

Applied Research and Innovation for World-class Forestry

Research and Innovation Strategy 2025-2028



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Foreword and implementation of the strategy

Skogforsk's statutes and mission state that the main pillars of the institute's activities are applied research and development, experimental and commissioned activities, and communication of knowledge. We will comprise a cohesive institute for the forestry sector.

The strategy will show the way towards the vision "World-class forestry for sustainable development", enabling Skogforsk to attain its overarching objectives and make substantial progress in the prioritised focus areas. The strategy, which integrates a sustainability perspective, is based on Skogforsk's mission and values. Skogforsk's strength is conducting research that is of practical use. A solid scientific base, understanding of the needs of the forest sector and society, and consideration of proven experience enable Skogforsk to work efficiently with both practical benefit and skills provision.

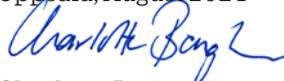
Through this strategy's four research areas, the aim is to place the current research issues in a broader perspective, and sometimes in a new context. Here, it is even more important than ever that we develop our ability and attractiveness for collaborations (new and existing). A new function in the strategy is that we are starting a 'workshop' for syntheses and knowledge compilations. We are also highlighting our unique research infrastructure that, together with our specialist and broad expertise, provides the basis for the strategy's implementation.

Society today is characterised by rapid changes, AI and technology development, geopolitical issues that have revived contingency questions, and polarisation in many issues that concern forestry.

Against this background, a strategy like this is even more important as a guide. In the process of implementing this strategy, Skogforsk intends to take an active role in designing projects in a visionary and future-oriented way, implementing these in broad collaboration and, in various ways, communicating and building relationships with society at large.

The R&I Strategy has been drawn up by the Skogforsk management team during spring and summer 2024. The process has involved close collaboration with Skogforsk's partner companies, the Swedish Government through Formas representatives on the board, and Skogforsk personnel. The R&I Strategy was adopted by the Skogforsk board on 30 August 2024. The strategy is the board's instrument for deciding priorities regarding activities within the framework programme for 2025-2028, which is co-financed by Skogforsk stakeholders and the Swedish Research Council Formas. The R&I Strategy forms the basis for Skogforsk's annual operational plans and budget. The strategy will be reviewed annually.

Uppsala, August 2024



Charlotte Bengtsson
CEO

Challenges and opportunities

With increasing risks, rapid changes, and an unpredictable future, it is challenging to be at the forefront. By building stronger and broader internal competencies, and by strengthening collaborations with more organisations and expertise, our intention is to continue to be a relevant, flexible, and unifying research institute for forestry.

Development that requires both small and big leaps in knowledge

Sweden and the world are facing major challenges. An uneasy geopolitical world situation changes priorities, contingency planning, and commodity flows. Climate change, its consequences and the need to counteract them, is becoming increasingly acute. In addition comes the digital transformation, now with sweeping elements of artificial intelligence, which is taking place at an increasing rate. These major phenomena and societal challenges must be tackled both globally and locally at the same time. The challenge facing research and Skogforsk is to take significant steps to support the various aspects of sustainable development – economic, environmental and social – while exploring and enabling the implementation of research results in a shorter perspective. Against a new background, forestry is facing the transition. Availability of raw materials, silviculture for resilient forest ecosystems, focus on value creation for the valuable forest raw material and other ecosystem services, as well as attractiveness for high-level expertise for continued development, require openness to research, development and innovation.

Forestry and climate

The climate goals assume a rapid and major reduction in net emissions, both globally and in individual countries and organisations. The contribution of forest and forestry to this reduction concerns, primarily, strengthening the forest as a carbon sink and ensuring that the raw material extracted is used for products that can store carbon over time and can displace harmful emissions, combined with effective recycling and reuse. The climate transition can also be expected to impact trade, markets, and demand. Knowledge is therefore needed on how this influences the best ways to conduct forestry. At the

same time, forest and forestry must be adapted to the actual climate change, for example in the choice of forestry method, tree species, and forest planting materials. In addition, climate-related risks need to be analysed and managed. Forest health in a changed climate is crucial for both forest increment and carbon storage. Climate change is therefore an issue that permeates all our research and activities.

It is important to switch to fossil-free forestry operations, particularly harvesting and road transport. Combining energy sources such as fossil-free diesel, electricity and hydrogen can enable breakthroughs. The forest's potential as an energy supplier requires more attention, in the form of overall decision support for biofuel production, potential for sustainable production, and development of methods and logistics. Skogforsk is helping to address and counteract climate change through forest tree breeding, research into measures to increase increment, opportunities generated by and effects of a greater product mix, as well as projects relating to conversion to fossil-free activities.

Research and policy development

The global and national challenges offer major opportunities that can be exploited through a move toward sustainability. The 2030 Agenda and the global goals for sustainable development continue to be of great importance for Sweden's priorities, so forest, forestry and the forest industry are central. In addition to national goals and legislation the European green statutes are a given, including LULUCF (Land Use, Land Use Change and Forestry), the EU forest strategy, and the EU strategy for biodiversity, which in various ways place requirements on and influence forestry in Sweden. The policy landscape is considerably more complex now compared with just a few years ago. In the light of these policy processes, it is especially important to

develop knowledge about sustainable development in forestry that enables production, while maintaining carbon storage and ensuring important ecosystem services. The research has an important role in providing decision-makers and politicians with broad and comprehensive information and syntheses. This must increasingly take place on an international basis. At the same time as internationalisation is strengthening and becoming more strategic in terms of objectives and execution, in today's geopolitics a large measure of domestic knowledge and capacity is needed.

Skogforsk's role in promoting a competitive and sustainable forest industry

As the forestry sector's research institute, Skogforsk, with its applied research, development and innovation, contributes to greater competitiveness and sustainability in one of Sweden's most important industries and to society at large. We make tangible contributions to the development of the circular and biobased economy, which can generate broad societal benefits. Innovation, job opportunities and welfare are created at the same time as climate benefit increases through both carbon storage and substitution. The ambition of this strategy is to, within Skogforsk's areas of strength, contribute to both pioneering advances and to the development, knowledge generation, and constant improvements that the various components of forestry also need to increase competitiveness.

Collaboration - the key to success

Strengthening and developing Sweden's competitiveness within a sustainable transition requires R&I that stimulates the development of new products and services. R&I must also take a holistic view of the forest's role in exports, energy supply, rural development, enterprise, the labour market, the built environment, recreation, biodiversity, and other ecosystem services. These complex challenges and issues are best addressed through collaboration. This involves developing and renewing existing collaborations, but also finding com-

pletely new channels for collaboration, not least in areas in which development is most rapid (e.g. digitalisation and automation). Success factors are collaborations with national and international university research, actively connecting companies, organisations and public agencies in collaboration groups and projects, and through communication and methods of working aimed at ensuring that research is relevant and needs-based, to accelerate implementation of new research results.

Skogforsk is well equipped for the collaboration needed to successfully implement this. There are many tangible examples of how Skogforsk, with its strong ties with both academia and practice, has shortened the time from research to practical benefit. Skogforsk already has agreements and/or comprehensive collaboration interfaces with important partners such as SLU, Linnaeus University, the Natural Resources Institute Finland (LUKE), and FPInnovations in Canada. New collaboration interfaces will be sought, to meet broader societal needs and to supplement the mix of competencies at Skogforsk. Comprehensive collaboration interfaces, both within and outside forestry, are important for the development of the institute's role.

Within the framework of this R&I Strategy, we intend to increase our engagement and collaborations in international projects. The increasingly complex issues and a greater focus on social sustainability also require that Skogforsk's interdisciplinary collaborations be further strengthened. Together with other situation analyses, the collaborations will ensure that Skogforsk's activities maintain high international class, and that important results are disseminated in the international arena.

World-class forestry for sustainable development

This is Skogforsk's vision. By being active in the various parts of the innovation system - research, development, training, dissemination of knowledge, and practical application - Skogforsk will show how forestry can improve its ability to meet different needs and thereby accelerate the transition to a sustainable society.

Skogforsk's mission from the board is as follows: **Skogforsk will develop and communicate knowledge, services and products that will promote sustainable development in forestry for the benefit of society.** The mission therefore includes all aspects of sustainability - economic, social factors, and environmental - with the aim of showing the way for the sustainable green transition, while strengthening the country's competitiveness.

Skogforsk is an important link between research and practical benefit, and we have and develop leading expertise for sustainable forestry.

SUCCESS FACTORS

- » Strengthen the institute's role in uniting scientific, needs-based research with application in practical forestry.
- » Strengthen the R&I process by being attractive for employees and collaborations.
- » Demonstrate benefits and facilitate implementation of results.
- » Run collaboration groups for joint initiatives and development.
- » Create a positive development for Skogforsk's overarching operational objectives.
- » Have an active role in training, skills provision, and gender equality work to strengthen the attractiveness of the sector.

A research institute at the forefront

Access to the right expertise is crucial if Skogforsk is to be able to fulfil its mission. The role of the institute is to unite scientific research and proven

experience with application on the basis of needs in forestry and society. Quality and relevance is ensured through internal and external review and in close dialogue with partner companies and other stakeholders. Skogforsk takes an active role in the

sector's skills supply, for example through training, courses, supervision, and projects. Skogforsk also participates actively in the forest sector's gender equality work. Several success factors will ensure relevance and needs-adaptation in the research, and accelerate the application of new research results. These include a good ability to conduct high-quality applied research, collaborating with national and international universities and institutes, actively linking companies, organisations and public agencies in collaboration groups and projects, and needs-steered communication throughout the innovation process from concept to application. Skogforsk will create benefit from research results by having an efficient process for research and innovation, and a smooth development relationship with partner companies and other stakeholders. Compared with universities, Skogforsk has a more developed network with the forest sector. This makes us an important collaboration partner for many research practitioners, both national and international.

Research quality and effectiveness

Skogforsk's activities rest on a scientific base. The scientific quality is assured by, for example, assessing applications for funding in competition with research practitioners from other universities and university colleges and ensuring that articles are published in referee-reviewed journals. Internal processes for quality assurance are also in place.

An efficient organisation ensures good return on the R&I investments made by forestry and society, and maximises stakeholder benefit. Skogforsk's operation will therefore be efficient in terms of planning, implementation and reporting. This is secured through a common project model that facilitates resource planning, follow-up, and collaboration between different parts of the organisation, through skilled and engaged personnel, and national and international collaborations. The ambition is to be near the forefront in terms of IT tools and work processes that streamline the execution of research.

Professional development

Most professional development takes place through the everyday work, and through close collaboration with the forestry sector and research organisations. Scientific expertise will be maintained in new recruitment and through postgraduate education of existing personnel, and employees can have supervisor roles and/or adjunct positions at other research institutions. Professional development needs of staff members and individual development plans will be identified annually in planning meetings between staff members and managers.

Skogforsk will also encourage mobility between Skogforsk and other organisations, because scientific expertise among staff at management level in business, and business experience among researchers, is a success factor for the entire sector. In addition, knowledge of the Skogforsk operation is a pillar for employees.

Skogforsk needs to constantly develop its own conditions for working efficiently with R&I and promoting collaboration, both internally and externally. This includes continually developing our skills and expertise internally, and having appropriate and secure ways to gather, process, store, and refine data for models and tools for internal and external use.

Overarching operational objectives

An all-embracing perspective with cross-boundary research, development and innovation will permeate the work. The Code of Conduct, "We at Skogforsk", has been drawn up as an overarching policy document that, together with the objectives and goals for each research area presented below, clarify the foundation on which we conduct our operation. Performance indicators are stated and quantified in the annual operational plan.

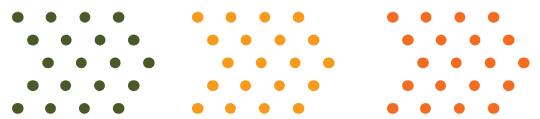
SKOGFORSK'S OVERARCHING OBJECTIVES WITH ASSOCIATED PERFORMANCE INDICATORS

- » **Skogforsk delivers innovations and knowledge that create value**
 - › Implemented research results
 - › Scientific publications, synthesis reports and policy analysis for decision-makers, and results adapted for active forestry practitioners
 - › Target figures for client satisfaction and credibility

- » **Skogforsk is a competent and attractive partner**
 - › Comprehensive expertise in the R&I Strategy areas
 - › Well-invested research infrastructure
 - › Active in international projects
 - › Lead strategically prioritised research projects

- » **Skogforsk works efficiently**
 - › Good ability to lead and work in projects
 - › Appropriate internal support systems
 - › Economy in balance over the framework period
 - › External financing that increases

- » **Skogforsk is an attractive workplace**
 - › Large number of applicants for new positions
 - › Active work on equality and sustainability
 - › Attractive and safe work environment



Research areas

In order to meet challenges, uncertainties, and development needs, four research areas have been drawn up that will guide our operation in the coming years. The vision “World-class forestry for sustainable development” and the mission indicate a clear direction but also enable adaptation of the operation in an uncertain and changeable world.



Skogforsk's method of working includes collaborating between research areas and between individual projects. Successful implementation of this strategy requires flexibility in the organisation and the right expertise.

It remains Skogforsk's ambition to expand the operation through financing from other sources in addition to the co-financed framework programme. Conditions for external financing for the different

research areas vary over time, and resources are allocated in the framework programme as a part of the annual budget and operational planning.

This strategy entails raising the level of ambition in all areas compared with the situation in 2024. New areas are a focus on knowledge compilations and syntheses, more precise development of the research infrastructure, and a need for extra resources to maintain the forest tree breeding.

1. Viable forests for long-term use and management

The transition to a circular, biobased economy that lives up to the global goals for sustainable development requires viable forests that enable long-term production while considering social values and the environment. Forest tree breeding forms a base that enables a high level of adaptability, resistance, quality, production capacity, and genetic diversity in future forests. Silviculture is a pillar for climate adaptation of forestry and for measures that can counteract undesirable climate effects and pests. Knowledge, technology, and forestry methods that give high and value-adding forest production are key, along with silviculture for variation, social conservation, and biodiversity.



Forest tree breeding and silviculture for productive, healthy forests, and long-term management that contributes to society's needs.

SUCCESS FACTORS

- » Lead forest tree breeding with high levels of genetic diversity in the breeding populations.
- » Monitor, test and evaluate new technical opportunities that support the breeding work and increase value production.
- » Promote bigger harvests in seed cultures and sustainable methods for seedling production.
- » Develop resource-efficient, value-generating and climate-adapted silvicultural systems.
- » Develop methods that prevent, limit, and manage forest damage.
- » Develop methods for more effective environmental conservation, active nature conservation and restoration, and analysis of ecological effects at landscape level of various forestry activities.

Operative tree breeding

Skogforsk will continue to develop and conduct forest tree breeding for increased growth, vitality and quality in the genetically improved material. In addition, individuals are selected that can be used for seed production, thereby transferring the genetic gains from breeding to forestry. In the selection process, great emphasis is placed on adaptation to different climates, both today's and the future's, and preserve the genetic variation. Much of the resources are devoted to spruce and pine, but resources to silver birch will increase. Breeding will continue for larch and lodgepole pine, while other

tree species will mainly be financed by external funding and will therefore be allowed to vary over time. To enable a greater variation of tree species in forestry, we are increasing breeding of domestic broadleaves to ensure a seed supply of tested materials, thereby enabling cultivation of more domestic broadleaves that are better adapted to a future climate. Operative breeding of domestic species also includes long-term management of genetic resources.

R&I for tree breeding activities

Climate change brings greater risks for forestry, for

example by increasing certain pests. Tree breeding will attempt to reduce these risks by developing material with greater resistance to different types of pest. One condition is that there are effective measures for measuring resistance of different tree individuals, which today is lacking for most pests. There is a method for root rot in spruce, but this too needs to be developed, and methods are under development for resin top disease in pine. A centre of expertise on pests should be developed that will include, for example, a screening centre where genetic material can be tested for resistance to various pests.

We will continue the development of genomics in breeding of spruce, pine and birch. This will influence the breeding strategy, which needs to be optimised to enable the best implementation of genomic selection and other tools. Development of SE seedlings is ongoing, mainly outside Skogforsk, but here too the breeding strategy must be reviewed to best disseminate genetically improved seedlings using this technology. The use of drones in field experiments will improve the efficiency of height measurements, but drones also have great potential for measuring properties that are today difficult to evaluate systematically. Tolerance to drought is becoming increasingly important, and effective methods for measuring this property in the breeding materials will be developed.

Skogforsk will continue its earlier work on increasing the seed supply, but this will not be limited to spruce. The work will be conducted in the network with actors that work with seed cultures, both researchers and those who manage the seed cultures.

Tree breeding and silviculture for the future climate

The breeding strategy is built around testing materials in different locations with different climate conditions. This is a requirement in order to select material that is viable, but also gives valuable data for selecting material that is best adapted to a future climate. Climate adaptation is therefore a natural component of the forest tree breeding. When setting up experiments, it will become increasingly important to choose locations that reflect a future climate. For southern Sweden, this means in practice that experimental facilities must be built up in other countries. Extreme events, such as drought and frost, will become more common in the future, and we are therefore developing effective methods through breeding to increase tolerance for such events.

The decision support tools Plantval and Plantval

optimal will be supplemented with models for birch and mixed forest, including extreme risks such as drought and frost. Plantval optimal will also be able to consider diversity at landscape level, and can be used in the establishment of new seed nurseries adapted to a future climate.

The growing need for forest raw material requires building up further knowledge about the effects of increment-promoting measures, seedling nutrient needs, and water regulation. By developing different silvicultural systems, Skogforsk will give landowners decision support for varied and flexible silvicultural systems for different species and for different objectives, while considering landscape conditions.

Climate change will affect the conditions for both existing and future pests. It is important to monitor this development together with public agencies and other experts in the field. Knowledge and recommendations will be produced on how to minimise the risks, and how infestation and spread can be counteracted. This includes ensuring collaboration and method development for effective management of fire risks. Trading regulations on forest plants and forest products must also be included in the risk management.

Vibrant and value-generating forests

Viable forests with high levels of increment are crucial. Skogforsk will conduct research and development on silvicultural methods that can create these forests under varying conditions and management objectives. The starting point is forestry with site preparation with minimal ground damage, vibrant forest seedlings, and an efficient, controlled chain from plant nursery to planting. Silvicultural methods such as pre-commercial thinning (clearing), thinning and choice of rotation time are combined into a system that gives high and valuable timber production, while protecting and developing biodiversity, and making use of synergies with the forest's other ecosystem services. Silviculture in mixed forests, multi-layered forests, and under continuous cover forest management will be developed. The Adaptive Forestry platform is a tool in this context.

Counteract, limit and manage damage in forests

More information is needed on the interaction between varied forests with a rich structure, and resistance to abiotic and biotic pests. Resilient forests can be created by planting materials adapted to the climate at the cultivation site, with strong resistance to serious pests, vibrant seedlings, richly varied forests, adapted silviculture, and active

measures linked to damage and risk spreading.

Skogforsk has special responsibility for research into damage caused by insects in seed nurseries and through browsing issues. Other important research areas are plant protection, tree species mixtures, and silvicultural systems to limit damage, and strategies for managing forests damaged through multiple causes.

Biodiversity and active nature conservation

Skogforsk will develop and evaluate how general and strengthened conservation schemes are implemented and managed in an effective and appropriate way seen over the entire rotation period. This includes active measures to strengthen and develop important habitats. Another important task is to develop and demonstrate landscape-adapted conservation that can retain and increase natural values both in production forests and in conservation set-asides. Skogforsk plays an important role by contributing data for decision support and practical advice to production forest managers on how biodiversity can be preserved and improved. Another priority is research and development aimed at limiting the negative effects of forestry on soils, water, and other valuable environments. It is

also important to integrate measures to restore and preserve functions of ecosystems and biodiversity.

Gene conservation has a central role in tree breeding, partly for the genetic biodiversity itself, and partly for further breeding work. During the framework period, we will upscale the breeding of several tree species, such as larch and many broadleaves, which in the future will benefit biodiversity so that more tree species are available for forestry. Breeding also focuses on particularly threatened species that are important for biodiversity, such as breeding to increase resistance of ash and elm.

A changed climate drives habitat change, which can increase the risks for species that are sensitive to change and that have a limited relocation ability. More knowledge is needed on the effect of climate change on biodiversity. Skogforsk will develop methods, tools and recommendations for green infrastructure and identification and creation of climate refuges.

2. Increased values from the forest ecosystem services

The forest creates values seen from a number of aspects. It is a societal challenge to balance claims on and benefits from forest for the greatest possible overall value and sustainability, both nationally and globally. Forest raw materials, such as wood, are vital for the transition to a biobased economy, with profitability through all value chains. Forest also offers a number of other ecosystem services, both tangible and non-tangible. The interaction between forestry and other uses, such as recreation and reindeer husbandry, will be given greater attention. The effect of silviculture on various ecosystem services sometimes causes conflict, but there are often synergies between different objectives. New methods for making use of these synergies will be developed. This area requires broad, interdisciplinary collaboration with different perspectives.



Knowledge, methods and tools increase economic and social values for people and society.

SUCCESS FACTORS

- » Develop tools, knowledge and decision support to balance claims on and benefits from the forest.
- » Contribute to improved utilisation of raw materials and increased integration with forest industry production to increase added value.
- » Develop digital and transparent models that enable new business for ecosystem services.
- » Strengthen capabilities within social sustainability by developing expertise and new collaborations.

Developed value chains in the forest

Forest raw materials are a limited resource that cannot be expected to cover all needs. It is therefore important to increase the added value in many different forest-related value chains. It is important, for both existing and new value chains, to maintain and strengthen good profitability at all levels in the forest industry.

Value chains based on other products than wood and forest fuel so far comprise only a small part of forest industry operations. However, new business models are being developed, for example for fossil-free energy production, carbon and biocredits, and tourism. Often, there are synergies between these value chains that should be strengthened, but there are also conflicts of interest that must be

managed. Skogforsk will contribute with impact analyses, knowledge compilations based on facts and experiences, and aggregated information and decision support to ensure optimised choices.

Social sustainability

Interest in and knowledge about the forest's social values, such as ecotourism, reindeer husbandry, people's health, and recreation, have increased. Skogforsk's work in the area will therefore be developed and strengthened in collaboration with relevant expertise, with the aim to increase forestry's contribution to the social values. Digital data and tools will also enable these values to be visualised and developed.

Business models and incentives for forest owners

to strengthen the social sustainability dimension will be developed. Central in these models will be methods for scenario analysis and multiple-objective optimisation to identify synergies and manage conflicts.

Skogforsk's networks in the interface between forestry and reindeer husbandry will be developed, with the aim to jointly present recommendations concerning forestry and reindeer husbandry in collaboration.

Work environment and gender equality for those who work in the forest sector are also an important social value.

Yield calculations, raw material management, and traceability

Skogforsk is studying and developing cost-effective methods for characterising and managing forest raw material. This includes possibilities to link together properties that can be estimated or measured in the forest with properties of the final product, which will enable content specifications for different forest products. Here, methods to enable traceability upstream in the value chain are important. Possibilities for bucking that is better adapted to conditions in the individual stand will be investigated. The link to industrial added value and new products will be strengthened.

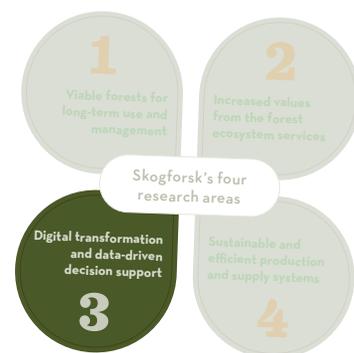
A greater timber proportion creates opportunities to make more long-life products with high value. Therefore, Skogforsk will work to identify and minimise factors that reduce the timber yield. This includes mapping wood with stem defects and developing technology for harvesters that help the operator identify crooked stems and other damage.

Wood quality and measurement

Better forecasting of wood properties and automatic, more accurate measurement, both in the forest and at industry, improves the efficiency of raw material use, which can increase value yield. Interest in and demand for wood from broadleaves are expected to increase, and here there is a potential for more long-life products and carbon storage. Digitalisation can enable more accurate measurement of the raw material, both in the forest and at industry delivery points. Measurements can be used to make utilisation more resource-efficient, and increase the efficiency of transports. This enables more efficient logistics and measurement. Greater automation of measurement of wood properties is urgent, both for raw material management and as a basis for payments.

3. Digital transformation and data-driven decision support

Technology, decision support, automation, standards, and data provision are important issues for the digital transformation in forestry, as well as for social and technical issues linked to work content, organisation and innovation. Digital transformation concerns how organisations and business are fundamentally changed through the use and impact of digital technology. The transformation – a strong megatrend that is affecting all sectors – has been going on for some time, but is now developing dramatically. Artificial intelligence (AI) is on the rise, with potential to revolutionise various technical applications and generate data-driven information for decision support. Skogforsk's role is to develop, assess, and demonstrate new methods and tools, and to analyse broader effects in the forest sector, such as gender equality, skills supply, and changes in the roles of different actors.



The forest actors make data-driven decisions, and use advanced technology in all aspects to increase efficiency and sustainability.

SUCCESS FACTORS

- » Develop user-friendly data-driven decision support and other digital aids.
- » Monitor, assess, and communicate new advanced technology relevant to forestry.
- » Secure access to strategically important and quality-assured data.
- » Drive and promote standardisation of forest-related applications in a broad sense.
- » Support digital transformation, including new methods of working in partner companies.
- » Explore new or changed business models resulting from digitalisation.

System innovation and specialist technology

The system perspective must permeate all research and innovation in the area, to identify the big potentials and to ensure that digitalisation and digital transformation will be of real benefit. Here, Skogforsk's role is to monitor the development of new and innovative technology and, where necessary, evaluate and drive such technology for applications relating to forest production and handling of forest products. Examples are technology that promotes automatic measurement of wood properties and advanced support for precision forestry. Another important role is to stimulate innovation that supports digital transformation, such as by increasing

collaboration with both large technology companies and small technology innovators.

Standards and data sharing

Successful and commonly used standards are a linchpin in the area. For a long time, Skogforsk has been developing and running StanForD (the global standard for data communication with forest machines) and Forestand (the standard for data on forest and forest production). This work will continue and be further developed. In addition, there are a number of other standards that are significant to forestry and forest applications, such as papiNet, which Skogforsk is continually monitoring. There

is also a need to standardise the design of different interfaces, formats and concepts, to facilitate collaboration between actors. Skogforsk will also assist with implementation support and management relating to the National Road Database for Forestry (SNVDB).

Secure and efficient data sharing enables the next steps in the digital transformation through greater collaboration between different actors and improved opportunities for developing different types of AI models that require large amounts of training data. Skogforsk will be involved in building up and testing solutions for secure data sharing that stimulates collaboration and service innovation.

Applications and decision support

Many decisions taken on how the forest is to be used for production are complex and require expert competencies. Today, many decisions are based on assessments, which require both experience and knowledge. The forest industry is currently facing a common challenge in recruiting and keeping people with the right competencies for these tasks. In order to facilitate decision making and ensure sufficient quality in the decisions, there is a big demand for various types of digital decision support. The user perspective is vital, in terms of how new digital tools are introduced and used. Skogforsk is therefore applying user-focused methods as an important element in the development of various types of decision support. Skogforsk's role regarding applications and decision support is to develop and demonstrate concepts and solutions that can later be implemented by commercial actors.

Planning with different perspectives

Planning is an important area that involves planning the entire chain from primary production and forest operations to wood flows. Skogforsk is in a particularly strong position to develop practical decision support tools that manage the entire chain for large and small forest owners and for forest compa-

nies with their own mills. Skogforsk will therefore develop and demonstrate tactical and operative planning and analysis tools for silviculture and harvest, and tools for flow and transport planning, which can then be implemented by forestry actors.

An important tool for forest owners when planning production in their forests is the forestry plan. The design of such plans and other tools for forest planning is affected by changes in policy and the regulatory framework at both EU and national level. Skogforsk is helping to develop future forestry plans in collaboration with public agencies and companies, by studying the needs of forest owners and developing information for designing decision support based on the forest owner's management objectives. Particular emphasis is placed on developing planning tools for continuous cover forestry.

4. Sustainable and efficient production and supply system

Constant growth of productivity with less environmental impact, contributing to improved performance and higher quality, is necessary for ensuring the sector's competitiveness, as is the move toward fossil-free forestry. This promotes profitability in all stages. The production and supply systems comprise technology, systems and organisation for felling, transport in the forest and onward, comminution of forest fuel, and storage. Both physical and digital technology for forestry is an important part of the puzzle, as is infrastructure, particularly the forest road network.



Logistics and forest technology are productive, with minimum impact on people and the environment.

SUCCESS FACTORS

- » Contribute to development of operational systems that are more productive, and with less impact on people and the environment than is the case today. Improvements in energy efficiency are particularly important.
- » Drive development toward fossil-free forestry.
- » Research technology, methods and logistics for new silvicultural systems.
- » Help develop mechanised thinning and pre-commercial thinning (clearing).
- » Investigate and promote better collaboration in and between forestry actors and other stakeholders.
- » Refine collection and analysis of forestry operational data.
- » Develop models for precise production control and logistics, including handling of deviations.

Technology for productive, safe harvesting and forestry

Skogforsk will work to develop and improve the efficiency of individual operations and processes, and ensure that all parts of the supply chain function efficiently as a whole. Continued improvement of the operational technology in forestry, from stand establishment to delivery of wood to the customer, is important in driving sustainable development of forestry. Skogforsk will be a unifying function for supporting technological development, based on analysis and experience of innovation in mechanical engineering. Initiatives will involve identifying concepts and technologies, linking

these with forest machine users and manufacturers, and providing support and evaluation from concept to demonstration and finished product. Particular focus will be placed on driving development and demonstration to enable significant steps towards mechanised and automated forestry.

The introduction of new silvicultural systems requires adapting existing technology and harvesting and forestry methods, and developing new decision support. The development will be integrated with impact analyses of the effects of new silvicultural systems on wood supply and onward logistics from forest to industry.

Fossil-free forest operations

Skogforsk will continue the work to make onward transport, harvesting and other operations fossil-free. Current research, development and demonstration of electrification of forest raw material transports, will be supplemented with similar projects for fossil-free forest machines.

Automation and remote control

We will run demonstration projects in forestry technology, harvesting and onward transport, including the forest technology field lab. Examples are autonomous control of the forwarder, development of virtual environments for simulation and evaluation, and programming of autonomous machine functions that are transferred to physical experimental machines. Robust telecommunications with high accessibility and bandwidth in the forest is crucial. An important issue is therefore to investigate the use of the public 5G network and satellite communications for monitoring and remote control of forest machines.

Roads and transport

We will continue to develop efficient transport technology for higher payloads and lower energy consumption in truck and rail transport, and efficient intermodal solutions between different types of transport. This also includes further development of technology for digital description of road infrastructure and algorithms for efficient road maintenance and transport planning.

Organisational development and collaboration

The forestry operational systems are undergoing constant changes, mainly as a result of digitalisation and automation. This in turn brings the need for new methods of working and organisational solutions. The digital transformation offers great opportunities for service innovation. Skogforsk will support this development through benchmarking and analysis, work to increase dialogue between clients and contractors, and efficient transfers between actors in the forestry chain, both in and between organisations. Another area involves issues relating to the work environment and safety, and greater dialogue between forestry representatives and other stakeholders with interests in and claims on forest and forest land.

Skogforsk will support partner companies' work with resource procurement and skills supply for forest work, through initiatives such as operator training and development of work teams.

Forestry operational data

Skogforsk will be well equipped with knowledge and data, particularly regarding operational systems in Swedish forestry, including figures on fuel consumption, costs and productivity. This is a strategically very important task. In addition to generating knowledge for Skogforsk stakeholders, this also builds up expertise and forms the basis of prioritisations regarding important development areas and initiatives. Skogforsk initiatives will also include collecting statistics and descriptions of relevant productivity measurements.

Impact of the forest sector on climate, analysis, and reporting

Skogforsk will monitor and describe energy consumption in forestry operations over time; total consumption, proportion of fossil-free energy, and increased gross weights in road transports, along with the effect of more efficient machines and the proportion of various types of transport.

Skogforsk will also actively monitor and, when necessary, coordinate and develop sustainability and climate reporting tools and models, on the basis of requirements in the EU directive and standards (e.g. CSRD and ESRS). This can also include coordination with initiatives such as CLEAR, the Greenhouse Gas Protocol, the Science Based Targets Initiative, and ISO certification.

Production control and logistics

Another basis for value creation is efficient and precise control of forestry processes and tools for feedback on the outcome. This is important on strategic, tactical and operative levels. Through detailed knowledge about the standing forest and customer needs, reliable planning and efficient control can be attained throughout the supply chain. There are potentials for greater control over wood production on the basis of tree properties, and for streamlining logistics, increasing precision in delivery plans, and increasing the degree of collaboration. In this way, business logistics and utilisation of the forest biomass can be developed. It is important to consider and manage variations caused by climate and the market.

Skogforsk will also help develop smooth-running terminals for efficient transport chains with combinations of road and rail transport, and help to improve efficiency on landings in the forest and at industry terminals. Developing structures and handling at terminals is important, especially for handling biofuels.

Relevant and useful communication

Communication is an important component in Skogforsk's ability to generate benefit. Through collaboration and objective, fact-based communication, we build credibility and long-term relationships. Return from Skogforsk's work will be realised first when it is implemented in the forest industry and society. In addition to contributing to world-class forestry, we are also helping to facilitate the everyday work of our target groups.

Skogforsk is the leading disseminator of knowledge about forest and forestry.

SUCCESS FACTORS

- » Communicate effectively and proactively for rapid application of our results.
- » Be, and be perceived as, a credible, inspiring, and useful source of knowledge.
- » Create solution-oriented dialogue between the forest sector and society at large.
- » Have a function for impact analyses and syntheses.

Skogforsk – a voice worth listening to

Skogforsk communicates in both scientific and popular form in its own and other actors' channels. The communication is mainly via the website, www.skogforsk.se, which is the hub. On the website, we present all our research results, in both scientific and popular scientific form, as well as information about our other activities, services and products.

Shifting trends and the large amount of information we encounter on a daily basis are a challenge, but they also create new paths and opportunities. The broadened expectations regarding what the forest is to contribute to society mean that Skogforsk must meet new target groups. These target groups move in other contexts and with other expressions, so we must learn to orientate in them. We will also continue the work of contributing to greater knowledge in society at large by building contacts with politicians, decision-makers at public agencies, and with journalists.

It is a challenge to get the messages out to the target groups, which are busy with many tasks. One big challenge is human behaviour, which largely in-

volves listening to information that confirms what people think they already know. For Skogforsk's message to get through, the communication must be clearly adapted to the target group, both in terms of message and choice of communications channel. We must express ourselves factually and concisely, to ensure we are worth listening to. We will be humble in relation to other parties' knowledge and experiences, not least for the sake of our credibility. If we, in addition, can be personal in our expression, it will be easier to create relationships with our target groups.

Impact analyses and syntheses

The requirements and expectations for those that manage and exploit the forest have grown with the growing societal interest (nationally, within the EU, and globally) for forest and forestry. This has meant there is a great need for decision support in the form of knowledge compilations, syntheses and impact analyses on how new requirements, laws and policies can be managed from a forestry perspective. To meet this need, a unit for *Impact Analyses and Syntheses* will be set up.

The unit will comprise a strategic platform for compiling research results and knowledge, and for performing impact analyses for different scenarios. It will function as a central node where experts from different disciplines collaborate on producing scientific articles, high-quality reports, and analyses. The target groups will vary, depending on subject, but the workshop products will comprise a support for well-founded decisions based on research and proven experience. The main target groups are:

- people in decision-making positions and administrative staff of forest companies, and forest owners
- decision-makers in society and their advisors, including government employees
- employees at public agencies
- stakeholder organisations

A spinoff from the unit for *Impact Analyses and Syntheses* will be that Skogforsk will become more visible in the media, for example in confirming arguments, addressing incorrect claims, and busting myths. By ensuring that we express ourselves factually, concisely, humbly, and personally, we can build credibility. In this way Skogforsk can contribute to a more fact-based societal debate and become a voice worth listening to for a broader stakeholder group.

From research to practical implementation

It is when Skogforsk's research results are used in practice that Skogforsk has succeeded with its mission. Close collaboration, already in the research projects, with the forest industry, forest owners and other relevant actors is the most effective way to ensure that the results will be of practical use. Often, they are already implemented in practice by the end of the project. Effective implementation is reached when there is well-documented data from studies in combination with practical experiences. An important part of the work going forward is to document and communicate successful examples and create understanding within Skogforsk for how preparatory implementation measures can be

incorporated early in the projects. These measures must then be applied in close collaboration with the recipient of the results.

We have continuous contact with stakeholders through our advisory groups and collaboration groups. The needs of collaboration groups change in line with the needs of Skogforsk and forest producers and society's expectations of the forest industry. In the 2025-2028 framework period, collaboration groups may be set up in social sustainability, such as *Skogforsk and reindeer husbandry* and on *Sustainability reporting according to the new reporting requirements*. The advisory groups' composition and methods of working will be adapted to the prevailing strategy.

Another important form for collaboration and information exchange is our company dialogues. Every year, we hold individual meetings with a selection of our partner companies, to share and increase knowledge about each other's operations and current needs.

Our commissioned activities comprise a broad palette of services such as impact analyses, calculation of carbon balances, time studies, and training courses. These commissions are an effective form of knowledge dissemination, as they are initiated by the client; we have a recipient who is in need of the result and is therefore receptive and interested. At the same time, through these collaborations, Skogforsk is increasing its knowledge about practical operations.

Research infrastructure

Forest research and tree breeding are based on a long-term approach and continuity. Research infrastructure is a crucial success factor for Skogforsk. It is a requirement for controlled experiments and studies in a number of different research fields. It includes long-term experiments in the field, modern research stations, and physical and digital labs. A first-class infrastructure is a competitive advantage, enabling valuable collaborations with both research organisations and the business community, and creating good conditions for demonstration, which shortens the time to practical implementation.

World-class infrastructure for attractive collaborations and successful research.

SUCCESS FACTORS

- » Maintain good status for long-term experiments in the field.
- » Develop research stations and existing and new test beds.
- » Operate digital environments with high capacity for data management and data sharing for strong R&I and demonstration.
- » Set up a centre of expertise for resistance breeding and forest pathology that includes a screening centre.

Long-term experiments

Research in many of the strategic areas requires long-term experiments in all parts of the country for data collection and impact analyses. Long-term experiments are important for both current research and future issues. Skogforsk will continue its long-term approach to maintain a good status in these field experiments. We will evaluate and maintain existing experiments and set up new experiments when needed. Databases with data from experiments will be kept updated.

Research stations

Skogforsk's research stations in Sävar and Ekebo are of vital importance for Skogforsk. They host *Plantservice*, which propagates plants for research purposes, greenhouses for cultivation and controlled experiments, and tree archives for preserving important breeding material. *Plantservice* also

provides services ordered by forestry. Continually improving methods and maintaining technical equipment at the seed service, *Fröservice*, is important for both tree breeding activities and forestry. This is particularly important in view of the growing interest in tree species such as birch and larch. The stations also have long-term storage of valuable seeds in seed archives.

An important part will be to ensure quality and capacity for grafting production for building up FyrO seed nurseries, which includes increasing areas for open-air and greenhouse cultivation and a wet cooler for winter storage of valuable forest planting materials.

Troëdsson Teleoperation Lab

Troëdsson Teleoperation Lab is a test environment for developing automation, remote control, use of sensor technology, development of advanced

decision support, and testing various communications solutions. The lab environment is a unique resource that attracts valuable collaborations with companies, machine manufacturers, and academia, which is relevant for large external funding bodies. Collaborations will be built with international technology-leading companies, which gives access to specialist technology in the relevant areas. In the lab, efficient digital prototype development can be conducted, based on simulations of machine systems in scanned authentic environments that can be implemented directly in forest machines in the test bed.

During the framework period, the laboratory environment will be further developed in terms of forestry technology for autonomous site preparation and planting, and autonomous mechanical pre-commercial thinning. The forest technology test bed should also be modernised with modern forest machines and associated equipment.

Databases and digital lab environment

Large quantities of data are gathered in many of our various long-term experiments and projects, for example in the BETT experiments, the regeneration project *Förnygringskollen*, and in genetic improvement. These comprise an important base for research and development of complex issues. An elaborate and functional infrastructure for data storage and databases will be created. *Forest Core* comprises Skogforsk's infrastructure for managing and refining standardised data from forest machines.

The Skogforsk Lab project, *Skogforsklabbet*, comprises the starting point for construction of a digital lab environment for effective and flexible handling of relevant data quantities, opportunities for secure and controlled data sharing, tools for training and validation of large AI models, and platforms

for dissemination of results and source codes to various stakeholders. The laboratory environment comprises a central resource for both internal and external collaboration and development in the area of advanced data processing and modelling.

Various types of IT tools are a key resource for research. Skogforsk applies a hybrid environment where cloud solutions and our own servers are combined to satisfy employees' and collaboration partners' needs with regard to both performance and security.

Skogforsk will continue to work for full access to scientific literature.

Screening centre

Diseases such as root rot and resin top disease cause significant losses for Swedish forestry. As a consequence of a changed climate, our domestic forest tree species are at risk of exposure to increased infestation of already existing diseases and pests. A changed climate also increases the risk that new diseases and pests will become established in Sweden. With appropriate infrastructure, large-scale resistance testing, screening, can be integrated with breeding of our domestic tree species. By identifying regeneration material with better resistance, the economic and ecological damage effects of different diseases and pests can be limited.

