  | 7.7                     | 6.4     | 5.7      | 6.1                    | 5.5     | 4.9      |
| Private                                 | 7.11                   | 12.5                    | 12.3    | 9.9      | 11.4                   | 10.6    | 9.3      |
| Total                                   | 66.45                  | 7.4                     | 6.1     | 5.5      | 5.8                    | 5.3     | 5.3      |
| CFM:                                    |                        |                         |         |          |                        |         |          |
| Public                                  | 33.17                  | 8.3                     | 7.7     | 6.9      | 7.4                    | 6.8     | 6.1      |
| Private                                 | 46.35                  | 7.6                     | 7.0     | 6.1      | 6.6                    | 6.0     | 5.4      |
| Total                                   | 79.52                  | 6.4                     | 5.8     | 5.1      | 5.4                    | 4.9     | 4.4      |

<sup>1</sup>The 55-year rotation is optimum for all site-productivity classes and for both price assumptions.

<sup>2</sup>The high-stumpage value assumption is that current average market prices are \$43.90 per thousand board feet and \$5.50 per cord. Sawtimber prices are assumed to increase at 1.1 percent per year and pulpwood prices at 0.5 percent per year over the length of the rotation.

<sup>3</sup>Low-stumpage prices are \$30.00 per thousand board feet and \$3.50 per cord. Expected price increases are the same as for the high-value stumpage assumption.

**Table 24.—Financial yields for larch plantations grown for sawlogs to the financially optimum rotation age for public establishment costs under high- and low-stumpage value assumptions, by site-productivity class**

(In percent, compound interest)

| Investment                              |                  | High price <sup>1</sup>  |                           |                            | Low price <sup>2</sup>   |                           |                            |
|-----------------------------------------|------------------|--------------------------|---------------------------|----------------------------|--------------------------|---------------------------|----------------------------|
| Source                                  | Dollars per acre | Site I, 40-year rotation | Site II, 40-year rotation | Site III, 60-year rotation | Site I, 40-year rotation | Site II, 40-year rotation | Site III, 60-year rotation |
| PLANTING ONLY                           |                  |                          |                           |                            |                          |                           |                            |
| ACP-CFM:                                |                  |                          |                           |                            |                          |                           |                            |
| Public                                  | 34.43            | 9.4                      | 7.7                       | 5.9                        | 8.9                      | 7.3                       | 5.6                        |
| Private                                 | 4.28             | 16.0                     | 13.7                      | 9.9                        | 15.5                     | 13.2                      | 9.6                        |
| Total                                   | 38.71            | 9.0                      | 7.4                       | 5.7                        | 8.6                      | 7.0                       | 5.4                        |
| CFM:                                    |                  |                          |                           |                            |                          |                           |                            |
| Public                                  | 18.17            | 11.4                     | 9.5                       | 7.1                        | 10.9                     | 9.1                       | 6.8                        |
| Private                                 | 26.16            | 10.2                     | 8.5                       | 6.4                        | 9.7                      | 8.1                       | 6.1                        |
| Total                                   | 44.33            | 8.6                      | 7.1                       | 5.4                        | 8.2                      | 6.6                       | 5.1                        |
| PLANTING AND SITE PREPARATION           |                  |                          |                           |                            |                          |                           |                            |
| ACP-CFM:                                |                  |                          |                           |                            |                          |                           |                            |
| Public                                  | 49.34            | 8.3                      | 6.8                       | 4.9                        | 7.8                      | 6.3                       | 4.9                        |
| Private                                 | 6.31             | 14.7                     | 12.5                      | 9.1                        | 14.2                     | 12.1                      | 8.8                        |
| Total                                   | 55.65            | 7.9                      | 6.4                       | 5.0                        | 7.5                      | 6.0                       | 4.7                        |
| CFM:                                    |                  |                          |                           |                            |                          |                           |                            |
| Public                                  | 24.50            | 10.4                     | 8.7                       | 6.5                        | 10.0                     | 8.3                       | 6.2                        |
| Private                                 | 35.15            | 9.0                      | 7.7                       | 5.9                        | 8.9                      | 7.3                       | 5.6                        |
| Total                                   | 59.65            | 7.7                      | 6.2                       | 4.9                        | 7.3                      | 5.8                       | 4.6                        |
| PLANTING AND FENCING                    |                  |                          |                           |                            |                          |                           |                            |
| ACP-CFM:                                |                  |                          |                           |                            |                          |                           |                            |
| Public                                  | 44.43            | 8.6                      | 7.1                       | 5.4                        | 8.2                      | 6.6                       | 5.1                        |
| Private                                 | 5.08             | 15.2                     | 13.2                      | 9.6                        | 15.0                     | 12.8                      | 9.3                        |
| Total                                   | 49.51            | 8.3                      | 6.8                       | 4.9                        | 7.8                      | 6.3                       | 4.9                        |
| CFM:                                    |                  |                          |                           |                            |                          |                           |                            |
| Public                                  | 26.84            | 10.2                     | 8.5                       | 6.4                        | 9.7                      | 8.1                       | 6.1                        |
| Private                                 | 37.36            | 9.0                      | 7.7                       | 5.8                        | 8.9                      | 7.3                       | 5.5                        |
| Total                                   | 64.20            | 7.5                      | 6.0                       | 4.8                        | 7.0                      | 5.6                       | 4.4                        |
| PLANTING, SITE PREPARATION, AND FENCING |                  |                          |                           |                            |                          |                           |                            |
| ACP-CFM:                                |                  |                          |                           |                            |                          |                           |                            |
| Public                                  | 59.34            | 7.7                      | 6.2                       | 4.9                        | 8.2                      | 5.8                       | 4.6                        |
| Private                                 | 7.11             | 14.3                     | 12.2                      | 8.9                        | 13.8                     | 11.7                      | 8.6                        |
| Total                                   | 66.45            | 7.4                      | 5.9                       | 4.7                        | 7.8                      | 5.5                       | 4.4                        |
| CFM:                                    |                  |                          |                           |                            |                          |                           |                            |
| Public                                  | 33.17            | 9.4                      | 7.8                       | 5.9                        | 9.0                      | 7.3                       | 5.6                        |
| Private                                 | 46.35            | 8.3                      | 6.9                       | 5.2                        | 8.1                      | 6.5                       | 5.0                        |
| Total                                   | 79.52            | 6.8                      | 5.5                       | 4.4                        | 6.5                      | 5.1                       | 4.1                        |

<sup>1</sup>The high-stumpage value assumption is that the current market price is \$35.00 per thousand board feet and that it will increase at a rate of 1.1 percent per year over the length of the rotation.

<sup>2</sup>The low-stumpage price assumption is \$30.00 per thousand board feet, with an annual increase of 1.1 percent per year.

Table 25.—Financial yields of Norway spruce plantations grown for pulpwood to the financially optimum rotation age for public establishment costs under high- and low-stumpage value assumptions, by site-productivity class.

(In percent, compound interest)

| Source                                  | Investment       | High price <sup>1</sup>  |                           | Low price <sup>2</sup>   |                           |
|-----------------------------------------|------------------|--------------------------|---------------------------|--------------------------|---------------------------|
|                                         | Dollars per acre | Site I, 30-year rotation | Site II, 50-year rotation | Site I, 40-year rotation | Site II, 50-year rotation |
| PLANTING ONLY                           |                  |                          |                           |                          |                           |
| ACP-CFM:                                |                  |                          |                           |                          |                           |
| Public                                  | 34.43            | 9.0                      | 6.5                       | 7.8                      | 5.8                       |
| Private                                 | 4.28             | 17.1                     | 11.3                      | 14.1                     | 10.6                      |
| Total                                   | 38.71            | 8.6                      | 6.2                       | 7.4                      | 5.5                       |
| CFM:                                    |                  |                          |                           |                          |                           |
| Public                                  | 18.17            | 11.4                     | 7.9                       | 9.7                      | 7.2                       |
| Private                                 | 26.16            | 10.0                     | 7.1                       | 8.6                      | 6.4                       |
| Total                                   | 44.33            | 8.0                      | 5.9                       | 7.0                      | 5.2                       |
| PLANTING AND SITE PREPARATION           |                  |                          |                           |                          |                           |
| ACP-CFM:                                |                  |                          |                           |                          |                           |
| Public                                  | 49.34            | 7.7                      | 5.7                       | 6.7                      | 5.0                       |
| Private                                 | 6.31             | 15.6                     | 10.4                      | 12.9                     | 9.7                       |
| Total                                   | 55.65            | 7.2                      | 5.4                       | 6.4                      | 4.7                       |
| CFM:                                    |                  |                          |                           |                          |                           |
| Public                                  | 24.50            | 10.3                     | 7.2                       | 8.8                      | 6.5                       |
| Private                                 | 35.15            | 8.9                      | 6.4                       | 7.7                      | 5.7                       |
| Total                                   | 59.65            | 6.9                      | 5.2                       | 6.2                      | 4.5                       |
| PLANTING AND FENCING                    |                  |                          |                           |                          |                           |
| ACP-CFM:                                |                  |                          |                           |                          |                           |
| Public                                  | 44.43            | 8.0                      | 5.9                       | 7.0                      | 5.2                       |
| Private                                 | 5.08             | 16.2                     | 10.7                      | 13.4                     | 10.0                      |
| Total                                   | 49.51            | 7.7                      | 5.7                       | 6.7                      | 5.0                       |
| CFM:                                    |                  |                          |                           |                          |                           |
| Public                                  | 26.84            | 10.0                     | 7.1                       | 8.6                      | 6.4                       |
| Private                                 | 37.36            | 9.0                      | 6.4                       | 7.7                      | 5.7                       |
| Total                                   | 64.20            | 6.6                      | 5.0                       | 5.9                      | 4.3                       |
| PLANTING, SITE PREPARATION, AND FENCING |                  |                          |                           |                          |                           |
| ACP-CFM:                                |                  |                          |                           |                          |                           |
| Public                                  | 59.34            | 6.9                      | 5.2                       | 6.2                      | 4.5                       |
| Private                                 | 7.11             | 15.1                     | 10.1                      | 12.4                     | 9.4                       |
| Total                                   | 66.45            | 6.0                      | 5.0                       | 5.9                      | 4.3                       |
| CFM:                                    |                  |                          |                           |                          |                           |
| Public                                  | 33.17            | 9.1                      | 6.5                       | 7.8                      | 5.8                       |
| Private                                 | 46.35            | 8.0                      | 5.9                       | 6.9                      | 5.1                       |
| Total                                   | 79.52            | 5.9                      | 4.6                       | 5.4                      | 4.0                       |

<sup>1</sup>The high-stumpage value assumption is that the current market price is \$7.50 per cord and that it will increase at a rate of 1.1 percent per year over the length of the rotation.

<sup>2</sup>The low-stumpage price is \$5.50 per cord, with an annual increase of 1.1 percent.

**Table 26.—Financial yield to investments in cleaning and cull-tree removal in oak and northern hardwood stands, by site-productivity class**  
(In percent, compound interest)

| Investment         |                     | Site I | Site II | Site III |
|--------------------|---------------------|--------|---------|----------|
| Source             | Dollars<br>per acre |        |         |          |
| OAK STANDS         |                     |        |         |          |
| ACP-CFM:           |                     |        |         |          |
| Public             | 33.29               | 5.4    | 4.1     | 1.0      |
| Private            | 6.95                | 8.3    | 7.1     | 3.2      |
| Total              | 40.24               | 5.1    | 3.7     | 1.0      |
| ACP-CFM:           |                     |        |         |          |
| Public             | 12.94               | 7.2    | 5.9     | 1.6      |
| Private            | 25.00               | 6.0    | 4.7     | 1.0      |
| Total              | 37.94               | 5.2    | 3.9     | 1.0      |
| NORTHERN HARDWOODS |                     |        |         |          |
| ACP-CFM:           |                     |        |         |          |
| Public             | 33.29               | 7.3    | 6.3     | —        |
| Private            | 6.95                | 10.3   | 9.7     | —        |
| Total              | 40.24               | 7.0    | 5.9     | —        |
| CFM:               |                     |        |         |          |
| Public             | 12.94               | 9.2    | 8.4     | —        |
| Private            | 25.00               | 7.9    | 7.0     | —        |
| Total              | 37.94               | 6.7    | 6.1     | —        |

Table 27.—*Financial yield to investments in precommercial thinning in oak, northern hardwoods, and cove hardwood stands, by site-productivity class*

(In percent, compound interest)

| Investment         |                     | Site I | Site II | Site III |
|--------------------|---------------------|--------|---------|----------|
| Source             | Dollars<br>per acre |        |         |          |
| OAK STANDS         |                     |        |         |          |
| ACP-CFM:           |                     |        |         |          |
| Public             | 33.29               | 7.9    | 6.0     | 1.0      |
| Private            | 6.95                | 12.1   | 10.2    | 4.4      |
| Total              | 40.24               | 7.4    | 5.4     | 1.0      |
| CFM:               |                     |        |         |          |
| Public             | 12.94               | 10.4   | 1.0     | 2.7      |
| Private            | 25.00               | 8.6    | 11.8    | 1.0      |
| Total              | 37.94               | 7.5    | 5.6     | 1.0      |
| NORTHERN HARDWOODS |                     |        |         |          |
| ACP-CFM:           |                     |        |         |          |
| Public             | 33.29               | 11.1   | 10.2    | —        |
| Private            | 6.95                | 16.7   | 15.7    | —        |
| Total              | 40.24               | 10.5   | 9.5     | —        |
| CFM:               |                     |        |         |          |
| Public             | 12.94               | 14.5   | 13.5    | —        |
| Private            | 25.00               | 12.1   | 11.2    | —        |
| Total              | 37.94               | 10.7   | 9.7     | —        |
| COVE HARDWOODS     |                     |        |         |          |
| ACP-CFM:           |                     |        |         |          |
| Public             | 33.29               | 12.4   | 9.9     | —        |
| Private            | 6.95                | 18.0   | 15.5    | —        |
| Total              | 40.24               | 11.7   | 9.2     | —        |
| CFM:               |                     |        |         |          |
| Public             | 12.94               | 15.8   | 13.3    | —        |
| Private            | 25.00               | 13.4   | 10.9    | —        |
| Total              | 37.94               | 11.9   | 9.4     | —        |

Table 28.—Average public, private, and total costs for individual practice accomplishments under ACP-CFM and CFM  
(In dollars per acre)

| Practice                 | Public costs | Private costs | Total costs |
|--------------------------|--------------|---------------|-------------|
| ACP-CFM-SUPPORTED        |              |               |             |
| Planting practices:      |              |               |             |
| Planting                 | \$34.43      | \$ 4.28       | \$38.71     |
| Site preparation         | 14.91        | 2.03          | 16.94       |
| Fencing plantations      | 10.00        | .80           | 10.80       |
| Timber stand improvement | 33.29        | 6.95          | 40.24       |
| Pruning                  | 22.81        | 2.68          | 25.49       |
| Fencing natural stands   | 14.19        | .82           | 15.01       |
| Total ACP-CFM            | 29.81        | 4.49          | 34.30       |
| CFM-SUPPORTED            |              |               |             |
| Planting practices:      |              |               |             |
| Planting                 | 18.17        | 26.16         | 44.33       |
| Site preparation         | 6.33         | 8.99          | 15.32       |
| Fencing                  | 8.67         | 11.20         | 19.87       |
| Timber stand improvement | 12.94        | 25.00         | 37.94       |
| Fencing natural stands   | 13.63        | 3.59          | 17.22       |
| Total CFM                | 15.38        | 22.23         | 37.61       |
| Harvesting assistance    | 12.11        | —             | 12.11       |
| Total CFM                | 13.71        | 22.23         | 24.56       |
| Total ACP-CFM and CFM    | \$23.52      | \$ 8.72       | \$30.50     |

**Table 29.—Rates of interest calculated on total investments in  
ACP-CFM and CFM practices, by site-productivity class**  
(In percent, compound interest)

| Practice                 | Site I | Site II | Site III     |
|--------------------------|--------|---------|--------------|
| <b>ACP-CFM-SUPPORTED</b> |        |         |              |
| Planting: <sup>1</sup>   |        |         |              |
| White pine               | 7.9    | 6.8     | 3.8          |
| Red pine                 | 8.0    | 7.4     | 6.8          |
| Larch                    | 9.0    | 7.4     | 5.7          |
| Norway spruce            | 8.6    | 6.2     | <sup>2</sup> |
| Cleaning and liberation: |        |         |              |
| Oak                      | 5.1    | 3.7     | 1.0          |
| Northern hardwoods       | 7.0    | 5.9     | <sup>2</sup> |
| Thinning:                |        |         |              |
| Oak                      | 7.4    | 5.4     | 1.0          |
| Northern hardwoods       | 10.5   | 9.5     | <sup>2</sup> |
| Cove hardwoods           | 11.7   | 9.2     | <sup>2</sup> |
| <b>CFM-SUPPORTED</b>     |        |         |              |
| Planting: <sup>1</sup>   |        |         |              |
| White pine               | 7.6    | 6.5     | 3.6          |
| Red pine                 | 7.7    | 7.1     | 6.2          |
| Larch                    | 8.5    | 7.1     | 5.4          |
| Norway spruce            | 8.0    | 5.9     | <sup>2</sup> |
| Cleaning and liberation: |        |         |              |
| Oak                      | 5.2    | 3.9     | 1.0          |
| Northern hardwoods       | 6.7    | 6.1     | <sup>2</sup> |
| Thinning:                |        |         |              |
| Oak                      | 7.5    | 5.6     | 1.0          |
| Northern hardwoods       | 10.7   | 9.7     | <sup>2</sup> |
| Cove hardwoods           | 11.9   | 9.4     | <sup>2</sup> |

<sup>1</sup>Returns for planting are returns earned under the higher of the two stumpage price assumptions employed in the calculations.

<sup>2</sup>Physical yield data not available for site-productivity class III.



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