Lesson 3

Forest Fertilization Program

45 minutes

Objectives

- Review and expand on the guidance found in the *Forest Fertilization Guidebook* on the strategic planning of fertilization
- Discuss the questions to address for meeting forest estate management objectives before embarking on a fertilization program
- Understand the importance of the careful consideration of forest fertilization as a management tool to meet forest estate objectives using the stand management prescription

Equipment Needs

- Overhead projector
- Lesson 3 transparencies
- Flip chart, wide-tip felt pens and masking tape

Method

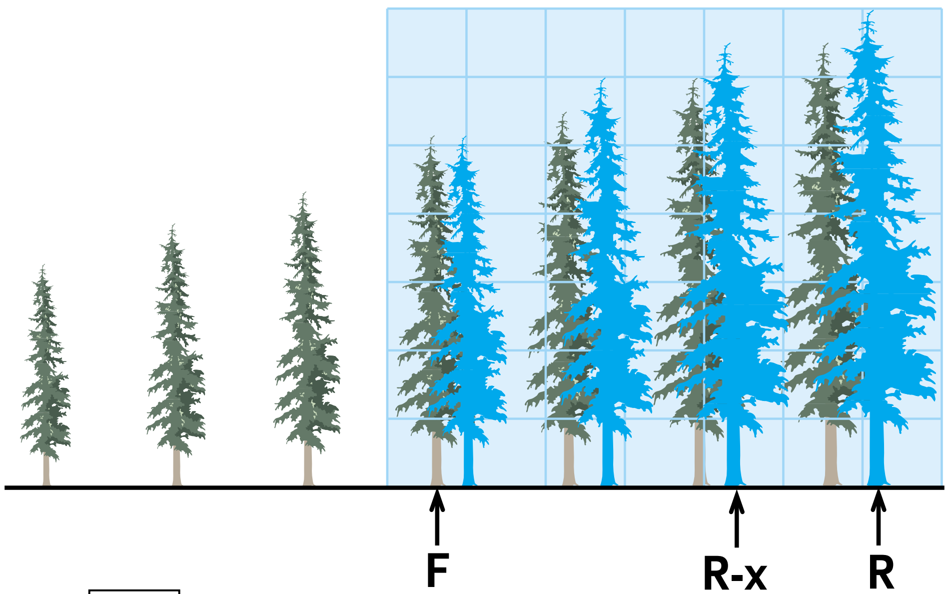
- Lecturette with overheads and group discussion using flip charts
- Case studies

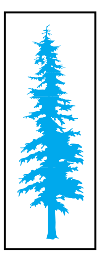
Instructions

This lesson focuses on the strategic goals of a forest fertilization program. The facilitator will need to gauge the participants' experience with fertilization and the degree of their need for an introduction to strategic planning before beginning this lesson. In the group introductions, try to get an idea of how in-depth this lesson should be. All participants should receive some instruction from this lesson, but the facilitator will need to judge the level of detail and emphasis required. The questions to participants and case studies should be led by the facilitator accordingly.

Statements on the strategic purpose of fertilization are on page 1 of the *Forest Fertilization Guidebook* under the "Response to Fertilization" section and on page 7 under "Forest Level Planning." They state in part that one requires the knowledge of the timber supply profile and future wood supply needs, both spatially ("*What stands to fertilize?*") and temporally ("*When to fertilize?*"). With this information one can schedule fertilization of stands of a specific age class and species and optimize treatment investments. The overheads for this lesson will introduce participants to these concepts.

Fertilization as a Strategic Tool





F – Fertilized trees get boost in growth

R-x – rotation size can be reached sooner through fertilization.

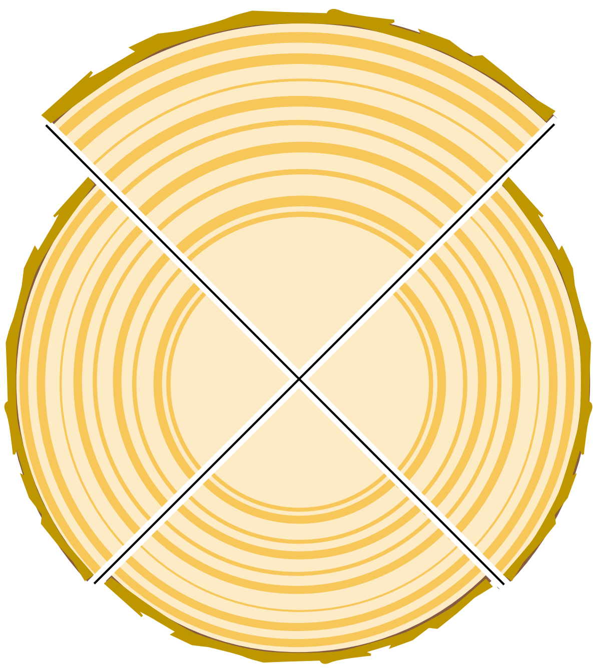
R – fertilization yields larger trees at natural rotation age.

Overhead: Fertilization as a Strategic Tool

Key Points

- The key response from forest fertilization is that the application of deficient nutrient(s) speeds up stand development, producing a stand with target properties (volume, diameter) earlier than without treatment. Or, a stand with a larger diameter and volume will be produced at the same rotation. A fertilized stand will not otherwise differ significantly from a non-fertilized stand grown over a longer rotation. *This is one of the basic tenets of forest fertilization.*
- Fertilization is subsequently used to accelerate the development of specific age classes and timber types in conjunction with the timber supply profile and the timing and magnitude of projected wood supply needs.
- A well-planned fertilization program can therefore be used to facilitate an even supply of wood at the forest-estate level.
- Fertilization programs should be planned and implemented as part of an overall enhanced forestry strategy that includes juvenile spacing and pruning. This will ensure that fertilization treatments are optimized on selected crop trees that will maximize stand value at harvest.
- In summary, fertilization is not a sole treatment on an ad hoc basis; it must be incorporated at the forest-estate planning level to maximize returns on timber values from merchantable stands and to mitigate projected timber supply shortfalls.

Response to Fertilization



Overhead: Response to Fertilization

Key Points

- Overhead shows control (no treatment) on the bottom, thinned only on the left, fertilized only on the right, and thinned and fertilized on the top
- Note how thinning or fertilizing as single treatments produce a small response, whereas together, the response is dramatic
- The response from fertilizing only would depend on stand density and the potential for response
- This overhead shows how a fertilization program must be planned as part of an overall enhanced forestry program with treatments for each candidate stand carefully planned and properly conducted to produce the desired effect and optimize the investments of the treatments

Exercise: (Facilitator addresses entire group or delegates one question per sub-group)

* *Note that these questions are posed in a chronological sequence. The facilitator should point this out to participants when the questions are all addressed and ensure that participants understand this important sequence as part of strategic planning of fertilization.*

1. Do you have defined investment priorities for the funds you spend on fertilization? If not, how should priorities be determined to set up the program?
2. Do you have defined stand targets for determining the rotation age of different tree species across all sites? If not, how would you go about defining them?
3. How would you determine either the reduction in the rotation age or the increase in wood volume from fertilization treatments?
4. How would you decide if you have sufficient land area by age class to fertilize and have a significant impact on the wood supply?
5. What operational falldown factor do you apply to the research results for modeling stand response from fertilization?
6. What should be part of a long-term monitoring plan for the measurement of growth response to fertilization?

Responses

1. Do you have defined investment priorities for the funds you spend on fertilization? If not, how should priorities be determined to set up the program?

   There should be defined investment priorities based on age classes for fertilization. In other words, what is the age class distribution of the forest? Then determine priorities using the stand selection guidelines in the Forest Fertilization Guidebook *and develop a 5–10 year program based on the priorities and the individual stands' "readiness" for fertilization. A stand may be currently too young for fertilization but may become a high priority at the end of the planning timeframe when it is a more suitable age for treatment.*

2. Do you have defined stand targets for determining the rotation age of different tree species across all sites? If not, how would you go about defining them?

   Use yield projection models, such as TIPSY, stand density management diagrams or Prognosis, to determine rotation by species and site. Empirical data and observations could be helpful to adjust model results for application.

3. How would you determine either the reduction in the rotation age or the increase in wood volume from fertilization treatments?

   The response should relate back to the basic premise of fertilization, as shown in Overhead 3•1. Fertilization can produce the same-sized tree in a shorter timeframe or produce a larger-diameter tree if the rotation age is unchanged. It is important to define why the rotation would be shortened or wood volume increased – this depends on projected wood supply and the anticipated increased value of a larger piece size.

4. How would you decide if you have sufficient land area by age class to fertilize and have a significant impact on the wood supply?

   For a 10-year program, for example,what is the number of hectares that could reasonably be fertilized each year? Multiply this number by the average expected volume response rate per hectare. The increased overall volume harvested per year is the Allowable Cut Effect (ACE). *Decide if this amount will produce a significant impact on the wood supply at the forest estate level.*

5. What operational adjustment factor (OAF) do you apply to the research results for modeling stand response from fertilization?

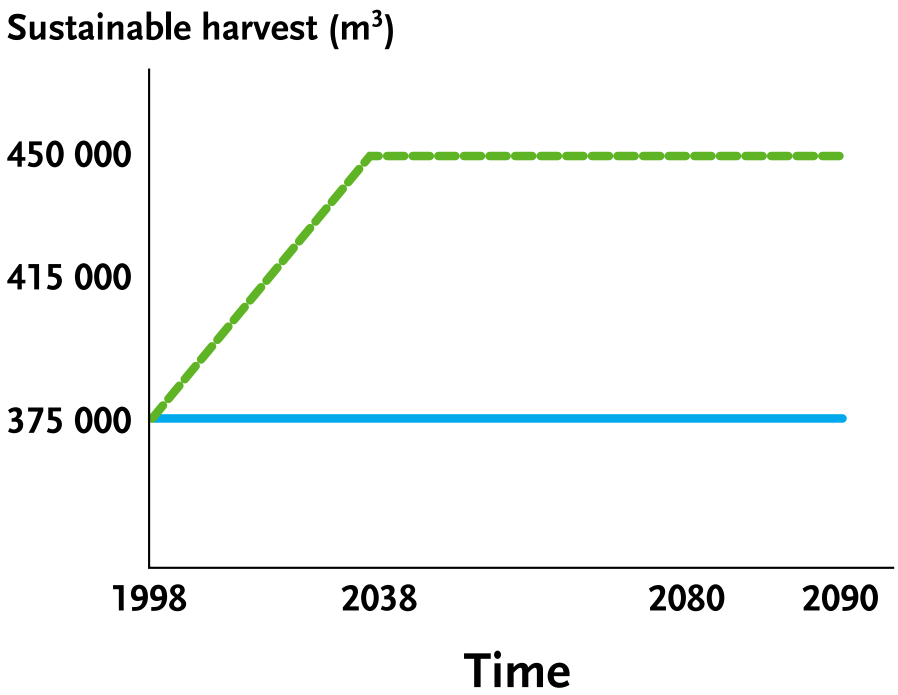
   If the OAF1 from incomplete stocking means a 15% reduction in yield, fertilization, if properly prescribed and conducted, would be able to offset this reduction to some extent, for example to 10%. This results in a net gain in yield compared to an unfertilized stand. OAF2 (regarding forest health concerns) may be reduced similarly or it may actually increase if fertilization increases forest health agents and reduces net yield.

6. What should be part of a long-term monitoring plan for the measurement of growth response to fertilization?

   A long-term monitoring plan could include growth and yield plots, forest health monitoring (especially if problems are suspected), Sx trials, E.P. (experimental project) research trials, foliar sampling 5 years after fertilization to determine response and decide whether or not to refertilize.

Forest Fertilization Case Study

(Coast)



Overhead: Forest Fertilization Case Study (Coast)

The private land base of this managed forest consists of approximately 80 000 ha of forested land. The even-flow, long-run sustainable rate of harvest is estimated at 375 000 m^3 if these lands were unmanaged. The management practices employed to date and currently used – such as immediate reforestation, achieving free growing status, conducting juvenile spacing, and fertilization at the time of spacing – are expected to sustain a harvest of 415 000 m^3 which could be increased to 450 000 m^3 in 2038.

The company's long-term wood requirements indicate that within 20 years, and due to the expiration of Old Temporary Tenure licenses, the harvest from these private lands should be closer to 500 000 m^3. However, simulations with a forest estate model indicate that this level of harvest is not sustainable with current practices. To reach this target it has been determined that the management strategy must include fertilizing 4000 ha/year of stands about 10 years before harvest. The estimated gain in volume from this strategy is approximated at 15 m^3/ha or a total gain of 60 000 m^3 of harvest volume. This treatment should take place starting immediately and continue for the next two decades. Such a management strategy has been shown to allow the harvest of 480 000 m^3/year through to 2038 and an increase to approximately 500 000 m^3/year thereafter. This cut level could then be maintained indefinitely, provided such a program of fertilization was repeated again during the period of 2080 and 2090, thereby offsetting a projected deficit anticipated to occur during the period 2095 and 2104.

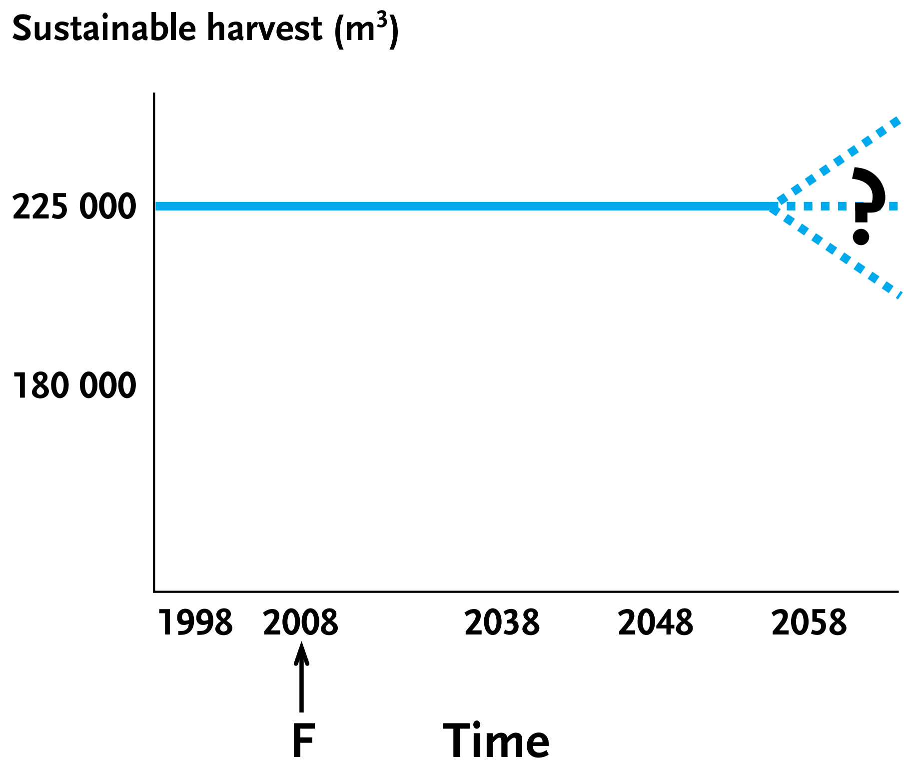
It is expected that fertilization approximately 10–15 years before harvest should accelerate the growth of the stand and help overcome a projected wood supply problem by producing 15 m^3/ha greater yield at 60 years of age. The diameter distribution after the treatment would shift stems into the merchantability category and increase the stand average diameter by about 3 cm. The range of diameters is reduced because increased between-tree competition will remove numbers of smaller understorey trees. Harvest costs will be reduced because fewer trees will be handled.

Summary

Forest fertilization is a silvicultural treatment that must be applied with discretion and proof that it is an appropriate strategy for the wood supply problem. It requires a strong guarantee of security over the land base so that the benefits can be counted on for the near and longer term. It works best where there is a stand-based information system that can relate to the future wood supply needs and harvest scheduling. Finally, there is a need for reliable growth and yield information to assist in prescribing the most effective and timely application of the fertilization treatments.

Forest Fertilization Case Study

(Interior)



Overhead: Interior Forest Fertilization Case Study

A typical age class structure of many interior forest management units consists of a substantial area of young stands and a large area of old growth stands with little or no area in the intermediate age classes. The development of the forest age-class structure resembles a wave, with a harvest level in the near term based on the reduction of the initial standing old growth. If this rate exceeds the time necessary for the current young stands to develop into merchantable stands, there is a sudden and rapid timber supply falldown in the future.

Even if the rate of harvest is sufficient to allow the young stands to grow to merchantable size, these “new” harvestable stand types will typically have less standing volume than the previous old-growth stands because the age at which a stand is scheduled for harvest will probably be the culmination of mean annual increment and not the point of maximum standing volume. This is a simplified explanation of the falldown effect so common to the province’s forest management units.

In this example, without forest fertilization, the harvest volume cannot be sustained at 225 000 m^3/year past 60 years in the future, after the year 2058. This is not simply because the second growth stands were not given sufficient time to reach merchantability; in fact, some second growth stands are harvested as early as 41 years from present. The reasons are that some of the stands in the oldest age classes are assumed to be lost to insects and diseases. These stands recycle back onto the regenerated yield curve but have not provided any volume to the harvest. As well, the standing volume of the regenerated stands when harvested is up to 50 m^3/ha less than that of the old growth stands.

Clearly, the only way to maintain the present harvest level of 225 000 m^3 is to apply those silvicultural treatments that will result in earlier merchantability and greater volume at a younger age. Before reading further, sketch the shape of the volume over age curve on the curve shown for this base case. What is the magnitude of the differences?

The application of fertilizer to only 50% of the stands was found to be adequate to bridge the wood supply problem at 60 years from the present. The shape of the yield curve assigned to this treatment and the stand types to which it was applied are known. The effect of the fertilization is represented in the diagrams and described as follows: **The fertilization yield curve does not give more volume per hectare, but rather it produces a similar volume at a younger age and reduces the age of merchantability.** This is a basic tenet of forest fertilization as a silvicultural treatment for reducing projected timber supply falldowns.

The age-class structure develops much as before for the initial 40 years, except that now as the initial harvested area begins at 1000 ha/year, it can quickly increase with the availability of the fertilized stands reaching merchantability sooner. Now the second growth stands that are harvested 41 years from present have standing volumes similar to stands 15 to 20 years older. The fact that 50% of the second growth stands now have volumes similar to the pre-existing old growth stands means that the area harvested does not need to increase as much. The one caveat that should be mentioned, however, is that the fertilized stands are preferentially harvested in the initial stages. The repercussions of this policy is that when the unfertilized second growth stands are harvested, at least half of them will have to be fertilized to perpetuate this strategy. Therefore, the entire forest is assumed to consist of potential fertilization candidate stands, an unlikely occurrence in many areas.

In summary, different forest estates have different opportunities to maintain or increase timber supply from a strategically planned forest fertilization program. There is also the potential from fertilization to maintain revenue to the Crown from timber harvesting while harvesting less area because each fertilized hectare of forest is producing more volume.

Stand Management Prescription

- Use Section D-1 Post-treatment Standards
- Fertilization included as treatment under 'Schedule'

Year	Age/ Height	DBH	Treatment	Area (ha)
1996	18/7	6.5	Juvenile space 800 sph	22.7
1997	19/7.5		Prune	22.7
1998	20/8.6	9.2	Fertilize @ 250 kg N/ha	24.0
2002	24/11.5	15.6	Prune	22.7
2005	27/13	19	Fertilize @ 250 kg N/ha	24.0
2038	60/30	37	Harvest	22.7

For more information refer to the *Stand Management Prescription Guidebook* (1999)

Overhead: Stand Management Prescription

Key Points