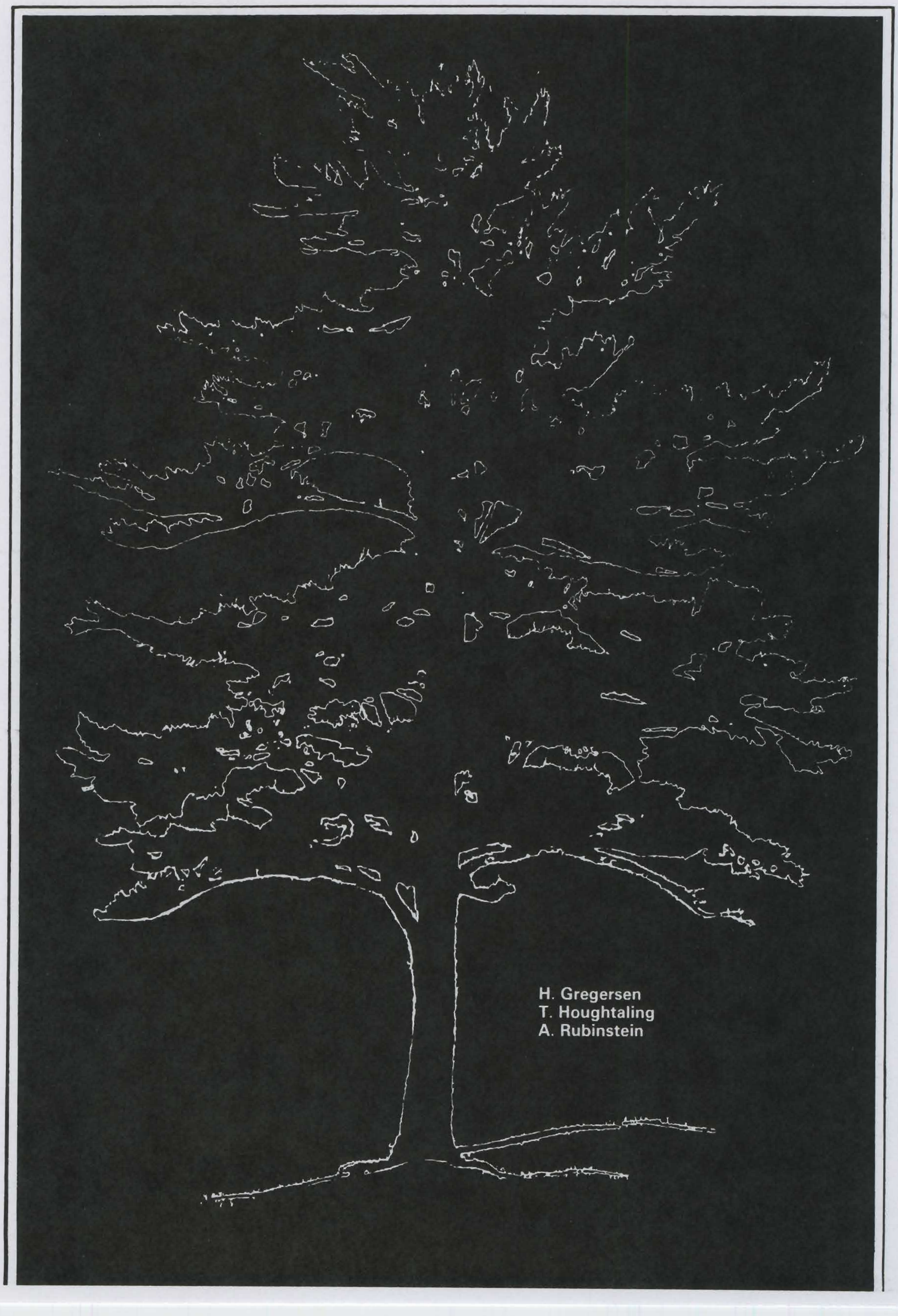
Technical Bulletin 315 — 1979
AGRICULTURAL EXPERIMENT STATION
UNIVERSITY OF MINNESOTA

Economics Of Public Forestry Incentive Programs: A Case Study Of Cost-Sharing In Minnesota



H. Gregersen
T. Houghtaling
A. Rubinstein

Preface

This report, using Minnesota as a case study, outlines the results of an economic analysis of REAP-A7 cost-sharing. The emphasis is on: A) development of a method to evaluate forestry incentive programs; B) *ex post* evaluation of the effectiveness and efficiency of a specific program; and C) discussion of application of the method and results in FIP and alternatives which need to be analyzed.

Authors:

H. Gregersen is a professor in the Department of Forest Resources, University of Minnesota; T. Houghtaling is a forest economist, Minnesota Power and Light Company; A. Rubinstein, a former University of Minnesota graduate student, is employed by Carton de Colombia, Cali, Colombia.

Contents

Chapter		Page
One	Introduction	4
	1.1 Study Objectives	4
	1.2 The NIPF Owner and Public Incentives	4
	1.3 Questions of Interest	5
	1.4 Organization of Study	5
Two	A Basic Model for Estimating Effectiveness and Efficiency of Subsidy Programs	6
	2.1 Landowner's Decision Framework	6
	2.2 Program Benefits	6
	2.3 Program Effectiveness (PE)	7
	2.4 Social Efficiency (SE)	7
	2.5 Criteria for Subsidy Allocation	7
	2.5.1 Unlimited Program Budget	8
	2.5.2 Limited Program Budget	8
	2.5.3 SE and PE Ratios for Participants Meeting Subsidy Allocation Criteria	8
Three	Results	8
	3.1 Data Sources	8
	3.2 Program Benefits, Program Expenditures and Program Effectiveness	9
	3.2.1 Program Benefits (B_p)	9
	3.2.2 Program Expenditures (X_p)	10
	3.2.3 Program Effectiveness	10
	3.3 Social Efficiency of the Program	10
	3.4 Applying the Criteria for Subsidy Allocation	11
Four	Sensitivity Analysis	12
	4.1 Effect of Rotation Length	13
	4.2 Designation of Tables and Figures	15
	4.2.1 Values for Program Benefits and Program Effectiveness (PE)	15
	4.2.2 Values for Social Efficiency (SE)	18
	4.2.3 Values for Participant Farms Meeting the Criteria for Subsidy Allocation Under an Unlimited Program Budget	18
	4.2.4 Number of Acres Meeting Subsidy Allocation Criteria Under a Limited Program Budget	18
	4.3 Results of Sensitivity Analysis	18
	4.3.1 Annual Stumpage Price Growth Rate (g)	18
	4.3.2 Annual Land Value Growth Rate	30
	4.3.3 Site Index	31
	4.3.4 1972 Base Period Stumpage Price	31
	4.3.5 Private Land Cost and Land Tax Cost	31
	4.3.6 Most Favorable-Least Favorable Assumptions	32
Five	Discussion of Results and Their Limitations	32
	5.1 Timber Availability	32
	5.2 Estimation of Program Benefit (B_p) Group and Possible Net Secondary Benefits	33
	5.3 Summary of Questions of Interest and Limitations of the Analysis	34
Six	Policy Implications and Applications	35
	6.1 Adaptation of the Criteria for Subsidy Allocation to FIP	35
	6.2 Comparing Alternative Means for Motivating Non-industrial Private Forest Land Owners	37
	6.2.1 Alternative Incentive Approaches	37
	6.2.2 Subsidized Loans Versus Direct Cost-Sharing	38
	6.2.3 Fiscal Incentives Versus Other Direct Incentives	39
	6.2.4 Combining Direct and Indirect Subsidies	40
	6.3 Characteristics of NIPF Lands and Their Owners; Implications for Future Timber Supplies	40
References Cited		42

List of Tables

Table		Page
2.1	Investment Conditions Determining Landowner Decision	7
3.1	Estimated Program Effectiveness (PE)	10
3.2	Estimated Social Efficiency (SE)	11
3.3	Performance Measures for Participants Meeting Criteria for Subsidy Allocation Under Unlimited Program Budget	12
3.4	Order of Funding Under a Limited Program Budget	12
4.1	List of Assumptions	13
4.2A	Distribution of Optimum Financial Rotations (number of farms)	16
4.2B	Distribution of Optimum Financial Rotations (number of acres)	16
4.3	Effect of the Discount Rate on Optimum Rotation and Present Value of Benefits per Acre	16
4.4	Program Benefits (B_p)	17
4.5	Program Effectiveness (PE)	18
4.6A-C	Social Efficiency (SE)	22
4.7A-C	Performance Measures for Participants Meeting Criteria for Subsidy Allocation Under Unlimited Program Budget	23
6.1	Principal Public Incentive Programs for Private Forestry in the United States	38

List of Figures

Figure		Page
4.1A-G	Rotation Groups 1-7	14-15
4.2	Number of Acres Associated with Program Benefits	17
4.3	Full Nine-Way Sensitivity of Program Effectiveness (PE) to Privately Assumed Annual Stumpage Price Growth Rate	17
4.4A	Estimated Sensitivity of PE to g_p	19
4.4B	Estimated Sensitivity of PE to g_L	19
4.4C	Estimated Sensitivity of PE to Site Index (30/3)	19
4.4D	Estimated Sensitivity of PE to Site Index (50/5)	19
4.4E	Estimated Sensitivity of PE to Private Land Cost	20
4.4F	Estimated Sensitivity of PE to "Most Favorable" and "Least Favorable" Private Assumptions	20
4.5A	Estimated Sensitivity of SE to g_p	20
4.5B	Estimated Sensitivity of SE to g_L	20
4.5C	Estimated Sensitivity of SE to Site Index (30/3)	21
4.5D	Estimated Sensitivity of SE to Site Index (50/5)	21
4.5E	Estimated Sensitivity of SE to Private Land Cost	21
4.5F	Estimated Sensitivity of SE to "Most Favorable" and "Least Favorable" Private Assumptions	21
4.6A-C	Number of Acres Meeting Subsidy Allocation Criteria Under an Unlimited Program Budget	24
4.7A-C	Program Expenditure for Farms Meeting Subsidy Allocation Criteria Under an Unlimited Program Budget	24-25
4.8A-C	Program Effectiveness (PE) for Farms Meeting Subsidy Allocation Criteria Under an Unlimited Program Budget	25-26
4.9A-C	Social Efficiency (SE) for Farms Meeting Subsidy Allocation Criteria Under an Unlimited Program Budget	26
4.10A-N	Number of Acres Meeting the Criteria for Subsidy Allocation Under a Limited Program Budget	27-30

Appendices

		Page
A.	REAP Objectives	44
B.	ASCS Form RE-245	46
C.	Questionnaire Sent to ASCS County Offices	47
D.	Landowner Questionnaire	49
E.	Site Index and Social Land Value Assumptions (by county)	55
F.	Red Pine Yield Table	55
G.	Classification of Farms According to Criteria for Subsidy Allocation	56
H.	Computer Program	57
I.	Investment Decision Framework	64

Economics Of Public Forestry Incentive Programs: A Case Study Of Cost-Sharing In Minnesota

CHAPTER ONE

Introduction

The United States has a variety of public programs for subsidizing forest management practices by non-industrial private forest (NIPF) owners.[1] Some of these "incentive" programs involve direct subsidization through cost-sharing between owner and government. Others involve indirect subsidies.

1.1 STUDY OBJECTIVES

The overall objectives of the University of Minnesota's forestry incentives research program are to: 1) analyze the extent to which public forestry subsidy or incentive programs for the private sector bring forth benefits which justify the expenditures of public funds; 2) suggest means for improving the present approaches (programs) to make them more effective and efficient; and 3) outline a general method for evaluating the effectiveness and efficiency of public forestry incentive programs.

Our initial approach to these objectives as reported here looks at the timber production objective of REAP-A7[2] cost-sharing in Minnesota in 1972 as a case study. Under the REAP program, about half a million dollars were given on a cost-sharing basis to Minnesota non-industrial private landowners in 1972 for the purpose of carrying out forestry and conservation related practices. Some of these funds were intended primarily as an incentive to induce private landowners to increase the timber production capacity of the state. Cost-share funds were given to individuals who, in theory at least, would not have carried out those forestry activities without the REAP support.[3]

REAP-A7 was the main program providing this type of cost-share subsidization up until the passage of the 1973 farm bill, which established the Rural Environmental Conservation Program (RECP).[4] The latter included a specific authorization of $25 million for cost-sharing (for timber production) under what is called the Forestry Incentives Program (FIP). This program has essentially substituted for the REAP program in terms of forestry incentives related to increasing timber supply.[5]

[1] These programs were the subject of the April, 1975, issue of the *Journal of Forestry.*
[2] Rural Environmental Assistance Program, practice A7 (see Appendix A).
[3] The subsidized applicant for REAP had to sign a statement saying that he would not have carried out the activities involved without the government funds (see Appendix B).
[4] 87 Stat. 221, 245; 16 U.S.C. 1509, 1510)
[5] See Mills, *et. al.,* (1973), and McGuire (1974), for background. The 1975-76 appropriation was $15 million.

A major question regarding the implementation of the FIP program concerns the distribution of funds: A) between states and B) within states to achieve the stated goals of the program. Since the FIP program is similar in intent and provisions to the REAP-A7 program, it is of interest to know how effective and efficient the REAP-A7 program was. Such an analysis can provide insights into the best approach for allocating and controlling use of funds under the FIP program. Thus, the present study specifically analyzes the timber production objective of the REAP-A7 program with the purpose of providing some guidance to operating agencies that have to develop the specific guidelines and criteria for allocation of funds to landowners under the FIP program. Hopefully, it also provides a framework and methodology for evaluating other incentive programs.

In this case we are interested in: 1) the "effectiveness" of REAP-A7 in terms of the extent to which **public** funds spent in the program achieved the objective of increasing timber production, and 2) "efficiency" in terms of additional social benefits resulting from the **total** expenditure associated with preparing and planting additional lands (*i.e.*, both public and private funds). It is a partial analysis in the sense that we do not consider non-timber aspects of the program.

1.2 THE NIPF OWNER AND PUBLIC INCENTIVES

With the passage of the 1973 farm bill, the U.S. Congress again reaffirmed its belief that there are **social** benefits associated with more intensive management and development of NIPF lands which justify public involvement and subsidization. Justification for public expenditures to increase wood supplies from NIPF lands is based on the assumptions that:

- The nation's demand for products and services from the forest cannot be met from public and industrial forest lands alone.
- NIPF owners, who own some 59 percent of the nation's total commercial forest land, could and should contribute to a much greater extent to the nation's wood needs.
- A forestry incentives program could effectively motivate and encourage the owners of NIPF lands to intensify protection, utilization, and development of their lands in order to increase their contribution to the U.S. timber supply.[6]

A great deal of forestry research in the past has focused on the "problem" of the non-industrial private woodland owner.[7] Many of the studies have dealt with the reasons why such owners have not responded adequately to the nation's timber

[6] In addition, such programs are often justified on the basis of desirability of redistributing income to and within rural areas and desirability of "good" forest management which considers environmental "needs."
[7] Zivnuska, 1974, provides a perspective on this "problem".

"needs." Most of these studies have found the following bottlenecks to be important: 1) lack of information and knowledge, 2) lack of motivation to invest because individual private time preferences or relevant discount rates are too high to make investment profitable in more intensive protection, management and development (*i.e.*, at prevailing rates, alternative uses of available funds are more attractive), and 3) lack of technical ability on the part of the landowners.[8] Incentive programs involving financial subsidies aim at overcoming the second of these bottlenecks or problems, while the technical advice associated with such subsidies aims at overcoming the first and third problems.

Public incentive programs such as REAP-A7 or FIP supposedly induce individuals (or firms) to carry out some action that is considered socially desirable. To the extent that the socially desirable action is the same as the action which is considered desirable from the private point of view, there is no need for incentive payments – the private individual, acting in his own self-interest, with market prices as the incentive, accomplishes the desired result. However, if there is a divergence between public and private costs and benefits, then it is argued that an incentive payment (subsidy) may change the private individual's actions and induce him to move toward a socially desirable result. Such an incentive payment should be just sufficient to accomplish the objective. If it is greater, then public funds will be inefficiently distributed. If it is less, then obviously the objective will not be accomplished and the program is ineffective.[9]

1.3 QUESTIONS OF INTEREST

Several questions arise in evaluating the effectiveness of the REAP-A7 program in terms of one of its stated major objectives: Did the participant really intend to plant for the purpose of timber supply in the future, or did he have some other objective (*e.g.,* to improve his land for recreation or future sale and investment purposes)? If he did intend to grow wood on his land for future timber supply, would he have done so with less incentive monies? If he had not intended to plant without receiving the A7 monies was it because the expected rate of return was too low (if he had to pay all costs), or was it because he lacked information on the returns he could have expected to receive?[10]

Several additional questions are raised by those who are particularly concerned with income distribution problems. Did the REAP-A7 money go to lower income persons or more to those who have the education and experience to know how and where to apply for them, but who have a lesser financial need? We do not get into this question in any depth here, since an incentive payment under REAP-A7 is meant to achieve certain production goals, and, in this context, it is valid to subsidize wealthy persons as well as poor persons as long as they would not have undertaken the desired forestry activities without the incentive payment.[11]

[8] See also Worrell (1970, Chapter 8).

[9] See President's Science Advisory Committee, 1967, Chapt. 9, "Production incentives for farmers."

[10] Related to the last two questions is a more fundamental question which we do not tackle here, but which is relevant. If prices for wood were allowed to increase, would timber growing have become profitable for the landowner even without the subsidy? What is the "right" price for stumpage?

[11] This point is emphasized in a number of writings. Cf. President's Science Advisory Committee, 1967.

We can summarize the major questions of interest in this study as follows:

1) To what extent were expected rates of return **without** the REAP support equal to or above the alternative rates of return of the NIPF owners who received support?

2) What was the effectiveness of the program? This is measured by the relationship between the total **public** expenditures and program benefits (*i.e.*, those benefits **due to** the program, or total benefits of all lands minus those which would likely have been forthcoming **without** the program).

3) What was the overall social efficiency of the program (*i.e.*, the relationship between program benefits and **total** costs associated with bringing forth those benefits)? Put in other terms, what is the likely overall productivity of the investments induced by the A7 monies, regardless of who pays and who benefits?

4) What economic and political criteria are relevant in determining who gets a subsidy and in determining the overall subsidy program budget? And, in addition, if the program budget is limited, how should the individual program investments be ranked in order to maximize the present value of net social benefits?

5) Finally, given answers to the above questions, what can we learn from the past approach to forestry incentives (REAP-A7), and what suggestions can we make with regard to how to improve forestry incentive programs and how to monitor the current forestry incentives program?

The empirical investigation is limited to REAP-A7 payments in 1972 for site preparation and/or planting of red pine (*Pinus resinosa*) in Minnesota for eventual timber production. However, the method of analysis should have widespread applicability, both in other areas and for other programs. With the Forestry Incentives Program funding debate continuing between Congress and the Office of Management and Budget, a good opportunity exists to expand the model further so it may contribute to setting up a system for: A) determining total public incentive funding, B) determining state or county allocations of these incentives funds, and C) monitoring the effectiveness of the program over time.

1.4 ORGANIZATION OF THE STUDY

The following is the approach taken in the present study. In Chapter 2 a general economic model is developed for evaluating effectiveness and efficiency of public forestry incentive programs and for allocating future subsidy program funds. In Chapter 3 the results of the empirical investigation of REAP-A7 in Minnesota are discussed. We analyze the benefits which can be attributed to the program, the costs of the program for the public sector and the recipients, and the effectiveness and efficiency of the program in terms of the model presented in Chapter 2. We also estimate the number of farms and acres which meet our criteria for allocating future subsidy funds both under a limited and unlimited subsidy budget. In Chapter 4 we develop an analysis of the sensitivity of the results to various alternative assumptions regarding values of inputs and outputs. This is a critical step because of the uncertain nature of many of the assumptions underlying the results in Chapter 3. In Chapter 5 we discuss the results of the empirical investigation and explore some of the reasons which can be suggested for the results obtained. Finally, in Chapter 6 we look at the policy implications of the results, discuss generalizations of the model and their limitations and the need for expanding the type of research reported. We also make some suggestions for future programs aimed at increasing the contribution of the non-industrial forest land owner to the nation's timber supply.

CHAPTER TWO

A Basic Economic Model For Estimating Effectiveness And Efficiency Of Subsidy Programs

In the present chapter a model is developed to help answer three basic questions:

1) What was the **effectiveness** of spending public funds through the REAP-A7 program in Minnesota in 1972? More specifically, what was the relationship between **public** expenditures in the program and expected benefits **due to** the program?

2) What was the overall (**social**) **efficiency** associated with the program; *i.e.*, the relation between expected program benefits and the total cost of bringing forth these benefits, regardless of who pays and who benefits?

3) What economic criteria are relevant in determining who gets a subsidy, and if the program budget is limited, how should the individual program investments be ranked in order to maximize the present value of net social benefits?

2.1 LANDOWNER'S DECISION FRAMEWORK

Let's first consider the profitability of program practices on participating lands from the private point of view without the subsidy.

In making a decision on what he should do with his land, the NIPF owner, acting as a rational investor,[1] considers the relationship between four different rates of return:[2]

r_L = rate of value increase in his land, if he does nothing with it.

r_I = rate of return on practice(s) being considered (*e.g.*, site preparation, planting) excluding the costs and returns of holding his land (r_L)

r_r = total rate of return, or the composite rate of return on holding the land **and** carrying out the practice(s)

r_a = alternative rate of return, which is equal to either: 1) the rate of return from other use of the land, if any, or 2) the rate of return which the owner could get by selling his land and investing the money received plus the money he would have had to put into the practice, or 3) the rate of interest he would have to pay to borrow money to buy land and/or carry out the practice, if such borrowing actually would have taken place (whichever of these is highest is r_a)

The landowner actually has two decisions to make (if he is acting as a rational investor). He has to decide whether or not to keep his land, and, if he decides to keep his land, whether or not he should invest in the practice in question (in this case site preparation and/or planting).

If he is looking at his land as an investment, then the logical decision would be that if $r_L \geqslant r_a$ he should keep his land as an investment. If $r_L < r_a$ the decision is not quite so simple. In such a case the landowner should sell his land if he cannot find a profitable use for it. However, if he could put his land to some profitable use (*i.e.*, a use that had a high enough return to make his **total** rate of return on the package, (r_r), greater than or equal to his r_a), it would be logical for him to keep his land and use it in whatever way would give him the highest r_r, (as long as that $r_r \geqslant r_a$).

In the case of practice I, the investment decision rule would be as follows: If $r_I < r_a$ he should not invest in I (regardless of the relationship between r_L and r_a). If $r_I \geqslant r_a$ he should invest in I, *if* $r_r \geqslant r_a$ also holds. If $r_I \geqslant r_a$ but r_r is less than r_a, his opportunity cost for holding the land is too high and he would be better off selling his land (or possibly putting it to some alternative use that has a greater expected return). Without his land he obviously cannot invest in I.

We can convert the above decision rule to the following: If both the net present worth associated with the practice (NPW_I) and the total net present worth (NPW_r) are greater than or equal to zero (when costs and returns are discounted to the present using r_a), he should invest in practice I. If NPW_I and/or NPW_r are less than zero, he should not do so.[3] Put in simpler terms, if NPW_I and/or NPW_r is (are) negative, we define the "investment deficit" (ID) as the **absolute** value of the more negative of the two. Obviously, if both NPW_I and NPW_r are greater than or equal to zero, ID equals zero. We can then say that if ID is greater than zero, the NIPF owner should not invest and if ID equals zero he should invest.

The landowner's decision as to whether or not he will carry out a given practice thus depends on his estimate of certain relationships between NPW_I, NPW_r and r_a and r_L as they are determined empirically or estimated by the landowner. The relevant relationships and the rational decisions for each are indicated in Table 2.1.

If, as in Table 2.1, we assume that the NIPF owner pays all costs, we could conclude that all those participants for whom ID = zero would invest in Practice I **without** the program subsidy (under the assumptions above), and all the others (falling in the bottom two rows of Table 2.1) with ID > 0 would **not** invest in the practice(s) without a subsidy at least equal to ID.

2.2 PROGRAM BENEFITS (B_p)

Now we can look at the approach to estimating program benefits for each participant (i).

[1] "Rational" here refers to the fact that the landowner looks at his land just like any other investment. If he derives consumption benefits from the land, a slight modification in the model is necessary. This can be done with no major changes.

[2] To simplify the model, the four rates of return listed here are assumed to be known with certainty by the investor. Furthermore, each rate is assumed to remain constant over the life of the investment (i.e., rotation period). These assumptions could be relaxed and the model would still be valid, but then additional complexity would be introduced.

[3] The following is given by definition: (i refers to a specific landowner)

if $r_{Ii} \geqslant r_{ai}$, then

$NPW_{Ii} \geqslant 0$, when r_{ai} is used to discount costs and benefits, and

if $r_{ri} \geqslant r_{ai}$, then

$NPW_{ri} \geqslant 0$, when r_{ai} is used to discount costs and benefits.

Table 2.1. Investment conditions determining appropriate landowner decision (landowner pays all costs).

Decision	Condition	ID
– Hold land and invest in I	NPW_r and $NPW_I \geqslant 0$ (or $r_r \geqslant r_a$ and $r_I \geqslant r_a$)	= 0
– Hold land, but do not invest in I	$r_L \geqslant r_a$ and $NPW_I < 0$	>0
– Sell land	$r_L < r_a$, $NPW_r < 0$	>0

Note: Appendix I presents a more detailed consideration of the relationships.

Let,

NPW_{Ii} = the net present worth (for each individual, i,) of the particular program practice (I), when costs and returns are discounted back to the present using r_{ai}

NPW_{ri} = the net present worth of the entire investment (a composite including land costs and returns). Costs and returns are discounted using r_{ai}

B_{di} = present value of expected timber benefits (discounting with r_{ai})

C_{wi} = present value of labor costs (discounting with r_{ai})

C_{li} = present value of land cost minus present value of expected resale value or value of property at the time of the final harvest (using r_{ai})

C_{ni} = present value of property taxes over rotation (using r_{ai})

C_{mi} = present value of primary costs other than C_w, C_1, C_n needed to bring forth B_d (using r_{ai})

r_{ai} = individual i's alternative rate of return, as defined earlier

r_s = social discount rate

B_p = present value of program benefits (using r_s)

ID = investment deficit as defined earlier

We determine the relevant net present worth for each participant as follows:

(I) $NPW_{Ii} = B_{di} - (C_{wi} + C_{mi})$

(II) $NPW_{ri} = B_{di} - (C_{wi} + C_{mi} + C_{li} + C_{ni})$

And we can then say from the previous discussion (and Table 2.1) that all those for whom **both** $NPW_{Ii} \geqslant 0$ and $NPW_{ri} \geqslant 0$ (or ID = 0) did **not** need the program subsidy.[4] The sum of total expected social benefits for those participants **not** fitting in this category, *i.e.*, those with ID > 0, discounted back to the present (with r_s), constitutes an approximation of the present social value of program benefits (B_p).

[4] However, technical assistance may have been needed. See Chapter 6.

2.3 PROGRAM EFFECTIVENESS (PE)

We can now look at the effectiveness of the program from the public point of view. Program effectiveness is defined as the ratio of program benefits to total program expenditures (*i.e.*, public expenditures):[5]

(III) $$PE = \frac{B_p}{X_p}$$

where

PE = program effectiveness ratio

B_p = present value of program benefits (discounting with r_s)

X_p = present value of program expenditures for all participants (discounting with r_s)

If the ratio is equal to or greater than one, the program has brought forth benefits equal to or greater than the program expenditures and the program is relatively effective. If PE is less than one, it is relatively ineffective – benefits brought forth by the expenditure of public funds are less than the public expenditures.

2.4 SOCIAL EFFICIENCY (SE)

In addition to program effectiveness, we are interested in the overall social efficiency (SE) of the practices involved in the program. This can be measured by the relationship between program benefits and **total** social costs for program participants with ID > 0:

(IV) $$SE = \frac{B_p}{C_t}$$

where

SE = social efficiency ratio

B_p = present value of program benefits (using r_s to discount benefits)

C_t = present value of **total** social costs for those properties which needed a subsidy, *i.e.*, the same properties included in B_p, above (using r_s to discount all costs)[6, 7]

If the SE ratio is less than one the total social costs were not justified in terms of timber production, accepting the assumptions and measures of values used. If the ratio is larger than one we can say that the investment was "relatively" efficient, although not necessarily justified in a broader social context.[8]

2.5 CRITERIA FOR SUBSIDY ALLOCATION

Both the PE and SE ratios are measures of past program

[5] It should be emphasized again that the REAP-A7 program had several objectives, although the major one stated is increased timber production. We only consider the timber production objective in this study.

[6] C_t includes the program administrative cost for participants with ID > 0 as well as for those with ID = 0, since they are costs of the program.

[7] The social costs for these properties which didn't need a subsidy (where ID=0) are not costs associated with bringing forth program benefits. Those costs would have been incurred without the program.

[8] This means "relative" in the sense that while social benefits from timber production are expected to exceed social costs, we have no way of comparing the net social benefits with those which could have been obtained from putting the funds expended into some alternative activity or program.

performance. Another item of interest here relates to future program allocations of subsidy payments. It is important to know *ex ante* which participant properties should receive subsidies. And under conditions of a limited program budget, it is necessary to rank participant properties in a "funding order" which maximizes the net present social worth (NPW_s) of the program.[9]

2.5.1 UNLIMITED PROGRAM BUDGET[10]

The first step in determining which properties should receive a subsidy is to calculate the net present social worth (NPW_s, as defined in footnote 9, below) for each property. The second step is to classify the properties into two groups, those for which $NPW_s \geqslant 0$ and those for which $NPW_s < 0$. Only the first group provides socially efficient opportunities for public investment in NIPF timber production, *i.e.*, where the expected rates of return on timber production are greater than or equal to r_s. Properties for which $NPW_s < 0$ should **not** receive a subsidy since they represent socially inefficient investments.

Third, for those properties identified as having $NPW_s \geqslant 0$, the amount of subsidy needed to make the investment of interest to each landowner can be determined. Such a subsidy must be sufficient to make both $NPW_l \geqslant 0$ and $NPW_r \geqslant 0$ (or ID=0) when the landowner's alternative rate of return (R_{ai}) is used to discount **his** costs and benefits. The minimum subsidy required to make the investment of interest to the landowner (*i.e.*, make the investment "privately profitable") equals ID[11]. Therefore, the owner of property for which ID=0 should **not** receive a subsidy since he requires no subsidy. He would undertake the investment in the absence of a subsidy program.

These criteria can be summarized as follows: a subsidy equal to ID should be granted only to the owners of properties for which $NPW_s \geqslant 0$ and $ID > 0$. In other words, only properties representing a "socially profitable," but "privately unprofitable" investment should be subsidized, and that subsidy should be the minimum amount necessary to induce the investment.

2.5.2 LIMITED PROGRAM BUDGET

Under an unlimited program budget all properties meeting the two subsidy criteria, $NPW_s \geqslant 0$ and $ID > 0$, would be subsidized. However, it is very often the case that a maximum limit is set on a public program's budget, which in the case of a forestry incentives program could lead to a situation where all of the properties meeting the above two criteria could not be funded. It is necessary, then, to develop a ranking system for properties which maximizes NPW_s for any level of public budget.

The objective of such a ranking system is to maximize NPW_s per dollar of program budget. If, as in the case of the Forestry Incentives Program (FIP), the budget is authorized primarily for subsidy payments (not for administrative or other costs, which are funded by various federal and state agencies), then each property could be ranked according to the ratio of NPW_s to ID. Since each ID represents the potential portion of the program budget spent for a particular property, NPW_s/ID represents the social return per program dollar spent for that property. A limited program budget should then be allocated to the properties with the highest NPW_s/ID ratios, thereby maximizing the total NPW_s for the limited program budget.

2.5.3 SE AND PE RATIOS FOR PARTICIPANTS MEETING SUBSIDY ALLOCATION CRITERIA

The SE for the participating farms meeting the subsidy allocation criteria can be calculated by dividing the present value of total benefits for the individuals for whom $NPW_s \geqslant 0$ and $ID > 0$, by the present value of total social costs. (At the margin, *i.e.*, for the last individual for whom a subsidy is justified, $NPW_s = 0$ and the benefit to cost ratio for that individual is therefore one.) Similarly, the PE ratio can be calculated for those meeting the subsidy allocation criteria.[12] These SE and PE ratios can be compared with the actual PE and SE of a subsidy program to gain some insight into the potentials for improving efficiency and effectiveness of the program in question.

CHAPTER THREE

Results

Under practice A7 of the REAP program, $73,500 of public funds were spent[1] in Minnesota in 1972 to provide incentives for owners of 399 NIPF properties to prepare land for and/or plant red pine (*Pinus resinosa*) for future timber production.[2] The model developed in Chapter 2 is applied to this particular part of the REAP program as a case study.

The following four sections discuss the results. First, a brief description of the data sources and assumptions is presented. Second, program benefits, program costs, and the effectiveness of the program (PE) are analyzed. Third, taking a broader look at the benefits and costs associated with the program, an estimate of the social efficiency (SE) of the program is developed. Finally, the criteria for subsidy allocation are applied to determine which properties should have received subsidies and how those properties should have been ranked for funding purposes.

3.1 DATA SOURCES

Four main sources were used in generating the data used in the analysis. These were:

1) ASCS **Form RE 245** (ACP 245) for all 399 recipients of

---

[9] NPW_s for each program participant is calculated as follows: discount all project benefits for the participant back to the present using r_s as the relevant discount rate. Do the same for all costs (including the opportunity cost for land). The difference between the discounted benefits and costs is NPW_s.

[10] An unlimited program budget means that sufficient program funds are available to subsidize all of the participant properties which meet the criteria for subsidy allocation (developed here).

[11] It should be noted that once given a subsidy equal to ID, one or the other of NPW_i or NPW_r will always be just equal to zero.

[12] The PE ratio for farms meeting the subsidy allocation criteria is calculated by dividing the present value of total benefits for those farms having $NPW_s \geqslant 0$ and $ID > 0$ by the total program expenditure if only those farms were funded (which equals the total ID for those farms plus the program administrative cost).

[1] $67,114 was the direct cost-share subsidy and the remainder, $6,386, represented the estimated direct administrative costs associated with processing applications and approving the cost-sharing.

[2] Actually there were 409 recipient lands, but 10 landowners received funds for two farms each.

1972 REAP-A7 red pine cost share funds in Minnesota. These forms, maintained by county ASCS offices, give location of property, planting practice used, species planted, amount of acreage involved in planting and site preparation, and amount of cost sharing.[3]

2) Results from a questionnaire sent to all county ASCS offices in Minnesota. This questionnaire provides information on costs of seedlings, site preparation and planting costs, administrative costs, etc.[4]

3) Results from a questionnaire sent to all 399 recipients of 1972 REAP-A7 cost share funds in Minnesota for planting red pine.[5] Since 20 of the 399 recipients were county governments, schools, clubs, and other institutions, they were excluded from the analysis. Returns from 277 of the 379 individual recipients (hereafter called program participants) were obtained after two mailings. About 62 percent of the questionnaires were returned after the first mailing and an additional 11 percent were returned after the second mailing, giving a 73 percent total response.

4) Secondary sources giving information on expected yields, stumpage prices, land values, costs, etc. These sources are referenced as they are used.

The final group of respondents used in the analysis of program benefits, program effectiveness, social efficiency, and the values for farms meeting the subsidy allocation criteria, includes those 159 participants who gave complete answers to questions 12, 16 and 19 on the landowner questionnaire, which were necessary to carry out the analysis. Thus the sample used represents 42 percent of the total population.

3.2 PROGRAM BENEFITS, PROGRAM EXPENDITURES, AND PROGRAM EFFECTIVENESS

The measure of program effectiveness (PE) used in this study is the relationship between the present value of program benefits (B_p) and **public** dollars spent in the program (X_p), both as defined in Chapter Two.

The program effectiveness measure indicates the extent to which public funds (direct subsidy expenditures and administrative costs) are expected to accomplish the objective of increased timber production. In the case of REAP-A7, an ostensible major objective is increased timber production **over and above what would have been forthcoming without the program expenditure.** The first task is thus to estimate expected benefits which can be **directly** associated with the program.

3.2.1 PROGRAM BENEFITS (B_p)

The assumptions regarding private costs and returns used in this analysis are as follows:

Site. It was assumed that each property had a site index equal to an estimated average for the county in which the property is located (see Appendix E). Either a site index of 40 or 60 was assumed (50-year basis). This generalizing was necessary due to the difficulty of estimating site index for specific lands and the lack of adequate data in Minnesota.

Expected yields. Yields were estimated by counties based on unpublished data from the U.S. Forest Service, North Central Forest Experiment Station (see Appendix F). The assumption was that each individual would use that rotation which maximized his NPW_I.[6] This in turn determined the expected physical yields from his property and the timing of such yields.

Alternative rate of return. (r_a) This was determined for each participant based on his response to question 16 in the landowner questionnaire. (See Appendix D for questionnaire). The range was between 4 percent and 20 percent (29 percent of respondents had r_a's of 10 percent and above, 23 percent said between 8 and 9 percent, 20 percent said 7 percent, and 28 percent had values between 4 and 6 percent).

In our judgment these rates reflect the general pre-tax **market** rates of return available on alternative investments at the time the questionnaire was circulated, and thus they include a built-in allowance for inflation.[7] Our best estimate of the long-run average inflation rate (assumed by the investor) in the fall of 1972 was 3 percent. (See Chapter 4 for the effects when other inflation rates are assumed).

Instead of working with real rates of interest and real or constant prices, we elected to use estimates of current price and current rates of interest (*i.e.,* including inflation). Since we only present our data in present value terms (1972 dollars), it makes no difference in our results if we use current or constant dollars, as long as there is consistency.[8]

Expected stumpage prices. Estimated average 1972 stumpage prices used are $30/MBF and $3.00/cord.[9] We assumed that 1972 prices increased at a rate of 5 percent annually (on a compound basis) until harvest. (This includes a long-term inflation factor of 3 percent and a real price increase of about 2 percent per year.)

Present values of stumpage receipts (B_{di} in equation I and II, Chapter 2). These were estimated by multiplying the relevant price assumption times estimated yields and then discounting these values back to the present using the participants alternative rate of return (r_a).

Private land cost. (C_l) Each individual may or may not perceive a real cost associated with use of his land for timber production as compared with other uses. There would be a real cost involved if he could (and would) sell his land (assuming that he could **not** earn his alternative rate of return by holding his land and doing nothing with it), or if he could (and would) produce something else on it if he did not use it for timber production. Others would have no other use for their land, but would not have sold it even if they did not plant. In this case the perceived land cost to them is zero and land would not enter into their decision regarding investment in the practice. Since we did not have usable information for classifying particpants in terms of their actual perception of

[3] A sample of form RE 245 is reproduced as Appendix B.

[4] A copy of this questionnaire is included as Appendix C.

[5] A copy of the landowner questionnaire is included in Appendix D, together with a summary of responses to each question.

[6] Optimum financial rotation is defined here as that rotation which will maximize NPW_I, using costs and returns relevant to the individual (including his estimated alternative rate of return for discounting costs and expected returns).

[7] Using pre-tax rates of return allowed the authors to avoid introducing income tax costs into the calculations of NPW_I and NPW_r. Such income tax costs would have been nearly impossible to determine accurately.

[8] See H.M. Gregersen "Effect of Inflation on Evaluation of Forestry Investments". Journal of Forestry, vol. 73, no. 9, 1975.

[9] From figures provided by the Department of Iron Range Resources and Rehabilitation for 1972 for red pine.

land cost, we used an average land cost for each participant equal to one-half his estimated land value as given on the questionnaire minus one-half the present value of the estimated resale value at rotation. This was based on the assumption that the bare land market value would increase by five percent per year in current dollars, regardless of whether or not the participant planted (*i.e.*, if he held onto his land without doing anything with it the average increase in land value would still be around two percent per year in real terms). This increase in land value shows up in the residual land value at the end of the rotation and includes inflation.[10]

Hand planting cost. About 75 percent of participants indicated that they or their families did the planting, and it is unlikely that all or even a majority of these participants considered their own labor as a cost in their investment decision. Further, it is doubtful whether much of this labor has any opportunity cost (for the time spent planting). Consequently, instead of using the market wage rate in estimating total costs, we used a wage rate of zero for family planting and full estimated wage rates for contracted labor ($36.50/1,000 trees).

Machine planting costs. This was assumed to be $30 per 1,000 trees planted, based on information from county ASCS offices.

Private seedling costs. These were assumed to be $15 per 1,000 seedlings, plus $15 per property for transportation (regardless of the number of seedlings).

Site preparation cost. This was assumed to be zero when no subsidy was approved for this practice. When a subsidy was approved, it was supposed to be equal to 80 percent of actual cost. Therefore, the full cost of site preparation was assumed to be 1.25 times the subsidy for site preparation. No weeding or brush clearing/spraying costs were assumed after planting.

Land tax cost. (C_n) This was assumed to be one-half of the actual tax, where actual annual tax was the 1972 tax per acre reported on the landowner questionnaire, compounded at 5 percent over the rotation.[11]

In addition, it was assumed that there was negligible uncertainty and risk associated with the investments and that all available timber will be sold at each calculated thinning and final harvest.

Using these assumptions and equations I and II from Chapter Two, we estimated NPW_I and NPW_r for each of the 159 participating farms in the study. There were 94 participating farms having NPW_I and/or $NPW_r \leqslant 0$, (or $ID > 0$) using our assumptions with regard to private costs and returns. (See column 1, Table 3.1). As defined in the model, B_p is the sum of the present values of expected future gross stumpage returns for those participating properties for which NPW_i and/or NPW_r is(are) less than zero, or $ID > 0$. An r_s of 6 and 7/8 percent was used to discount the benefits back to the present.[12] For the other participants (those with ID=0), it was assumed that the investment would have been undertaken without direct subsidy. Thus their returns cannot properly be attributed to the program under the "with and without" rule.

Using this approach, our approximation of program benefits (B_p) was $64,483 for the 159 participating properties used in the analysis.

Table 3.1. Estimated program effectiveness.

(1) Number of farms in program benefit group	(2) Number of acres in program benefit group	(3) B_p ($)	(4) X_p ($)	(5) PE
94	445	64,483	29,300	2.20

3.2.2 PROGRAM EXPENDITURES

Program expenditures are defined here as the total amount of cost-share funds (subsidy) given to all 159 participants in the sample plus the associated direct administrative costs for processing and checking their applications. We could obtain no firm data for administrative costs, but estimated them to be $2,544, or $16 per participating farm, including field checking and processing and approval work in the ASCS office. This is probably conservative.[13] The subsidy expenditure was $26,756 and the total X_p was about $29,300.

3.2.3 PROGRAM EFFECTIVENESS (PE)

We can now answer the question posed earlier: "What was the effectiveness of the program in terms of the expected value of future timber benefits actually due to the program expenditure?"

PE was defined as the ratio of B_p to X_p. Using X_p as estimated earlier and the approximation of B_p shown in Table 3.1, column 3, the ratio was 2.20. Since the ratio is greater than one, it appears on the surface that the program was effective, accepting our assumptions. However, the only thing the ratio suggests is that more dollars are returned to society than are spent by the **public** sector in that program. The ratio implies nothing about relative efficiency, since private costs are not taken into account. (Further sensitivity analysis of the various assumptions used is presented in Chapter 4.)

3.3 SOCIAL EFFICIENCY OF THE PROGRAM

The next question of interest concerns the efficiency of the program from the social point of view, *i.e.*, the relationship between program benefits and the **total** costs which were needed to bring forth the benefits on these properties. We defined SE earlier as the ratio of the present value of program benefits (B_p) to the present value of the total costs (C_t) for those properties, which includes the $16 per farm administrative cost for all 159 properties (see Section 2.4 in Chapter 2).

The present value of program benefits is as calculated for PE (B_p = $64,483).[14] Total costs, on the other hand, are equal

[10] See Mandale and Raup (1973, 1974) regarding rural land value increases in Minnesota.

[11] One-half was used to be consistent with land value assumption.

[12] 6 and 7/8 percent is the rate suggested for public water and related land resource programs in the Water Resources Council's guidelines (see Water Resources Council, 1973). The rate is tied to the current cost of federal borrowing, i.e., it includes a built-in allowance for inflation. Other rates are used in the sensitivity analysis presented in Chapter 4.

[13] Manthy (1970) found that the cost was about $11 per acre. The cost we assumed was $4 per acre on the average.

[14] B_p is equal to the sum of the present values of expected stumpage returns for all participant properties having $ID \geqslant 0$, using 6 7/8 percent (r_s) for obtaining present values.

to the sum of present values of the total social costs for those same properties, properties where ID ⩾ 0.

Social land cost was assumed equal to one-half of the average county agricultural land value in 1972 as estimated by Mandale and Raup.[15] No residual value was assumed since we use the social land value as an estimate of the present value of the opportunity costs of putting the land under trees. The values used are shown in Appendix E. Taxes were not included since they are a transfer payment (private cost equals public benefit). Seedling cost is also subsidized (in addition to the REAP subsidy), so we adjusted the cost to $40 per 1,000 seedlings, to reflect the actual cost of production in the state nurseries. Other costs were assumed the same as in the private investment analysis.

The resulting estimate of C_t is $65,059. Dividing B_p by C_t we arrive at an SE of 0.99 as indicated in Table 3.2. (In Chapter 4 the sensitivity of SE to the various cost and benefit assumptions is discussed.) The resulting estimate of SE can appropriately be considered as a type of average social benefit-cost ratio for the program activities being studied. This ratio is slightly below one and provides a useful initial measure of average social efficiency, or the social returns per dollar spent on the lands associated with the program. However, this measure indicates nothing about **marginal** social efficiency. It is likely that many individual farms in the "B_p group" were socially efficient ($B_{pi} \geqslant C_{ti}$) and many socially inefficient ($B_{pi} < C_{ti}$).[16]

Table 3.2. Estimated social efficiency.

(1) B_p ($)	(2) C_T ($)	(3) SE
64,483	65,059	0.99

3.4 APPLYING THE CRITERIA FOR SUBSIDY ALLOCATION

The model in Chapter 2 includes an *ex ante* approach to estimate which properties should be subsidized and how such properties should be ranked if the program budget is limited. Briefly, the approach is as follows:

A) Determine the economic productivity of participating lands, using **social** values of inputs and outputs, *i.e.*, estimate NPW_s using the privately determined rotation.

B) For those lands which are socially productive (*i.e.*, for which $NPW_s > 0$) determine the subsidies needed to induce investment by the owner of the land in the practice being studied. The amount needed will depend on the individual's alternative rate of return and his perception of costs and expected returns involved. (It is equal to ID in the terminology of this analysis.)

C) If the program budget is not limited, select those properties for which both $NPW_s > 0$ and ID > 0, and grant a subsidy equal to ID to each. If the program budget is limited, rank these properties by the ratio of NPW_s to ID and subsidize the properties with the highest ratios until the budget is used up.

In the following paragraphs these subsidy allocation criteria are applied to the 1972 REAP-A7 properties analyzed in this study. In that respect this is an *ex post* analysis using *ex ante* criteria. However, it is useful to compare the effectiveness and efficiency of the actual program with what would have been the effectiveness and efficiency if the above criteria had been applied. Of course, to have applied these criteria would have required a substantial amount of data which was not available to program administrators. We fully recognize that limitation (see Chapter 6, Section 6.1 for a discussion of the adaptation of the criteria for subsidy allocation to FIP).

Using these criteria, the number of participants and the number of acres are determined for both the unlimited budget case and the case where the program budget is smaller than the cumulative ID for those participants having $NPW_s \geqslant 0$ and ID > 0 (limited budget case). In addition, PE and SE ratios are computed for the program under the unlimited budget assumption.[17]

For each of the 159 participating properties we determined the net present social worth (NPW_s) using: A) yields and rotations as determined by the financial analysis for the individual participants; B) an r_s of 6 7/8 percent; and C) our best estimates of social values of inputs and outputs, which were the same estimates used in the calculation of SE in the previous section.

An approximation of the acreage to be funded under an unlimited program budget is developed as follows:

	Acres	Farms
Total (receiving subsidies under REAP-A7)	773	(159)
First elimination ($NPW_s < 0$)	-318	(-75)
Socially "profitable" acres ($NPW_s \geqslant 0$)	455	(84)
Second elimination (ID=0)	-315	(-60)
Socially "profitable" and privately unprofitable acres	140	(24)
(Properties to be funded under unlimited program budget)		

Based on the costs and returns for the above "fundable" properties, we calculated the associated PE and SE for those program participants. As indicated in Table 3.3, the PE and SE ratios were quite large — considerably larger than the ratios for the actual program (although they are not directly comparable). On the other hand, the qualifying acreage and number of properties are quite small.

It should be stressed that the subsidy level calculated here collectively maximizes total NPW_s for all program participants, not SE. There would likely be a different level of subsidization (less than that calculated here) which would maximize SE. However, since we are attempting to determine the appropriate scale of a subsidy program, the relevant criterion is maximum present value of net benefits (NPW_s).

Under a limited program budget properties are ranked

[15] Mandale and Raup (1973). We could obtain no adequate estimates of the opportunity cost of Minnesota forest land.

[16] By definition those properties used to measure SE (the "B_p group") are privately unprofitable (ID > 0). Most factors which lead to private unprofitability (such as poor site, high site preparation and planting costs, etc.) also lead to **social** unprofitability ($NPW_s < 0$). Therefore, it is not surprising that SE is less than one.

[17] PE and SE ratios could also be computed for any level of a limited budget, but we chose not to do so here.

Table 3.3. Performance measures for participants meeting criteria for subsidy allocation under unlimited program budget.

(1) Number of farms	(2) Number of acres	(3) Total ID ($)	(4) Administrative cost ($)	(5) Program expenditures (3) + (4)	(6) Social benefits ($)	(7) Social costs ($)	(8) PE (6) ÷ (5)	(9) SE (6) ÷ (7)
24	140	9,524	384	9,908	97,424	15,658	9.83	6.22

Note: Terms defined as follows:
B_p – program benefits
C_T – total costs for "B_p group"
ID – investment deficit
PE – program effectiveness ratio
SE – social efficiency ratio
X_p – program expenditures

Table 3.4. Order of funding under a limited program budget (6.875% social discount rate).

Number of Participants	NPW_s:ID Ratio	Acres	Cumulative Acres	ID	Cumulative ID
1	1,508.003	30.	30.	4.44	4.44
2	41.721	11.	41.	58.41	62.85
3	14.552	10.	51.	152.04	214.90
4	12.300	5.	56.	78.93	293.82
5	9.960	13.	69.	241.99	535.81
6	5.795	7.	76.	230.92	766.73
7	4.854	5.	81.	266.32	1,033.05
8	4.651	1.	82.	35.88	1,068.92
9	4.229	1.	83.	59.68	1,128.60
10	3.691	1.	84.	53.33	1,181.93
11	3.529	5.	89.	391.14	1,573.07
12	2.254	5.	94.	657.77	2,230.84
13	2.099	1.	95.	78.41	2,309.25
14	1.912	23.	118.	3,557.31	5,866.56
15	1.553	6.	124.	1,007.42	6,873.98
16	1.264	3.	127.	161.08	7,035.06
17	1.220	2.	129.	272.34	7,307.40
18	0.997	3.	132.	686.98	7,994.38
19	0.855	1.	133.	141.59	8,135.96
20	0.595	2.	135.	173.58	8,309.55
21	0.575	1.	136.	439.14	8,748.69
22	0.543	2.	138.	492.22	9,240.90
23	0.476	1.	139.	81.16	9,322.07
24	0.006	1.	140	201.94	9,524.00

An evaluation of the results of the analyses shown in this chapter and their implications is presented at some length in Chapters 5 and 6, after we present in Chapter 4 an analysis of the sensitivity of PE, SE, and the farms meeting the criteria for subsidy allocation to variations in assumptions.

according to their NPW_s:ID ratios. The ratios for the 24 properties meeting the criteria for subsidy allocation under an **unlimited** budget are shown in Table 3.4. They range from a high of 1,508 to a low of nearly zero. If the program budget limit had been $5,000, the first 13 properties would have been fully funded, and the 14th property would have been funded for 17.4 acres [(5,000-2,309.25) x 23/3,557.31)], which would have completely exhausted the budget. A graphic presentation of these rankings is present in Figure 4.10A (see Chapter 4, Section 4.2.4 for an explanation of this figure).

CHAPTER FOUR

Sensitivity Analysis

The set of assumptions presented in Chapter 3 is a plausible description of economic conditions and the characteristics and values of recipient landowners in 1972.[1] However, realizing that some readers may believe that different sets of assumptions are equally or more valid, and wanting to show the sensitivity of our results to various assumptions regarding inputs, we have analyzed 13 additional assumption sets (hereafter called only assumptions).

Table 4.1 lists the mix of values of the variables for each of the 14 assumptions. Assumption 1 is the identical set presented in Chapter 3. In the 11 succeeding assumptions the following parameters were individually varied:

1. **Private annual stumpage price growth** was altered from 5 percent to 4 percent and 6 percent in Assumptions 2 and 3, respectively.
2. **Annual land value growth** was changed from 5 percent to 2 percent and 8 percent in Assumptions 4 and 5, respectively. As in Assumption 1, land value

[1] See Section 3.2.1 of Chapter 3 for the basic "most likely" set of assumptions.

Table 4.1. List of assumptions.

Assumption	Land cost factor	Site index	1972 stumpage price	Private annual stumpage price growth rate (%)	Private annual land value growth rate (%)	Annual property tax growth rate (%)
1	.5	regular	30/3	5	5	5
2	.5	regular	30/3	4	5	5
3	.5	regular	30/3	6	5	5
4	.5	regular	30/3	5	2	5
5	.5	regular	30/3	5	8	5
6	.5	high	30/3	5	5	5
7	.5	low	30/3	5	5	5
8	.5	regular	50/5	5	5	5
9	.5	high	50/5	5	5	5
10	.5	low	50/5	5	5	5
11	0.0	regular	30/3	5	—	—
12	1.0	regular	30/3	5	5	5
13	0.0	high	50/5	6	—	—
14	1.0	low	30/3	4	2	5

growth was used only in private benefit and cost calculations, not in social analysis.[2]

3. **Site index** was raised to high site (all site index 60) and lowered to low site (all site index 40) in Assumptions 6 and 7, respectively.
4. **1972 stumpage price** was raised from $30 per MBF and $3 per cord to $50 per MBF and $5 per cord in Assumptions 8, 9, and 10. This base period stumpage price change was applied to all three site index variations, resulting in three different assumptions for this one price change.
5. **Land cost and land tax cost** were lowered from one-half (.5) to zero (0.0) and raised to full (1.0) in Assumptions 11 and 12, respectively. The land cost changes were applied to both the differing private and social analyses in the same manner as the one-half land cost was applied to Assumption 1. Tax cost was only applied to the private analysis, as was explained in Chapter 3.

The remaining two assumptions, 13 and 14, incorporate the two extremes of the variations in the previous 12 assumptions. Assumption 13 is the "most favorable" assumption from the private investment point of view since benefits are maximized and costs are minimized by the mix of values of the variables comprising the assumption. Likewise, Assumption 14 is the "least favorable" assumption from the private investment point of view since costs are maximized and benefits are minimized.

In all cases the results are tested for sensitivity to three levels of the social discount rate (5 percent, 6 and 7/8 percent and 8 percent) for each of the 14 assumptions. Thus, the results are tabulated for all three social rates of discount.

4.1 EFFECT OF ROTATION LENGTH

In the sensitivity analysis we alter the values of two variables which affect the optimum financial rotation length; the private annual stumpage price growth rate (g_p) and site.[3]

Both of these variables exert a direct influence upon the present value and current values of program benefits. In addition they have an indirect influence on the present value of those benefits by their effect on the rotation. All other things being equal, a higher site or a higher g_p lengthens the rotation. In the case of site index this is because higher sites of red pine remain productive longer and at much higher volumes than do lower sites. Higher values for g_p lengthen the rotation because stumpage prices become relatively much higher in the future compared to the present.

In addition to the two variables affecting the optimum financial rotation, three factors assumed fixed in our analysis also affect rotation. These are site yields, the predetermined timing of thinnings and potential harvests, and the private discount rate, r_a.

Seven rotation groups emerge from the seven g_p and site combinations used in the 14 assumptions. Figures 4.1A-4.1G (Tables 4.2A and 4.2B) show the breakdown by years and site for each of the seven rotation groups and identify the assumption number(s) corresponding to each group. For any given g_p and site, the higher r_a becomes, the shorter the rotation becomes. Therefore, within each of the rotation groups the different individual rotation lengths per site are determined **solely** by r_a, the participant's alternative rate of return. The longer rotations per site in each group correspond to r_a's of 5 percent and 6 percent, while the shorter rotations correspond to r_a's of 10 percent or greater. At some level of r_a a point is reached where no shorter rotation exists within the confines of the established yield table. For site 60 this is 30 years, and for site 40 it is 40 years. This is the "get out point" for the investor who demands a relatively high rate of return on investment, as measured solely by timber benefits. At that "get out point" losses have been minimized, but indeed losses have occurred.[4] In fact, within a particular rotation group most of the private investment losses occurred on the shorter rotation properties. The cause of these losses was r_a and the effect was a short rotation, *i.e.,* getting out."[5] To further illustrate the effect of r_a, Table 4.3 lists a set of

[2] See Section 3.2.1 and 3.3 of Chapter 3 for an explanation of land cost treatments in private and social analyses.

[3] See footnote 1 of Section 3.2.1 of Chapter 3 for a definition of optimum financial rotation.

[4] Losses in this context mean that ID>0, using only timber values as benefits.

[5] Obviously serious investors don't invest with the intention of incurring losses. This seemingly inconsistent behavior could be explained by expected net secondary (non-timber) benefits. See Chapter 5 for a discussion of secondary benefits.

Figure 4.1A. Rotation group 1.
(g_p = 4%, low site)
(Corresponding to assumption 14)

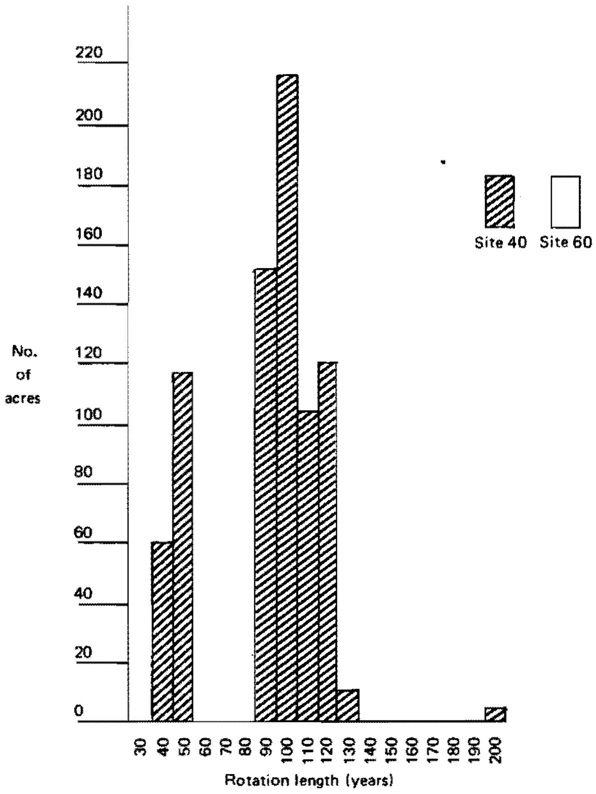


Figure 4.1B. Rotation group 2.
(g_p = 4%, regular site)
(Corresponding to assumption 2)

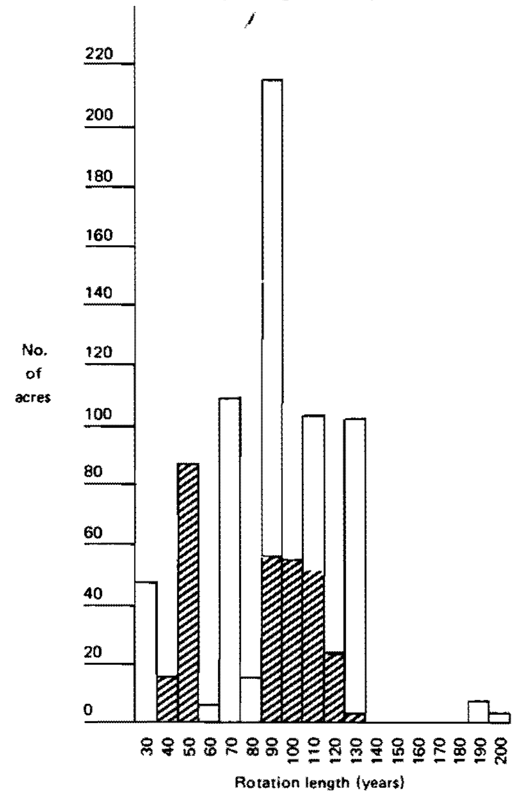


Figure 4.1C. Rotation group 3.
(g_p = 5%, low site)
(Corresponding to assumptions 7 and 10)

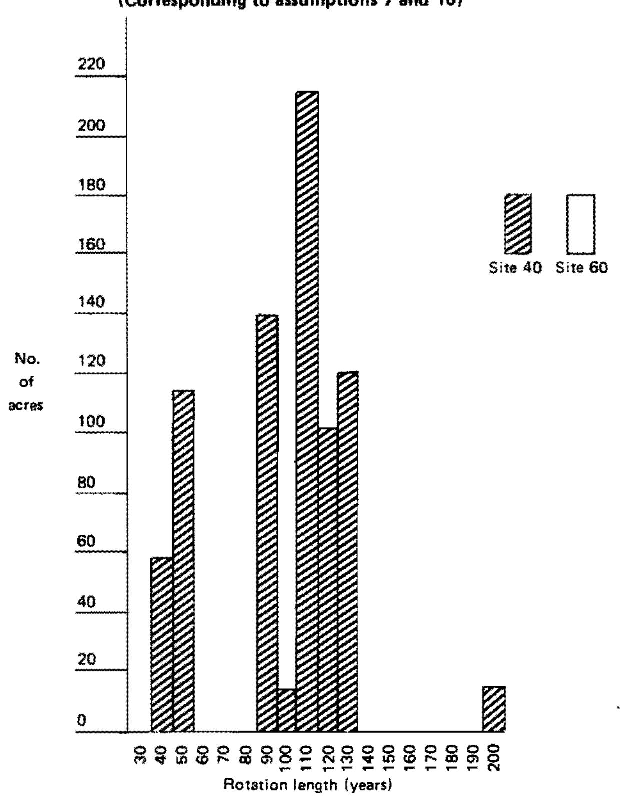


Figure 4.1D. Rotation group 4.
(g_p = 5%, regular site)
(Corresponding to assumptions 1, 4, 5, 8, 11, 12)

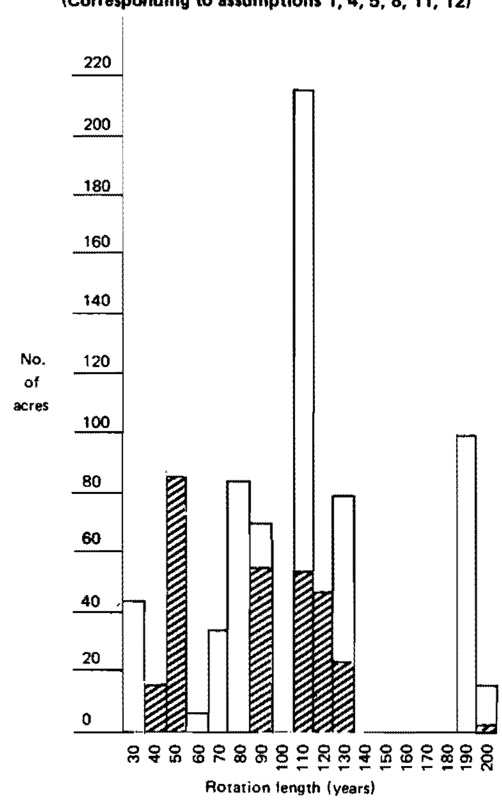


Figure 4.1E. Rotation group 5.
(g_p = 5%, high site)
(Corresponding to assumptions 6 and 9)

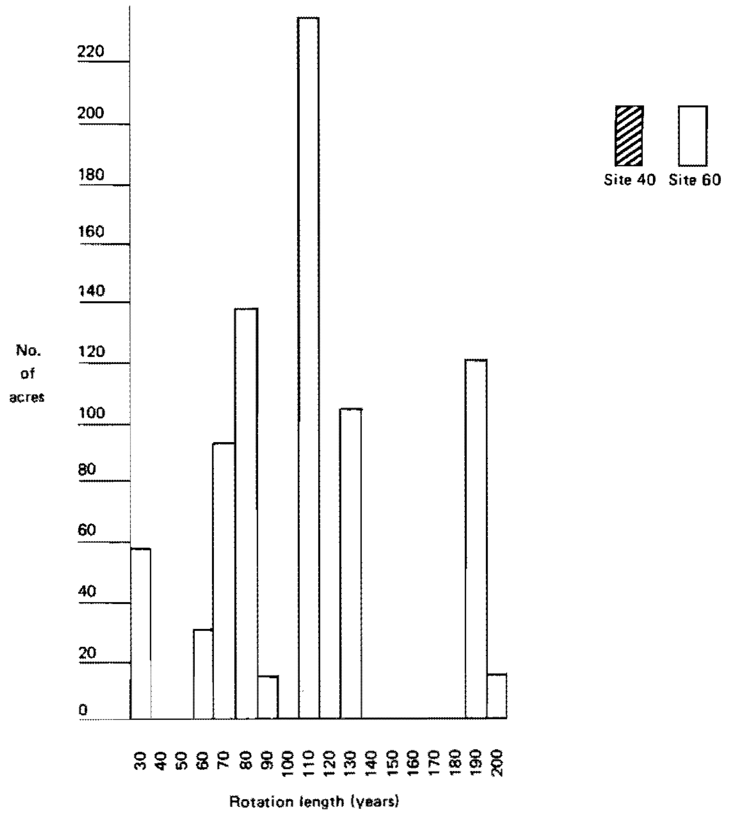


Figure 4.1F. Rotation group 6.
(g_p = 6%, regular site)
(Corresponding to assumption 3)

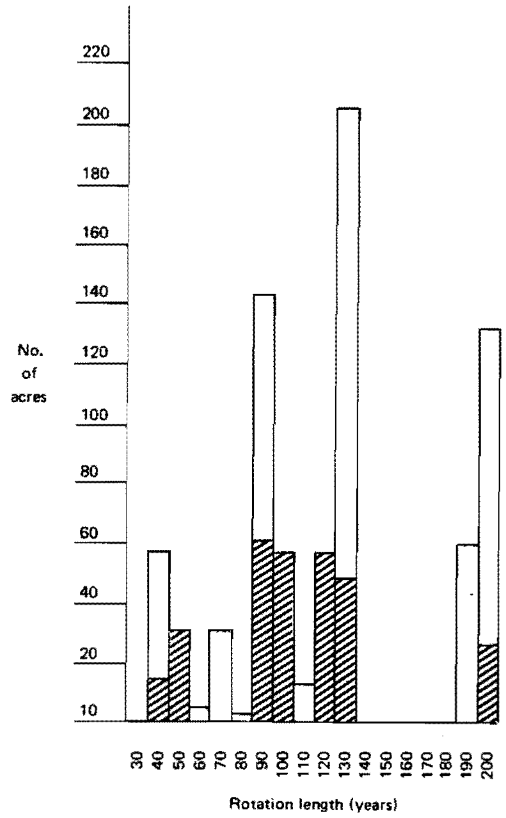
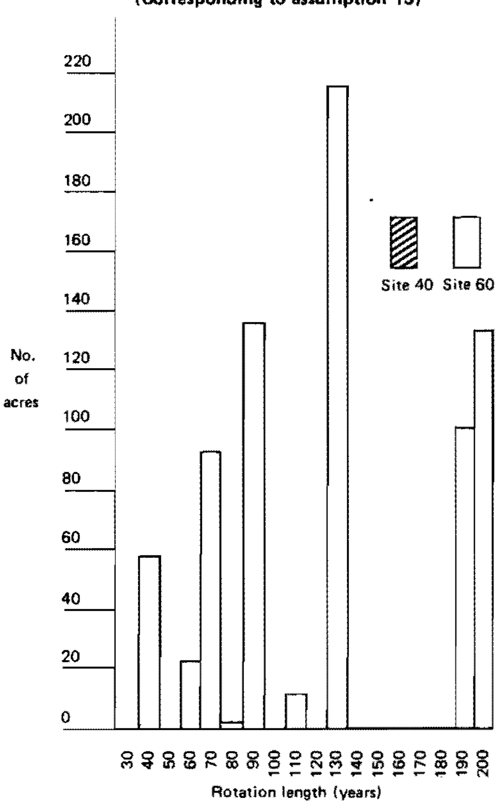


Figure 4.1G. Rotation group 7.
(g_p = 6%, high site)
(Corresponding to assumption 13)



present values of benefits per acre calculated by using a range of discount rates from 5 percent to 20 percent. The time periods shown are the optimum financial rotations for each of the 16 combinations of eight discount rates and two sites. Both the benefits and the rotations fall sharply with an increasing discount rate under both site assumptions.

Analogous to the "get out point" for high r_a's, for low r_a's a maximum point of 200 years is reached (by constraint of the yield table), where no longer rotation exists. Figures 4.1F and 4.1G illustrate this for the two rotation groups where this occurs most frequently. For the rotation group illustrated by Table 4.3, this point would have been reached by anyone with an r_a of 5 percent or less.

4.2 DESIGNATION OF TABLES AND FIGURES

As in Chapter 3, the model developed in Chapter 2 was used to analyze the results for the entire set of 14 assumptions. Each program benefit, PE, SE. etc., calculated in Chapter 3 (Assumption 1), has its counterpart in each of the other 13 assumptions. To facilitate direct comparison of values between assumptions, several groups of tables and graphs incorporating all 14 assumptions were constructed.

4.2.1 VALUES FOR PROGRAM BENEFITS AND PROGRAM EFFECTIVENESS (PE)

Program benefits for each of the 14 assumptions are listed in columns 3-11 of Table 4.4, and the acreage associated with each (all farms where ID > 0) is shown in column 2 (also

Table 4.2A. Distribution of optimum financial rotations (number of farms).

Rotation group	Corresponding assumption number(s)	Annual stumpage price growth rate (%)	Site assumption	Site index	Optimum financial rotation (years) 30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200
1	14		low	40	–	8	21	–	–	–	22	39	27	35	6	–	–	–	–	–	–	1
2	2		regular	40	–	3	12	–	–	–	10	20	14	11	1	–	–	–	–	–	–	–
				60	5	–	–	3	15	3	19	–	13	–	24	–	–	–	–	–	5	1
3	7,10		low	40	–	8	19	–	–	–	21	3	39	27	35	–	–	–	–	–	–	7
4	1,4,5,8,11,12		regular	40	–	3	11	–	–	–	11	–	20	14	11	–	–	–	–	–	–	1
				60	4	–	–	4	6	9	3	–	19	–	13	–	–	–	–	–	24	6
5	6,9		high	60	7	–	–	11	11	19	3	–	39	–	27	–	–	–	–	–	35	7
6	3		regular	40	–	3	8	–	–	–	4	10	–	20	14	–	–	–	–	–	–	12
				60.	–	4	–	3	6	1	9	–	3	–	19	–	–	–	–	–	13	30
7	13		high	60	–	7	–	8	12	2	19	–	3	–	39	–	–	–	–	–	27	42

Table 4.2B. Distribution of optimum financial rotations (number of acres).

Rotation group	Corresponding assumption number(s)	Annual stumpage price growth rate (%)	Site assumption	Site index	Optimum financial rotation (years) 30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200
1	14		low	40	–	59	116	–	–	–	150	214	102	120	9	–	–	–	–	–	–	3
2	2		regular	40	–	13	86	–	–	–	54	53	45	22	2	–	–	–	–	–	–	–
				60	46	–	–	4	109	13	161	–	57	–	98	–	–	–	–	–	7	3
3	7,10		low	40	–	59	114	–	–	–	139	13	214	102	120	–	–	–	–	–	–	12
4	1,4,5,8,11,12		regular	40	–	13	85	–	–	–	55	–	53	45	22	–	–	–	–	–	–	2
				60	43	–	–	7	26	83	13	–	161	–	57	–	–	–	–	–	98	10
5	6,9		high	60	56	–	–	29	90	137	13	–	214	–	102	–	–	–	–	–	120	12
6	3		regular	40	–	13	27	–	–	–	59	54	–	53	45	–	–	–	–	–	–	24
				60	–	43	–	5	27	1	83	–	13	–	161	–	–	–	–	–	57	108
7	13		high	60	–	56	–	24	93	2	137	–	13	–	214	–	–	–	–	–	103	132

Table 4.3. Effect of the discount rate on optimum rotation and present value of benefits per acre.

Stumpage price: $30.00/MBF, $3.00/cord 5.000% stumpage price inflation

Discount rate (%)	Site index 40 Optimum financial rotation (years)	Present value of benefits per acre ($)	Site index 60 Optimum financial rotation (years)	Present value of benefits per acre ($)
5.000	200	769.21	200	3,294.04
6.000	130	200.84	190	967.14
6.875	120	93.40	140	422.27
8.000	110	35.95	110	173.80
10.000	90	8.45	80	48.11
12.000	80	2.55	70	16.79
15.000	50	0.73	60	4.34
20.000	40	0.11	30	0.75

shown separately in Figure 4.2). In Table 4.4 nine different values (g_s-r_s groups) are given for each assumption, one for each of the nine combinations of three social discount rates (r_s's) and three social annual stumpage price growth rates (g_s's). Each of the 14 assumptions has assumed a single fixed **private** annual stumpage price growth rate (g_p), which is one of the factors determining ID (Table 4.1). However, for **social** analysis the same or a different growth rate could be assumed once the private investment decision has been made. Therefore, we have included the additional two stumpage price growth rates to allow this flexibility.[6] Also, we included the social discount rates of 5 percent and 8 percent for a further measure of sensitivity.

[6] It should be noted that only the privately assumed annual stumpage price growth rates and the private discount rates were used in calculating ID's, thereby determining how many acres would fall into program benefit category. The socially assumed rates apply in the social analysis only after the farms (acres) have been categorized.

Figure 4.3 illustrates the effect of the nine different estimates on the values of PE for the first three assumptions. Each of the nine lines represents one g_s-r_s combination, connecting the resulting PE values for the three assumptions. The highest line corresponds to the highest g_s (6 percent) and to the lowest r_s (5 percent). The lowest line corresponds to the exact opposite conditions, the lowest g_s (4 percent) and the highest r_s (8 percent). The other seven combinations fall in between in the order indicated.

Table 4.5 shows the PE values for all of the 14 assumptions and 9 g_s-r_s groups. Each value in this table is the result of dividing the corresponding benefit from Table 4.4 by the

Table 4.4. Program benefits.

Assumption	Number of acres needing subsidy	Dollars of program benefits (Bp): 4% price inflation (g_s), social discount rate (r_s) 5%	4%, 6 7/8%	4%, 8%	5% price inflation (g_s), social discount rate (r_s) 5%	5%, 6 7/8%	5%, 8%	6% price inflation (g_s), social discount rate (r_s) 5%	6%, 6 7/8%	6%, 8%
1	445	122,548	31,814	15,535	274,919	64,483	29,842	648,117	136,851	59,784
2	509	143,359	39,901	19,923	303,400	78,330	37,517	664,741	158,929	72,904
3	312	56,997	14,771	7,317	130,457	29,822	13,867	320,417	63,768	27,648
4	445	122,548	31,814	15,535	274,919	64,483	29,842	648,117	136,851	59,784
5	336	65,348	18,587	9,416	136,681	36,053	17,497	295,611	72,327	33,598
6	381	194,232	54,124	27,089	414,922	106,048	50,903	936,739	215,455	98,715
7	633	89,741	19,408	8,650	221,914	43,320	18,046	568,262	101,649	39,749
8	343	102,778	27,270	13,562	228,208	54,560	25,615	530,748	114,612	50,646
9	278	202,099	59,989	30,754	408,295	114,124	56,552	847,594	222,700	106,605
10	528	114,060	25,600	11,643	276,672	56,012	23,850	696,312	128,835	51,505
11	259	29,584	8,658	4,539	62,169	16,445	8,172	137,018	32,734	15,351
12	482	145,223	37,824	18,444	324,207	76,602	35,478	759,373	162,082	71,032
13	85	22,490	9,149	5,496	37,277	14,793	8,750	62,274	24,130	14,066
14	768	110,704	24,309	10,830	269,847	53,947	22,608	681,941	125,161	49,543

Figure 4.2. Number of acres associated with program benefits.

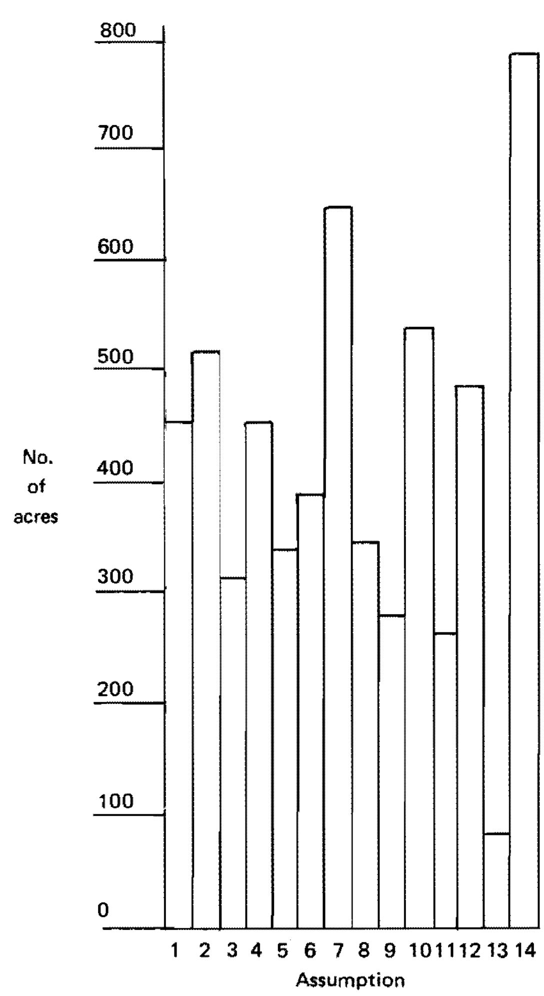


Figure 4.3. Full nine-way sensitivity of program effectiveness (PE) to privately assumed annual stumpage price growth rate.

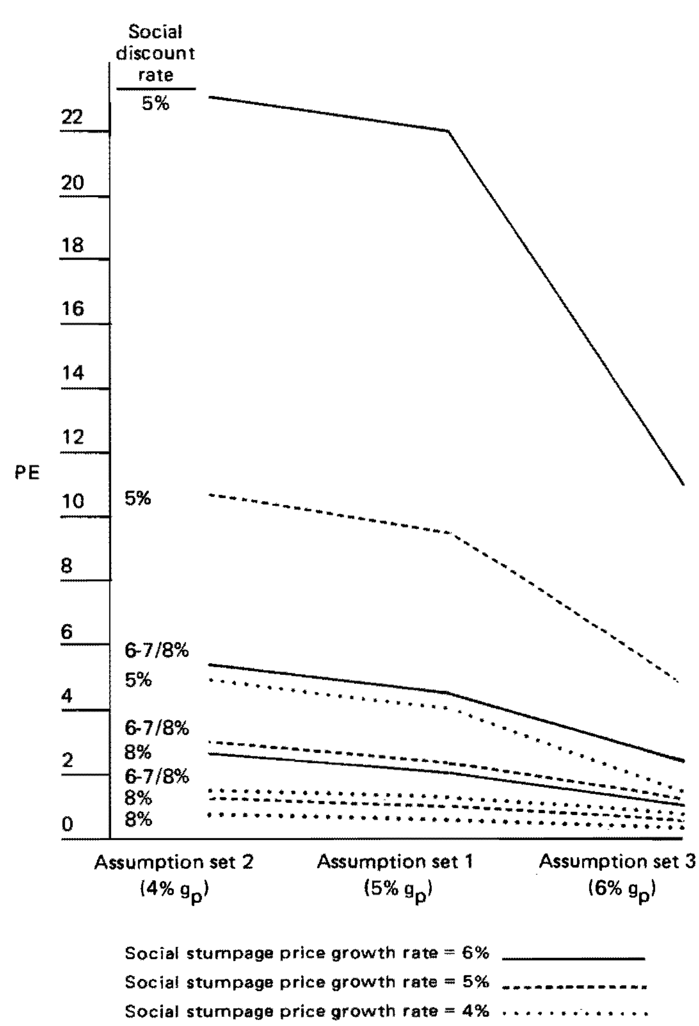


Table 4.5. Program effectiveness (PE).

Assumption	Number of acres needing Subsidy	4% price inflation social discount rate			5% price inflation social discount rate			6% price inflation social discount rate		
		5%	6 7/8%	8%	5%	6 7/8%	8%	5%	6 7/8%	8%
1	445	4.18	1.09	0.53	9.39	2.20	1.02	22.13	4.67	2.04
2	509	4.89	1.36	0.68	10.36	2.67	1.28	22.70	5.43	2.49
3	312	1.95	0.50	0.25	4.45	1.02	0.47	10.94	2.18	0.94
4	445	4.18	1.09	0.53	9.39	2.20	1.02	22.13	4.67	2.04
5	336	2.23	0.63	0.32	4.67	1.23	0.60	10.09	2.47	1.15
6	381	6.63	1.85	0.92	14.17	3.62	1.74	31.98	7.36	3.37
7	633	3.06	0.66	0.30	7.58	1.48	0.62	19.40	3.47	1.36
8	343	3.51	0.93	0.46	7.79	1.86	0.87	18.12	3.91	1.73
9	278	6.90	2.05	1.05	13.94	3.90	1.93	28.94	7.60	3.64
10	528	3.89	0.87	0.40	9.45	1.91	0 81	23.78	4.40	1.76
11	259	1.01	0.30	0.15	2.12	0.56	0.28	4.68	1.12	0.52
12	482	4.96	1.29	0.63	11.07	2.62	1.21	25.93	5.53	2.43
13	85	0.77	0.31	0.19	1.27	0.51	0.30	2.13	0.82	0.48
14	768	3.78	0.83	0.37	9.21	1.84	0.77	23.28	4.27	1.69

total public expenditure (X_p= $29,300). Figures 4.4A - 4.4F summarize the PE values for six groups of multi-assumption comparisons, assuming a g_s of 5 percent and an r_s of 6 7/8 percent. A similar set of figures could be drawn for each of the other eight "g_s-r_s groups."

4.2.2 VALUES FOR SOCIAL EFFICIENCY (SE)

Three SE values can be calculated for each program benefit value found in Table 4.4, one for each of the three assumed total costs (C_t's). Tables 4.6A, 4.6B, and 4.6C individually show these values for the three assumed C_t's, C_{t1} where social land cost equals zero, C_{t2} where social land cost equals one-half the market value, and C_{t3} where social land cost equals full market value.[7] Figures 4.5A - 4.5F summarize the SE values for multi-assumption comparisons for all three C_t's. These comparisons are analogous to the PE comparisons presented in Figures 4.4A - 4.4F. Again, the comparisons are provided only for a g_s of 5 percent and an r_s of 6 7/8 percent.

4.2.3 VALUES FOR PARTICIPATING FARMS MEETING THE CRITERIA FOR SUBSIDY ALLOCATION UNDER AN UNLIMITED PROGRAM BUDGET

Eight items were calculated for farms meeting the criteria for subsidy allocation under an unlimited program budget. These were as follows: number of farms, number of acres, total ID (program subsidy), social benefits, program expenditure, social cost, program effectiveness, and social efficiency. Each of these eight values is listed for all 14 assumptions in Table 4.7A for the 5 percent social discount rate. Tables 4.7B and 4.7C list the values for the social discount rates of 6 7/8 percent and 8 percent, respectively.

To determine which farms met the first criteria for subsidy allocation, individual NPW_s's were calculated for each assumption using only one social stumpage price growth rate and one land cost factor, the same ones used in the private assumption. Therefore, no sensitivity to stumpage price growth or land cost was included **within** each assumption as was done for the SE values in Tables 4.6A - 4.6C. We felt that the sensitivity for g_s and land cost was sufficient for **between** assumption comparisons.

[7] C_{t2} is the same cost used in Section 3 of Chapter 3, where land cost treatment in the social analysis is explained in more detail. The other two C_t's assume the same costs as C_{t2} (Chapter 3) except for social land cost.

Sets of three figures each (one each for r_a's of 5 percent, 6 7/8 percent, and 8 percent) are presented for four of the values calculated for farms meeting the subsidy allocation criteria. These values are the number of acres (Figures 4.6A - 4.6C), program expenditure (Figures 4.7A - 4.7C), program effectiveness (Figures 4.8A - 4.8C), and social efficiency (Figures 4.9A - 4.9C).

4.2.4 NUMBER OF ACRES MEETING SUBSIDY ALLOCATION CRITERIA UNDER A LIMITED PROGRAM BUDGET

For each of the 14 assumptions and 3 social discount rates, the number of acres meeting the subsidy allocation criteria under a limited program budget was determined. In Figures 4.10A - 4.10N the number of acres qualifying for a subsidy is plotted against the program subsidy budget. Each figure corresponds to one of the 14 assumptions, and each shows the number of acres qualifying under the three assumed social discount rates, where applicable. Many of the curves shown in Figures 4.10A - 4.10N exhibit several inflection points (*i.e.,* have a "wavy" pattern) since the ranking criteria maximizes NPW_s, not the number of acres planted. However, most of the curves generally indicate a decrease in the number of qualifying acres per dollar of program budget as the budget is increased. In general then, ranking participating farms by the NPW_s/ID ratio roughly maximizes the number of qualifying acres per budget expenditure level as well as maximizing NPW_s.

4.3 RESULTS OF SENSITIVITY ANALYSIS

Six sets of variations in assumptions were made from the original assumption set (Assumption 1), as described at the beginning of the chapter. The general effects upon the output values are presented below for each variation. Specific comparisons can be made from Tables 4.4-4.7 and Figures 4.2-4.10, as explained in Section 4.2

4.3.1 ANNUAL STUMPAGE PRICE GROWTH RATE (g_p)

Assumptions 2 and 3 individually vary the private annual stumpage price growth rate (g_p) from 5 percent (Assumption 1) to 4 percent and 6 percent, respectively. As discussed in Section 4.1, g_p has a significant impact on the optimum

Figure 4.4A. Estimated sensitivity of program effectiveness (PE) to privately assumed annual stumpage price growth rate (g_p). (g_s = 5%, r_s = 6-7/8%)

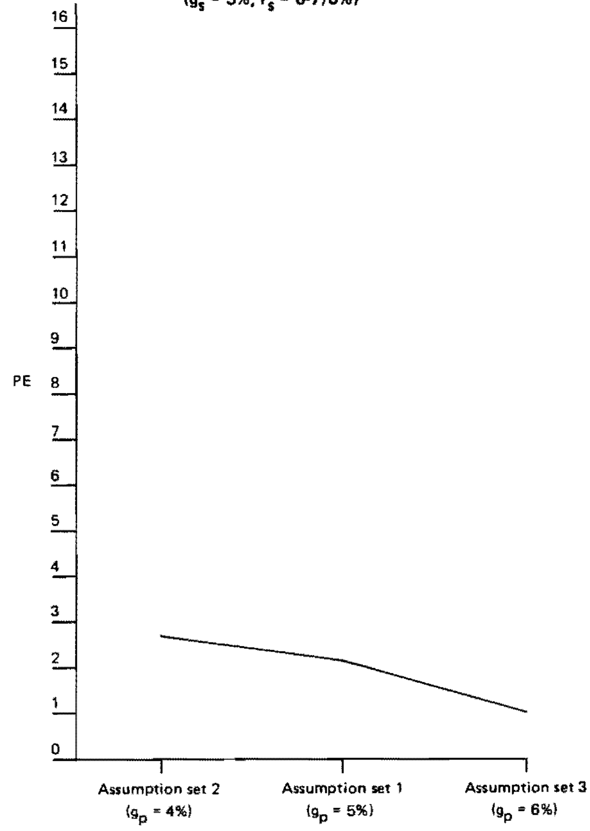


Figure 4.4B. Estimated sensitivity of program effectiveness (PE) to privately assumed annual land value growth rate. (g_s = 5%, r_s = 6-7/8%)

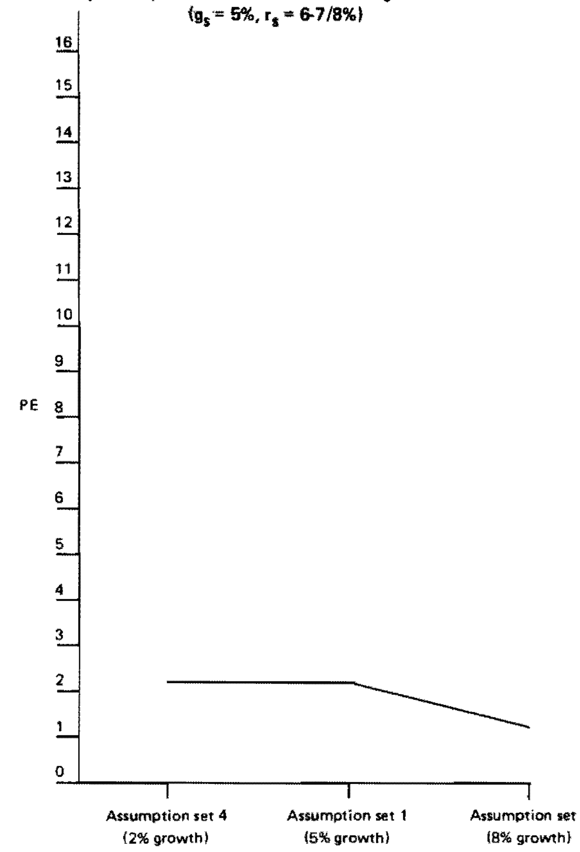


Figure 4.4C. Estimated sensitivity of program effectiveness (PE) to site index for 1972 stumpage price of $30/MBF and $3/cord. ($g_s$ = 5%, r_s = 6-7/8%)

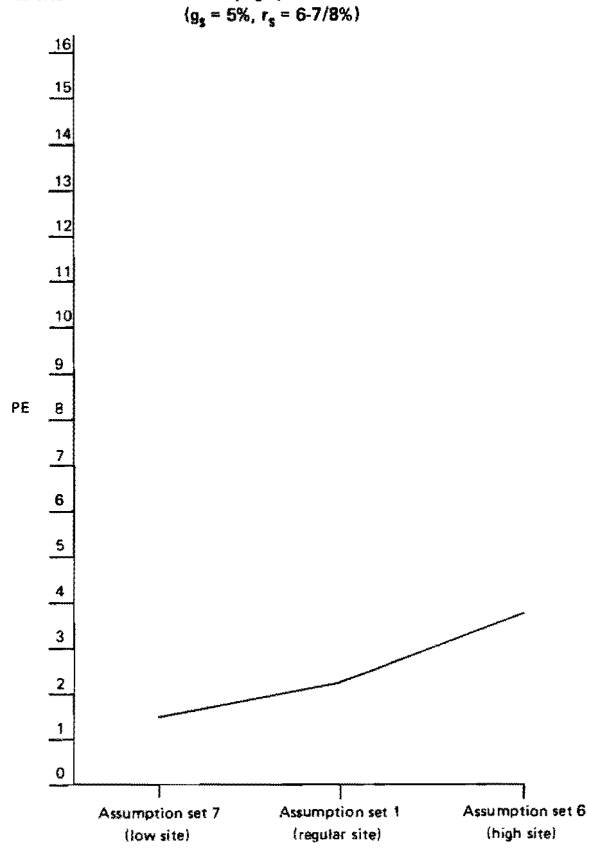


Figure 4.4D. Estimated sensitivity of program effectiveness (PE) to site index for 1972 stumpage price of $50/MBF and $5/cord. ($g_s$ = 5%, r_s = 6-7/8%)

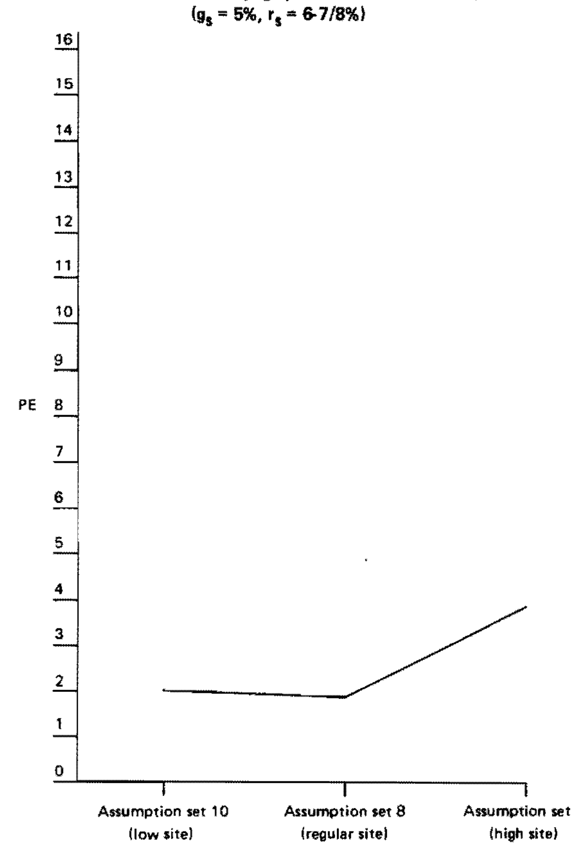


Figure 4.4E. Estimated sensitivity of program effectiveness (PE) to private land cost.
(g_s = 5%, r_s = 6-7/8%)

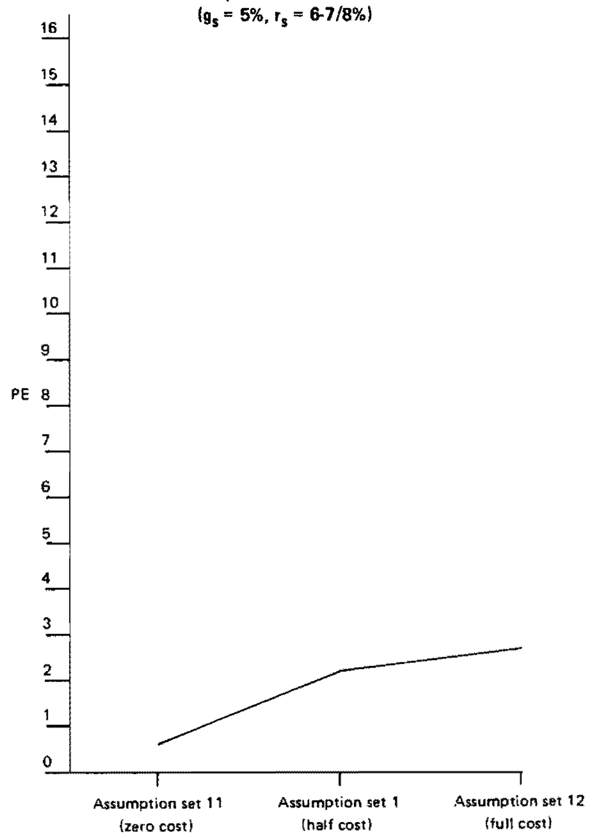


Figure 4.4F. Estimated sensitivity of program effectiveness (PE) to "most favorable – least favorable" comparison.
(g_s = 5%, r_s = 6-7/8%)

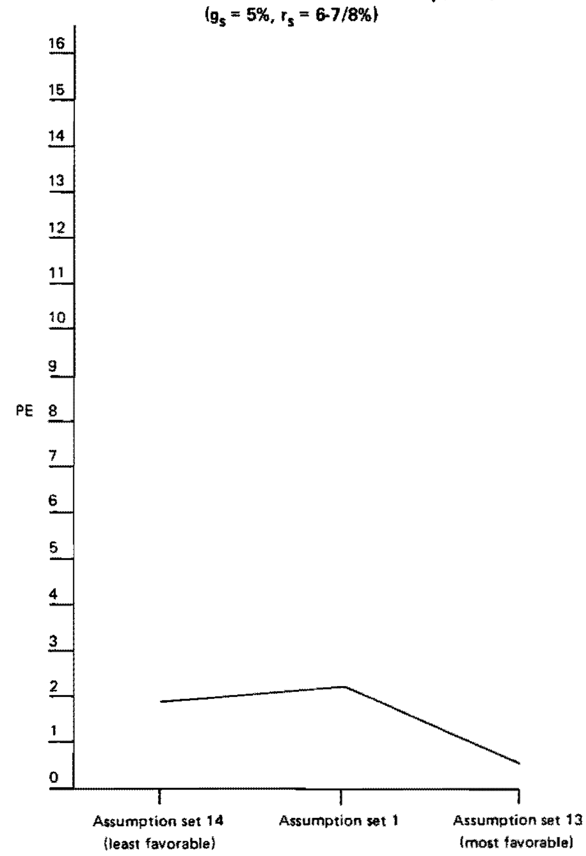


Figure 4.5A. Estimated sensitivity of social efficiency (SE) to privately assumed annual stumpage price growth rate (g_p).
(g_s = 5%, r_s = 6-7/8%)

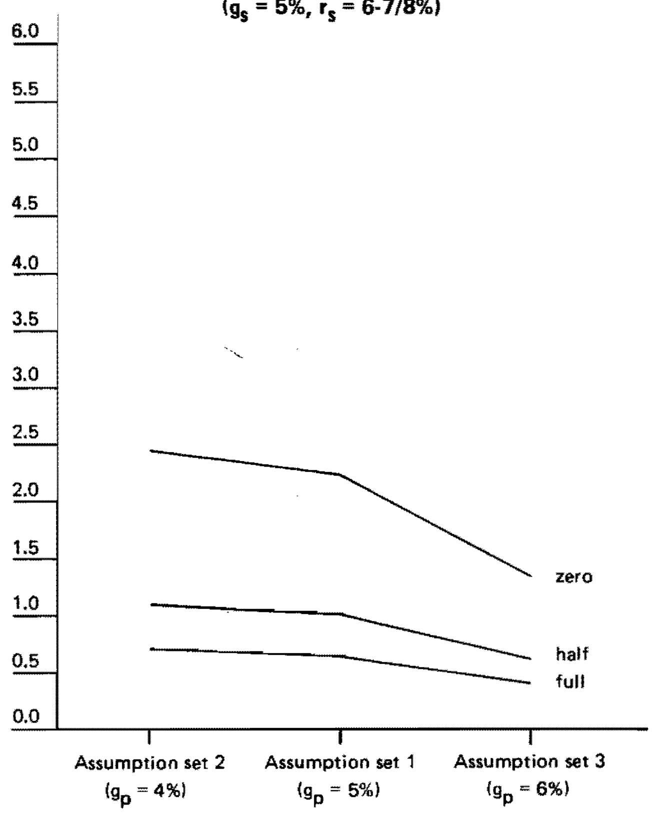


Figure 4.5B. Estimated sensitivity of social efficiency (SE) to privately assumed annual land value growth rate.
(g_s = 5%, r_s = 6-7/8%)

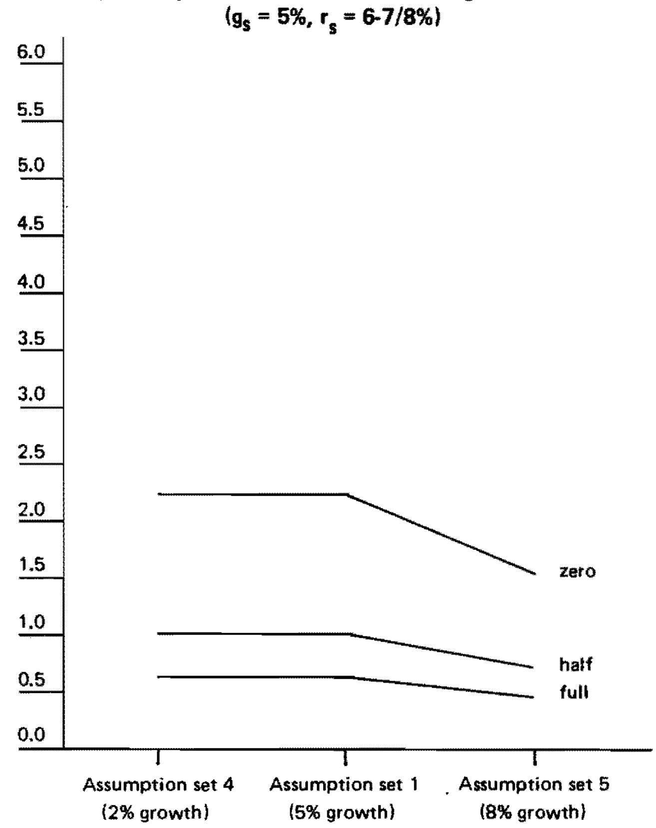


Figure 4.5C. Estimated sensitivity of social efficiency (SE) to site index for 1972 stumpage price of $30/MBF and $3/cord.
(g_s = 5%, r_s = 6-7/8%)

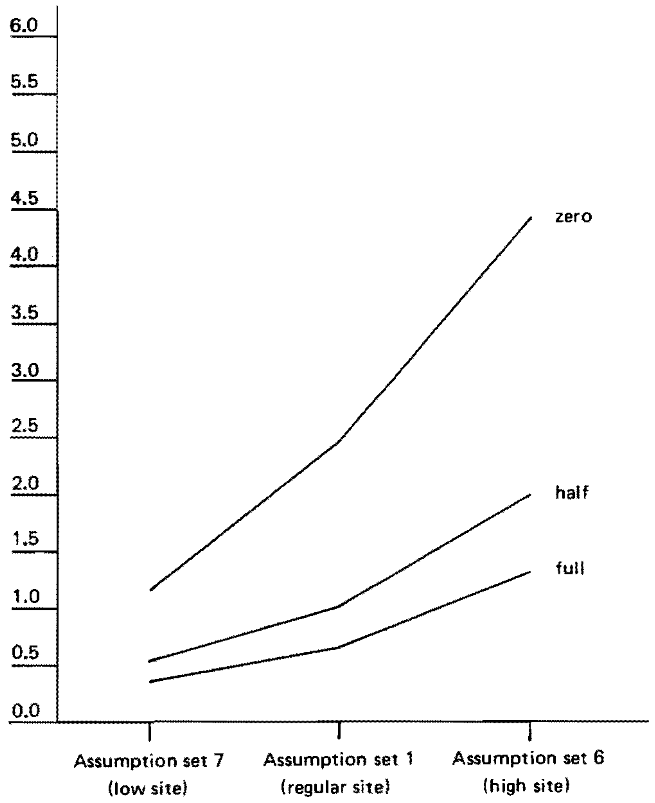


Figure 4.5D. Estimated sensitivity of social efficiency (SE) to site index for 1972 stumpage price of $50/MBF and $5/cord.
(g_s = 5%, r_s = 6-7/8%)

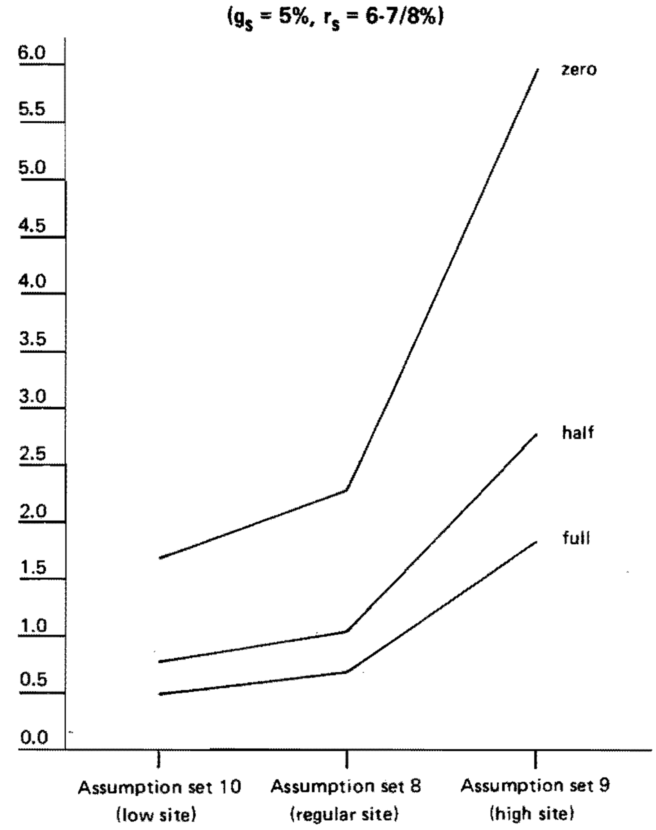


Figure 4.5E. Estimated sensitivity of social efficiency (SE) to private land cost.
(g_s = 5%, r_s = 6-7/8%)

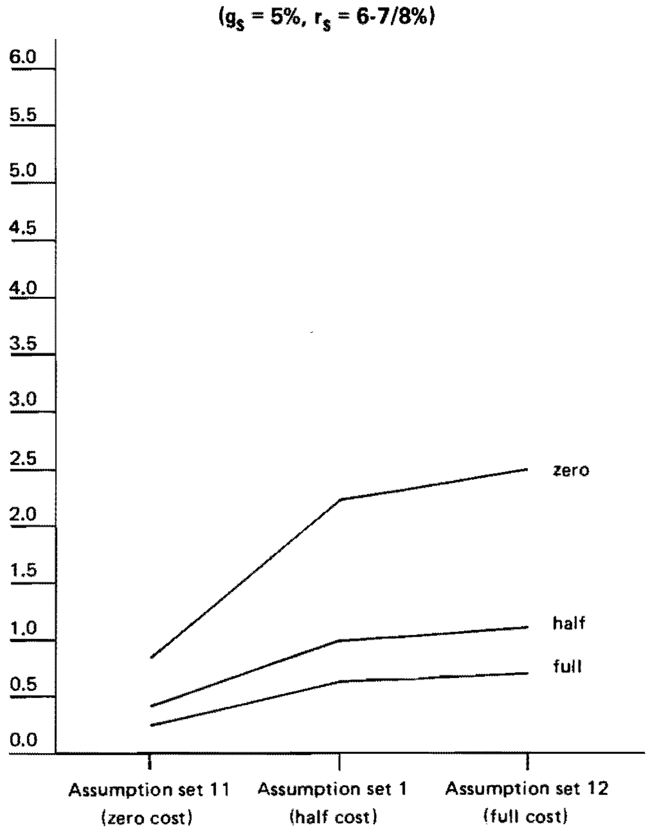


Figure 4.5F. Estimated sensitivity of social efficiency (SE) to "most favorable — least favorable" comparison.
(g_s = 5%, r_s = 6-7/8%)

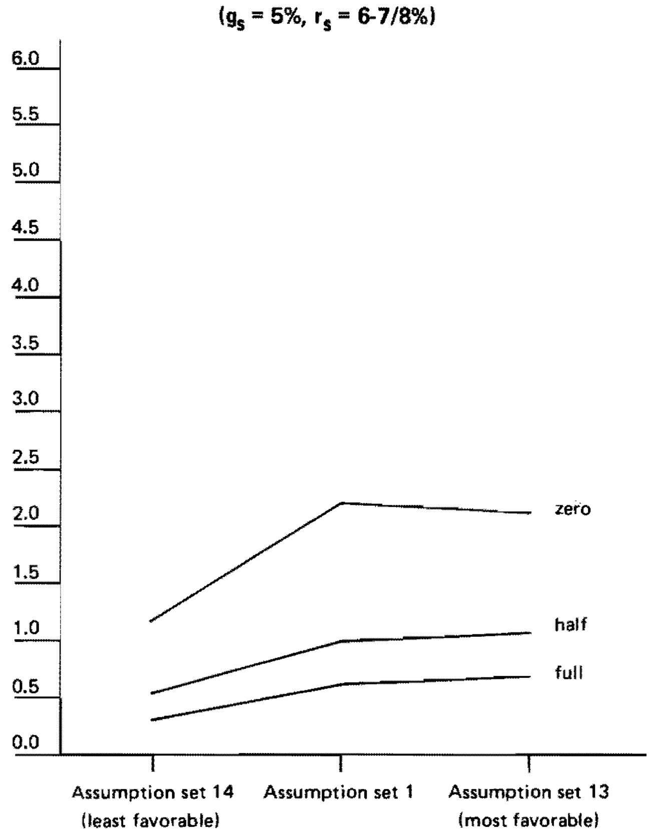


Table 4.6A. Social efficiency (Land cost = zero).

Assumption	Number of acres needing subsidy	4% price inflation social discount rate 5%	6 7/8%	8%	5% price inflation social discount rate 5%	6 7/8%	8%	6% price inflation social discount rate 5%	6 7/8%	8%
1	445	4.25	1.10	0.54	9.54	2.24	1.04	22.49	4.75	2.07
2	509	4.51	1.26	0.63	9.55	2.47	1.18	20.92	5.00	2.29
3	312	2.59	0.67	0.33	5.93	1.36	0.63	14.56	2.90	1.26
4	445	4.25	1.10	0.54	9.54	2.24	1.04	22.49	4.75	2.07
5	336	2.82	0.80	0.41	5.90	1.56	0.76	12.76	3.12	1.45
6	381	8.09	2.25	1.13	17.28	4.42	2.12	39.02	8.98	4.11
7	633	2.31	0.50	0.22	5.71	1.12	0.46	14.63	2.62	1.02
8	343	4.27	1.13	0.56	9.49	2.27	1.07	22.07	4.77	2.11
9	278	10.68	3.17	1.63	21.58	6.03	2.99	44.80	11.77	5.63
10	528	3.39	0.76	0.35	8.23	1.67	0.71	20.71	3.83	1.53
11	259	1.47	0.43	0.23	3.09	0.82	0.41	6.81	1.63	0.76
12	482	4.77	1.24	0.61	10.64	2.51	1.16	24.93	5.32	2.33
13	85	3.25	1.32	0.79	5.38	2.14	1.26	8.99	3.48	2.03
14	768	2.41	0.53	0.24	5.87	1.17	0.49	14.83	2.72	1.08

Table 4.6B. Social efficiency (Land cost = half).

Assumption	Number of acres needing seeding	4% price inflation social discount rate 5%	6 7/8%	8%	5% price inflation social discount rate 5%	6 7/8%	8%	6% price inflation social discount rate 5%	6 7/8%	8%
1	445	1.88	0.49	0.24	4.23	0.99	0.46	9.96	2.10	0.92
2	509	1.99	0.55	0.28	4.21	1.09	0.52	9.21	2.20	1.01
3	312	1.19	0.31	0.15	2.73	0.62	0.29	6.71	1.34	0.58
4	445	1.88	0.49	0.24	4.23	0.99	0.46	9.96	2.10	0.92
5	336	1.30	0.37	0.19	2.72	0.72	0.35	5.89	1.44	0.67
6	381	3.65	1.02	0.51	7.79	1.99	0.96	17.59	4.05	1.85
7	633	1.04	0.23	0.10	2.57	0.50	0.21	6.59	1.18	0.46
8	343	1.94	0.52	0.26	4.31	1.03	0.48	10.03	2.16	0.96
9	278	4.94	1.47	0.75	9.98	2.79	1.38	20.73	5.45	2.61
10	528	1.52	0.34	0.16	3.69	0.75	0.32	9.28	1.72	0.69
11	259	0.72	0.21	0.11	1.51	0.40	0.20	3.33	0.80	0.37
12	482	2.10	0.55	0.27	4.69	1.11	0.51	10.99	2.35	1.03
13	85	1.64	0.67	0.40	2.72	1.08	0.64	4.54	1.76	1.03
14	768	1.10	0.24	0.11	2.69	0.54	0.23	6.79	1.25	0.49

Table 4.6C. Social efficiency (Land cost = full).

Assumption	Number of acres needing subsidy	4% price inflation social discount rate 5%	6 7/8%	8%	5% price inflation social discount rate 5%	6 7/8%	8%	6% price inflation social discount rate 5%	6 7/8%	8%
1	445	1.21	0.31	0.15	2.71	0.64	0.29	6.40	1.35	0.59
2	509	1.27	0.35	0.18	2.70	0.70	0.33	5.91	1.41	0.65
3	312	0.78	0.20	0.10	1.78	0.41	0.19	4.36	0.87	0.38
4	445	1.21	0.31	0.15	2.71	0.64	0.29	6.40	1.35	0.59
5	336	0.85	0.24	0.12	1.77	0.47	0.23	3.83	0.94	0.44
6	381	2.35	0.66	0.33	5.03	1.29	0.62	11.35	2.61	1.20
7	633	0.67	0.15	0.06	1.66	0.32	0.14	4.25	0.76	0.30
8	343	1.26	0.33	0.17	2.79	0.67	0.31	6.49	1.40	0.62
9	278	3.21	0.95	0.49	6.49	1.82	0.90	13.48	3.54	1.70
10	528	0.98	0.22	0.10	2.37	0.48	0.20	5.98	1.11	0.44
11	259	0.48	0.14	0.07	1.00	0.26	0.13	2.20	0.53	0.25
12	482	1.35	0.35	0.17	3.01	0.71	0.33	7.05	1.50	0.66
13	85	1.10	0.45	0.27	1.82	0.72	0.43	3.04	1.18	0.69
14	768	0.71	0.16	0.07	1.74	0.35	0.15	4.40	0.81	0.32

Table 4.7A. Performance measures for participants meeting criteria for subsidy allocation under unlimited program budget. (r_s = 5 percent)

Assumption	Number of farms	Number of acres	Total ID ($)	Social benefits ($)	Program expenditure ($)	Social cost ($)	Program effectiveness	Social efficiency
1	76	304	60,271	637,376	61,487	45,004	10.37	14.16
2	66	303	55,538	593,725	56,594	37,648	10.49	15.77
3	59	271	71,676	317,314	72,620	40,218	4.37	7.89
4	76	304	63,716	637,376	64,932	45,004	9.82	14.16
5	55	195	26,738	284,869	27,618	29,806	10.31	9.56
6	64	325	80,063	933,658	81,087	44,571	11.51	20.95
7	94	460	76,897	555,645	78,401	63,213	7.09	8.79
8	63	202	49,124	512,842	50,132	32,677	10.23	15.69
9	48	222	66,012	842,459	66,780	31,951	12.62	26.37
10	76	375	67,091	678,398	68,307	53,489	9.93	12.68
11	43	192	7,047	133,191	7,735	14,905	17.22	8.94
12	83	340	132,818	747,947	134,146	75,690	5.58	9.88
13	18	85	1,662	62,274	1,950	4,668	31.94	13.34
14	46	243	25,517	319,954	26,253	36,573	12.19	8.75

Table 4.7B. Performance measures for participants meeting criteria for subsidy allocation under unlimited program budget. (r_s = 6 7/8 percent)

Assumption	Number of farms	Number of acres	Total ID ($)	Social benefits ($)	Program expenditure ($)	Social cost ($)	Program effectiveness	Social efficiency
1	24	140	9,524	97,424	9,908	15,658	9.83	6.22
2	26	187	16,871	117,785	17,287	20,456	6.81	5.76
3	50	215	66,313	55,862	67,113	30,219	0.83	1.85
4	24	140	10,434	97,424	10,818	15,658	9.01	6.22
5	19	75	2,968	43,739	3,272	8,128	13.37	5.38
6	63	324	79,809	213,320	80,817	44,307	2.64	4.81
7	4	46	440	10,471	504	4,053	20.76	2.58
8	29	89	16,978	69,151	17,442	10,963	3.96	6.31
9	48	222	66,012	219,682	66,780	31,951	3.29	6.88
10	36	195	32,810	65,521	33,386	22,711	1.96	2.89
11	24	80	1,287	19,884	1,671	5,099	11.90	3.90
12	28	172	31,854	121,246	32,302	29,873	3.75	4.06
13	18	85	1,662	24,130	1,950	4,668	12.38	5.17
14	–	–	–	–	–	–	–	–

Table 4.7C. Performance measures for participants meeting criteria for subsidy allocation under unlimited program budget. (r_s = 8 percent)

Assumption	Number of farms	Number of acres	Total ID ($)	Social benefits ($)	Program expenditure ($)	Social cost ($)	Program effectiveness	Social efficiency
1	18	131	8,729	41,862	9,017	14,355	4.64	2.92
2	–	–	–	–	–	–	–	–
3	12	37	2,231	9,807	2,423	3,967	4.05	2.47
4	18	131	9,637	41,862	9,925	14,355	4.22	2.92
5	13	66	2,189	19,392	2,397	6,825	8.09	2.84
6	36	242	56,129	74,961	56,705	29,549	1.32	2.54
7	–	–	–	–	–	–	–	–
8	16	54	2,908	25,908	3,164	5,969	8.19	4.34
9	43	212	64,864	98,940	65,552	28,469	1.51	3.48
10	–	–	–	–	–	–	–	–
11	9	20	293	4,730	437	1,298	10.83	3.64
12	5	27	4,579	8,897	4,659	3,935	1.91	2.26
13	18	85	1,662	14,066	1,950	4,668	7.21	3.01
14	–	–	–	–	–	–	–	–

Figure 4.6A. Number of acres meeting subsidy allocation criteria under an unlimited program budget. (r_s = 5%)

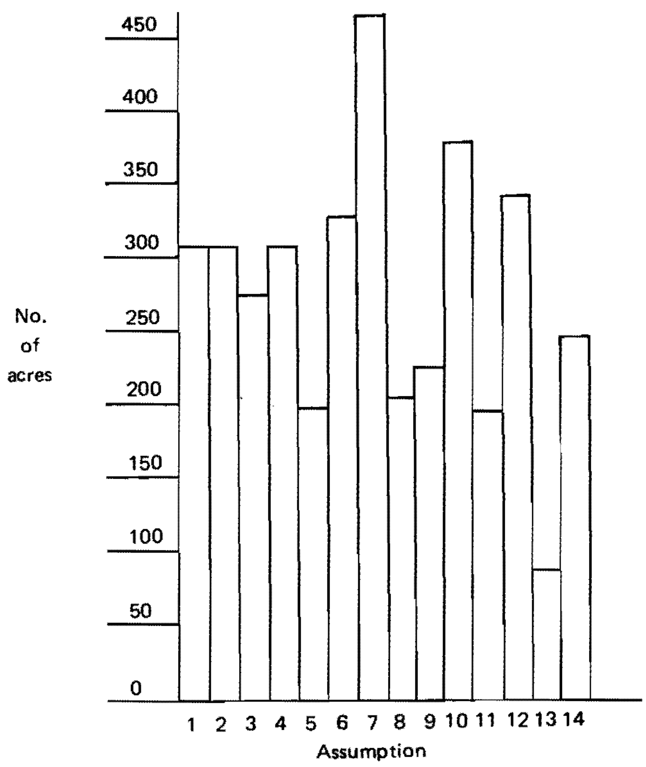


Figure 4.6B. Number of acres meeting subsidy allocation criteria under an unlimited program budget. (r_s = 6-7/8%)

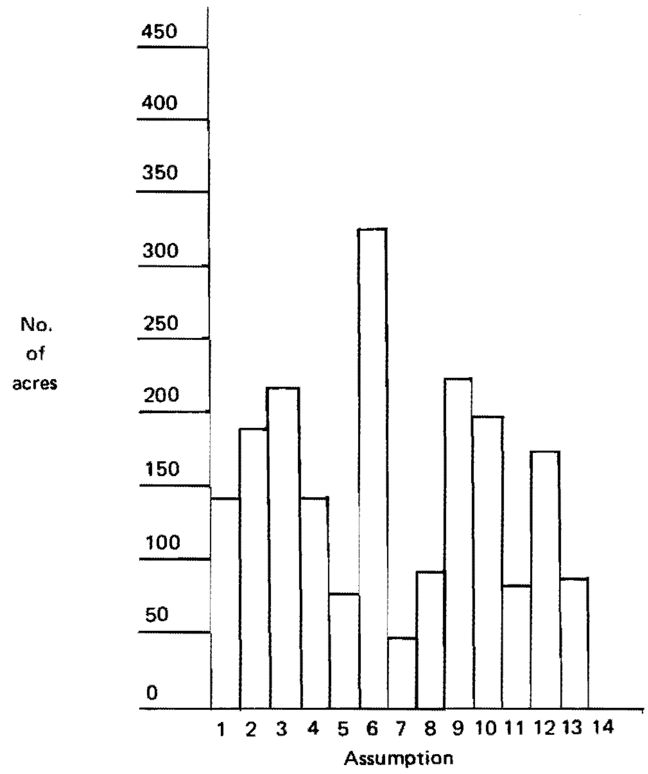


Figure 4.6C. Number of acres meeting subsidy allocation criteria under an unlimited program budget. (r_s = 8%)

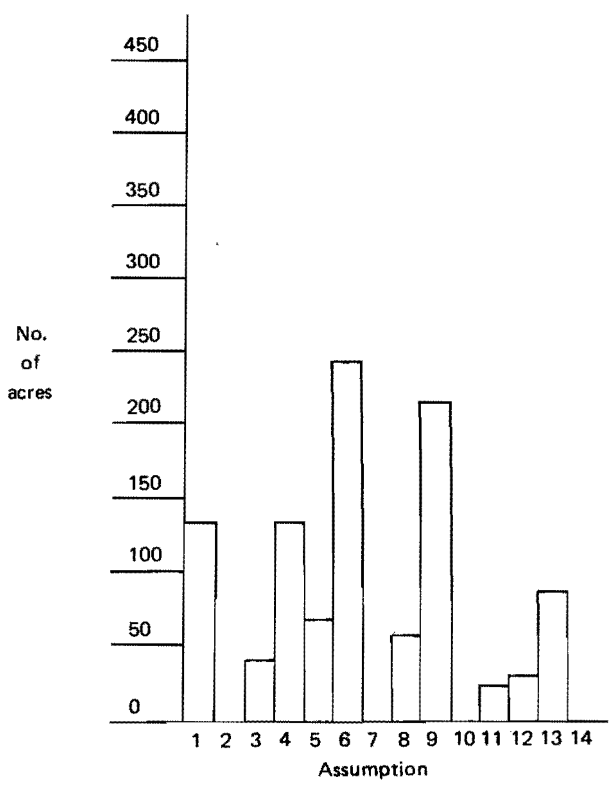


Figure 4.7A. Program expenditure for farms meeting subsidy allocation criteria under an unlimited program budget. (r_s = 5%)

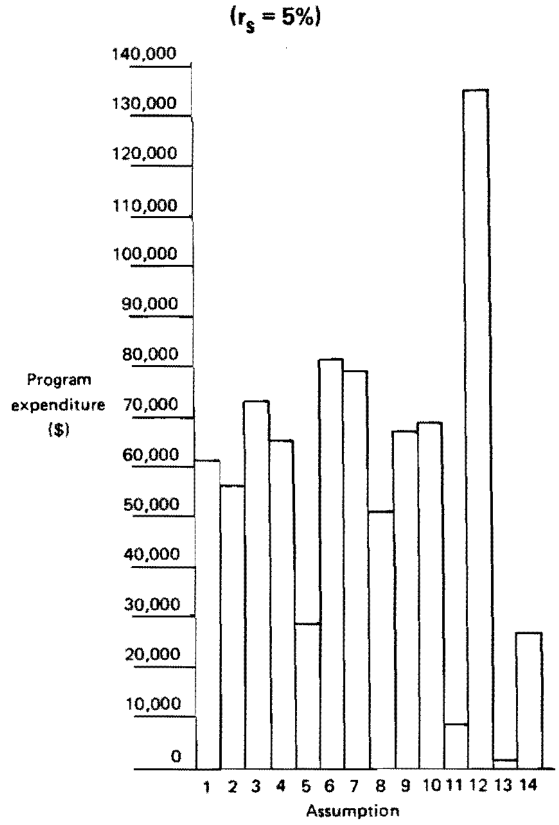


Figure 4.7B. Program expenditure for farms meeting subsidy allocation criteria under an unlimited program budget. (r_s = 6-7/8%)

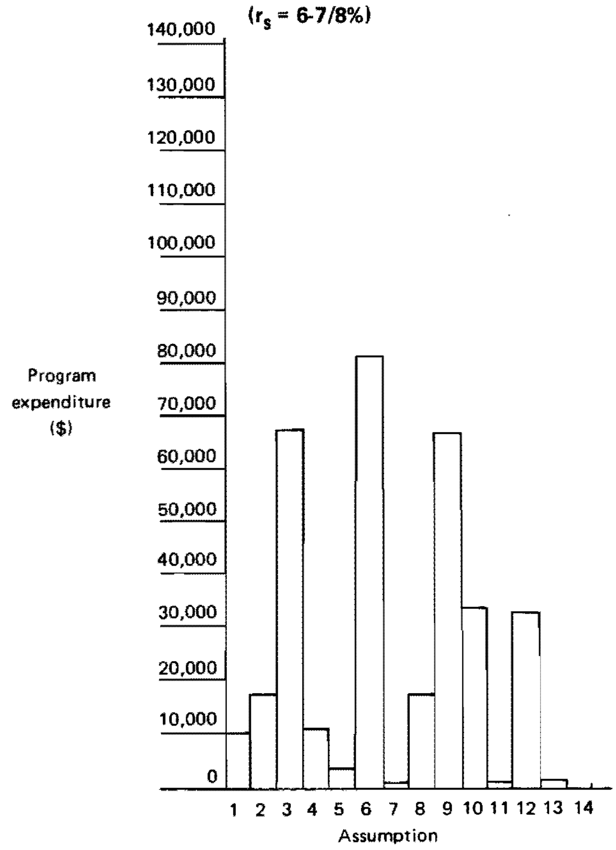


Figure 4.7C. Program expenditure for farms meeting subsidy allocation criteria under an unlimited program budget. (r_s = 8%)

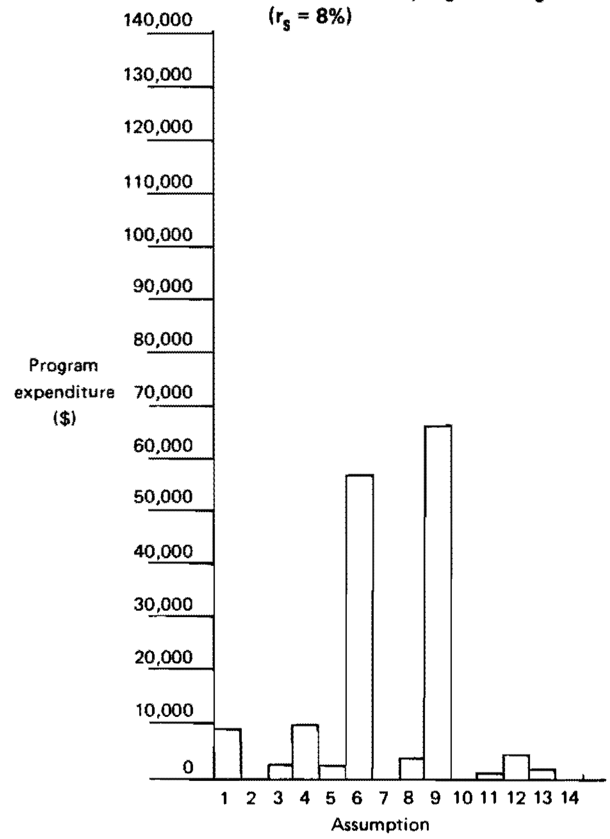


Figure 4.8A. Program effectiveness (PE) for farms meeting subsidy allocation criteria under an unlimited program budget. (r_s = 5%)

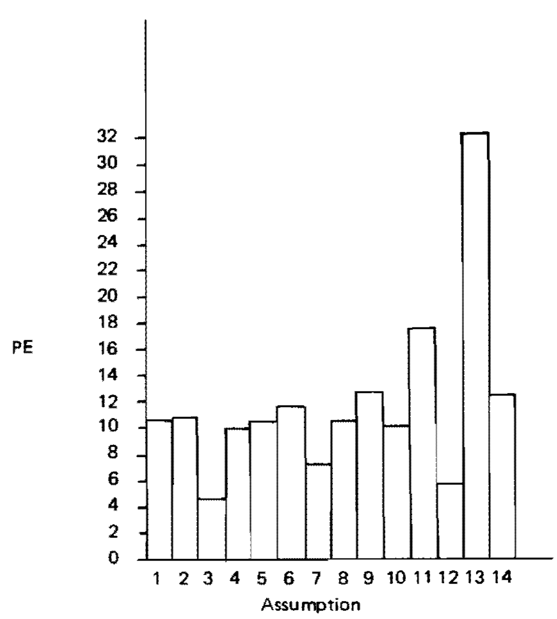


Figure 4.8B. Program effectiveness (PE) for farms meeting subsidy allocation criteria under an unlimited program budget. (r_s = 6-7/8%)

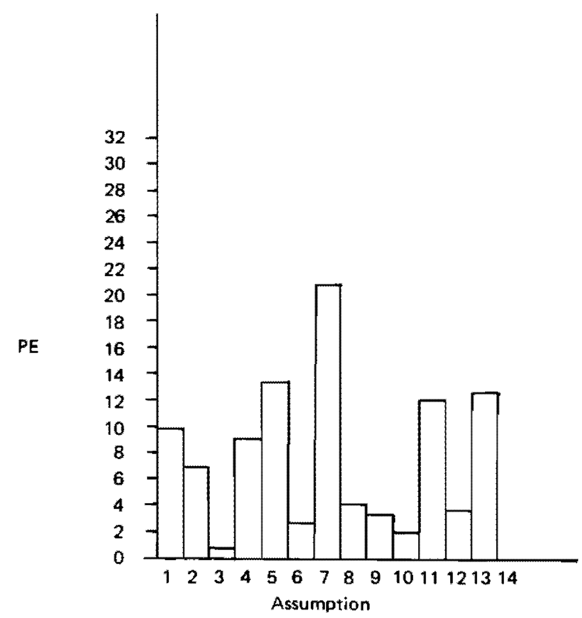


Figure 4.8C.
Program effectiveness (PE) for farms meeting subsidy allocation criteria under an unlimited program budget.
(r_s = 8%)

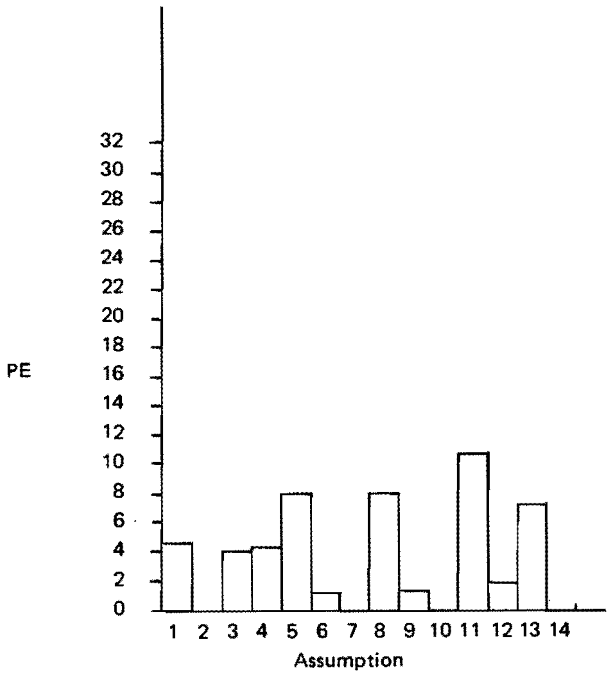


Figure 4.9A. Social efficiency (SE) for farms meeting subsidy allocation criteria under an unlimited program budget.
(r_s = 5%)

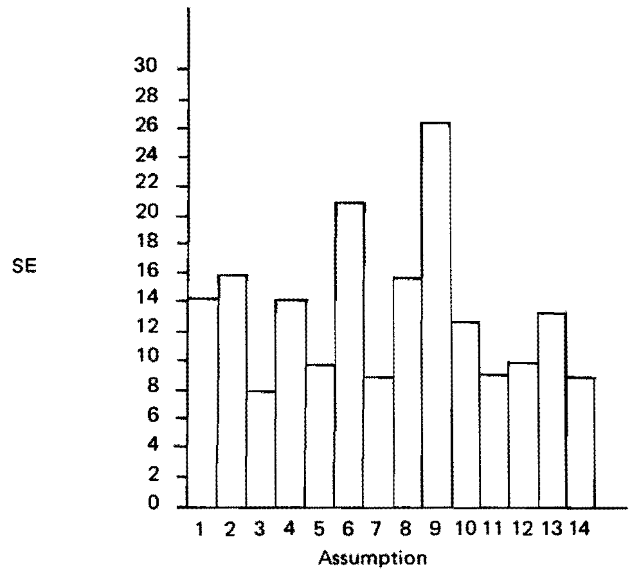


Figure 4.9B. Social efficiency (SE) for farms meeting subsidy allocation criteria under an unlimited program budget.
(r_s = 6-7/8%)

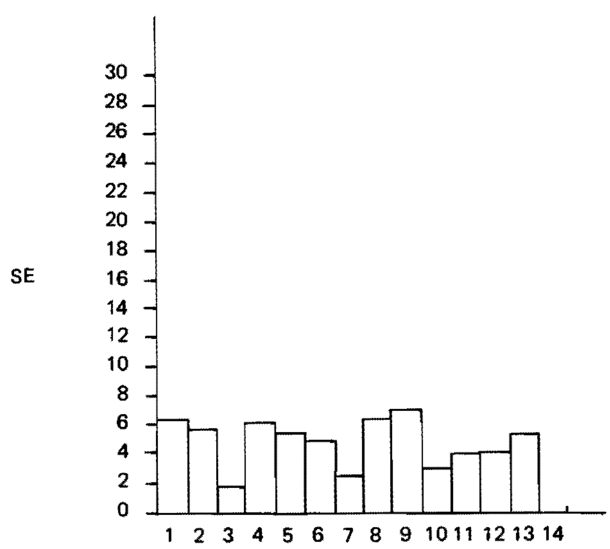


Figure 4.9C. Social efficiency (SE) for farms meeting subsidy allocation criteria under an unlimited program budget.
(r_s = 8%)

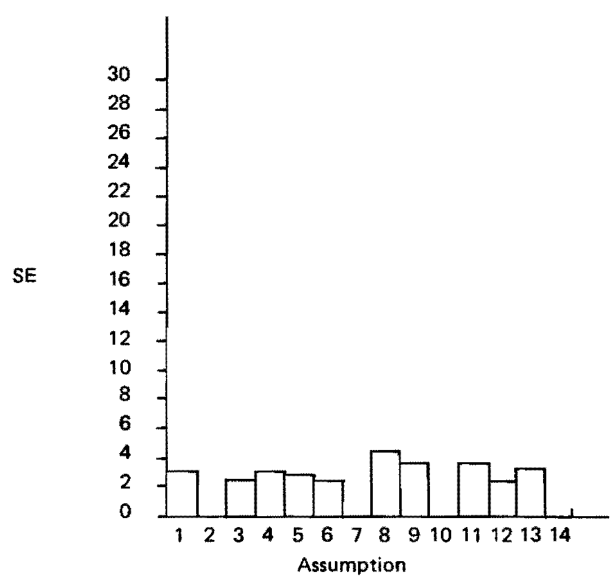


Figure 4.10A. Number of acres meeting the criteria for subsidy allocation under a limited program budget. (assumption set 1)

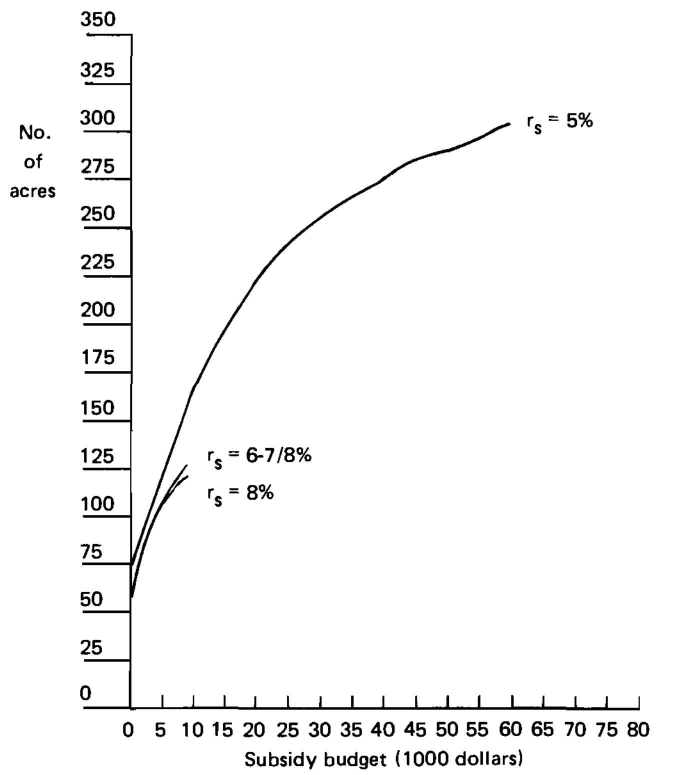


Figure 4.10B. Number of acres meeting the criteria for subsidy allocation under a limited program budget. (assumption set 2)

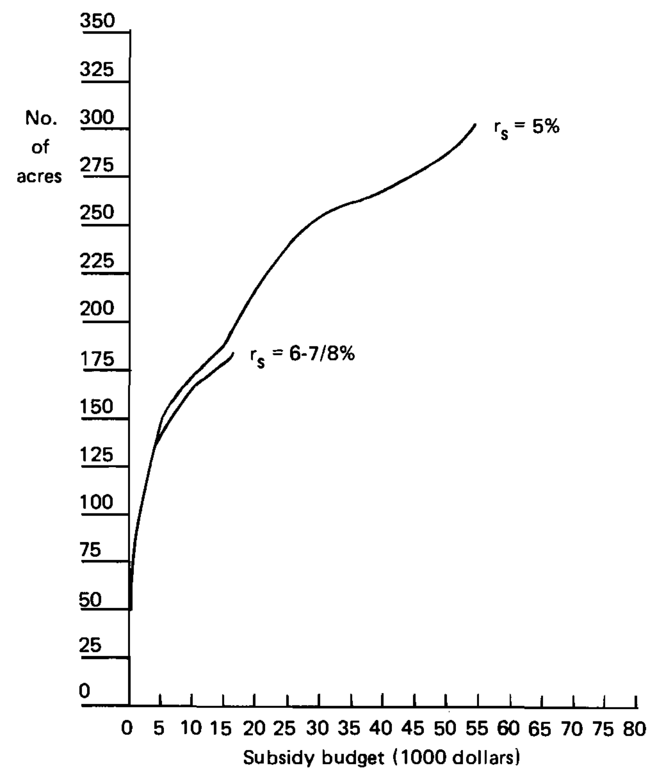


Figure 4.10C. Number of acres meeting the criteria for subsidy allocation under a limited program budget. (assumption set 3)

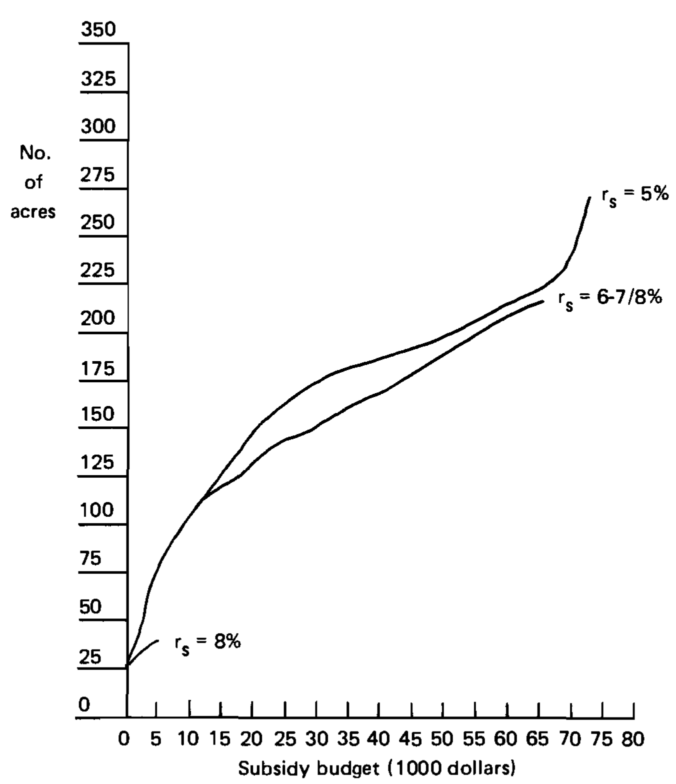


Figure 4.10D. Number of acres meeting the criteria for subsidy allocation under a limited program budget. (assumption set 4)

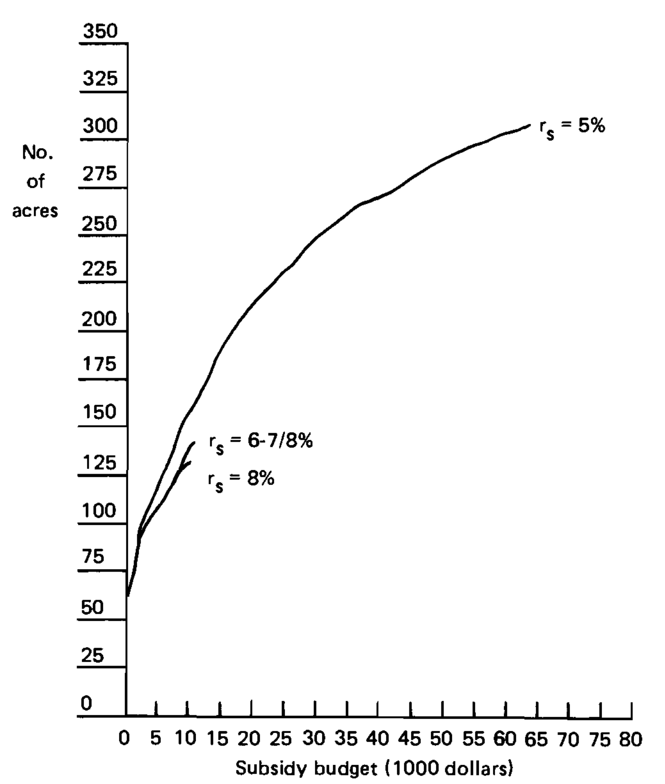


Figure 4.10E. Number of acres meeting the criteria for subsidy allocation under a limited program budget. (assumption set 5)

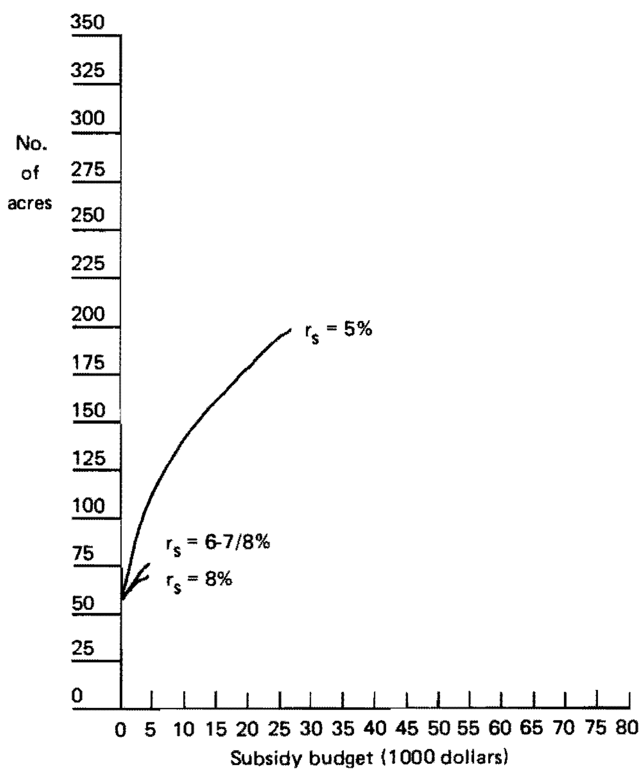


Figure 4.10F. Number of acres meeting the criteria for subsidy allocation under a limited program budget. (assumption set 6)

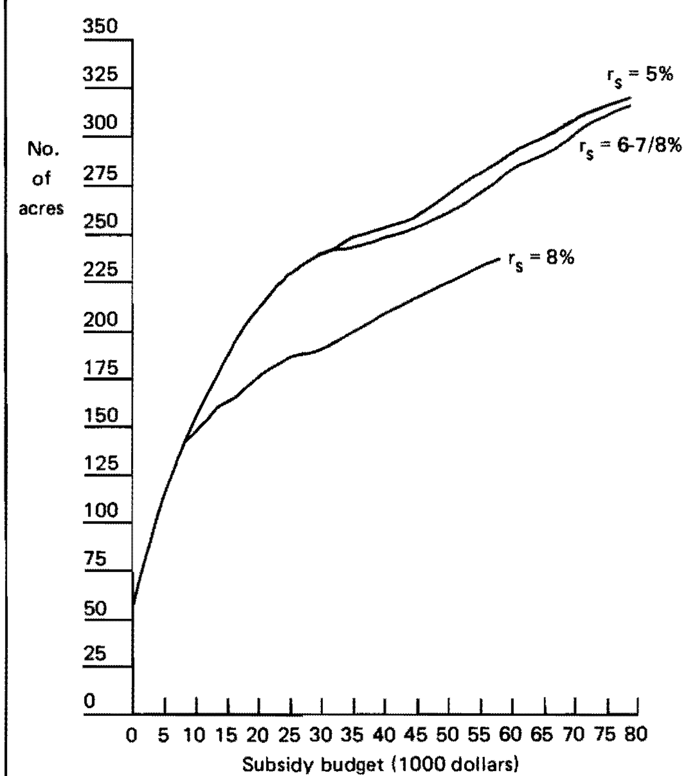


Figure 4.10G. Number of acres meeting the criteria for subsidy allocation under a limited program budget. (assumption set 7)

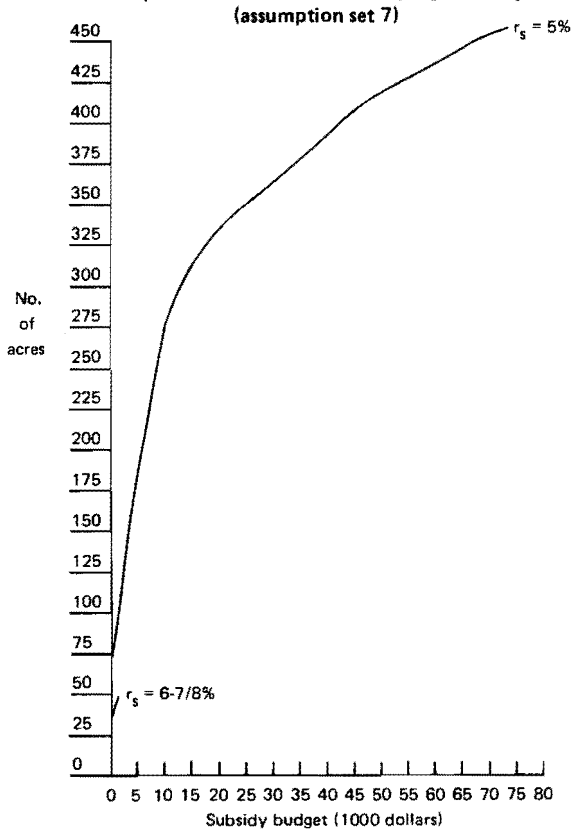


Figure 4.10H. Number of acres meeting the criteria for subsidy allocation under a limited program budget. (assumption set 8)

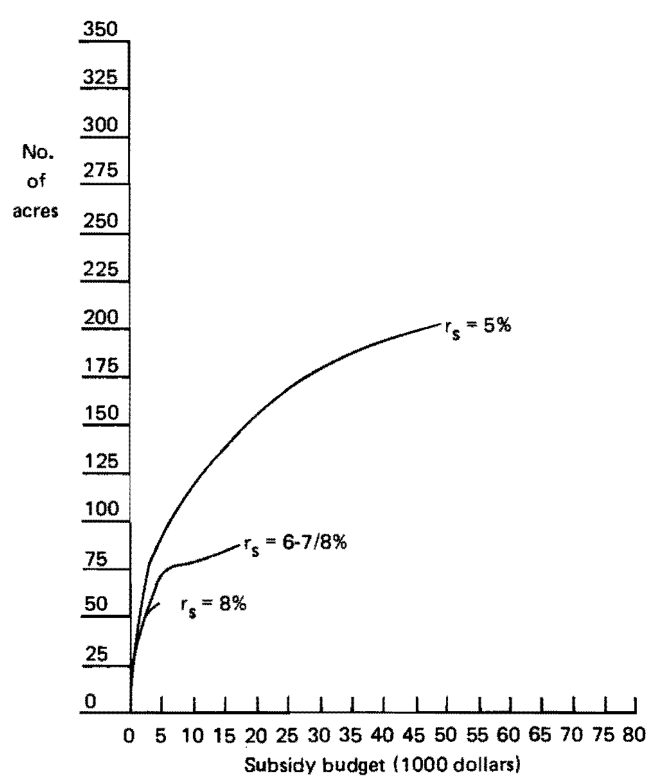


Figure 4.10I. Number of acres meeting the criteria for subsidy allocation under a limited program budget. (assumption set 9)

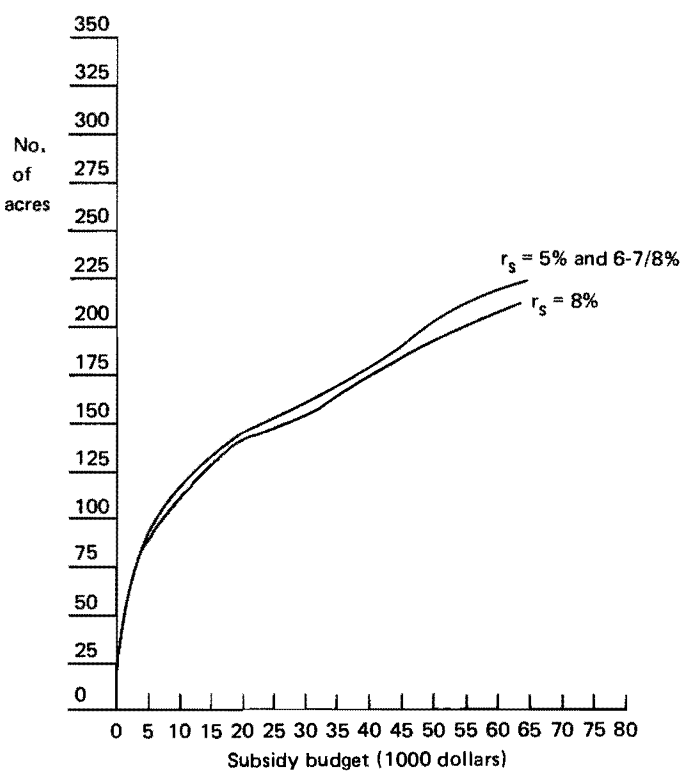


Figure 4.10J. Number of acres meeting the criteria for subsidy allocation under a limited program budget. (assumption set 10)

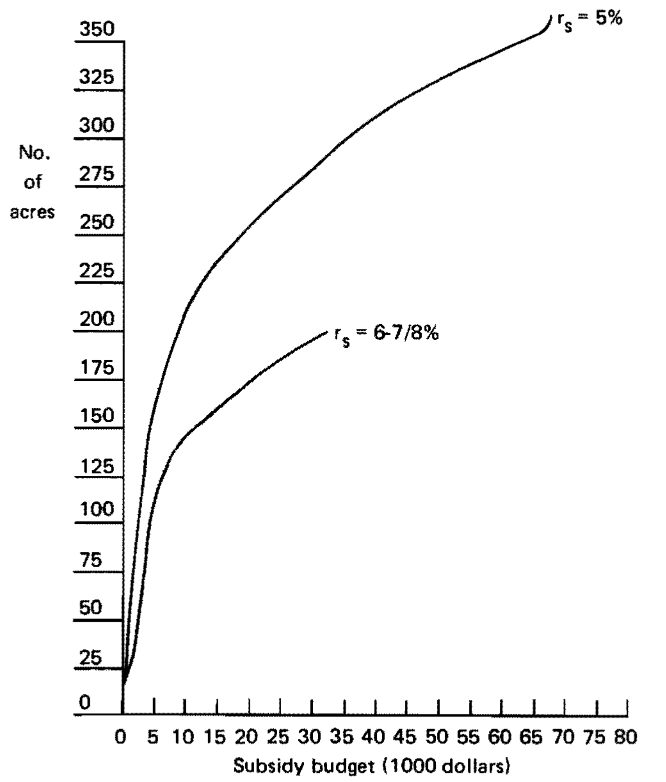


Figure 4.10K. Number of acres meeting the criteria for subsidy allocation under a limited program budget. (assumption set 11)

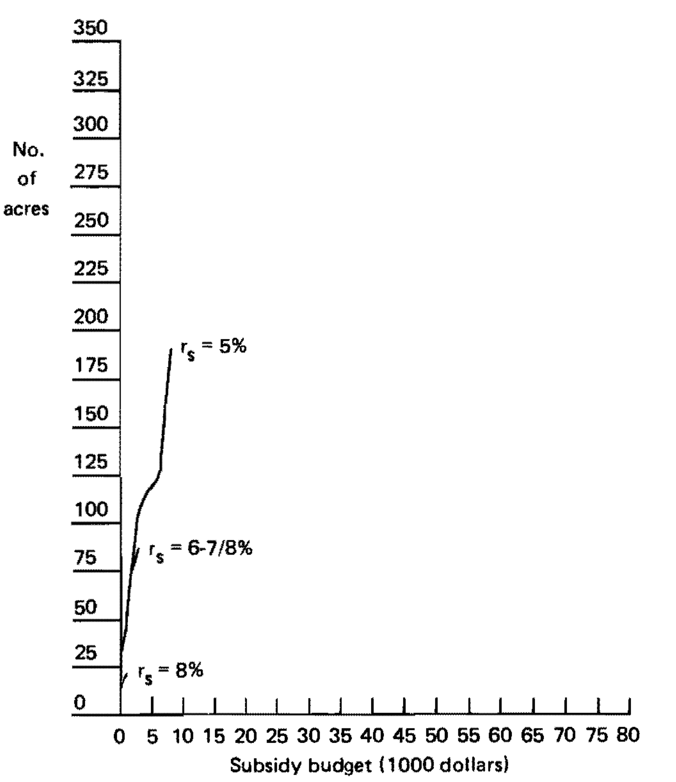


Figure 4.10L. Number of acres meeting the criteria for subsidy allocation under a limited program budget. (assumption set 12)

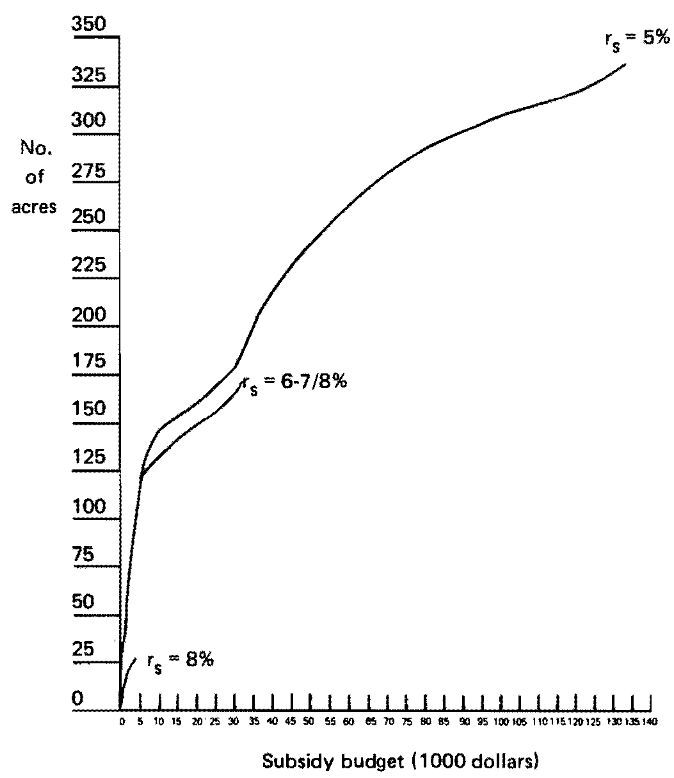


Figure 4.10M. Number of acres meeting the criteria for subsidy allocation under a limited program budget. (assumption set 13)

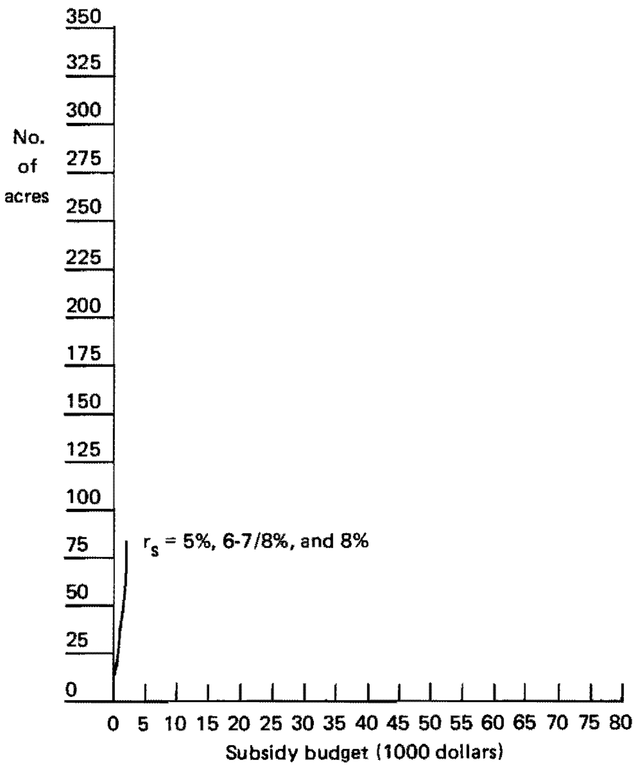
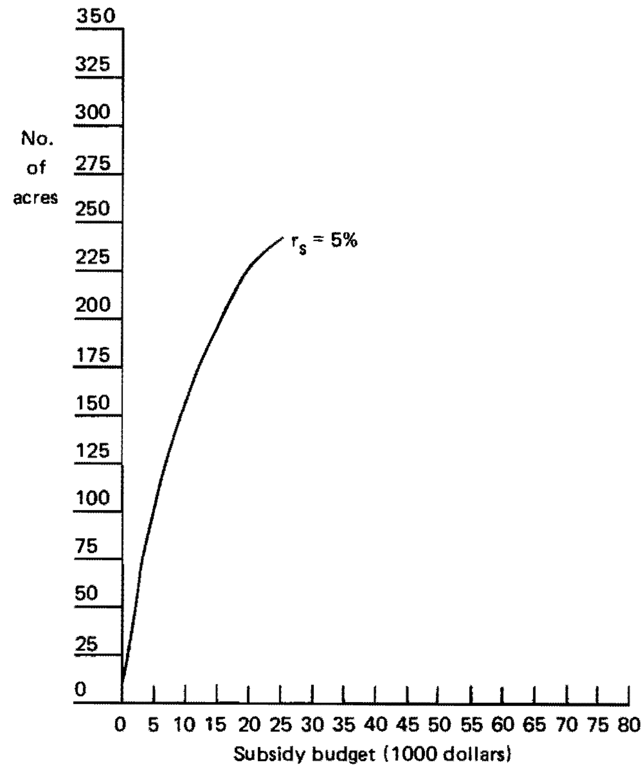


Figure 4.10N. Number of acres meeting the criteria for subsidy allocation under a limited program budget. (assumption set 14)



financial rotation. In fact, an increase of 1 percent in price growth has virtually the same effect on computed benefits and rotation length as a decrease of 1 percent in r_a.[8]

As mentioned earlier in Section 3.2.1 of Chapter 3, long-term price inflation has been incorporated into our assumptions regarding the annual stumpage price growth rate. The values for price growth rates of 4 percent, 5 percent, and 6 percent are assumed to include 3 percent inflation and real annual stumpage price increases of approximately 1 percent, 2 percent, and 3 percent, respectively. However, if one does not wish to assume a 3 percent long-term price inflation rate, the residual **real** price increase can be adjusted, within limits, so that the composite of the two equals one of the above rates. By incorporating inflation into the annual stumpage price growth rate (and later into private land value growth rates), we have attempted to eliminate the bias of discounting benefits computed in real terms with an r_a which reflects inflationary expectations.

The effects on benefits, PE, and SE of raising and lowering g_p are varied. Higher rates decrease the number of acres associated with program benefits (Figure 4.2) due to a smaller number of positive ID's. For a fixed **social** annual stumpage growth rate (g_s) and a fixed social discount rate (r_s), the effect of this decrease in acreage upon the program benefits, PE, and SE is somewhat mitigated by the longer rotations generated by a higher g_p. In general, the overall effect of higher g_p's is to decrease program benefits, PE (Figure 4.4A), and SE (Figure 4.5A).

The value of g_p affects the number of farms meeting the subsidy allocation criteria in a wide variety of ways, depending upon the social discount rate selected (see Tables 4.7A-4.7C, column 2).[9] Higher g_p's greatly increase NPW_s's, which suggests greater numbers of acres meeting the criteria, but high g_p's also eliminate many ID's causing a reduction in the number of acres qualifying. For farms meeting the subsidy allocation criteria, these two offsetting influences lead to greatly different comparisons between assumptions (see Figures 4.6A-4.9C and Figures 4.10 A-C).

4.3.2 ANNUAL LAND VALUE GROWTH RATE

Assumptions 4 and 5 individually vary the annual land value growth rate from 5 percent to 2 percent and 8 percent, respectively. Land value growth is only incorporated into the private land cost calculations since estimates of social land cost were computed differently. (See Section 3.3 of Chapter 3 for social land cost determination). As for g_p, these rates include inflation, so real rates are a residual of our rates less the assumed long-term annual inflation rate.

The land growth rate only influences the cost side of the calculations, has no effect on rotation, and affects **private** ID's,

[8] They are not exactly offsetting. For example, $\frac{(1.05)^n}{(1.08)^n} > \frac{(1.04)^n}{(1.07)^n}$

[9] The reader should note that in determining which farms meet the subsidy allocation criteria the stumpage price growth rate assumed in the social analysis (g_s) is assumed equal to the rate privately assumed (g_p). Therefore, much of the effect of changing g_p results from the corresponding change in g_s, which affects NPW_s.

but not **social** NPW_s's. The 2 percent rate did not increase any ID's enough to add to the acreage associated with program benefits, but the increase to 8 percent greatly decreased the number of positive ID's, and, therefore, decreased acreage (Figure 4.2). Since program benefits, program expenditures, and social costs are calculated identically as in Assumption 1, only the associated acreages included in the benefit categories are relevant in determining PE's and SE's. Therefore, those values are unchanged for Assumption 4. However, PE's and SE's were lower for the 8 percent land value growth rate (Figures 4.4B and 4.5B) because of acreage reductions.

Lowering the private land value growth to 2 percent had negligible effect on the values for farms meeting the subsidy allocation criteria (Figures 4.6A-4.9C and Figures 4.10A, 4.10D, and 4.10E). Raising the land value growth rate to 8 percent greatly reduced the farms, acres, total investment deficits, program expenditures, and social cost for the farms meeting the subsidy allocation criteria. This was due to the large shift from positive ID's to zero ID's. The ratios (PE and SE) for the above group were not as greatly altered by the 8 percent land value growth rate because the numerators and denominators were reduced almost proportionately (see Figures 4.8A-4.9C).

4.3.3 SITE INDEX

Assumptions 6 and 7 individually vary the site index from regular (site 40 or 60 depending upon an assumed county site index) to high site (all site 60) and low site (all site 40), respectively. Costs are not affected by these changes. Higher sites greatly decrease the number of acres associated with program benefits because many ID's become zero (Figure 4.2). However, the tremendously increased yields, together with the increased rotation lengths, more than offset the decline in acreage. Program benefits and PE become much higher for the high site assumptions (PE=3.62) and they become much lower for the low site assumptions (PE=1.48) even though the associated acreage increases under the low site assumption (Figure 4.4C). Also, SE is similarly affected by increased and decreased site quality as indicated in Figure 4.5C.

Most of the values for farms meeting the subsidy allocation criteria are heavily dependent upon site index. Higher sites increase NPW_s but decrease ID, and lower sites decrease NPW_s and increase ID. These effects can be somewhat offsetting, but were not for our group of participants. For the low site assumption only the 5 percent social discount rate assumption generates a significant number of farms meeting the subsidy allocation criteria (Figures 4.6A-4.9C, 4.10A, 4.10F and 4.10G). For the high site assumption, most of the values increase, although results vary somewhat by the rate of discount.

Further sensitivity for site index is presented in the next section for higher base period price assumptions. The interaction of price with site leads to slightly different relationships between sites.

4.3.4 1972 BASE PERIOD STUMPAGE PRICE

Assumptions 8, 9, and 10 as a group vary the base period (1972) stumpage price from $30 per 1,000 board feet and $3 per cord to $50 per 1,000 board feet and $5 per cord for **all three** site assumptions (Table 4.1). In effect Assumptions 8, 9, and 10 correspond to Assumptions 1 (regular site), 6 (high site), and 7 (low site), respectively, for the higher base price. The direct effects of the price increase were to decrease the number of positive ID's and to increase the number of farms with NPW_s's exceeding zero. The increase in price does not affect the optimum financial rotation. The results of site variation between these three assumptions exhibit the same general relationships explained in the previous section. However, the exact variations **due to site** are somewhat different because of the influence on ID and NPW_s caused by the increased base price. A comparison of Figures 4.4C and 4.4D illustrates this contrast.

The effect of lowering the number of positive ID's with the 50/5 price reduced the acreages associated with program benefits by about 25 percent (Figure 4.2). However, the remaining acres' benefits, PE's, and SE's were calculated for higher prices which offset most or all of the reduction of benefits due to acreage reductions alone. This offsetting influence was highly variable depending upon the site inherent in the assumption (see Figures 4.4C, 4.4D, 4.5C, and 4.5D). The effects of the higher base price on the values for farms meeting the subsidy allocation criteria were also widely variable, especially between contrasting social discount rates. The number of acres generally declined at the higher price because the effect of reducing the number of positive ID's outweighed the effect of gains in positive NPW_s's. However, the higher benefits generated at the 50/5 price reduced the numerical disadvantage somewhat (Figures 4.6A, 4.10H, 4.10I, and 4.10J).

4.3.5 PRIVATE LAND COST AND LAND TAX COST

Assumptions 11 and 12 individually vary the private land cost and land tax cost from one-half of the amount given on the landowner questionnaire to zero cost and full cost, respectively. Lower land and tax costs greatly decreased the number of positive private ID's, but they substantially increased the number of positive NPW_s's (because the social land cost **factor** is assumed equal to the private **factor** for calculations of the values for farms meeting the subsidy allocation criteria). Higher land costs have directly opposite influences on the above values. Rotations are not affected by land cost as long as the assumption is maintained that all stands are replanted after harvest.

As illustrated in Figure 4.2, the number of acres associated with program benefits falls (from 445 to 259) when land cost decreases and rises (from 445 to 528) when land cost increases. Since benefit calculations for individual farms remain unchanged from Assumption 1, the **only** effect of the land cost variation on the PE and SE values is the effect on the acreages associated with program benefits. For all social discount rate and stumpage price growth assumptions, PE and SE declined when land cost was assumed equal to zero and increased when land cost was assumed to be the full amount (see Tables 4.5 and 4.6A-4.6C).

The values for the farms meeting the criteria for subsidy allocation vary according to the social discount rate assumption. No generalizations can be made about the relationships between assumptions (see Figures 4.6A-4.6C, 4.10A, 4.10K, and 4.10L).

4.3.6 MOST FAVORABLE-LEAST FAVORABLE ASSUMPTIONS

To provide a sensitivity for all of the factors varied individually in the first 12 assumptions, we chose the most favorable combination (zero land cost, high site index, 50/5 stumpage price, and 6 percent g_p) and the least favorable combination (full land and tax cost, low site index, 30/3 stumpage price, 4 percent g_p, and 2 percent land value growth) to show the extremes of our assumptions. These are represented by Assumptions 13 and 14, respectively. While these are unrealistic assumptions, they serve to better illustrate how the calculated values depend upon the assumptions used to generate them.

In addition to the direct effect of the variable factors, the indirect effect of rotation length exerted an influence which further widened the gap between the two extremes; Assumption 13 generated the longest rotations and Assumption 14 generated the shortest (Figures 4.1A-4.1G). As could be expected, Assumption 13 caused most positive ID's to be eliminated, leaving the least acreage in the program benefit group, and Assumption 14 caused associated acreage to be the greatest (Figure 4.2). The effect of these assumptions on PE and SE is varied (see Tables 4.5 and 4.6A-4.6C).

The number of farms which met the criteria for subsidy allocation was very low for both Assumptions 13 and 14 (Figures 4.6A-4.6C, 4.10M, and 4.10N). At social discount rates of 6 7/8 percent and 8 percent each extreme had virtually eliminated itself from either the positive NPW_s group (Assumption 14) or the positive ID group (Assumption 13). The other values for farms meeting the subsidy allocation criteria differ widely according to the social discount rate assumption (see Figures 4.7A-4.9C).

CHAPTER FIVE

Discussion Of Results And Their Limitations

The calculated program effectiveness ratio (PE) and social efficiency ratio (SE) were 2.20 and 0.99 respectively. This means, accepting our basic assumptions, that REAP-A7 as applied to red pine planting in Minnesota in 1972 had program benefits exceeding program expenditures and had total benefits approximately equal to total costs. Thus, the program **as a whole** was marginally justified on the basis of expected timber benefits alone according to the first level criterion that present value of social benefits have to exceed present value of social costs.

However, if the criteria suggested in Chapter Three for subsidy allocation under an unlimited program budget had been used, both PE and SE would have been greater and the number of acres subsidized would have been considerably smaller (see pp. 11-12). We thus conclude that application of the subsidy allocation approach could have improved both the effectiveness of the program and the overall social efficiency associated with timber production on the lands planted under the program. The implication is that the 1972 REAP-A7 funds spent in Minnesota could have produced greater social benefits; or conversely, expenditure of less funds could have achieved the same results.[1]

The above results and conclusions depend heavily on our assumptions; and a great deal of uncertainty surrounds these assumptions concerning input and output values. Therefore, we provided the sensitivity analysis in Chapter Four. The analysis indicates highly variable results, but in each case, adopting the subsidy allocation approach would yield the highest net social benefits possible for any given program expenditure and any set of assumptions used.

The magnitudes of PE, SE, and NPW_s are particularly sensitive to r_s. While several intuitively appealing arguments can be made for using a lower rate than 6 7/8 percent for social evaluation of forestry projects, the logic of such arguments is not convincing enough to consider forestry projects as a special case in public investment. Indeed to do so would confuse a basic rationale underlying allocation of public funds.[2]

The remainder of this chapter discusses the limitations of the analysis – other than uncertainties regarding appropriate values of inputs and outputs which were discussed in Chapter Four. These other limitations include uncertainty concerning the basic conceptual assumptions of the model and limitations in terms of variables and relationships not considered in the analysis (*e.g.,* secondary benefits and costs associated with purposes other than timber production).

5.1 TIMBER AVAILABILITY

The most obvious limitation is the optimistic assumption that all of the increased timber production associated with the program will be available for harvest when it becomes financially mature. This is a very optimistic assumption for two reasons. First, natural reduction in physical volumes could result due to fire or insect or disease attacks. Second, the assumption is that all owners of the timber produced will be willing and able to sell when it is financially mature at the prices assumed in the analysis.

Some proponents of forestry incentives, ignoring any economic rationale, argue that as long as we can induce additional tree planting on idle acres, it really does not matter what the present owner's motivations or intentions are, since he will most likely have sold the property long before the planting is ready for harvest. And who knows what the new owner's objective will be. It might very well be to sell the timber.

As far as the argument goes, it is reasonable. Past experience indicates that ownership will likely change at least several times over the period it takes for a new stand of trees to mature in Minnesota. Similarly, ownership intentions certainly do change with ownership (although in the past they generally change more in the direction of recreation and preservation than toward timber production.[3]

---

[1] The contention that subsidies given were too high is supported by the answers given to question 18 on the landowner questionnaire (see Appendix D). About 70 percent of respondents said they would have planted the same acreage with less subsidy. See also Yoho and James (1958) for confirmation of this result.

[2] This is not meant to be an argument in favor of the 67/8 percent rate, but rather an argument in favor of using a uniform rate, regardless of what rate is accepted within our political system. As such we included two additional rates in the sensitivity analysis.

[3] Much depends on how stumpage prices move over time in the future.

Thus, we have to face a more basic question concerning the justification for forestry incentives for timber production on NIPF lands. Simply stated, is it justifiable to spend large sums on such uncertain prospects, particularly if more certain (and possibly more efficient alternatives) are available to meet the same objective of a larger, secure flow of timber over time. Just as many states and local governments are reluctant to provide a yield tax option for forest lands because of the resulting uncertainty and annual fluctuations in revenues, so we should question the wisdom of relying on NIPF ownerships for a significant portion of our timber supply, unless such ownerships can be placed under some form of long-term commitment through contracts or timber purchase rights agreements.[4] Results of our questionnaire (Question 23) indicate that only about 24 percent of the respondents would consider such long-term contracts, and then only if most received unreasonably high annual rents or payment (which would not be justified under any of our price assumptions).

This point transcends questions of effectiveness of public programs and efficiency which assume expected yields from planted lands to be a certainty. We have no way of predicting when and what portion of the future supply will be **economically** available.[5]

The question of economic availability is an important one in terms of justifying programs such as REAP-A7. Given the small average size of the individual plantings under REAP-A7, is it likely that harvest of such areas will be commercially attractive in the future? Zivnuska argues that the minimum size area for economical exploitation may well be between 200 and 500 acres.[6] Even if we reduce this estimate by 50 percent – to 100-250 acres – it can still be seen that the median size of area planted in Minnesota under REAP-A7 in 1972 (4 acres), even if combined with similar size plantations established in other years, was far too small to permit efficient harvesting. One implication is that PE, SE, and the number of farms meeting the subsidy allocation criteria, as estimated here, may be unrealistically high. It might be argued from a standpoint of economic efficiency, following this line of thought to its logical conclusion, that public incentives programs (such as FIP) should specify and concentrate on areas **larger** than a certain minimum, rather than specifying a maximum area and no minimum in terms of qualification for cost-sharing funds. Politically, this may be unacceptable on the basis of negative income distribution effects, in which case such a constraint on FIP objectives should be stated.

There is a related point which needs to be clarified and questioned. FIP regulations state that anyone who has harvested timber on his land in the past five years is not eligible for planting incentives on those lands. (The argument is that the owner should be able and willing to plant at his own expense.)[7] However, this ignores the whole logic behind incentives payments as we understand it. If the above owner (who has harvested within five years) would not replant without subsidization – *i.e.*, he has an ID>0, in the terms of this analysis – then it is just as logical to provide him an incentive as any other landowner. He may have sold timber to get money to pay off the land purchase or for some other reason, but there is no reason to assume that he necessarily will be willing to reinvest in replanting (which is quite a separate investment decision). A further argument for subsidizing these owners is the likelihood that they have more of a timber production orientation than many who have not harvested in the past five years.

Finally, if NIPF lands are so critical to our wood supply, we ought to ask why we have not been more successful in utilizing presently mature stands of timber on these lands. Growth on NIPF lands is greater than cut. Even in the case of softwood sawtimber – the accepted critical wood category today – growth on NIPF lands is 23 percent **greater** than cut, as compared to a 16 percent **shortage** for all ownerships.[8] Is one of the problems with existing areas a lack of economically attractive opportunities (markets) even now? Do these owners of presently mature stands **want** to sell timber (if they could realize an economic gain)? These two questions and others need to be explored, since they directly relate to our "hopes" or expectations that expanded timber crops from such lands (supported with public subsidies) will be economically available in the future. Is it not likely that future NIPF owners will, in general, be less oriented toward timber production and more toward recreation and other uses of their forest lands? Similarly, as we necessarily move toward more capital intensive exploitation systems to increase labor productivity in response to wage increases, is it not likely that the opportunities for economical exploitation of a given size timber tract will be less than at present?

One possible reason for answering "no" to the latter two questions would be higher future stumpage prices than assumed in this study. This would make timber sales more attractive to owners and exploitation more economical.[9] However, is not the major impetus behind our concern for timber supplies predicated on the implicit (or in some cases explicit) policy assumption that prices should be kept down? If we accept the high price assumptions of the *Outlook*, for example, then future expected timber supplies would not appear to be a major problem.[10] If we let prices rise freely, then supply and demand will come into balance. We do not wish to open Pandora's box here, but the question of timber price policies is a central one which must be faced squarely in making the socially "correct" decision regarding subsidization of private (as well as public) timber production opportunities.

5.2 ESTIMATION OF PROGRAM BENEFIT (B_p) GROUP AND POSSIBLE NET SECONDARY BENEFITS

Another obvious limitation of our analysis is the explicit assumption underlying our approximation of B_p, namely, that

[4] In the case of industrial lands the commitment is quite obvious; and in the case of public lands, planning for future timber supply is at least somewhat more feasible than in the case of NIPF ownerships.

[5] There is, of course, also the uncertainty surrounding the estimate of future **physically** available supply, since it may be reduced due to fire, disease, insect problems, etc. In the present study, we assumed an estimated yield that excluded these possible losses. If we had introduced some allowance for losses, the results would have been more discouraging, since B_p would have been reduced in all cases.

[6] Zivnuska (1974), p. 13. See also Stoddard (1961), pp. 122-123; PAPTE (1973), p. 92, states that: "Holdings of less than 200 acres are generally too small to justify intensive forest management on a commercial basis unless they are of better than average site quality."

[7] See McGuire, 1974, p. 20.

[8] Zivnuska, 1974, p. 231.

[9] Loggers are not so much concerned with the fact that high value species such as cherry and walnut are found in isolated areas and only a few trees per area. Much depends on prices for a given species.

[10] U.S. Department of Agriculture, Forest Service (1974).

all those for whom estimated ID equaled zero would have planted without the subsidy, and all the others (those for whom estimated ID was greater than zero) would **not** have planted without the subsidy.

There are a number of reasons why this assumption may not be valid. First, some participants may have perceived primary costs and benefits and possibly their alternative rates of return (r_a's) as being different from those used in our calculations, thereby making their perceived rates of return (and ID's) larger or smaller than the calculated values. Second, there may have been net secondary benefits associated with plantations which some participants perceived, but which were not included in the calculations. Third, and closely related, many participants may have not been considering their planting and site preparation activities in the limited **investment** framework provided by our model, *i.e.,* they may have lacked any perception of the potential return from the program activities (and not really cared about it).

It is not possible to say much about these possibilities based on information available, other than the fact that they are possibilities. However, they can be checked indirectly by looking at the number of participants who, after adding the subsidy to their benefits (or subtracting it from their costs), moved into the category where there was no ID (or both NPW_I and NPW_r are equal to or greater than zero). Such an analysis indicates that, even after the subsidy is added, about 90 percent of those with ID greater than zero before the subsidy still had ID's greater than zero, *i.e.,* estimated ID was greater than the subsidy given. Therefore, the interpretation of estimated ID as the minimum subsidy necessary to induce the investment by the participants is incorrect for many participants. It is quite likely that several participants for whom we identified an ID in fact had no ID. In that case, PE would be lower than the estimates determined in Chapters 3 and 4. The actual minimum subsidy necessary is obviously not greater than the subsidy actually granted, usually about $30-$40 per acre. Such an upper level for ID could be incorporated into the *ex ante* model for subsidy allocation and consequently increase the PE for the program.[11] (See Section 6.1 of Chapter 6 for a discussion of the adaptation of the subsidy allocation model to FIP.)

A major indirect effect of over-estimation of ID for a participant is the resultant short optimum financial rotation (see Chapter 4, Section 4.1, where determination of optimum financial rotations is discussed). If the financial rotation is much shorter than the optimum social rotation, it usually causes NPW_s to be negative, even if at a longer rotation NPW_s would be positive.[12] A negative NPW_s, of course, precludes the farm from meeting the first criterion for subsidy allocation.

It is very likely then, given the nature of the participants and the above assumptions, that many participants perceived some net secondary benefits associated with their plantations which were not included in our financial investment analysis (*e.g.,* additional land value increases for future vacation homes development).[13] Unfortunately, we have no basis for accurately quantifying such benefits for the isolated plantings undertaken with REAP-A7 support, so all we can do is recognize their possible existence.

The existence of net secondary benefits does not alter the subsidy allocation **approach** described in Section 2.5 of Chapter 2. However, under those circumstances the approach cannot be applied empirically without firm estimates of such secondary benefits. In addition, it would be necessary to distinguish between private net secondary benefits and social net secondary benefits if they differ.[14] Once estimates of net secondary benefits are obtained, they can be included in the calculations of NPW_s and ID. Their inclusion would increase the number of participating farms meeting the first criterion for subsidy allocation ($NPW_s \geq 0$), but reduce those meeting the second criterion ($ID > 0$). The net effect in terms of the number of farms and acres to be subsidized could be small, although the decision on which farms to subsidize could be greatly affected. The effects of including secondary benefits would, of course, vary depending upon the estimates and assumptions used.[15]

5.3 SUMMARY OF LIMITATIONS OF THE ANALYSIS

In summary, the results and conclusions can legitimately be justified only for the case studied, *i.e.,* REAP-A7 program for red pine planting in Minnesota in 1972. It is quite possible that significantly different results would be obtained if the same type of study were undertaken in Alabama, North Carolina, or some other state with quite different ownership characteristics, productive potentials, etc. (It is our hope that comparative studies can be undertaken in some other areas of the country.)

In addition, there are the usual limitations involved with a study based on survey data. However, in this case we had both the survey results and agency information on all participants to work with. As such, somewhat greater confidence can be placed in the results. Further, as discussed in Chapter 3, the response to our landowner questionnaire was relatively high, and our analysis of differences between respondents to the first and second mailings indicated no significant differences in the responses (with the exception of a few questions which were not central to the main analysis of effectiveness and

[11] Such an upper level for a subsidy payment would likely be more politically acceptable as well.

[12] The optimum social rotation is defined to be the rotation which maximizes NPW_s, and it is highly dependent upon r_s, socially estimated secondary benefits, and social timber benefits.

[13] It is important to insure that secondary benefits are net of secondary costs such as deterioration of wildlife habitat due to large monotypic plantations. Also, it is important to recognize that many perceived secondary benefits would accrue **without** the project, and consequently are not secondary benefits of the plantation. For example, esthetic enjoyment of the natural hardwood forest could be as great as that of softwood plantations.

[14] Even if private and social net secondary benefits were assumed equal in timing and amount per year, different social and private discount rates would lead to different present values. However, it is quite likely that different yearly amounts of net secondary benefits would exist as well. For example, if the landowner receives a benefit from the esthetic enjoyment he gets from walking through his red pine plantation, does society gain equally since the owner is a member of society? If the above owner allows other individuals to walk among his trees, is society's gain larger than before? It is likely that the answers to one or both of the above questions would lead to different private and social valuations of secondary benefits.

[15] If secondary benefits are large relative to timber benefits (in which case they could actually be the primary benefits and timber could be secondary), it is possible that the owners would be unwilling to harvest away the source of those benefits, *i.e.,* the owners could be adverse to selling timber. Even if such owners or future owners would be willing to harvest timber, they might choose such long rotations that NPW_s would become negative (assuming social secondary benefits are lower than private secondary benefits).

efficiency). It should also be recognized that some of the questions asked might not have been fully understood by respondents. One always runs that risk in a mailback questionnaire survey.

Finally, as mentioned earlier, our assumptions with regard to the value of inputs and outputs involved were in some cases arbitrary. However, the sensitivity analysis presented in Chapter 4 indicates that the results of the study are not very sensitive to many of the assumptions, and, as such, the limitation due to such assumptions is lessened. As is usual in analyses of long-term investments, the results are most sensitive to interest rates used and the number of years between initial investment and main returns. Concerning other limitations of the study discussed in this chapter, there is not much we can do here other than to recognize them.

CHAPTER SIX

Policy Implications And Application

What are the implications of this study in terms of public policies and programs to deal with non-industrial private forest lands and their future contribution to wood supply? Three seem to be relevant in the context of our objective and recognizing the limited scope of the study. The first relates to use of the model developed herein making cost-share subsidy decisions under the Forestry Incentives Program (FIP). The second relates to the need for parallel studies of other incentive programs in Minnesota and the same programs in other states, to provide a basis for making comparisons between alternative programs for motivating private landowners. The third implication relates to the findings of our study (as well as those of others) concerning NIPF owner characteristics and motivations and the generally discouraging implications in terms of intensified management on NIPF lands. While we do recognize the potential for future increase in the relative contribution of NIPF lands in Minnesota and elsewhere, our feeling is that the opportunities are limited using the present approach of cost-share incentives. Thus, alternatives need to be explored.

6.1 ADAPTATION OF THE CRITERIA FOR SUBSIDY ALLOCATION TO FIP

While the empirical results of this case study have limited implications, the general approach (Chapter 2) should have broader applicability in Minnesota as well as other parts of the nation in terms of guiding cost-share allocations under FIP. The model as presented provides a logical, conceptual approach to *ex ante* evaluation of cost-share subsidy programs, but relies somewhat upon ex post data. The model also likely overestimates the amount of ID, given the fact that the participant accepted a subsidy no greater than about \$30-\$40 per acre. Therefore, the model needs to be converted to an **operational model** for use in *ex ante* evaluation of cost-share subsidy allocations. Such an adaptation involves no change in the conceptual framework, but does involve development of a different type of information base for applying the model.

In brief, the subsidy allocation approach suggested earlier is to estimate which lands are socially productive, *i.e.,* those for which NPW_s is greater than or equal to zero, or, alternatively, those for which the expected social rate of return from intensified forestry is equal to or greater than the appropriate social discount rate.[1] For those properties which have socially productive potentials, an estimate is developed of the subsidy needed to induce the landowner to invest in the practice(s) being considered. Under an unlimited program budget those landowners who need a subsidy would be offered it (subsidy=ID). Under a limited program budget, a further step would be applied. Each participant who meets the above two criteria ($NPW_s \geqslant 0$ and $ID > 0$) would be ranked according to a ratio of NPW_s to ID (NPW_s/ID). Limited funds would be given to those with the highest ratios until the budget was exhausted. This is conceptually the way it would work. However, there are a number of problems involved in making the necessary calculations when applying the approach on an *ex ante* basis.

The first problem relates to the estimation of NPW_s for properties within an administrative area.[2] In the longer term, it is desirable to develop an information base such that NPW_s can be determined individually for all NIPF lands in a given state (or administrative area). All those owners of properties with $NPW_s \geqslant 0$ could then be approached by service or extension foresters concerning their interest in participating in the program. This would insure a broader and probably greater participation than is possible with the present "shot-gun" approach. Such an information system and base also could be used for many purposes other than the incentives program being studied. As such the cost of the information generating activities could be spread over a number of programs and attributed to a number of purposes.

In the shorter term, and in terms of immediate application of the proposed system to FIP, a more selective approach will be useful: as in the past, a landowner would apply to the appropriate authority for participation in the program. The local service forester would then make an estimate of the NPW_s for the property for which subsidy is being applied.

In either case, there will be a need to generate information related to productivity, costs, markets, etc. Much of this information will have to be developed in terms of averages for a county or for a broader area. Initially, "guesstimates" will have to be utilized. Regardless of the nature of the data initially used, it also will be necessary for service foresters to have a good comprehension of the process of estimating NPW_s. This may require some in-service training programs.

A second problem relates to estimating the necessary subsidy required to induce the landowner to invest in intensive forestry (whether stand improvement or site preparation and planting). Again several operational approaches are possible for overcoming this problem.

A straightforward approach would be to ask the applicant to state how much of a subsidy would be required to get him to invest in the practice. The service forester would then ex-

[1] The assumption here is that timber production is the actual objective of FIP. To the extent that other benefits are involved, they should be included in the analysis. If they can be quantified, they can be worked directly into the calculation of NPW_s. If not, then they must be treated in qualitative — but explicit — terms in the analysis.

[2] A major part of this problem relates to the estimation of site quality and biological production potentials for different species and estimation of the relevant rotations which are accepted by the NIPF owners. As indicated earlier, the optimum **private** rotation (and therefore yields) is used in calculating NPW_s.

plain to the landowner that each applicant receives a funding ranking based upon his land's potential "social value" and the required subsidy estimated by the landowner. The service forester should make clear that because of a limited budget it is unlikely that all applicants will be funded, and that the funding ratio is adversely affected by high required subsidies. The applicant might then be given a second chance to lower his estimate of the required subsidy. It is felt here that if the landowner has been given the appropriate help in estimating a realistic cash flow for his property, then he should be able to make a reasonable estimate of the subsidy required to meet his particular investment criterion.[3] However, giving him a second chance to reduce his required subsidy may not be wise, since the applicant would tend to initially overestimate the incentive payment needed, knowing that he would have a second chance to reduce it. If an applicant knows that he only has one chance to "bid" for the subsidy, he will likely make a realistic estimate, if he is serious about the investment in the first place, and if he has adequate information on which to base his estimate of profitability.

Another approach to estimating the needed subsidy for farms with $NPW_s \geq 0$ might be the following: in the absence of direct information from individual applicants, average private cost and return estimates could be used in conjunction with an estimate of the relevant alternative rate of return for an individual with a similar income and profession as the applicant. Such estimates would necessarily be rough initially, but over time it should be possible to refine them so that fairly realistic results are obtained. Using these estimated values for inputs and outputs, the service forester and/or administering agency can calculate an estimated rate of return which would be needed by the applicant to induce investment. If the estimated **actual** rate of return on the practice for the landowner is less than the estimated rate needed to get him to invest, then the difference needed to equate the two rates is the subsidy needed. This subsidy would then be offered to the applicant if the program budget permitted. If the landowner accepted, it could be assumed that the calculation was correct or erred on the high side. If the individual refused to undertake the forestry investment with the subsidy offered, then it could be assumed that the values used for inputs and outputs were not those perceived by the applicant.

Either of the above two approaches to determining the required subsidy and ascertaining landowner interest in participation in the cost-share subsidy program (in this case FIP) could be used. It is not possible to determine *ex ante* which would be best over time. The latter approach would take longer to develop, since initially it can be expected that the appropriate averages to use in calculating the required subsidy would be difficult to determine. However, once the appropriate estimates have been developed, it is likely that this system might prove to be more efficient and perhaps a little more flexible than the approach requiring applicants to "bid" for cost-share amounts.

A major problem with either approach is the unequal subsidy provision. All farms with $NPW_s \geq 0$ would not be subsidized equally, and some (those with ID=0) not at all. It would likely be unacceptable to the public to allow for major flexibility in subsidy amounts, and it could lead to administrative abuse as well. To depart from the second subsidy allocation criterion completely would lead to much lower program effectiveness (as measured by the PE ratios) and higher program expenditures. (See Section 6.2 for alternative subsidy approaches which attempt to deal with this problem.)

Another problem with both of the above approaches is the lack of trained manpower to make the necessary calculations and to administer the program. More foresters would be needed — and particularly foresters with practical economics/management training. (These individuals must be able to calculate NPW_s and to develop appropriate financial cash flow analyses for potential participants.)

A third problem relates to the uncertainty mentioned earlier concerning appropriate values for future costs and returns. However, this problem is the same whether we use the current approach for allocating incentives funds or the methods proposed here. There is nothing much we can do at present about this problem — neither in terms of policy nor in terms of practical application of our subsidy allocation model — other than to intensify our basic data gathering programs.

However, something can be done about one type of uncertainty that is associated with changing owner objectives. There is no way in which a cost-share subsidy program should or could irrevocably tie a given owner to his land or require that the commitment to timber production be carried from one owner to another. Rather, the program should require long-term contracts which provide for reasonable forfeiture, if a penalty is paid. The penalty should be at least equal to the subsidy plus accrued interest on it at some rate reflecting market borrowing rates. Some provisions for adjustment of the interest rate to changing market conditions and the rate of inflation would be desirable.

Some argue that this approach would reduce interest in the program; many owners do not want to make longer term commitments. However, the other side of the argument is that those who are serious about timber production would still be interested, so in the long run we may get the same result in terms of available timber output, but at less cost.[4]

In order to take full advantage of the subsidy allocation approach, several changes in FIP regulations (in effect at the time of this writing) might be considered. These include:

1. Changing the provision that a recipient cannot own more than 500 acres to a **required minimum** size area to be treated for any given property (*i.e.,* need to consider questions related to economies of scale).[5]

2. Changing the provision that an owner who has carried out commercial harvests on his land within the past five years cannot receive FIP cost-share funds to permit support for such owners.

3. Changing the provision that minimum cost-share is fifty percent of cost and maximum is 75 percent to a flexible cost-share approach. In some cases, less might be needed; in others more might be needed. There should be no minimum.[6]

[3] See p. 5 for discussion of the equity issue involved.

[4] We may still want to subsidize forestry activities for conservation or environmental purposes. This, however, is a matter which needs to be explored separately.

[5] Several studies indicated that the minimum size would be somewhere around 100-200 acres, depending on specific conditions, species, etc. Cf. PAPTE (1973, p. 92) and Zivnuska (1974, p. 233).

[6] Some "socially acceptable" maximum would likely be desirable on equity and political grounds. However, from a strict economic efficiency standpoint, no maximum should be set since subsidy payments are merely transfers.

4. Provision for more direct coordination of FIP with other programs to support NIPF forestry development, *e.g.,* technical aid, harvest aid, etc.

Incorporating some of the suggestions made above should help to increase the effectiveness and efficiency of cost-share subsidy programs, which are apparently politically acceptable and here to stay for the foreseeable future. However, the basic question still remains: is the cost-share subsidy approach the most appropriate one to use in providing an incentive for timber production on NIPF lands? Could we get better social returns on our limited funds available for this purpose by increasing the emphasis on other programs and decreasing the emphasis on cost-share subsidies? Should we be devoting more efforts and funds to intensification of management of federal, state and local government lands and less to incentives programs for NIPF lands? Would such changes be politically feasible, and what is the cost of not making changes which appear to produce better results (in terms of our objectives) than the cost-share subsidy approach? These questions are discussed in the remainder of the chapter.

6.2 COMPARING ALTERNATIVE MEANS FOR MOTIVATING NON-INDUSTRIAL PRIVATE FOREST LAND OWNERS

The second major implication relates to the need to develop parallel economic analyses of other major types of incentive programs – fiscal incentives, subsidized loans, technical aid and extension, etc.[7] Using the results of such studies, it becomes possible to make meaningful comparisons between alternatives, or combinations of alternative programs, thus providing an improved basis on which to choose among policies and programs for providing an incentive to NIPF owners. This would be a major step toward achieving effectiveness and efficiency of programs which currently rely on political rhetoric and vague impressions. The need for such comparisons becomes all the more important when we consider the weaknesses of the cost-share subsidy approach, the main program used in the U.S. at present.

Taken in isolation, the empirical results of the present study have little meaning for national policy; we have nothing to compare the results with, and thus we cannot really say anything about the relative efficiency of the REAP-A7 approach versus other approaches to public incentives for NIPF lands.[8] If the political decision is that we will provide incentive or subsidy programs for the NIPF sector, then we need comparisons between alternative program approaches and between various combinations of incentive programs, *e.g.,* subsidies and technical assistance, fiscal incentives and loans, etc.

6.2.1 ALTERNATIVE INCENTIVE APPROACHES

Conceptually, one can conceive of a number of specific types of incentive programs for stimulating timber production on NIPF lands. In practice, and in an economic context, they boil down to two main types – direct and indirect incentives.[9] Within the direct incentive category, we can distinguish between fiscal incentives and non-fiscal incentives. The major categories, as well as examples of specific past or present programs that fit in each category, are shown in Table 6.1. Only a few of the specific approaches shown have immediate relevancy in terms of the types of comparative studies envisioned here. With one or two exceptions, those approaches that are relevant have already been tried at one time or another in the U.S., although not always in the most appropriate form.

The three specific types, which at this point seem worth comparing, are: 1) subsidized loans, 2) fiscal incentives, and 3) indirect price incentives in the form of technical aid or extension. These will be discussed after a few general points are clarified.

First, we want to avoid the impression that each type of incentive program or option will have a uniform result, regardless of where or how it is applied. There is no question that a given incentive approach may be highly ineffective and inefficient in Minnesota, while it might be both effective and efficient in North Carolina, Alabama, or in some other area with a basically different physical/biological environment and with owners having different characteristics. This is also an argument for carrying out the type of analysis presented here for the same program type in other parts of the country. Such comparisons are as important and relevant in terms of policies as comparisons between different programs in the same area. There is no reason to believe that a given federal program or combination of programs that is suitable in one area will also be suitable in another area. This contention underlies the approach to the model developed in Chapter 2: Even within a state, each individual case will have different circumstances and will, theoretically, require separate treatment if effectiveness and/or efficiency are to be maximized.

Second, many states have forest practices laws which regulate private forestry activities. Some argue that these act as incentives for private forestry. However, in reality, they act more as incentives for avoiding poor forestry practices and have little to do with increasing productivity and production from private lands over present levels. (Regulations do not require individuals to improve or invest; rather, they tend to say that an owner cannot do such and such and imply nothing about what he should do to make a positive, increased contribution to timber supply.)

There are some cases where regulations, used in combination with incentives, have a positive influence on timber supply. For example, in the state of Virginia, the law states that at least six seed trees must be left per acre in any harvest operation, unless the area is planted immediately after harvest. With the rising price for stumpage, many owners find it attractive to cut all trees and plant. The revenue from selling the six potential seed trees outweighs the cost of reforestation, par-

[7] In addition, it would be desirable to make some comparisons of the results of this study with results of studies of the same type of program (e.g., REAP-A7 or FIP) in other parts of the country.

[8] To the best of our knowledge, no other analyses have been made of other programs using the "with and without" approach.

[9] Direct price incentives are those that have a direct influence on the values of inputs and outputs for specific individual NIPF owners who carry out certain socially desirable actions. Indirect price incentives are not tied directly to an individual landowners actions, but are rather influences on general knowledge and understanding (and technology) which may or may not indirectly influence an individual's investment decision and profits, regardless of whether or not he conforms to any socially desirable actions (see Skok and Gregersen, 1975).

Table 6.1. Principal public incentive programs for private forestry in the U.S.

Types and examples	Comments
Direct fiscal (exemption, remission, or deferred payment of taxes)	
1. Capital gains treatment for timber	1. Of greatest importance to industrial ownership – involves procedures too complex to be of interest to many nonindustry small private forest land owners
2. Yield taxes	2. Declining in acceptance
3. Modified property tax laws	3. Increasingly popular approach
4. Tax exemptions and rebate laws	4. Limited effectiveness as practiced – one of earliest forms, adopted by Michigan and Wisconsin in 1887
Direct nonfiscal (subsidization of inputs through low-cost credit, outright subsidies, etc.)	
1. Forestry Incentives Program (FIP)	1. This is now main direct subsidy or cost share program for timber production
2. Rural Environmental Assistance Program, practices A-7 and B-10 (formerly ACP)	2. Main cash payment program prior to FIP program
3. FHA loans (and other subsidized loans)	3. Low interest, long-term for forestry purposes – limited usefulness to date
4. Low cost seedlings	4. Partly financed with federal funds
Indirect (government research, training, technical assistance, and extension, marketing information, etc.)	
1. Funding of extension foresters, Cooperative Forest Management (CFM) program	1. Programs carried out in conjunction with states
2. U.S. Forest Service, state, and university applied research programs	2. Effective dissemination of results through extension and other outlets
3. Funding of production and marketing cooperatives	3. These are also funded privately and with state funds – not, in general, successful yet
4. Public cooperative forest protection programs such as Clarke-McNary Act and Forest Pest Control Act of 1947	4. Necessary since fire, disease, and insects do not recognize ownership boundaries and represent large risks without provision of protection strategies

Source: R.A. Skok and H.M. Gregersen, "Motivating Private Forestry: An Overview," in the *Journal of Forestry*, vol. 73, no. 4, April, 1975

ticularly if the landowner can receive subsidies for planting.[10]

Third, as mentioned earlier, it is reasonable to expect that combinations of various approaches will be more effective and probably more efficient.[11] Such combinations will include different, complementary approaches for a given level of activity and combinations of different programs that are coordinated for different levels of activity – from silviculture to harvesting, marketing, and processing. This complicates and expands considerably the analytical task proposed here, but is a necessary aspect of it if we seek better solutions to the NIPF problem.

Finally, there is the related question of coordination between the multitude of federal, state, and industry incentive programs. If such programs are not coordinated, a duplication of efforts may occur, or worse, programs may end up working at cross purposes, thus reducing the effectiveness and efficiency of all programs.

6.2.2 SUBSIDIZED LOANS VERSUS DIRECT COST-SHARING

One alternative to cost-share subsidies is loans at subsidized interest rates. The idea would be to give the NIPF owner a loan that he would pay back at some predetermined date(s) when returns on the planting were expected. At that time he would pay back both the principal plus accrued interest calculated at the social rate of discount (r_s). The loan might be supplemented by an insurance program for loss, with the premium paid by the NIPF owner. The subsidy element of the loan theoretically would be at least equal to the needed amount of subsidy (ID) as determined in the calculations presented earlier.

It was mentioned previously that the private discount rate associated with long-term investments such as forestry can be expected to be higher than the relevant rate for short-term investments for the same individual. In other words, the NIPF owner will require a greater expected rate of return on an investment that will not yield actual returns until some 30 years or more in the future, than on one which yields immediate (or yearly) returns.

This problem of higher interest rates to some extent can be avoided with the loan option, since the NIPF owner has no funds tied up in the forestry investment other than his land, if he receives a loan at least equal to the silvicultural costs. Whether or not he will agree to this type of arrangement depends on his perceived alternative rate of return, the potential economic yield from his land, and his personal reaction to long-term commitments. Since he would have invested no funds in the forestry activity (if he got the loan) and since he would pay nothing – neither principal nor interest – until sale of the crop is realized (or until it could be realized) he would not be concerned with the long-term nature of the investment, except in tying up his land for that period of time. Even in that case, he could at any time sell his land and pay the forfeiture fee on the loan and the principal, discounting into his sales price the cost of forfeiture on the loan; alternatively, he

[10] In the case of FIP, the owner cannot receive cost-share subsidies if he has harvested timber on his land in the past five years. This provision needs to be studied and probably revised. The Virginia incentive program has no such provision (see Rodger, 1973).

[11] Further, different combinations will probably be most effective in different regions. This brings up the whole question of federal vs. state programs – something which we do not wish to get into here.

could transfer the loan obligation to the purchaser of the land.

The advantages of this type of approach are obvious: first, the government would receive a financial rate of return on its investment at least equal to the prevailing social rate of discount (*i.e.,* in a present value sense there would be no transfer payment to the landowner, which would reduce or eliminate major distributional and equity questions regarding outright subsidies). Second, only those owners with intentions to plant for wood production would likely take the loans. Third, we would somewhat overcome one of the critical problems associated with NIPF owners, that is, the long time period involved with forestry investments and the corresponding higher (expected) rate of return which the landowner would want to obtain in order to make the investment attractive to him.[12]

The disadvantages of the subsidized loan approach are less obvious, yet just as real: first, administrative problems may be more significant than in the case of an outright subsidy in the form of cost-sharing. Second, loans will require a larger initial public budget to obtain the same results (since, as we mentioned, the loan would have to be great enough so that its subsidy effect is the same as the calculated cost-share subsidy needed to achieve the same result). If the program budget is fixed, this will mean reaching fewer owners. For example, if there is a fixed annual budget of $15 million and the average cost share subsidy is $30 per acre, about 500,000 acres could be planted with the subsidy approach. However, if an average loan of $50 is required to obtain the same actual subsidy effect per acre, then only 300,000 acres could be planted with the loan approach. If the first loan is not repaid for 30 years, this means (with a fixed budget) that at that time about 200,000 acres times 30 years, or 6 million additional acres could have been planted under the subsidy program. Alternatively, if we wish to have planting carried out on the same number of acres (500,000) with the two approaches, it would mean an annual outlay of $25 million for the loan approach, compared to only $15 million for the cost-share subsidy approach. The financial implications in terms of public budgets are obviously great.[13] And finally, a third disadvantage of this type of loan approach is that it only serves as an incentive to those who have high private discount rates. If the cause of the divergence between NPW_l, NPW_r and NPW_s is land cost or other costs and/or benefits, this approach is not useful.[14]

We can envision three approaches to the loan alternatively:

1) Ideally the loan would be such that the cost of the loan to the NIPF owner (principal plus accrued interest, discounted to the present using r_a), subtracted from the initial loan amount, would equal the needed subsidy (ID) determined by using the criteria for subsidy allocation presented earlier.[15]

2) A much simpler approach would be to offer loans equal to the silvicultural costs involved. In this case, all owners who have lands on which forestry could provide returns so that the estimated NPW_s was equal to or greater than zero would be eligible to obtain a loan equal to their silvicultural costs (site preparation, planting, cultural activity, etc.).

3) Combining 1 and 2 above results in a third approach. This approach would be to offer loans to NIPF owners so that the subsidy effect would equal ID (as in 1, above), but setting a maximum loan amount equal to the owner's silvicultural costs as in 2, above.

The advantage of the first approach would be that it provides for minimum direct expenditure of public funds, although administrative expenses would likely be higher than for the other two approaches. It would provide much the same result as the criteria for optimum direct subsidy allocation, except for farms where social and private values for costs and/or benefits differed sharply. The advantage of the second approach is that it would require no sophisticated analysis of appropriate levels of loans needed and consequently would be cheaper to administer. Each individual who qualifies in terms of the potential of his land for producing at least the social rate of return would be offered the loan and could take it or leave it. We would not need to estimate alternative rates of return for individuals nor would we have to estimate their valuation of inputs and outputs.

The advantage of the third approach is that it introduces some program effectiveness criteria, but does not get into the difficult situation of justifying loans in excess of silvicultural costs (as does approach 1).

6.2.3 FISCAL INCENTIVES VERSUS OTHER DIRECT INCENTIVES

Selective fiscal policy (through "negative taxation"[16]) also can be used to encourage timber production. There are a number of taxes that affect investments in forestry and forest conservation. Of these, we are particularly interested in those that have been or could be used on a selective basis to stimulate additional timber production from NIPF lands.

A great deal of effort has been expended in studying the impact of different types of taxes on investment actions of private forest owners. Much of this discussion is excellent.[17] However, there are few studies that actually document or attempt to quantify the effects of specific tax incentives other than the capital gains provision. Further, much of the discussion relates more to the negative effects that taxes have on forestry investments. Here we are interested in the use of fiscal policy as a tool for encouraging positive action by NIPF owners.

The possible types of taxes and their potential uses in providing incentives to NIPF owners are numerous. Of particular interest are the property, yield, and income taxes.

Property taxes can be reduced, or their payment deferred, to provide incentives for NIPF owners. The first acts as a sub-

[12] The landowner would still require a rate of return equal to or exceeding his alternative rate of return (r_a) on the funds he invested. However, he would only need to earn the social rate at discount (r_s) on the loan funds. Therefore, the necessary private rate of return on the entire investment will be reduced.

[13] However, again, the relative effectiveness and/or efficiency of the approaches is the relevant consideration.

[14] Another alternative type of loan approach could be used in cases where social and private values differed sharply. The loan granted to the NIPF owner could be set equal to the private silvicultural costs, but the loan amount to be repaid could be set equal to the social value of the costs minus any net social secondary benefits due to the participant's actions. As before, the social rate of discount would be the loan rate of interest.

[15] This would assume, of course, that r_a is greater than r_s.

[16] For example, tax bonuses such as depletion or depreciation allowances, reduction or deferment of taxes, and outright subsidies tied to a particular fiscal system.

[17] Particularly useful overviews were produced by the University of Oregon (1959), which presented papers and discussion based on a conference sponsored by Resources for the Future, Inc. See also Gaffney (1967).

sidy; the second, if not associated with any reduction in actual amount paid, merely acts to make investment possible for those who could not carry the costs of the timber production until harvest.

Yield taxes or severance taxes are similar in a sense to the deferred property tax. The difference is that the yield tax is paid on the volume actually harvested, while the property tax is generally based on an assessment of the value of the stand as it grows.[18] If not provided on a subsidized basis, the yield tax has no effect on an investment decision except in the case where there is a great deal of uncertainty surrounding the availability or value of the final crop or in cases where the NIPF owner cannot afford to pay annual property taxes out of his own pocket until his timber is harvested. Yield taxes are levied on gross timber income. As such, they do not take into account costs. Thus, they are fairly insensitive to profits. (A yield tax could theoretically wipe out any potential profit.)

Income taxes, on the other hand, are related to profits or net income. Therefore, they are sensitive to the profit picture. A specific aspect of income taxation which is particularly important in the forestry and forest products sector is the capital gains provisions of present laws which permit individuals to expense many of their annual costs against current income and to pay tax rates on income from timber that are lower than those on oridinary income, depending on the individual's income level.

Income tax incentives have been used in various parts of the world to promote private forestry. In Brazil, for example, an income tax rebate of 50 percent of income taxes due was used successfully to get hundreds of thousands of acres of new plantations started. The U.S. uses capital gains treatment for timber as an incentive for production.[19] This provision has little effect on NIPF owners other than the wealthy ones. It could have a much greater effect.[20]

There are a number of fiscal incentives which might substitute for, or complement, cost-share subsidies and indirect price incentives. The potential effectiveness, efficiency, and distributional (equity) effects of such alternatives, as well as their effect on government revenues (the "cost" to the government), need to be analyzed and the results compared with results of studies such as the present one, which looks at cost-share subsidies. Until such studies are available for specific situations, it is difficult to make further practical judgements on relative merits of one type compared to another.

6.2.4 COMBINING DIRECT AND INDIRECT SUBSIDIES

It seems to the present writers that much more attention needs to be given to the appropriate balance between direct subsidization (*e.g.*, cost-sharing or fiscal incentives) and indirect subsidization (*e.g.*, technical aid and extension).

For the particular case studied, and based on the responses to our NIPF owner questionnaire, a rather clear conclusion emerges: technical aid should have been greater (and perhaps different than that given), while direct subsidies should have been less. Specifically, if we accept the results with regard to the number of respondents to our questionnaire who would have planted with less subsidy (70 percent) then one possible implication is that if service foresters had done a more effective job of analyzing the financial potentials for these participants and other NIPF owners and presenting the results to the same, there might have been a greater response for the same cost.[21] Since we have no economic analyses to confirm or reject this possibility, all we can do here is raise questions. First, to what extent do service foresters know how to develop a cash flow analysis that they could present to a landowner to give him some idea of the relationship between his expected costs and returns? Even if they know how to develop this type of analysis, how do they develop contacts with the landowner to present it to him? To what extent were funds for this type of work limiting?

It appears that direct subsidies have been used in some cases in the past as an "easy out" or an excuse for not intensifying technical aid and extension work with NIPF owners. We would speculate here that more intensive technical aid work with owners of larger NIPF properties would pay off in the long run. If landowners have opportunities for gaining profits from their lands, they might very well invest in such opportunities, if they know about them. Our contention is that many landowners who have an interest in timber production have no concept of their investment opportunities. Of course, there are those who have no interest in growing wood for sale or selling existing wood on their lands, regardless of the profit picture. However, the point is that such individuals cannot generally be "bribed" by subsidies into producing timber for sale, unless the subsidy payments are so high that they are also socially and politically unacceptable. So subsidy programs will be no more and no less effective in such cases than technical aid and extension work.

Rather than using technical assistance and extension as a support for cost-share subsidy programs, it should be the other way around: our basic efforts should be devoted toward increasing understanding of potentials by NIPF owners, with direct subsidies coming into the picture in a supporting role when such incentives are needed and can be justified in terms of the potential social rates of return associated with forestry investments.[22]

The basic point is, of course, that there are very few studies that have made a serious attempt to evaluate technical assistance and extension services in terms of effectiveness and/or efficiency.[23] We need such studies, both for making improvements in particular programs and for making comparisons and choosing among alternative programs.

6.3 CHARACTERISTICS OF NIPF LANDS AND THEIR OWNERS: IMPLICATIONS FOR FUTURE TIMBER SUPPLIES

As the PAPTE report states: "the small private forests will

[18] The annual property tax that takes timber value into account will always tend to shorten the optimum financial rotation since annual taxes will be accumulating from year to year; *i.e.*, it is a variable cost for the landowner in terms of the number of years he holds a stand.

[19] A thorough (and critical) analysis of capital gains treatment for timber is given by Sunley (1972).

[20] Cf. Zivnuska (1974).

[21] At this point, this statement is mere speculation, since we have no idea of how effectively increased funds in extension could have been spent. This question needs to be analyzed, along with the question of relative returns expected from investment of public funds in other alternatives, such as federal and local government lands, industrial program, etc.

[22] Some states and some service foresters do take this point of view. However, the linkage and priorities need to be more systematically emphasized if comparative studies indicate justification for such.

[23] An interesting study is WESTAT (July, 1972), which evaluates certain aspects of the CFM program.

continue to produce much wood for harvest so long as the rain falls and the sun shines."[24] This is certainly an "encouraging" conclusion (which cannot logically be disputed). However, our interest here is in the extent to which public programs can provide incentives for NIPF owners to produce **more** timber than would be produced with just the rain and sun. In other words, we can accept the fact that NIPF lands have contributed to the nation's timber supply and will continue to do so. Our question is: have government programs been effective in increasing the contribution of such lands and are there ways in which we can adjust or change such programs so they become more effective?

Regarding the distribution of subsidized tree seedlings, the PAPTE report states that:

> It is extremely difficult to know to what extent federal, state, or industry programs have been a net addition; that is, many of the forest landowners who have planted tree seedlings provided from one of these sources might have bought seedlings from commercial sources and planted them, even if the public programs had not been available. No informed person would deny that these public and industry programs have had some effect in increasing total wood production on small private forests, but it is impossible to put a quantitative estimate on the extent of this increase, nor on the results achieved per unit of cost.[25]

In the present study, we have attempted to develop estimates of both effectiveness of public dollars spent and some measure of overall social efficiency associated with the expected production from the lands involved in one specific program. The results were based on application of a model that made a number of assumptions about NIPF owners, their intentions and views of investments in forestry, and the future availability of wood grown on these lands.

While the model may be logical and internally consistent from a conceptual point of view, we have to explore in more detail some of the assumptions, particularly those concerning the nature of NIPF owners as investors in timber production, and the future **economic** availability of the expected increased wood production on lands associated with the REAP-A7 program. Even if most NIPF landowners do not act as "rational" investors as suggested in our model, and even if the economically available timber supply in the future will be much less than suggested in our results, due to diseconomies associated with small scale or individual holdings and due to change in ownership objectives, etc., this is no reason to abandon the aim of developing more efficient and effective ways of providing incentives for private landowners. It is particularly no reason to accept incentive programs based on the simple dictum that the more trees planted the better.

Rather, we should proceed to develop more cost effective means for securing increased timber production from NIPF lands, fully recognizing the political necessities involved and the fundamental problems with NIPF ownerships and the inherent uncertainties involved. This means developing a much more selective approach to the NIPF incentive problem, an approach that involves consideration of: 1) our best estimates of the effectiveness of alternative approaches; 2) efficiency criteria that are related to the potentials for increasing the nation's wood supply by investing in more intensive management of federal, state, and local forest lands and support for industry programs; and 3) the political constraints on adapting effectiveness and efficiency criteria. Such a selective approach will not be perfect. The uncertainties surrounding the present analysis will also be associated with analyses of other programs or the same type of program in other areas. More important, the political constraints on introducing effectiveness and efficiency criteria will be major and strong. This selective approach would be a step in the right direction.

Basic to a selective approach to incentives is the recognition that most NIPF properties and their owners share some common characteristics which are adverse to investment in forestry. Zivnuska sums them up as follows:

- properties are too small for efficient forestry operations.
- tenure is too short for the continuity in inputs essential to long-term investments.
- ages of owners are too high for remote returns to be of interest and also too high for personal participation in the often heavy work of forestry operations.
- low income farmers and other NIPF owners are in no position to invest in forestry.
- the high income owner tends to have non-resident status and is thus poorly situated to supervise such investments and his time horizon is often too short for the benefits of forestry investment to be of interest.
- in many cases forest land ownership is essentially accidental in nature and the owner is unwilling to incur the costs of learning about management possibilities.
- for many owners, acting as rational investors, investment in increasing timber growth at much lower rates of return than the interest which they have to pay on mortgages or personal debts would be financially unsound and personally unwise, even if it were feasible at all.[26]

In addition, many of the NIPF lands, owned by persons who may perhaps be willing to invest if given subsidies, do not have the physical/biological potentials that would make investment attractive from a social point of view. Adding up all of these factors we reach an implied conclusion that many, if not most, NIPF lands can be written off in terms of future contribution to timber supplies **above what these lands would contribute without any government programs.**[27]

A selective approach to providing incentive for NIPF owners would accord first priority to those lands that appear to have promise from an economic point of view, including owner intentions and commitment as key parameters. This is indeed the basic concept underlying the subsidy allocation model developed earlier, and the *ex ante* approach presented in this chapter (Section 6.1).

We have no idea at present how large the actual area of NIPF land is that has potential from an economic point of

[24] President's Advisory Panel on Timber and the Environment (1973, p. 93).

[25] President's Advisory Panel on Timber and the Environment (1973, p. 93)

[26] Zivnuska (1974, p. 234).

[27] See President's Advisory Panel on Timber and the Environment, Chapter 8 and Appendix I.

view. The Forest Service has estimated that for the Southeast – the region with most promise – only about 20 percent of the total NIPF land was suitable for intensified silviculture.[28] If the approach of the present study had been followed, it would likely have been found that a significantly smaller portion of the total area and owners would have needed **and also would have been eligible for** cost-share subsidies, although expansion of other types of incentives may be justified. In the case of Minnesota, we found that only 24 NIPF owners out of 159 who applied for and received cost-share support should have received it under the REAP-A7 program in 1972, using our model, sample, and assumptions.

While our analysis may have carried the idea of selectivity based on effectiveness and efficiency to the extreme, even a major relaxation of the effectiveness and efficiency criteria would likely have resulted in a much smaller total cost-share program for the given group of participants than was actually the case.

The implication of this conclusion is **not** that we should reduce the amount of funds put into public incentives programs for encouraging timber production of NIPF lands. Rather, to repeat, we should look at alternative ways in which such funds could be spent more effectively on providing incentives for NIPF owners. Maybe the results would indicate that we should be putting more money into other types of incentive programs. Another distinct possibility – which may not be politically palatable – is that we should be shifting our funds and efforts into intensification of federal, state, and local forest management at the same time that we are developing a much more selective approach to NIPF forest policy and programs. Our suspicion is that this latter possibility may turn out to be so in many cases, given the fundamental economic problems associated with NIPF lands. But it will remain as speculation until further analysis can provide some evidence on the effectiveness and efficiency of alternatives available to us.[29]

It is not denied here that there are many NIPF properties on which adequate private returns to induce investment can only be obtained with direct subsidization. The question, however, is whether social returns on these lands are such that timber production on them should be subsidized as long as social rates of return on investments in other NIPF lands, industrial lands, and/or federal and local government lands are higher.

The inevitable political answer is that everyone should share in the direct subsidy pie, including NIPF owners.[30] Politically it is impossible to move to a program based entirely on efficiency or cost-effectiveness criteria. However, taking temporary refuge in the "ivory tower," we can for the moment argue that we should concentrate on allocating public funds designated for timber production in such a way that they most effectively and efficiently accomplish the objective of increasing the timber supply. This means investing public money where it is most effective in terms of results achieved, whether on industrial lands, on NIPF ownerships in a few states, or on public lands.

Somewhere in between the politically acceptable solution and the "academic" solution based on economic efficiency criteria lies the answer. Apparently, a first step in this direction has been taken in the case of FIP.[31] Further steps need to be taken if we are serious about increasing timber production on NIPF lands (and if relatively lower timber prices or growth in such prices are accepted as socially desirable).

The implications of such a compromise are: 1) a need to distribute timber production subsidies on the basis of proven potential and interest (this will mean unequal distribution among states and regions); 2) more strict control of distribution within states based at least partly on efficiency criteria such as suggested in this study and elsewhere; and 3) a need for increased analysis of the effectiveness of technical aid, extension, and other types of subsidy programs.

[28] U.S. Forest Service, Oct. 1973, p. 110. The report further points out that "this estimate may overstate the area on which landowners would be both willing and able to intensify management."

[29] Of course, we might also reach the conclusion that more funds should be committed to **both** activities.

[30] Cf. Branch, Taylor, "The Screwing of the Average Man: Government Subsidies – Who Gets the $63 Billion", *The Washington Monthly,* March, 1972. See also Zivnuska (1974) for the specific case of forestry incentives.

[31] Cf. Mills, et. al., 1974. This article discussed the rationale for distributing FIP funds. Their Table 2 shows the highly uneven distribution among states on the basis of productive potential, number of NIPF owners, and efficiency criteria. See also McGuire, 1974.

References Cited

Branch, Taylor. 1972.
The Screwing of the Average Man: Government Subsidies – Who Gets the $63 Billion? The Washington Monthly, Volume 4, No. 1. p. 9-27.

Department of Iron Range Resources and Rehabilitation. 1973.
Minnesota Forest Products Marketing and Pricing Review: July through December, 1972. Hibbing, Minnesota.

Forest Farmers Association. 1975.
Forestry Incentives Program for 1975. Forest Farmer, Vol. XXXIV, No. 7, p. 8-9.

Gaffney, Mason. 1967.
Extractive Resources and Taxation: Proceedings. 450 p. University of Wisconsin Press, Madison, Wisconsin.

Gregersen, Hans M. 1975.
Effect of Inflation on Evaluation of Forestry Investments. Journal of Forestry, Vol. 73, No. 9. p. 570-572.

Hosemann, John K. and John E. Waldrop, Jr. 1971.
Annual Income Payments: An Approach to Increased Productive Efficiency in Small Forestland Resource Use. Mississippi State University Agricultural and Forestry Experiment Station. State College, Mississippi. 86 p.

James, Lee M. and Con H. Schallau. 1961.
Forestry Practices Under the Agriculture Conservation Program. Land Economics Vol. 37, No. 2. p. 142-149.

Journal of Forestry, Vol. 73, No. 4. 1975.
Forestry Incentives Series. p. 202-225.

Mandale, Maurice and Phillip M. Raup. 1973.
The Minnesota Rural Real Estate Market in 1972. Department of Agriculture and Applied Economics, Institute of Agriculture, University of Minnesota, Economic Study Report S 73-1, 39 p. St. Paul, Minnesota.

Mandale, Maurice and Phillip M. Raup. 1974.
The Minnesota Rural Real Estate Market in 1973. Department of Agriculture and Applied Economics, Institute of Agriculture, University of Minnesota, Economic Report ER 74-1, 44 p. St. Paul, Minnesota.

Manthy, Robert S. 1970.
An Investment Guide for Cooperative Forest Management in Pennsylvania. U.S.D.A. Forest Service Research Paper NE-156, 59 p. Northeastern Forest Experiment Station, Upper Darby, Pennsylvania.

McGuire, John R. 1974.
Forestry Incentives – Status and Outlook. Cross Ties, July, 1974. p. 18-23.

Mills, Thomas J., Thomas P. Hart, and J.S. McKnight. 1974.
Forestry Incentives: How Funds Were Apportioned to States in 1974. Journal of Forestry Vol. 72, No. 8, p. 478-482.

President's Advisory Panel on Timber and the Environment. 1973.
Final Report, Chapter 8. U.S. Government Printing Office, Washington, D.C.

President's Science Advisory Committee. 1967.
Production Incentives for Farmers. The World Food Problem: A Report of the President's Science Advisory Committee, Volume II Report of the Panel on the World Food Supply, Chapter 9. U.S. Government Printing Office, Washington, D.C. p. 504-535.

Rodger, E.E. 1973.
Virginia Incentives Program Aids Reforestation. Journal of Forestry Vol. 71, No. 5. p. 287-289.

Siegel, William C. 1973.
Long Term Contracts for Forest Land and Timber in the South. U.S.D.A. Forest Service Research Paper SO-87, 14 p. Southern Forest Experiment Station, New Orleans, Louisiana.

Siegel, William C. 1973.
Long Term Timber Contracts in the South. Forest Farmer Volume 34, No. 1, p. 8-9.

Skok, Richard A. and Hans M. Gregersen. 1975.
Motivating Private Forestry: An Overview. Journal of Forestry. Vol. 73, No. 4. p. 202-205.

Stoddard, Charles H. 1961.
The Small Private Forest in the United States. 171 p. Resources for the Future, Inc. Washington, D.C.

Subcommittee on Evaluation Standards of the Inter-Agency Committee on Water Resources. 1958.
Proposed Practices for Economic Analysis of River Basin Projects. Revised report submitted by the Subcommittee on Evaluation Standards to the Inter-Agency Committee on Water Resources. 56 p. Washington, D.C.

Sunley, Emil M., Jr. 1972.
The Federal Tax Subsidy of the Timber Industry. The Economics of Federal Subsidy Programs: A Compendium of Papers Submitted to the Joint Economic Committee, Congress of the United States, Part 3 – Tax Subsidies. U.S. Government Printing Office, Washington, D.C. p. 305-316.

University of Oregon Bureau of Business Research. 1959.
Taxation and Conservation of Privately Owned Timber: Proceedings of a conference held at the University of Oregon, January 27, 28, 1959. University of Oregon Bureau of Business Research. Eugene, Oregon.

U.S. Department of Agriculture, Forest Service. 1973.
The Outlook for Timber in the United States. Forest Resource Report No. 20, 367 p. U.S. Government Printing Office, Washington, D.C.

U.S. Water Resources Council. 1973.
Water and Related Land Resources: Establishment of Principles and Standards for Planning. Federal Register Volume 38 Number 174 Part III, 167 p. U.S. Government Printing Office, Washington, D.C.

Webster, Henry H. and Carl H. Stoltenberg. 1959.
What Ownership Characteristics are Useful in Predicting Response to Forestry Programs? Land Economics Vol. XXXV, No. 3. p. 292-295.

Westat, Inc. 1972.
Survey and Analysis of CFM Forestry Assistance: Management Plans and Timber Marking Assists. Report Submitted to U.S. Department of Agriculture, Forest Service, Division of Cooperative Forest Management, by WESTAT, Inc., Research Division, Rockville, Maryland. 90 p. plus appendices.

Worrell, Albert C. 1970.
Public Cooperation With Private Forest Owners. Principles of Forest Policy, Chapter 8. McGraw-Hill, Inc., New York.

Yoho, James G. and Lee M. James. 1958.
Influence of Some Public Assistance Programs of Forest Landowners in Northern Michigan. Land Economics Vol. XXXIV, No. 4. p. 357-364.

Zivnuska, John A. 1974.
Forestry Incentives for Multiple Uses Among Multiple Ownership Types. Forest Policy for the Future: Conflict, Compromise, Consensus. Resources for the Future, Inc., Washington, D.C. p. 221-279.

Appendix A

REAP Objectives

A-7 Planting trees or shrubs

A. Purpose. To establish a stand of trees or shrubs for soil protection, forestry purposes, or environmental improvement.

B. Applicability. To farm land suitable for growing trees or shrubs. Preference should be given to varieties beneficial to wildlife.

C. Other provisions.

1. Cost-sharing is authorized for planting trees or shrubs:
   a. Primarily for the production of forest products.
   b. For windbreaks, shelterbelts, or establishing streambanks.
2. Cost-sharing is not authorized for planting orchard trees or for plantings for ornamental purposes. Plantings established for Christmas tree production are not eligible, except as provided in subparagraph G.
3. Plantings must be protected from destructive fire and destructive grazing.
4. Cost-sharing is authorized for clearing land occupied largely by scrubby brush of no economic value, if needed to permit planting desirable tree species. Technical assistance must be utilized to determine suitability of the land for clearing and the measures necessary to prevent erosion.
5. Chemicals used in performing this practice must be federally and locally registered and must be applied strictly in accordance with authorized registered uses, directions on the label, and other federal or state policies and requirements.
6. Plantings primarily for the production of forest products:
   a. Cost-sharing is authorized for inter-planting to bring stand up to desirable number.
   b. Cost-sharing is not authorized for mechanical site preparation on land covered with brush which requires heavy crawler type tractors with heavy duty planters.
7. Plantings primarily for field windbreaks, gully stabilization, or shelterbelts:
   a. Acceptance of cost-sharing by the producer will constitute an agreement to control competitive vegetation and make replacements, if necessary, for two years following the year of planting regardless of whether cost-sharing is offered.
   b. Cost-sharing is authorized for the control of competitive vegetation by either cultivation or use of herbicides for trees and shrubs planted in the current or previous two years if the initial planting was cost-shared.
   c. Cost-sharing is not allowed for establishing shelterbelts which are designed primarily to protect farmstead, farm buildings, or feedlots. To be eligible, the shelterbelts must be primarily for protecting eligible farmland from soil erosion and for preventing or reducing the pollution of water, air, or land. (Incidental protection of farmsteads, farm buildings or feedlots is not prohibited, providing such protection is not the primary purpose of the shelterbelts.)

D. Specifications.

1. All plantings should be as early as possible in the spring, but not later than May 31, unless approved for a later date by the state development group.
2. Plantings primarily for the production of forest products:
   a. Site preparation may be done by spraying, bulldozing, plowing, disking, or similar operations. On slopes of 30 degrees or more, chemical spraying is the only approved method. Fact sheets, Forestry No. 5 and Forestry No. 6, issued by the University of Minnesota Agricultural Extension Service, sets forth the recommended herbicides, rates and times of application.
   b. Planting should be done in shallow furrows or with a machine equipped with scalping attachments in areas of heavy sod or growth that would seriously interfere with the growth of the seedlings, unless otherwise recommended by the Division of Lands and Forestry representative. Furrowing or scalping rows should be as nearly as practical on the contour to prevent erosion.
   c. Solid plantings should not be less than 800 nor more than 1,800 trees per acre. Cost-sharing is limited to 1,200 trees per acre.
   d. Cost-sharing is not authorized for planting less than 1,000 trees.
   e. The following species of trees may be approved providing they are adapted to the particular soil type, climatic conditions, moisture conditions, and site: black spruce, white spruce, Norway (red pine, jack pine, white pine, Ponderosa pine, balsam fir, tamarack, northern white cedar, sugar maple, soft maple, basswood, green ash, white ash, cottonwood, red oak, black cherry, juniper, black walnut, hybrid poplar, and hackberry. Other species may be approved if recommended by the Division of Lands and Forestry representative.
3. Plantings primarily for field windbreaks and gully stabilization:
   a. The average spacing between trees and/or shrubs in the row should not deviate more than 20 percent in excess of the specified maximum, in the initial planting.
   b. Cost-sharing for site preparation on farm bound-

aries shall be limited to that which is essential to the establishment of the field windbreak.

c. Replacements shall be made to prevent gaps of two or more consecutive trees and/or shrubs if needed to develop an adequate windbreak.

d. Cost-sharing is not authorized for planting less than 100 trees and/or shrubs.

e. The following species of trees and shrubs may be approved provided they are adapted to the soil type, climatic conditions, moisture conditions, and site: green ash, soft maple, cottonwood, hybrid poplar, willow, hackberry, Siberian elm (dropmore, Manchu, Harbin, Chincota), Russian olive, Siberian crabapple, wild plum, chokecherry, gray dogwood, honeysuckle, caragana, lilac, buffalo berry, willow (purea), white spruce, Colorado blue spruce, black spruce, Norway spruce, Norway (red) pine, jack pine, and red cedar. Other species may be approved if recommended by the technician of the Soil Conservation Service.

4. Plantings primarily for shelterbelts:

a. A detailed sketch is required for shelterbelts showing design, relation to buildings, number of rows, species in each row, distance between trees in the row, distance between rows, previous plantings, and maintenance information.

b. Where there is ample space, plantings shall be designed with eight or more rows of trees and/or shrubs. Exception: see subparagraph E, 8.

c. Approval may be given to planting fewer than eight rows only where there is lack of space or there is an established planting and the additional planting will bring the shelterbelt up to standard.

d. Cost-sharing is not authorized for planting less than 250 trees and/or shrubs.

e. The following species of trees and shrubs may be approved provided they are adapted to the soil type, climatic conditions, moisture conditions, and site: Colorado spruce, Black Hills spruce, white spruce, white cedar, Norway spruce, red pine, white pine, Ponderosa pine, cottonwood, black walnut, soft maple, white ash, green ash, Russian olive, American plum, hackberry, black cherry, bush cherry, lilac, honeysuckle, caragana, and red osier dogwood. Other species may be approved if recommended by the technician of the Soil Conservation Service.

f. Planting arrangement should provide a roof effect when trees have reached full growth. The goal should be a standard shelterbelt. (See Extension Bulletin 196, Revised 1966.)

E. Maximum federal cost-share.

1. Site preparation:

a. For plantings primarily for the production of forest products:

(1) Herbicides – 80 percent of the cost not to exceed $9 per acre.

(2) Mechanical – 80 percent of the cost not to exceed $30 per acre.

b. For plantings primarily for field windbreaks on farm boundaries – 80 percent of the cost not to exceed $1.90 per 100 linear feet.

c. For plantings primarily for shelterbelts:

(1) Herbicides – 80 percent of the cost not to exceed $9 per acre.

(2) Mechanical – 80 percent of the cost not to exceed $75 per acre.

2. Hand planting – $3.65 per 100 trees or shrubs planted except as provided in 6 below.

3. Machine planting – $2.80 per 100 trees or shrubs planted except as provided in 6 below.

4. Machine planting with heavy equipment on brushland: $3.65 per 100 trees planted.

5. Hand planting on predominant slopes of 25 percent or more: $4.05 per 100 trees planted.

6. Where the cost of trees and/or shrubs exceeds $1.50 per 100 (not applicable to plantings primarily for the production of forest products) the cost-share rate shall be:

a. For plantings primarily for field windbreaks or fully stabilization:

(1) 80 percent of the cost of trees and shrubs not to exceed 50¢ per tree or shrub.

(2) Planting – 80 percent of the cost not to exceed $5 per 100 trees or shrubs planted.

b. For plantings primarily for shelterbelts:

(1) 80 percent of the cost of trees and shrubs not to exceed $2 per tree or shrub and $300 per shelterbelt.

(2) Planting – 80 percent of the cost not to exceed $5 per 100 trees or shrubs planted.

7. For cultivation or use of herbicides on plantation shelterbelts or field windbreaks established with cost-sharing under the current or two preceding years – $12 per acre.

8. For the east half of Fillmore, all of Houston, Wabasha and Winona Counties, authority is granted to reduce plantings to six or more rows. Total payment for trees and/or shrubs and planting limited to $180 per shelterbelt.

F. Technical responsibility. Assigned to Forest Service for plantings primarily for the production of forest products. Assigned to SCS for field windbreaks, gully stabilization, or shelterbelts for all components except cultivations.

G. Special provisions for low income farmers. Christmas tree plantings may be approved for cost-sharing on any farmland owned and operated by low income farmers and ranchers.

Appendix B

ASCS form RE-245

FORM RE-245 (6-21-71)

Form approved by Comptroller General, U.S. November 9, 1964

REQUEST FOR COST-SHARING

RURAL ENVIRONMENTAL ASSISTANCE PROGRAM

U.S. DEPARTMENT OF AGRICULTURE

Agricultural Stabilization and Conservation Service

FARM NO.	NAME AND ADDRESS	PROGRAM YEAR	FUNDS CONTROL	DATE
			1. Tentative Obligation Posted	
			2. Column E Posted	
			3. Adjustment Posted	
			4.	
			5. Column G Posted	
			6.	

EXPIRATION DATE ➧ | 7. PRACTICE MUST BE COMPLETED AND REPORTED BY | 8. REPORT PERFORMANCE IN COL. F BELOW BY ENTERING: The Extent Performed / The Word "Yes"

Farmer or Rancher Request			Committee Action				
NO. — A —	DESCRIPTION OF PRACTICE — B —	EXTENT REQUESTED	EXTENT APPROVED — C —	RATE — D —	COST-SHARES APPROVED — E —	— F —	— G —

9.

STATISTICAL DATA	EXTENT	EARNED $

APPROVAL ISSUED FOR THE COUNTY COMMITTEE | DATE

BY

WRITTEN CONSERVATION PLANS FOR FARM BY: SCS ☐ NONE ☐ OTHER ☐

FARMER OR RANCHER CERTIFICATION

I request cost-sharing under the Rural Environmental Assistance Program to perform the practice shown above. The practice is needed to conserve soil or water resources on the farm identified above, and would not be performed to the extent requested and needed by me without Federal cost-sharing.

I plan to start the practice in *(month)*____________ and complete it by_________

Sign Here ➧ | DATE

OTHER FARMS

REMARKS

COMMITTEE ACTION

ESTIMATED COST-SHARE VALUE $ | TENTATIVE APPROVAL PENDING REFERRAL $

The conservation needs and the farmer's conservation plans for this farm have been considered. The county committee approves the extent shown in Col. C and the cost-shares shown in Col. E for this practice.

FOR THE COUNTY COMMITTEE | DATE

BY

CMS

	YES	NO	VENDOR *(If selected by farmer)*
P.O. Requested			
Eligible for CMS			
PURCHASE ORDER TO BE ISSUED FOR			

Appendix C

Questionnaire sent to ASCS county offices

Please return to: May 22, 1973

A. Rubinstein
College of Forestry
University of Minnesota
St. Paul, Minnesota 55101

County: ____________________

Information needed on REAP practice A7

1. Where do landowners in the county obtain seedlings?

   A. a) name of nursery:
      b) location:
      c) manager:

   B. a) name of nursery:
      b) location:
      c) manager:

   C. Other sources:

2. Do you know what price is paid for seedlings at the nursery? Please indicate price for each species you have used in the program.

	$/hundred plants	
Species	1969	1972

3. What is the actual price charged by operators for machine planting in your county? If you refer landowners to a specific operator, state his price. Otherwise, please give an estimated average or range of prices.

4. If you commonly refer landowners to a specific operator, please give his name and address.

(continued)

5. Can you estimate the cost to the landowner of seedlings delivered to the planting site?

6. How many applications for cost sharing under A7 (planting and site preparation) did you receive for 1973:

   Number of farms:
   Total number acres to be planted:
   Total number acres for site preparation:

7. What would have been the total cost if practices were undertaken with the program?

8. How many 1973 applications have been withdrawn?

   Number of farms:
   Total acres of planting:
   Total acres of site preparation:
   Total cost share represented by above withdrawals:

9. Has the 1 percent of the county budget which can be allotted for payment of service forester referrals been adequate to cover cost of all referrals in your county?

   ____ Yes ____ No

   If no, do you have any estimate of the amounts which would have been needed to cover service forester costs in 1969, 1970, 1971, and 1972?

   $ ______________ (1969) $ ______________ (1971)

   $ ______________ (1970) $ ______________ (1972)

10. Some of your RE-245 forms (A-7 practices) lack information regarding the species planted. Please identify those species for the following forms. (To help you find that information, we are providing the form number and the year in which the application was made.)

    Year: 1970

    Farm number Species

    Year: 1972

    Farm number Species

Appendix D

Landowner questionnaire

1. In which county is the property located for which you received REAP/ASCS forestry funding?

   ________________ (name of county)

2. What is your age group?

   ☐ less than 20 years
   ☐ 20-30 years
   ☐ 31-40 years
   ☐ 41-50 years
   ☐ over 50 years

3. On how many acres did you receive REAP (ASCS) forestry cost-sharing funds in 1972?

   ________ acres

4. Did you and/or your own family do the actual planting of trees on this area?

   ☐ yes
   ☐ no

5. Have you received REAP forestry funds in years other than 1972?

   ☐ yes (if yes, for how many acres total: ________ acres)
   ☐ no

6. Did you in 1972 live year round on the property for which you received REAP forestry funds, or were you an "absentee" owner?

   ☐ lived on property (check one)
   ☐ absentee owner (lived less than full-time on property)

7. How long have you owned the property for which you received REAP forestry support in 1972?

   ☐ no longer own it
   ☐ 1-5 years
   ☐ 6-10 years
   ☐ 11-20 years
   ☐ more than 20 years

(continued)

8. What is (or was in 1972) the primary use or purpose of the total property where the forest planting site is located?

- ☐ farming
- ☐ produce forest products
- ☐ recreation (check one)
- ☐ investment
- ☐ other (specify) ________________

9. What is the total acreage of the property? (including farmland, etc.)

_________ acres

10. What is the total acreage of woodland in the above property?

_________ acres

11. Have you carried out forestry activites (thinning, pruning, tree planting, etc.) on the areas other than the land for which you received REAP payments?

- ☐ yes
- ☐ no

12. What would you estimate is the average market price per acre of the land you planted with REAP forestry funding (or what did you sell it for if you no longer own it)?

_________ $ per acre - does any of this land border on water (lake, river, etc.)? ☐ yes ☐ no

13. Have you sold pulpwood or timber from your property in the past five years?

- ☐ yes - if yes, what was total payment received for this period? $_____
- ☐ no - if no, why?
  - ☐ no market
  - ☐ did not want to
  - ☐ other (specify) ________________

14. Were you satisfied with the public assistance you received from:

A. REAP/ASCS
☐ yes ☐ no comments:

B. Service forester
☐ yes ☐ no comments:

(continued)

15. What was the total cost per acre for the (1972) forestry activities on your REAP/ASCS supported acreage (including public and your own expenses)?

$________ per acre

16. If you had funds available for investment (in savings account, stocks, other property, livestock, etc.) what would you think would be the maximum rate of return or interest you could get per year?

__________ percent per year

17. If the government would have provided a greater share of the cost, would you have planted more acres than you did plant with REAP funds?

☐ yes ☐ no

18. If the government had provided a smaller share of the cost would you have prepared and/or planted less acres?

☐ yes ☐ no

19. What was the property or other tax per acre on your woodland in 1972?

$________ per acre annual tax

20. What were you paying in tax per acre three years ago (1969)?

$________ per acre per year in 1969

21. Do you think that the presence of woodlands affect the value of your property? (or affected it, if you sold since 1972)

☐ has no effect
☐ don't have any opinion
☐ decreases value of property
☐ increases value of property Why?
  ☐ wood value
  ☐ recreation value
  ☐ other ______________________________

22. Do you intend to plant more acres on your property?

☐ yes How many? _________acres over next 5 years?
☐ no

(Continued)

23. Would you consider putting your woodland acreage under long-term contract to a forestry association or forest industry for an annual fee or rent? (The association or company would manage and harvest the wood when they decided it was ready. They would pay you the annual fee or rent instead of stumpage payment when wood is cut.)

☐ yes ☐ no

If answer is yes, what would you estimate a fair annual rental to be per acre?

$_________ per acre per year

24. What other types of public assistance would you like to have for your woodlands in addition to REAP cost sharing and service forester advice?

25. Do you feel that in your locality woodland products can be sold:

☐ readily
☐ with some difficulty (check one)
☐ cannot be sold now

26. If there is a market, what is the average price on the stump being paid in your area now?

$_________ per cord

$_________ per 1,000 board feet

$_________ per ___________ (other products)

_____ don't know

27. Do you envision that your property will be in your hands or the hands of your family when you receive the first income from your REAP funded forestry practice?

☐ yes ☐ no

28. What is your approximate total income per year?

☐ less than $5,000
☐ $5,000-10,000
☐ $10,000-12,000
☐ over $15,000

Answers to Questions

Question 2. What is your age?

	N	Total
1. less than 31 years	35	12.77%
2. 31-40 years	45	16.42%
3. 41-50 years	72	26.28%
4. over 50 years	122	44.53%
Total	274	100%

Question 3. On how many acres did you receive REAP (ASCS) forestry cost sharing funds in 1972?

	N	Total
1. 1-2 acres	97	38.65%
2. 3-5 acres	66	26.29%
3. 6-10 acres	43	17.13%
4. 11 or more	45	17.93%
Total	251	100%

Question 4. Did you and/or your own family do the actual planting of trees on this area?

	N	Total
1. yes	205	74.55%
2. no	70	25.45%
Total	275	100%

Question 5. Have you received REAP forestry funds in years other than 1972? If yes, for how many acres total?

	N	Total
1. no, 0 acres	105	42.68%
2. yes, 1-5 acres	42	17.07%
3. yes, 6-10 acres	42	17.07%
4. yes, 11+ acres	57	23.17%
Total	246	100%

Question 6. Did you in 1972 live year round on the property for which you received REAP forestry funds, or were you an "absentee" owner?

	N	Total
1. resident	152	55.27%
2. absentee	123	44.73%
Total	275	100%

Question 7. How long have you owned the property for which you received REAP forestry support in 1972?

	N	Total
1. 1-5 years	106	38.27%
2. 6-10 years	49	17.69%
3. 11-20 years	55	19.86%
4. 21+ years	67	24.19%
Total	277	100%

Question 8. What is (or was in 1972) the **primary** use or purpose of the total property where the forest planting site is located?

	N	Total
1. farming	92	34.07%
2. produce forest products	71	26.30%
3. recreation	49	18.15%
4. "other" (includes investment)	58	21.48%
Total	270	100%

Question 9. What is the **total** acreage of the property? (including farmland, etc.)

	N	Total
1. 0-40 acres	71	26.01%
2. 41-80 acres	52	19.05%
3. 81-160 acres	69	25.27%
4. 161+ acres	81	29.67%
Total	273	100%

Question 10. What is the acreage of woodland in the (above) property?

	N	Total
1. 0-15 acres	69	25.56%
2. 16-40 acres	61	22.59%
3. 41-120 acres	89	32.96%
4. 121+ acres	51	18.89%
Total	270	100%

Question 11. Have you carried out forestry activities (thinning, pruning, tree planting, etc.) on the areas **other than** the land for which you received REAP payments?

	N	Total
1. yes	121	44.65%
2. no	150	55.35%
Total	271	100%

Question 12. What would you estimate is the **average** market price per acre of the land you planted with REAP forestry funding (or what did you sell it for if you no longer own it)?

	N	Total
1. $0-50	64	29.22%
2. $51-100	51	23.29%
3. $101-300	51	23.29%
4. $301+	53	24.20%
Total	219	100%

Question 13. Have you sold pulpwood or timber from your property in the past five years?

	N	Total
1. yes	46	17.04%
2. no – didn't want to	101	37.41%
3. no – "other"	85	31.48%
4. no – no market, or no – no reason given	38	14.07%
Total	270	100%

Question 14A. Were you satisfied with the public assistance you received from REAP/ASCS?

	N	Total
1. yes	253	94.76%
2. no	14	5.24%
Total	267	100%

Question 14B. Were you satisfied with the public assistance you received from the service forester?

	N	Total
1. yes	245	95.33%
2. no	12	4.67%
Total	257	100%

Question 15. What was the total cost per acre for the 1972 forestry activities on your REAP/ASCS supported acreage (including public and your own expenses)? (**Note**: Anyone answering less than $20 per acre was treated as a non-response.)

	N	Total
1. $20-35	54	34.18%
2. $36-59	56	35.44%
3. $60+	48	30.38%
Total	158	100%

Question 16. If you had funds available for investment (in savings account, stocks, other property, livestock, etc.) what would you think would be the **maximum** rate of return or interest you could get per year?

	N	Total
1. 0-6%	62	28.18%
2. 7%	43	19.55%
3. 8-9%	51	23.18%
4. 10+%	64	29.09%
Total	220	100%

Question 17. If the government would have provided a greater share of the cost, would you have planted **more** acres than you did plant with REAP funds?

	N	Total
1. yes	101	37.00%
2. no	172	63.00%
Total	273	100%

Question 18. If the government had provided a **smaller** share of the cost would you have prepared and/or planted **less** acres?

	N	Total
1. yes	82	30.26%
2. no	189	69.74%
Total	271	100%

Question 19. What was the property or other tax per acre on your woodland in 1972?

	N	Total
1. $.10-$.50	62	28.18%
2. $.51-$1.00	43	19.55%
3. $1.01-$3.00	51	23.18%
4. $3.01+	64	29.09%
Total	220	100%

Question 20. What were you paying in tax per acre three years ago (1969)?

	N	Total
1. $.10-$.50	49	23.11%
2. $.51-$1.00	50	23.58%
3. $1.01-$3.00	56	26.42%
4. $3.01+	57	26.89%
Total	212	100%

Question 21. Do you think that the presence of woodlands affect (or affected it, if you sold since 1972) the value of your property?

	N	Total
1. has no effect, or don't have any opinion, or decreases value of property	62	22.79%
2. increases value of property — wood value	86	31.62%
3. increases value of property — recreation value	97	35.66%
4. increases value of property — other	27	9.93%
Total	272	100%

Question 22. Do you intend to plant **more** acres on your property? How many acres over the next five years?

	N	Total
1. no (0 acres)	44	26.51%
2. yes, 1-5 acres	45	27.11%
3. yes, 6-15 acres	45	27.11%
4. yes, 16+ acres	32	19.28%
Total	166	100%

Question 23. Would you consider putting your woodland acreage under long term contract to a forestry association or forest industry for an annual fee or rent?

	N	Total
1. yes	60	23.72%
2. no	193	76.28%
Total	253	100%

Question 25. Do you feel that in your locality woodland products can be sold?

	N	Total
1. readily	157	60.62%
2. with some difficulty	73	28.19%
3. cannot be sold now	29	11.20%
Total	259	100%

Question 26. Is there a market (for products)?

	N	Total
1. don't know	186	77.82%
2. do know	53	22.18%
Total	239	100%

Question 27. Do you envision that your property will be in your hands or the hands of your family when you receive the first income from your REAP funded forestry practice?

	N	Total
1. yes	205	83.67%
2. no	40	16.33%
Total	245	100%

Question 28. What is your approximate total income per year?

	N	Total
1. $0-$5,000	39	14.77%
2. $5,000-$10,000	76	28.79%
3. $10,000-$15,000	63	23.86%
4. $15,000+	86	32.58%
Total	264	100%

Appendix E

Site index and social land value assumptions

Code number	County	Site index	1972 land value ($) per acre	Code number	County	Site index	1972 land value ($) per acre
1	Wright	40	163	30	Koochiching	60	76
2	Winona	40	370	31	Kandiyohi	40	208
3	Washington	40	163	32	Kanabec	60	163
4	Wadena	40	117	33	Itasca	60	76
5	Wabasha	40	370	34	Isanti	40	163
6	Todd	40	208	35	Hubbard	60	117
7	Swift	40	208	36	Houston	40	370
8	Stearns	40	208	37	Hennepin	40	163
9	Sherburne	40	163	38	Grant	40	208
10	Scott	40	370	39	Goodhue	40	370
11	North St. Louis	60	76	40	Fillmore	40	370
12	South St. Louis	60	76	41	Faribault	40	370
13	Roseau	40	117	42	Douglas	40	208
14	Rice	40	370	43	Crow Wing	40	208
15	Renville	40	379	44	Cook	60	76
16	Redwood	40	379	45	Clearwater	60	117
17	Pope	40	208	46	Clay	40	117
18	East Polk	40	117	47	Chisago	40	163
19	Pine	60	163	48	Cass	60	76
20	East Ottertail	40	208	49	Carver	40	370
21	West Ottertail	40	208	50	Carlton	60	76
22	Olmsted	40	370	51	Brown	40	379
23	Nicollet	40	370	52	Blue Earth	40	370
24	Morrison	40	208	53	Benton	40	208
25	Mille Lacs	60	163	54	Beltrami	60	117
26	Meeker	40	208	55	Becker	40	117
27	Marshall	40	117	56	Anoka	40	163
28	Lake of the Woods	60	117	57	Aitkin	60	76
29	Lake	60	76	58	Mahnomen	40	117

Appendix F

Yield Data

	Site 40				Site 60			
	Thin		Harvest		Thin		Harvest	
Year	BF	CD	BF	CD	BF	CD	BF	CD
30						5.6		8.2
40		2.3		5.3		11.1		17.5
50		5.1		12.2	1,222.5	8.1	2,157.3	14.3
60		5.8		16.3	44,302.6	2.2	8,504.9	4.4
70	177.6	4.7	594.8	15.9	6,256.2		13,906.9	
80	703.0	2.8	2,838.3	11.2	6,777.5		17,000.2	
90	1,090.8	1.4	5,411.2	7.1	6,884.2		19,535.1	
100	1,263.9	0.6	7,882.7	3.8	6,705.1		21,551.7	
110	1,265.7	0.1	10,202.3	1.0	6,365.5		23,193.9	
120	1,069.3		11,518.4		5,909.7		24,657.4	
130	812.6		12,676.4		5,413.6		26,136.2	
140	582.8		12,722.1		4,793.4		26,676.5	
150	393.7		13,078.8		4,273.4		27,122.0	
160			13,602.3				31,318.5	
170			14,044.8				35,583.0	
180			14,570.3				39,861.8	
190			15,161.3				44,092.2	
200			16,000.9				48,197.7	

•Lundgren, Allen L., Unpublished manuscript, North Central Experiment Station, St. Paul, Minnesota.

Appendix G

Classification of farms according to the criteria for subsidy allocation

The two subsidy allocation criteria developed in Chapter 2 for classifying farms (and then applied in Chapters 3 and 4) required each participant's subsidized activity to be:

1. Socially "profitable" ($NPW_s > 0$).[1]
2. Privately unprofitable ($ID > 0$).

The program participants who fit in this category (who represented between zero and 460 acres of 773 total acres depending upon the assumptions) are of special interest because they are the only ones who should be subsidized according to these criteria. However, in order to more completely understand the effects of altering assumptions as was done in the sensitivity analysis (Chapter 4), it is helpful to observe which criteria the other "excluded" program participants failed to meet. Appendix Table G-1 places all 159 actual participants (773 acres), for all 14 assumptions and three social discount rates, into four categories based on the above two criteria. First, **socially** "unprofitable" and "profitable" farms are separated into the left and right halves of the table, respectively. Then, each of these two categories are further

[1] As mentioned in the text, we are only dealing with social profitability in terms of timber production.

Table G-1.

		Socially "unprofitable"					Socially "profitable"				
		Privately unprofitable			Privately profitable		Privately unprofitable			Privately profitable	
	Social discount	$NPW_S < 0 < ID$			$NPW_S < 0 = ID$		$NPW_S \geq 0$ and $ID > 0$			$0 = ID \leq NPW_S$	
Assumption	rate	Farms	Acres	Total ID ($)	Farms	Acres	Farms	Acres	Total ID ($)	Farms	Acres
	5%	18	141	42,559	0	0	76	304	60,270	65	328
1	6 7/8%	70	305	93,305	5	13	24	140	9,523	60	315
	8%	76	314	94,100	6	14	18	131	8,728	59	314
	5%	40	206	60,266	0	0	66	303	55,538	53	264
2	6 7/8%	80	322	98,932	1	5	26	187	16,871	52	259
	8%	106	509	115,803	51	249	0	0	0	2	15
	5%	12	41	15,821	0	0	59	271	71,676	88	461
3	6 7/8%	21	97	21,184	2	2	50	215	66,312	86	459
	8%	59	275	85,266	17	44	12	37	2,230	71	417
	5%	18	141	43,333	0	0	76	304	63,715	65	328
4	6 7/8%	70	305	96,614	5	13	24	140	10,433	60	315
	8%	76	314	97,412	6	14	18	131	9,636	59	314
	5%	18	141	3,947	0	0	55	195	26,737	86	437
5	6 7/8%	54	261	63,239	21	57	19	75	2,968	65	380
	8%	60	270	64,018	22	58	13	66	2,188	64	379
	5%	7	56	4,452	0	0	64	325	80,061	88	392
6	6 7/8%	8	57	4,706	0	0	63	324	79,809	88	392
	8%	35	139	28,386	14	35	36	242	56,128	74	357
	5%	27	173	44,941	0	0	94	460	76,896	38	140
7	6 7/8%	117	587	121,397	33	116	4	46	440	5	24
	8%	121	633	121,837	38	140	0	0	0	0	0
	5%	18	141	42,419	0	0	63	202	49,063	78	430
8	6 7/8%	52	254	74,565	6	13	29	89	16,977	72	417
	8%	65	289	88,635	11	30	16	54	2,907	67	400
	5%	7	56	4,424	0	0	48	222	65,961	104	495
9	6 7/8%	7	56	4,424	0	0	48	222	66,012	104	495
	8%	12	66	5,572	2	4	43	212	64,863	102	491
	5%	25	153	44,070	0	0	76	375	67,090	58	245
10	6 7/8%	65	333	78,350	11	19	36	195	32,809	47	226
	8%	101	528	111,159	58	245	0	0	0	0	0
	5%	12	67	1,527	0	0	43	192	7,047	104	514
11	6 7/8%	31	179	7,287	1	2	24	80	1,286	103	512
	8%	46	239	8,281	29	76	9	20	292	75	438
	5%	19	142	82,407	0	0	83	340	132,818	57	291
12	6 7/8%	74	310	183,371	3	10	28	172	31,853	54	281
	8%	97	455	210,645	25	93	5	27	4,578	32	198
	5%	0	0	0	0	0	18	85	1,661	141	688
13	6 7/8%	0	0	0	0	0	18	85	1,661	141	688
	8%	0	0	0	0	0	18	85	1,661	141	688
14	5%	109	525	251,270	0	0	46	243	25,516	4	5
	6 7/8%	155	768	276,786	4	5	0	0	0	0	0
	8%	155	768	276,786	4	5	0	0	0	0	0

broken down into **privately** unprofitable and profitable categories.

Each participating farm falls into one of the four categories described above. The effects on the above classification of altering the assumptions or social discount rate are evident from the shifts of farms (acres) between the four categories. For example, at the 6 7/8 percent social discount rate, a shift from a 5 percent annual stumpage price growth rate to a 4 percent rate (from Assumption 1 to Assumption 2) slightly reduced the number of socially "profitable" acres, and increased the number of privately unprofitable acres.[2] The final result on the farms meeting the subsidy allocation criteria increased from 140 acres to 187 acres (from 24 farms to 26 farms) and from $9,523 to $16,871 in subsidy payments.[3]

Similar comparisons can be made between any of the 14 assumptions and three social discount rates (rows in the table) for any of the four categories (columns in the table). Such comparisons clearly show the effects of altering assumptions and social discount rates upon the classification process and help to explain why the two subsidy allocation criteria lead to the rejection of large numbers of applicants for cost share funds regardless of the assumptions used.

[2] In this analysis the social annual stumpage price growth rate (g_s) assumption is set equal to the private annual stumpage price growth rate (g_p). Therefore, NPW_s is affected both by the altered optimum financial rotation and by direct changes in the value of benefits.

[3] It is not **necessarily** true that for a given category, such as the category of farms meeting the subsidy allocation criteria, all or even some of the farms found "remaining" after the change in assumptions or discount rate were in the same category before that change in assumptions or discount rate. In the example above it is not necessarily true that any or all of the 26 farms in that category (r_s = 6 7/8 percent) for Assumption 2 were in the same category for Assumption 1.

Appendix H

Computer program

The computer program was written in FORTRAN IV for an IBM 360 computer. Certain input data were calculated outside the program rather than being calculated internally. Using yield data from **Appendix** F, we calculated the "present value of benefits" (PVB) for annual stumpage price inflation rates of 4 percent, 5 percent, and 6 percent, and for discount rates of 1-20 percent and 6 7/8 percent.[1] From the calculated output we selected the highest PVB figure for each combination of site, annual stumpage price growth rate, and discount rate (1-20 percent), *i.e.,* we selected the PVB resulting for each optimum financial rotation. These were called private benefits (PVTBEN in the program) and became the first input.

We also selected the rotations (optimum financial rotations) corresponding to each benefit figure as a second input (ROTATE in the program). These two inputs were entered with data statements in the program (input A on the program flow chart). For the annual stumpage price growth rates of 4 percent, 5 percent, and 6 percent, and for the discount rates of 5 percent, 6 7/8 percent, and 8 percent we selected the PVB for both sites and all 18 rotation ages (30-200). These were called social benefits (SOCBEN in the program) and were read into the program on data cards (input B on the program flow chart). Other data read from cards were titles for an output table, planting labor costs, seedling costs, social land costs, and individual farm data which included alternative rates of return, private land costs, property tax levels, whether owners did their own planting, planting method, number of trees planted, number of acres planted, site preparation cost (if any), and subsidy payment.

All numerical results presented in the text (Chapters 3 and 4) were calculated by this program. Both the program outline and the program flow chart group the operations by statement numbers in their order of occurrence. A list defining all the variables used in the program is included for reference.

[1] The present value of benefits for any given year equals the present value of the thinnings for all previous years plus the present value of the harvest for that year. The present value of any one thinning or harvest equals the base stumpage price times the yield times $(1+g)^t/(1+r)^t$, where g equals the annual stumpage price growth rate, r equals the discount rate, and t equals the number of years since planting. The stumpage prices used for our precalculations of benefits were $10/MBF and $1/cord. The actual benefits used within the program were multiplied by either a factor of three or five to bring the benefits up to realistic levels.

Program Outline

Statement Number(s) 1/

001 - 036 Preparatory statements (DIMENSION, EQUIVALENCE, INTERGER-REAL, DATA)

037 Subroutine "CHOVER" called

038 - 054 READ-FORMAT statements establishing values used for assumptions comprising the assumption set, countywide establishment costs, and TITLES for output table.

055 - 061 Assumption set variables printed to identify each run

062 - 067 Initial values of variables (which later are incremented) are set to zero

068 - 151 Loop where calculations for individual farms take place, once through the loop per farm

069 - 072 Data for farm read from cards (one card per farm)

073 - 075 Labor cost established for farm

076 - 078 Private and social stand establishment costs calculated for farm

079 - 082 Index variables set up

083 NPW_I calculated for farm

084 - 087 Tax cost calculated for farm according to the present value of annuity formula

088 - 089 NPW_r calculated for farm

1/ Statement numbers shown here have ignored the last zero on each statement number shown in the program listing.

090 - 091 Three NPW_s 's calculated for farm

092 - 094 Investment deficit (ID) calculated for farm

095 - 098 Column numbers determined for NPW_s — ID table (TABLE)

099 - 101 NPWS/ID ratios calculated for each farm for 3 discount rates

102 - 106 Individual form calculations performed for funding order table

107 - 108 Column numbers determined for (CHART) output table

109 - 116 Mechanism for printing heading at the top of each page of output

117 - 119 Printing calculated values for farm

120 - 121 Rotation table values incremented for numbers of (1) farms and (2) acres

122 - 123 Public cost calculated for farm and incremented for a total for all farms

124 - 138 Program benefits, program costs, number of farms and acres calculated

139 - 149 NPW_s -ID table and resulting benefits, costs, and public costs calculated

150 - 151 End of loop (from 068)

152 - 156 PE's and SE's calculated for farms meeting subsidy allocation criteria

157 - 165 Program costs, program benefits, total farms and acres summed for total

166 - 176 PE's and SE's calculated

177 - 190 Output table (CHART) set up

191 - 208 Output tables printed

209 - 213 Headings for funding order table printed

214 - 216 Subroutine SPSORT called

217 - 242 Funding order table calculated and printed

243 - 244 End of program

Variables

A = (t.s.v.) program benefits.

ACREID (2,200,3) = number of ACREs and Investment Deficit per farm, used in funding order table (2 types, 200 farms, 3 social discount rates).

ASSMPT = ASSuMPTion set number — each run through the complete program given a number representing the set of assumptions.

B = (t.s.v.) socially optimum subsidy benefits.

BDFT = (t.s.v.) stumpage price per thousand BoarD FeeT.

CAT (3) = CATegory in NPW_s -ID table (cell number from left to right), (3 r_s 's).

CHART (3, 50) = table of number of farms and acres, program benefits and costs, and PE's and SE's (3 columns, 50 rows).

CHOVER = a system subroutine which changes a "two large" number, which would be printed as an asterisk '*', to a blank.

FAMPLT = FAMily PLanTing — whether or not the owner and/or his family did all or most of the planting and site prep.

FARM = FARM number — used to code each participant farm within each county.

FCTLND = FaCTor for LaND and property tax cost — either 0, ½, or 1) multiplied times land and tax cost.

FRT (3) = Funding RaTio, the NPW_s /ID ratio (3 social discount rates).

HAND (58) = HAND planting cost per thousand trees (58 counties.)

I = (i.v.) either farm number or social rate of discount, used in calculation of funding order table.

IB = (i.v.) social cost factor.

IC = (i.v.) cell number in CHART, based on ID value.

ID = Investment Deficit.

IS = (i.v.) cell (column) number in CHART.

ISTOP = a STOP mechanism for exiting from calculations for funding order table.

ITFARM (3) = Total FARMs, used in CHART (3 columns).

J = (i.v.) optimum financial rotation for participant, also social discount rate in funding order table.

JJ = (i.v.) cell in NPW_s -ID table.

K = (i.v.) alternative rate of return of participant, also column designation in funding order table.

L = (i.v.) stumpage price growth rate.

LC = (i.v.) Line Count used to space headings at top of page in the initial farm by farm output listing.

LABCST = LABor CoST of planting per thousand seedlings.

LNDGRW = annual LaND value GRoWth rate used in private land cost analysis.

M = (i.v.) site index for farm, also farm designation in funding order table.

MCHINE (58) = MaCHINE planting cost per thousand seedlings (58 counties).

N = couNty number which combined with the farm number identifies each participant.

NF = Number of Farms in funding order calculations.

NPWI = Net Present Worth on Investment per acre excluding land and tax cost.

NPWR = Net Present Worth (total Return) per acre including land and tax cost.

NPWS (3) = Social Net Present Worth per acre (3 r_s 's).

PE (3, 3, 3) = Program Effectiveness (3 columns, 3 g_s 's, 3 r_s 's).

PLACE (4) = PLACEs the index variable (JJ) in the correct column of TABLE (4 starting columns).

PLACRE = PLanted ACREs for farm.

PLMETH = PLanting METHod (hand or machine) used by participant.

PRGBEN (3, 3, 3) = PRoGram BENefits (3 columns, 3 g_s 's, 3 r_s 's).

PRGCST (3, 3) = PRoGram CoSTs (3 columns, 3 cost factors).

PUBCST = total PUBlic CoST being incremented for each farm through the loop.

PUTBEN (2, 20, 3) =
PVTBEN (2, 20, 3) = PriVaTe BENefits per acre — the present value of stumpage (based on our assumed yields and for a base price of $10/MBF and $1.00 per cord) as determined by a previous program (along with SOCBEN and ROTATE) to be used as an input for this program (2 sites, 20 alternative rates of return, 3 g_s 's).

PUTCST=PVTCST = PriVaTe CoST per acre of establishment (seedlings, labor, site prep., and transportation).

PUTSED=PVTSED (58) = PriVaTe SEeDling cost per thousand (58 counties).

RA = Alternative Rate of return of participant.

ROTATE (2, 20, 3) = optimum financial ROTATion determined where private benefits were maximized (output from previous program), (2 sites, 20 alternative rates of return, 3 g_s 's).

RPLACE = (t.s.v.) RePLACEs the social land cost factor index number (IB) from (1, 2, 3) to the actual factor (0, ½, 1).

RSQ (18, 2, 2) = Rotation, Site Quality — used for rotation table (18 rotation ages, 2 sites, and (1) farms — (2) acres).

S = (i.v.) social discount rate.

SACRE (3) = Sum of the ACREs in funding order category (3 social rates of discount).

SE (3, 3, 3, 3) = Social Efficiency (3 columns, 3 g_s 's, 3 r_s 's, 3 social cost factors).

SID (3) = Sum of the Investment Deficit in funding order category (3 social rates of discount).

SIPREP = SIte PREParation cost per acre for participant.

SITE (58) = SITE index (58 counties).

SOCBEN (2, 18, 3, 3) = SOCial BENefits per acre precalculated (as for PVTBEN), (2 sites, 18 rotations, 3 r_s 's, 3 g_s 's).

SOCCST = SOCial CoST per acre of planting, site prep, etc.

SOCLND (58) = SOCial LaND cost per acre (58 counties).

SOCSED (58) = additional SOCial SEeDling cost per thousand seedlings (above the private subsidized cost), (58 counties).

SORTER (2, 200, 3) = funding ratios and farm number used in funding order table (2 types, 200 farms, 3 social rates of discount).

SOSBEN = SOcial BENefits for all farms meeting subsidy allocation criteria under unlimited program budget (3 r_s 's).

SOSCST (3) = SOcial CoSTs for all farms meeting subsidy allocation criteria under unlimited program budget (3 r_s 's).

SOSPE (3) = Program Effectiveness ratio for all farms meeting subsidy allocation criteria under unlimited program budget (3 r_s 's).

SOSPUB (3) = PUBlic expenditure (program expenditure) for all farms meeting subsidy allocation criteria under unlimited program budget (3 r_s 's).

SOSSE (3) = Social Efficiency ratio for all farms meeting subsidy allocation criteria under unlimited program budget (3 r_s 's).

SPSORT = a system subroutine used to SORT farms by the funding ratio.

STMPRG = annual STuMpage PRice Growth rate — one used in each assumption set.

STMPRI = STuMpage PRIce factor — one used in each assumption set (to multiply times the base factor of $10/MBP and $1/cord).

SUBSDY = SUBSiDY (cost share) per acre received for planting and site preparation.

SUMBEN (3, 3, 3) = SUMming BENefits to obtain social benefits (3 categories, 3 g_s 's, 3 r_s 's).

SUMCST (3, 3) = SUMming CoSTs to get social costs (3 categories, 3 cost factors).

SUMPUB = SUMming PUBlic costs for particular farm.

T = (i.v.) land cost factor (1st time used), g_s (2nd time used).

TABLE (3, 13) = TABLE of ID-NPW$_s$ categories (3 r_s 's, 13 columns).

TAX72 = 1972 property TAX of participant.

TAXGRW = annual property TAX GRoWth rate.

TEMPRY = (t.s.v.) social cost for farm excluding land.

TITLES (2, 50) = TITLES for CHART (2 column widths, 50 rows).

TOTREE = TOtal TREEs planted (in thousands) for the whole participant farm.

TRNSPT (58) = seedling TRaNSPorTation cost for each participant's total planting (58 counties).

TTACRE (3) = ToTal ACREs planted — used in CHART (3 columns).

U = (i.v.) social discount rate.

XL (15) = the funding order table to be printed (15 columns).

---

parenthesis enclosing one or more numbers following the variable name indicate a dimensioned variable.

(i.v.) denotes an index variable.

(t.s.v.) denotes a temporary storage variable.

g_s = the annual stumpage price growth rate used in the social analysis.

r_s = the social discount rate.

```
      DIMENSION PUTBEN(2,20,3),PVTSED(58),FRT(3)
      DIMENSION SOCLND(58),      HAND(58),PUTSED(58),SOCSED(58),TRNSPT
     -(58),SITE(58),            SUMBEN(3,3,3),SUMCST(3,3),
     -PRGBEN(3,3,3),PRGCST(3,3),ITFARM(3),TTACRE(3),SOSBEN(3),
     -SOSCST(3)  ,SOSPUB(3)  ,SOSPE(3)  ,SOSSE(3)  ,RSQ(18,2,2),
     -SOCBEN(2,18,3,3)  ,PE(3,3,3),SE(3,3,3,3)
      EQUIVALENCE (PVTLND,PUTLND)
      EQUIVALENCE(PUTBEN,PVTBEN),(PUTSED,PVTSED),(PUTCST,PVTCST)
      INTEGER FARM,CAT(3),          S,T,U,ASSMPT,SITE,FAMPLT,PLMETH
      INTEGER PLACE( 4)/1,4,6,9   /
      REAL*4 MCHINE(58),NPWI,NPWR,NPWS(3),LABCST,LNDGRW,ID
      REAL*4 TABLE(3,10)/30*0./
      REAL*4 CHART(3,50)/150*0./
      REAL*4 PVTBEN(2,20,3)/58133.21,184183.9,8528.25,28418.73,1364.07,
     -5006.53,256.4,1098.01,72.89,319.08,27.3,124.6,11.71,56.75,5.44,
     -28.65,2.73,15.6,1.46,8.99,.84,5.41,.54,3.34,.36,2.11,.23,1.39,.15,
     -.93,.1,.63,.07,.43,.05,.31,.03,.24,.02,.19,385666.59,1192656.93,
     -54987.78,174393.27,8227.58,27453.5,1341.3,4928.9,256.4,1098.01,
     -73.61,322.38,27.78,126.6,11.98,57.93,5.59,29.35,2.82,16.04,1.52,
     -9.26,.86,5.6,.56,3.46,.37,2.19,.24,1.45,.16,.97,.11,.66,.07,.45,
     -.05,.32,.04,.25,542421.64,7767373.16,358104.70,1108160.1,52069.12,
     -165302.88,7943.13,26539.59,1319.35,4854.,256.4,1098.01,74.33,
     -325.66,28.26,128.6,12.26,59.13,5.74,30.06,2.9,16.47,1.57,9.53,.89,
     -5.78,.58,3.58,.38,2.27,.25,1.5,.17,1.01,.11,.69,.08,.48,.05,.34/
      REAL*4 ROTATE(2,20,3)/8*200.,130.,190.,120.,130.,2*110.,100.,90.,
     -90.,80.,90.,70.,50.,70.,50.,70.,50.,60.,50.,60.,50.,60.,40.,60.,
     -40.,60.,40.,30.,40.,30.,40.,30.,10*200.,130.,190.,120.,130.,2*110.
     -,100.,90.,90.,80.,90.,70.,50.,70.,50.,70.,50.,60.,50.,60.,50.,60.,
     -50.,60.,40.,60.,40.,30.,40.,30.,12*200.,130.,190.,120.,130.,2*110.
     -,100.,90.,90.,80.,90.,70.,50.,70.,50.,70.,50.,60.,50.,60.,50.,60.,
     -50.,60.,50.,60.,2*40./
      REAL SORTER(2,200,3),XL(15),SID(3) ,ACREID(2,200,3),SACRE(3)
      REAL*8 TITLES(2,50)
      DATA PRGBEN,PRGCST,       TTACRE,SOSBEN,SOSCST,SOSPUB,SOSPE,SOSSE,
     -           RSQ/126*0./
      DATA ITFARM/3*0/
      CALL CHOVER(' ')
      READ1,ASSMPT,STMPRI,STMPGR,FCTLND,LNDGRW,TAXGRW
    1 FORMAT(I2,F2.0,F5.5,F4.3,2F5.5)
      READ5,SITE
    5 FORMAT(58I1)
      READ12421,TITLES
12421 FORMAT(7X,6A8)
      READ6,SOCBEN
    6 FORMAT(10F8.4)
      READ3,HAND
      READ3,MCHINE
    3 FORMAT(26F3.2)
      READ2,SOCLND
      READ2,PUTSED
      READ2,SOCSED
    2 FORMAT(26F3.0)
      READ4,TRNSPT
    4 FORMAT(40F2.0)
      BDFT=10.*STMPRI
      PRINT9,ASSMPT,STMPRI,BDFT,STMPGR,FCTLND,LNDGRW,TAXGRW
```

```
  9 FORMAT('1'/////30X,'ASSUMPTION',15X,I2,//,30X,'STUMPAGE PRICE:',
   -/,35X,'PER CORD',12X,F5.2,/,35X,'PER MBF',13X,F5.2,/,35X,'ANNUAL
   -'GROWTH RATE',3X,F3.2,//,30X,'LAND COST FACTOR',10X,F4.2,/,35X,
   -'ANNUAL GROWTH RATE',4X,F3.2,//,30X,'ANNUAL TAX GROWTH RATE',5X,
   -F3.2)
    PUBCST=0.
    DO 6666 IS=1,7
    ITFARM(IS)=0
6666 TTACRE(IS)=0.
    LC=0
    NF=0
 503 CONTINUE
    READ(1,91,END=935)N,FARM,RA,Q18,PUTLND,TAX72,FAMPLT,PLMETH,TOTREE,
   -PLACRE,SIPREP,SUBSDY
    NF=NF+1
  91 FORMAT(2I2,F2.2,I1,F4.0,F3.1,2I1,F3.1,F2.0,2F3.1)
    IF(PLMETH.EQ.1.AND.FAMPLT.EQ.1)LABCST=0.
    IF(PLMETH.EQ.2)LABCST=MCHINE(N)
    IF(PLMETH.EQ.1.AND.FAMPLT.EQ.2)LABCST=HAND(N)
    TRACRE=TOTREE/PLACRE
    PUTCST=(PUTSED(N)+LABCST)*TRACRE+SIPREP+TRNSPT(N)/PLACRE
    SOCCST=PUTCST+SOCSED(N)*TRACRE+FCTLND*SOCLND(N)+(16./PLACRE)
    M=SITE(N)
    L=(STMPGR+.001)*100.-3.
    K=(RA+.001)*100.
    J=(ROTATE(M,K,L)-20.0)/10.+.1
    NPWI=(PUTBEN(M,K,L)*STMPRI)-PUTCST
    IF(TAXGRW.EQ.RA)TAXCST=ROTATE(M,K,L)*TAX72
    IF(TAXGRW.EQ.RA)GOTO65
    Q=(1.0+TAXGRW)/(1.0+RA)
    TAXCST=TAX72*(1.0-Q**(ROTATE(M,K,L)+1.0))/(1.0-Q)
  65 NPWR=NPWI-FCTLND*PVTLND*(1.0-(((1.0+LNDGRW)**ROTATE(M,K,L))/((1.0+
   -RA)**ROTATE(M,K,L))))-FCTLND*TAXCST
    DO59S=1,3
  59 NPWS(S)=(SOCBEN(M,J,S,L)*STMPRI)-SOCCST
       ID=-NPWR
    IF(NPWI.LT.NPWR)   ID=-NPWI
    IF(   ID.LT.0.)   ID=0.
    DO22S=1,3
    CAT(S)=1
    IF(NPWS(S).GE.0.)CAT(S)=3
  22 IF(ID.EQ.0.)CAT(S)=CAT(S)+1
    DO427S=1,3
    FRT(S)=0.0
    IF(CAT(S).EQ.3.AND.ID.GT.0.0001)FRT(S)=NPWS(S)/ID
    SORTER(1,NF,S)=FRT(S)
    SORTER(2,NF,S)=NF
    ACREID(1,NF,S)=PLACRE
    ACREID(2,NF,S)=PLACRE*ID
 427 CONTINUE
    IC=1
    IF(ID.EQ.0.)IC=2
    IF(LC.GT.3) GOTO96666
    PRINT10
  10 FORMAT('1 FARM',3X,'RA',2X,'ROTATION',2X,'SUBSIDY',6X,'NPWR',7X,
   -'NPWI',8X,'ID',4X,'NPWS.05000',1X,'NPWS.06875',1X,'NPWS.08000',
```

```
     -1X,'CAT1 CAT2 CAT3   FRT1    FRT2    FRT3')
      LC=63
96666 CONTINUE
      LC=LC-1
      PRINT11,N,FARM,RA,ROTATE(M,K,L),SUBSDY,NPWR,NPWI,ID,
     -NPWS(1),NPWS(2),NPWS(3),CAT(1),CAT(2),CAT(3),FRT(1),FRT(2),FRT(3)
   11 FORMAT(1X,2I2,F7.2,F7.0,7F11.2,3I5,1X,3F7.2)
      RSQ(J,M,1)=RSQ(J,M,1)+1.
      RSQ(J,M,2)=RSQ(J,M,2)+PLACRE
      SUMPUB=SUBSDY*PLACRE+16.
      PUBCST=PUBCST+SUMPUB
      TEMPRY=SOCCST-(FCTLND*SOCLND(N))-16./PLACRE
      DO2001L=1,3
      DO2002S=1,3
      SUMBEN(IC,L,S)=SOCBEN(M,J,S,L)*STMPRI*PLACRE
      PRGBEN(IC,L,S)=PRGBEN(IC,L,S)+SUMBEN(IC,L,S)
 2002 CONTINUE
 2001 CONTINUE
      DO2003IB=1,3
      RPLACE=IB-1
      RPLACE=RPLACE/2.
      SUMCST(IC,IB)=(TEMPRY+(RPLACE*SOCLND(N)))*PLACRE
      PRGCST(IC,IB)=PRGCST(IC,IB)+SUMCST(IC,IB)
 2003 CONTINUE
      ITFARM(IC)=ITFARM(IC)+1
      TTACRE(IC)=TTACRE(IC)+PLACRE
      DO3007S=1,3
      JJ=PLACE(CAT(S))
      TABLE(S,     JJ)=TABLE(S,     JJ)+1.
      TABLE(S,     JJ+1)=TABLE(S,     JJ+1)+PLACRE
      IF(JJ.NE.4.AND.JJ.NE. 9)TABLE(S,     JJ+2)=TABLE(S,     JJ+2)+ID
     -*PLACRE
      IF(JJ.NE.6)GOTO3007
      SOSBEN(S   )=SOSBEN(S   )+(SOCBEN(M,J,S,L)*STMPRI*PLACRE)
      SOSCST(S   )=SOSCST(S   )+(SOCCST*PLACRE)
      SOSPUB(S   )=SOSPUB(S   )+(    ID*PLACRE)+16.
 3007 CONTINUE
      GOTO503
  935 CONTINUE
      DO6001S=1,3
      B=SOSBEN(S)
      IF(SOSPUB(S    ).GT..000001)SOSPE(S    )=B/SOSPUB(S)
      IF(SOSCST(S    ).GT..000001)SOSSE(S    )=B/SOSCST(S)
 6001 CONTINUE
      ITFARM(3)=ITFARM(1)+ITFARM(2)
      TTACRE(3)=TTACRE(1)+TTACRE(2)
      DO3005T=1,3
      PRGCST(1,T)=PRGCST(1,T)+16.*ITFARM(3)
      PRGCST(3,T)=PRGCST(1,T)+PRGCST(2,T)
      DO3006U=1,3
      PRGBEN(3,T,U)=PRGBEN(1,T,U)+PRGBEN(2,T,U)
 3006 CONTINUE
 3005 CONTINUE
      DO3001IC=1,3
      DO3002L=1,3
      DO3003S=1,3
```

```
      A=PRGBEN(IC,L,S)
      PE(IC,L,S)=A/PUBCST
      DO3004IB=1,3
      IF(PRGCST(IC,IB).GT..000001)SE(IC,L,S,IB)=A/PRGCST(IC,IB)
 3004 CONTINUE
 3003 CONTINUE
 3002 CONTINUE
 3001 CONTINUE
      DO4001IC=1,3
      CHART(IC,1)=ITFARM(IC)
      CHART(IC,2)=TTACRE(IC)
      DO4002T=1,3
      CHART(IC,T+2)=PRGCST(IC,T)
      DO4003U=1,3
      CHART(IC,3*T+U+2)=PRGBEN(IC,T,U)
      CHART(IC,3*T+U+11)=PE(IC,T,U)
      DO4004IB=1,3
      CHART(IC,11+9*IB+3*T+U)=SE(IC,T,U,IB)
 4004 CONTINUE
 4003 CONTINUE
 4002 CONTINUE
 4001 CONTINUE
      PRINT700
  700 FORMAT('1',35X,'ID > 0',9X,'ID = 0',6X,'TOTAL'/)
      PRINT701,((TITLES(I1,I9),I1=1,2), (CHART(I1,I9),I1=1,3),I9=1,50)
  701 FORMAT(1X,2A8,'.........',3F15.2)
      PRINT703
  703 FORMAT('1',7X,'NPWS<0<ID',9X,'NPWS<0=ID',9X,'NPWS>=0   ID>0',6X,
     -                   '0=ID<=NPWS'/,1X,'FARMS ACRES',7X,
     -'ID    FARMS ACRES    FARMS ACRES',7X,'ID    FARMS ACRES')
      PRINT704,(((TABLE(I1,I9   ),I9=1,10),I1 =1,3))
  704 FORMAT(1X,F5.0,F6.0,F11.2,F7.0,F6.0,F9.0,F6.0,F11.2,F7.0,F6.0)
      PRINT705,SOSBEN,SOSPUB,SOSCST,SOSPE,SOSSE
  705 FORMAT(/////,26X,'RS=.05000',6X,'RS=.06875',6X,'RS=.08000',//,
     -(20X,3F15.2))
      PRINT150,(I6,I6=30,200,10)
  150 FORMAT(///,59X,'ROTATION'//6X,18(2X,I3,2X))
      PRINT151,(((RSQ(I6,I7,I8),I6=1,18),I8=1,2),I7=1,2)
  151 FORMAT(6X,18(2X,F4.0,1X)/4X,'40',18(1X,F6.1)/1X,'SQ'/6X,18(2X,
     -F4.0,1X),/4X,'60',18(1X,F6.1))
      PRINT152
  152 FORMAT('1',55X,'SOS FUNDING ORDER'///9X,'5.000% SOCIAL DISCOUNT',
     -' RATE',18X,'6.875% SOCIAL DISCOUNT RATE',18X,'8.000% SOCIAL ',
     - 'DISCOUNT RATE'//2X,3(1X,'FRATIO',2X,'ACRE  CUM ACRE',4X,'ID',4X,
     -'CUM ID',4X)/)
      DO8000I=1,3
      CALL SPSORT(5,SORTER(1,1,I),NF)
 8000 CONTINUE
      SID(1)=0.
      SID(2)=0.
      SID(3)=0.
      SACRE(1)=0.0
      SACRE(2)=0.0
      SACRE(3)=0.0
      DO8050I=1,NF
      ISTOP=0
```

```
      DO8010K=1,15
8010  XL(K)=1.E70
      DO8020J=1,3
      IF(SORTER(1,I,J).EQ.0.0)GOTO8020
      M=SORTER(2,I,J)
      XL(5*(J-1)+1)=SORTER(1,I,J)
      XL(5*(J-1)+2)=ACREID(1,M,J)
      SACRE(J)=SACRE(J)+ACREID(1,M,J)
      XL(5*(J-1)+3)=SACRE(J)
      XL(5*(J-1)+4)=ACREID(2,M,J)
      SID(J)=SID(J)+ACREID(2,M,J)
      XL(5*(J-1)+5)=SID(J)
      ISTOP=1
8020  CONTINUE
      IF(ISTOP.EQ.0)STOP
      PRINT153,(XL(I1),I1=1,15)
 153  FORMAT( 3(F9.3,F6.0,F8.0,2F10.2))
8050  CONTINUE
      STOP
      END
```

Appendix I

Investment decision framework

As explained in Section 1 of Chapter 2, three decision possibilities exist when a landowner analyzes his land from the point of view of financial return (Table 2.1). He can hold his land and invest in some practice on it (some use), he can hold his land and not invest in any practice, or he can sell his land. The choice of one of these depends upon whether NPW_I and/or NPW_r are positive or negative and whether $r_L \geq r_a$ or $r_L < r_a$.

Table I-1 is structured so that each of the six relevant combinations of the above criteria are considered individually, with the outcome for each possible combination listed in the cell corresponding to that combination. The three possibilities (decisions) each appear twice, which means that each depends upon only two of the three criteria represented by the table. This allowed Table I-1 to be simplified and presented as Table 2-1 in the text.

The interpretation of Table I-1 is the same as that for Table 2-1. The investor will hold his land and invest if **both** the investment opportunity (excluding the investment in land) and the total investment (land and trees) are profitable. The relationship between r_L and r_a does not matter as long as the first two criteria are satisfied ($NPW_r \geq 0$ and $NPW_I \geq 0$). The investor will always hold his land if $r_L > r_a$, but he will not invest in I if it is unprofitable ($NPW_I < 0$). Whether or not the total investment is profitable is irrelevant since the two components must be considered separately. Therefore, the landowner will hold his land and not invest if $r_L > r_a$ and $NPW_I < 0$. Finally, the landowner will sell his land if $r_L < r_a$, **unless** NPW_I was sufficiently above zero to make the total investment profitable ($NPW_r \geq 0$). If NPW_I was positive but not large enough to make NPW_r positive, the landowner will still sell his land when $r_L < r_a$. The necessary two criteria for the landowner to sell his land are that $r_L < r_a$ and $NPW_r < 0$. It does not matter whether NPW_I is positive or negative.

Table I-1. Investment decision framework for private landowner (as rational investor).

		$r_L \geq r_a$	$r_L < r_a$
$NPW_r \geq 0$	$NPW_I \geq 0$	invest in I (ID = 0)	invest in I (ID = 0)
	$NPW_I < 0$	do not invest in I, but hold land (ID > 0)	n.a.
$NPW_r < 0$	$NPW_I \geq 0$	n.a.	sell land (ID > 0)
	$NPW_I < 0$	do not invest in I, but hold land (ID > 0)	sell land (ID > 0)

Definitions:
- r_L = rate of value increase for bare land net of property taxes.
- r_a = alternative rate of return.
- NPW_r = net present worth for total investment (practice I and holding land using r_a for discounting costs and benefits).
- NPW_I = net present worth for practice I (using r_a).
- I = practice(s) being considered.
- n.a. = not applicable.
- ID = investment deficit as defined earlier.

Program flow chart
(additional information on computer outline)