Development of forest research in Norway since 1927: some issues

B. SOLBERG AND A. SVENDSRUD

Norwegian Forest Research Institute and Department of Forest Science, Agricultural University of Norway, P.O. Box 5044, 1432 Ås, Norway

Summary

A review is given of the development of forest research in Norway since 1927, focusing on four specific topics and the research setting in general. Research in 1927 was in its infancy, but still produced valuable results for practical forest management, and most of the results, with some modifications, are still valid. The general forest research development since 1927 is characterized by a manifold increase of personnel (the number of researchers, technical and administrative personnel have increased respectively about 12, 45 and 80 times from 1927 to 1991); new disciplines such as economics, planning, harvesting and wood technology have emerged; and considerable changes have taken place in the way research is organized and financed.

Introduction

Publicly financed forestry research in Norway started in 1897 with the establishment of the Department of Forestry at the Agricultural University of Norway. The main purpose of this institution was to provide a scientific education in forestry. Research was an additional requirement, but the research activities were rather limited. In 1916 a private forest research institute for Western Norway (Vestlandets forstlige forskstsasjon) was established with the aim of carrying out research on afforestation of this region. In 1917 the Norwegian Forest Research Institute (Det norske Skogforsøksvesen) was founded and occupied a central place in the research activities in this field.

In 1927 Erling Eide, who in 1920 had become director of the institute (by that time termed The Institute of Experimental Forestry), wrote a review article in Forestry (Eide, 1927) on recent forest research in Norway discussing the following issues, which were among the most important research topics being investigated at the institute at that time.

1 The regeneration of the pine forests in Northern Norway.
2 The relation between growth and consumption in Norwegian forestry.
3 Investigations on the form of trees.
4 On the fungal problems in forestry.

The purpose of this paper is first, to review the development since 1927 of the four issues mentioned, and second, to give a brief account and discussion of the general development of forest research in Norway since 1927.
The specific issues discussed by Eide

The regeneration of the pine forests in Northern Norway

The most important results reported by Eide (1927) were:

1. Summer temperatures (June–September) should be at least 10.5°C for pine seed to mature.
2. The weather conditions during the flowering seasons are exceedingly important for the seed quality.
3. Pine seed from northern Norway usually has a low germination percentage, but the plant production is, in proportion to the germination rate, considerably higher than that from souther districts.
4. The extension of pine forest in northern Norway has declined as a consequence of climatic change far back in the past, and the reasons for this are different in the coast and interior districts: in the latter, the low summer temperatures only give rise to seed-years at intervals of 50 years or more, whereas, in the coastal districts, seed production is better, but extensive development of raw humus seems to prevent the regeneration of the pine.

Since 1927, most of these results have been confirmed, except point 4, where Bergan (1981) concluded that the good seed years occur at intervals of 10–15 years. Studies of growth and regeneration in the forests of Northern Norway were done, especially by Jarle Bergan, who covered this field during the period 1952–1994. Among his many publications in this area are Bergan (1957, 1967, 1981, 1989, 1993). Research activity, especially related to Northern Norway, has decreased since the early 1990s. Sample plots and trials that have been established are being maintained for possible future analyses.

The relation between growth and consumption in Norwegian forests

The main results reported here by Eide (1927) were:

1. Norwegian forestry was maintaining a very small growing stock, and a considerable increase in increment and wood supply should be possible.
2. The main question—whether the production and the consumption were balanced—could not be determined in 1927.
3. Preliminary results from the national forest inventory showed that the annual increment per hectare would scarcely reach the quantity supposed by Barth (1916), but on the other hand the forest area appeared to be larger than formerly believed and the home consumption seemed to be smaller than the calculation by Barth.

These findings have been confirmed by later research. Total production has more than doubled since 1927, and now reaches about 20 million m³ a⁻¹. Development is illustrated by figures (Table 1) from the national forest inventory (Landsskogtakseringen, 1933; NIJOS 1996).

Growing stock has increased from 42 m³ ha⁻¹ in 1927 to 86 m³ ha⁻¹ today. The main reason for this is improved forest management (increased investments in planting, choice of species and provenances, silviculture in general), but also climatic factors and the fertilizer effect of air pollution might be significant in explaining the observed growth increase.

It is interesting that the problem in 1927 of possible overcutting of Norwegian forests, now has changed to one of under-utilization of potential industrial wood.

Research in the fields of yield, inventory and mensuration has increased considerably since

Table 1: Norwegian forest production

<table>
<thead>
<tr>
<th></th>
<th>Growing stock</th>
<th>Increment</th>
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<tbody>
<tr>
<td></td>
<td>Per ha (m³)</td>
<td>Total (million m³)</td>
</tr>
<tr>
<td>1925</td>
<td>42.1</td>
<td>310</td>
</tr>
<tr>
<td>1995</td>
<td>86.5</td>
<td>630</td>
</tr>
</tbody>
</table>
1927, both regarding inventories at national, regional county and forest ownership levels, and growth and yield models. A significant step was made in 1941 when the first yield table was developed using linear regression for Norway spruce as documented in Eide and Langsæter (1941). This work was based on 208 yield periods from permanent research plots (mostly in even-aged forest), the first established in 1918. Ten alternative increment functions were calculated. It took two men about 2 weeks to calculate one alternative. Based on the best function, yield tables were prepared for three different thinning regimes. Yield tables have become of great importance, both for practical forestry as well as research in forest economics and policy.

The development of forest management and harvesting regime models soon became important research topics. The first long-term harvest regime calculations in Norway were made in 1944, giving a 100-year view of forest development in the counties of Østfold, Akershus and Hedmark (Langsæter, 1944). To our knowledge this was the first study of this kind in Europe. This study was followed by Seip (1953) who improved the calculation method for six of the most important forest counties, and Kleppen (1959) who made the first long-term forest prognosis for the whole country, with separate estimates for softwood and hardwood. During the 1960s, methods were further improved by Delbeck (1965), Nersten and Delbeck (1965) and Nersten (1965), and the main aim was to find the maximum non-declining harvest path—the so-called balance line. The first computerized long-term forest planning model was developed in the late 1960s (Gotaas, 1967), which in addition to volume estimates also gave economic results for specified harvest regimes. Nersten (1968) incorporated the net present values of different harvesting strategies, as a measure of their preferability. During the late 1970s and early 1980s new growth models were constructed. The long-term forest model AVVIRK3 incorporated more sophisticated growth and economic variables (Hobbelstad, 1988). All the models mentioned above were pure simulation models. The first long-term forest optimization model—a linear programming model—was published in 1990 by Hoen (1990), based on the GAYA-model by Eriksson (1983).

At present the main research frontier in this field is to include geographical information systems (GIS) in the models, improve the biological data inputs (including more sophisticated growth models for uneven-aged and multi-species stands), and include multiple-use considerations like recreation and biological diversity.

Investigation on the form of trees

In order to provide reliable volume tables the study of tree form was an important topic, and Eide (1927) reports the following findings for Norway spruce:

1. Form factor is only dependent on the relation between height and breast-height diameter.
2. Form factor increases with increasing height, and decreases with increasing diameter.
3. Stand density and climate only influence the form factor to the extent that they may influence the relation between diameter and height.
4. Soil quality does not influence form factor, and nor does age.
5. Form factor follows the same equation in even-aged and uneven-aged stands.

These findings are still valid (Vestjordet, 1967). Taper tables for Norway spruce, which are still in use, were published in Eide and Langsæter (1929). Vestjordet (1967) presents the volume functions and tables used today for Norway spruce.

On the fungal problems in forestry

The main results reported by Eide here are:

1. The origin of seed is the most important factor causing resistance to Lophodermium infection in the pine forests of Western Norway.
2. Mycorrhiza formed in decaying wood is probably the main reason why, in the forest of Namdal, natural regeneration of spruce is almost entirely found on decaying wood under a canopy of rather dense stands.

Since 1927 considerable research has been done on fungal problems in Norway. Regarding the result reported in point (1) above this finding is no longer supported, as the present view is that it is climatic factors which are the main causes (Roll-Hansen, 1969:112). Regarding
point (2) the observation is in general supported, but today one has a more complex understanding of the role of mycorrhiza.

Research on fungal problems in Norway since 1927 has focused on several aspects. Root and butt rot of coniferous and wound rots have been studied by Roll-Hansen (1940), Huse et al. (1994) and Roll-Hansen and Roll-Hansen (1980). The relationship between bark-beetles and blue-stain fungi has been studied by Solheim (1992). Fungal diseases in coniferous needles like 

Developments in forest research in Norway since 1927

Looking back, significant changes in forest research have occurred. In this presentation we look at the following three aspects: amount of research, research topics, and administration and financing.

Amount of research

Table 2 shows the number of personnel engaged at the three main forest research institutions in 1927 and 1995.

<table>
<thead>
<tr>
<th>Department of Forest Sciences, NLH†</th>
<th>Scientific</th>
<th>Technical</th>
<th>Admin.*</th>
<th>Scientific</th>
<th>Technical</th>
<th>Admin.*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Norwegian Forest Research Institute‡</td>
<td>2</td>
<td>1.5</td>
<td>0.5</td>
<td>67</td>
<td>63</td>
<td>35</td>
</tr>
<tr>
<td>Vestlandets forsl. forsøksstasjon‡</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>8</td>
<td>1.5</td>
<td>0.5</td>
</tr>
</tbody>
</table>

Table 2: Personnel input in forest research in 1927 and 1995 (person years per year).

The table illustrates the strong growth in the number of staff that has taken place since 1927. The growth was especially strong during the post-war period up to around 1970 and reflects also the growth in the amount of research. From 1927 to 1995 the number of scientific, technical and administrative personnel increased respectively about 12, 45 and 80 times.

Research topics

In 1927, probably more than 98 per cent of research activity was on silviculture and the rest on inventory/mensuration. In 1991 the total research and development input in forest research (including wood technology research and development in the pulp and paper industry) was 90.6 million Norwegian krone (about 14 million US$) and it was distributed as shown in Table 3.

Although there are uncertainties in the data and the distribution in the various fields the figure illustrates the development in forest research the last 70 years. Today subjects like forest economics, forest operations, and wood technology have emerged, but silviculture/ecology is still dominant.

It might be of interest here to compare two priorities of forest research in Norway—one made in 1932 and the other in 1994. Eide (1932) characterized the following issues as the main ones for forest research:

- Forest treatment (regeneration, thinnings, yield etc.).
Table 3: Total forest research in Norway in 1927 and 1991 distributed by disciplines

<table>
<thead>
<tr>
<th>Disciplines</th>
<th>Distribution (%)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>1927*</td>
</tr>
<tr>
<td>Biology/ecology/silviculture</td>
<td>98</td>
</tr>
<tr>
<td>Economics/planning</td>
<td>2</td>
</tr>
<tr>
<td>Harvesting/operational techniques</td>
<td>0</td>
</tr>
<tr>
<td>Wood technology—forestry</td>
<td></td>
</tr>
<tr>
<td>Wood technology—sawmilling industry</td>
<td>0</td>
</tr>
<tr>
<td>Wood technology—pulp and paper industry</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
</tr>
</tbody>
</table>

* Own estimates; † From Solberg & Sørum (1992 unpublished); ‡ Note that this is the research on wood technology which is done by the industries' own research institutes, and is rather strongly oriented to the products.

- Utilization of forest resources.
- Forest protection against disease and other damage.
- Soil and vegetation analysis.
- Research methodology and techniques.

In 1994 a committee report from the Norwegian Research Council (see later) gave the following three-point priority for forest research:

1 Forest and environment: research base and environment values of the forest. Develop and contribute to implementation of knowledge regarding the connections between ecological conditions, preservation of biodiversity, cultural relics, outdoor life and landscape values, and the exploitation of the natural resources within a sustainable forestry.

Tasks with high priority:
- the effect of different forestry measures on ecological processes and composition of species;
- the ecology of important species and groups of species;
- natural regeneration of coastal conifer forests;
- the yield of uneven-aged forests.

2 Forestry and industry: markets, products, industrial processing and production. Develop and contribute to implementation of knowledge regarding markets, industrial processing, and wood production, which can form a basis for increased economic output and further development of the Norwegian forestry sector.

Tasks with high priority:
- market analyses for forest products (including environmental demands and life cycle analyses of the products);
- strengthening the competence regarding materials as a basis for increasing the level of further processing of wood products;
- optimizing the production chain from the establishment of forests to finished product (forest management, classification and sorting of the wood, and logistics).

3 Forest and society: national and international frameworks. Develop and contribute to the implementation of knowledge that can increase the efficiency in public and private use of resources in forestry and forest industry, and that can improve the ability to meet future changes in national or international frameworks.

Tasks with high priority:
- cost-efficient methods of forestry planning, that can contribute to efficient wood production and better adaptation to environmental demands;
- costs and benefits connected with the conservation of non-market benefits of forests;
- investment strategies in primary forestry considering the uncertainty regarding demand for forest products;
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- effects of ownership structure, current regulation of the market for agricultural and forest land, and taxation, on the efficiency of the forest sector, considering the other measures of the forest policy (judicial and economic measures, extension and information services, etc.);
- the impact of forestry in rural districts, and the effect of different measures on the industrial development and employment in such districts.

The changes in research priorities since 1927 have gone through several stages. During the 1920s and 1930s the possibilities of too high a harvest level was the main question, and the most important issue for forest management became to increase the timber resources. This view continued after World War II, and afforestation and reforestation became vital issues. Rapid technological development, together with a high demand for wood products, made fields like harvesting operations, wood technology, forest economics and policy relatively more important in forestry research. From the end of the 1960s environmental issues became increasingly important. First, natural science problems, such as the impact on forestry of air pollution and acid rain, lead to large research programmes like 'Acid rain impacts on forests' (started in 1972), 'Monitoring programme for forest damage' (started 1984), and 'Forest and the environment—growth and vigour' (started 1986). In the 1970s we also got severe bark beetle attacks, which influenced the research priority. Second, the conflicts between industrial wood production and other benefits from forest areas increased, and research related to the optimal combination of competing outputs became of significant interest. The 'Oslomarka research project' was one of the first projects in Scandinavia (started in 1971) on conflicting interests in forestry. In later years multidisciplinary research programmes were started, like 'Forest ecology and multiple use' (started 1990) and 'Ecological and economic consequences of untraditional forest treatment' (started 1993). Recent years have seen an even stronger emphasis on these issues as a follow up of the Rio and Helsinki declarations, and the debate about possible climate change. Forestry research is getting increasing attention from outside the forest sector. A 'user-steered' research and development programme 'living forest' (started 1995) is a good example, where the interests of the users of the research (mainly forest industry, forest owners and the Government) are steering all activities, and where the research components included are expected to give applied results only.

Another feature of development since 1927 is the increase in the degree of specialization. In the 1920s forest research was mainly done by persons having a forestry education and often having experience in practical forestry, particularly in fields like forest ecology, tree breeding, and soil research. Researchers today usually have their training and backgrounds in specialized fields, and often rather limited experience in forestry. In some fields like economics, policy, planning, silviculture and logging, most researchers still have a forestry background, probably because it is difficult to do meaningful research in these fields without a considerable understanding of the complex ecological, technical and economic issues which forest management has to consider in practice.

Administration and financing of research

In 1927 the administration of forest research was rather simple. Nearly all research activities were financed directly from the budget of the Ministry of Agriculture, which had established an advisory committee for forestry research. In 1949 the Research Council for Agriculture, Forestry, and Veterinary Medicine was established (together with similar ones for natural science, health and the social sciences) as a governmental instrument for planning and financing of research. At the beginning financing came from the profits of the state-run football betting pool, later supplemented by direct governmental funding. During the good times for forestry in the late 1940s and 1950s, a considerable financial contribution came from private forest industries and forest owners, but by and large the private sector has contributed little to the financing of forestry research in Norway.

In 1993 the existing research councils were merged into one large unit—The Research Council of Norway (NFR) with the main task of
giving advice to the Government on research policy matters and allocating public funds to different research fields and programmes, and stimulating the private sector's participation in research.

This has created a more complex situation for forestry research. Financing is less transparent; the stimulation of more 'user-oriented' research, financed in co-operation with private funding, has been criticised for favouring applied research at the expense of basic research. Another criticism is that there is too great a distance between the researcher doing the work, and having an idea of what are the most interesting tasks, and the decision bodies financing the research. There are too many levels that can stop work, particularly in basic research ideas. Considerable resources are being used in forest administration, and the question of how much steering is needed by forest research is receiving increased attention.

Concluding remarks

When Eide wrote his article in 1927 forestry research was still in its infancy. Research equipment was rather poor compared with today. Nevertheless, valuable achievements as a basis for practical forest management were made. The practical value of the research at that time was obvious. Even more important was the foundation for further research that had been established, not least through the setting up of a great number of research plots for future follow-up and analyses.

New demands and views on the forest resources have evolved over time creating new research needs, and research activity has become more specialized and fragmented. The basic problem of forest research, however, is still the same: what is optimal forest management at stand, property, regional and national level—how should the forests be treated?

In this connection, the value of long-term research should be underlined. For example, it is interesting to note that the discussions about the value of selection felling, natural regeneration versus planting, mixed stands versus monocultures, again predominate. And it is worth while considering that after nearly 100 years of forest research, in Norway we still cannot model properly the growth of even-aged mixed stands, not to mention uneven aged mixed stands. What are the challenges for forestry 70 years ahead, and how prepared will forestry research be to meet them?

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