Project No: 862681
Project acronym: ROSEWOOD4.0

Project title:

EU Network of Regions On SustainablE WOOD mobilisation ready for digitalisation

Programme: H2020-RUR-2018-2020 (Rural Renaissance)
Topic: RUR-15-2018-2019-2020 Thematic networks compiling knowledge ready for practice
Start date of project: 01.01.2020
Duration: 30 months

Deliverable D3.3

Report on conducted training actions, including corresponding training materials

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Due date of deliverable: 30.4.2022 **Actual submission date:** 04.05.2022

Work Package	WP 3
Associated Task	Task 3.2
Covered Period	M13 – M30
Deliverable Lead Partner	FBZ
Version	1.0

Dissemination Level		
PU	Public	X
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 862681.

CHANGE CONTROL

DOCUMENT HISTORY

Version	Date	Change History	Author(s)	Organization
0.1	25.04.2022	First complete version of the deliverable	M-Ch. Hoffmann, E. Hübner-Tennhoff Th. Wagner, A. Weller, N. Tennhoff, M. Nolte, R. Lehde, O. Müller, K. v. Zeist, M. Krondorfer Danijela Bartolovic, St	FBZ FAST Pichl CEKOM
0.2	28.04.2022	First complete revision	F° Javier Casado Hebrard	SIG
0.3	02.05.2022	New version including all suggestions & corrections from the first revision	M-Ch. Hoffmann	FBZ
1.0	04.05.2022	Final revision and submission	F° Javier Casado Hebrard	SIG

DISTRIBUTION LIST

Date	Issue	Group
04.05.2022	Submitted version circulated	Steering Committee & partners

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Abstract

The ROSEWOOD4.0 project supports digitalization in the forestry sector through European-wide knowledge transfer, sharing digital best practices and innovations through a joint database. To support the uptake of available digital solutions by practitioners, hybrid trainings each consisting of a sequence of MOOC, webinar, podcast, and practical on-site training have been developed and implemented with test audiences in Germany and Austria. The trainings are directed at three targets groups, namely forestry contractors facing the challenges of digitalization, private forest owners in need of climate-stable reforestation after calamities, and new – often urban, often female – forest owners.

Based on the experiences with the initial training implementation in the Central-West Europe hub (concretely in Germany and Austria), replication activities in the other ROSEWOOD4.0 regions will be conducted. Adapting the original workplan under the influence of the COVID-19 pandemic, consortium members decided to provide trainings not only in English, as originally planned, but also in regional languages. Based on the translated online training materials, a total of five trainings will be implemented in the Southern-East Europe hub (hybrid, with participants from Croatia, Greece and Slovenia), the Central-East Europe hub (on-site, Poland), the Northern Europe hub (on-site, Norway and also Sweden) and the Southern-West Europe hub (on-line). The present report provides an overview on conceptualization, implementation, and replication of the trainings. In addition, conference proceedings of the original on-site events (based on audio transcripts) are included to serve as information base and further training material. Content and development of the online training materials will be described in D3.4.

MOOCs, webinars and podcasts are publicly available at https://rosewood-network.eu/resources/training/ .

Deviations

Due to uncertain infection risks, the implementation of some of the physical replication events in other hubs was moved to May 2022 and will be reported in D3.4.

1. Introduction

1.1 Background

The use of digital solutions and tools is still underrepresented in forestry. To address this shortcoming, the ROSEWOOD4.0 project has established a European knowledge platform for sharing digital best practices and innovations in forestry. But even if digital solutions are available on the market, the experience of practitioners shows that their uptake is rather slow and hindered by mistrust, or lack of knowledge and experience. Therefore, the project has included a work package (WP3) to support this uptake through the elaboration of dedicated training material and the implementation of several trainings. This work package is coordinated by the Forestry Education Center North Rhine-Westphalia (FBZ) who has over 70 years of experience as a forestry school for the federal state of North Rhine-Westphalia (NRW) in Germany. With the ROSEWOOD4.0 project, digitalization in forestry teaching was taken up by the FBZ and the whole consortium as a challenge, fueled by the onset of the COVID-19 pandemic in the first year of the project.

Work package 3 of the ROSEWOOD4.0 project aims at developing training actions related to digitalization in two respects: (i) transferring knowledge on the *application of digital solutions and tools* in forestry, and (ii) *using digital teaching methodologies*. Three target groups (TG) had been set for these trainings: women in forestry, private forest owners and forest machine operators/contractors. The task included to develop examples for blended learning in forestry, i.e., to provide a suited combination of digital and physical training offers for each of the TG groups, to test these trainings in the Central-West Europe (CWE) hub in the original language (German), and to replicate them in the other four ROSEWOOD4.0 hubs (cf. Fig 47 in Chapter 3 for an overview on the hubs).

At the beginning of the trainings' development an analysis of the availability and the need for digital learning formats in the consortium and in Europe was performed which has been reported in detail in D3.1 and D3.2 but shall be briefly summarized here.

In 2020, a survey on e-learning formats resulted in 85 feedbacks from 20 countries, providing information about available e-learning formats, their languages and TG, and to who was offering them. The main results influenced the decisions of the ROSEWOOD4.0 consortium about their own development of digital training materials. One of the most important insights was, that there was *no dominance of an international „lingua franca"* - English was underrepresented, and the language distribution reflected the *regional availability* of the digital teaching programmes (cf. Fig. 1 and Fig. 2). The forestry sector has traditional roots: Local *languages*, local terminologies and jargons, and local *procedures* are especially important and must be considered to reach TG successfully.

Fig. 1 Relative distribution of reported languages

Another interesting result of the survey concerned the format in which e-learning programmes were offered, including webinars, PDF download or videos on websites or public channels as YouTube. Only 11 programmes were specified as interactive „Learning Management Systems" (LMS) requiring registration and user management, and those programmes were often offered by universities. This finding indicated a gap in e-learning offers that go beyond a mere provision of information online.

Country	E-Trainings	Hub	E-Trainings / Hub
Denmark	1		
Estonia	1		
Latvia	1		
Finland	8	NE	42
Sweden	18		
Norway	13		
Netherlands	1		
Switzerland	2		
Austria	1	CWE	18
Belgium	3		
Germany	4		
France	7		
Portugal	4	SWE	19
Spain	15		
Hungary	1	CEE	5
Poland	4		
Bulgaria	1		
Croatia	7	SEE	18
Greece	2		
Slovenia	8		
EU	3		

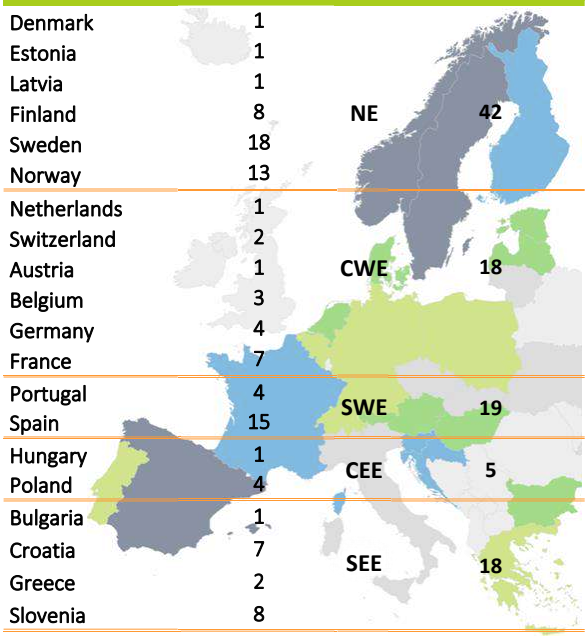


Fig. 2: Numbers of e-learning programmes per country and hub, Color code:
0 / 1 / 2-5 / 6-10 / 11-18

The assessment of partner's expectations at the ROSEWOOD4.0 kick-off meeting showed that all partners were interested to gain experiences with digital teaching, indicating that the combination with physical courses (blended learning) as the most promising format in forestry. The main challenges for the implementation of e-learning in forestry identified by consortium partners were related to affordability, the technical infrastructure, and the motivation.

It must be kept in mind that both challenges, affordability, and motivation, may not only concern course participants, but also the offering institutions: cost for implementation and maintenance of e-learning systems, and motivation of trainers who may have reservations about digital teaching.

To summarize, this first step of the ROSEWOOD4.0 consortium's road to new training formats, addressing and using digital solutions, had shown that:

- blended learning is of particular interest,
- local languages are important in forestry, and
- interactive LMS with user management are rarely offered and should be looked at closely.

In addition to providing the training materials, this deliverable, and the following (D3.4) intend to share some experiences and insights into the ROSEWOOD4.0 journey to the development of hybrid teaching formats. In this context, D3.3 focuses on the *physical trainings* (as part of full hybrid trainings) and the *replication activities* in all ROSEWOOD4.0 regions, including a summary of the training concept development, while D3.4 will present the (publicly available) *online training materials* and reflect on their production.

1.2 Concept development

The concept of the ROSEWOOD4.0 trainings has been presented in detail in D3.2 but some aspects shall be included into the introduction of D3.3 to complete the picture.

For the development of the trainings, the following main questions had to be addressed before starting the production of the digital content and the implementation of the hybrid trainings:

- Which topics are important and should be included to reach training goals?
- Who are the target groups, what are their needs, and what can be offered to them?
- Which formats (and technical solutions) shall be used to provide the online courses?

During a workshop at the ROSEWOOD4.0 kick-off meeting in January 2020, the consortium members assessed the importance of teaching topics for the trainings, especially with regard to focusing those trainings on digital tools and solutions (cf. Fig. 3).

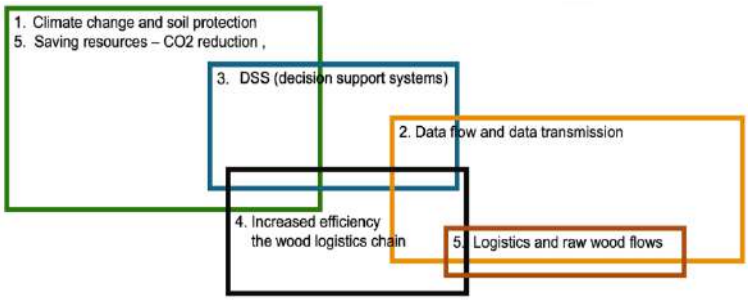


Fig. 3 Relevance and interrelation of training topics

Within the consortium, the CWE hub (partners from France, Austria, Switzerland, and Germany) had been assigned the responsibility for development and implementation of the hybrid trainings. A meeting took place in September 2020 to discuss the three TG and the concept development.

For the concept development, the first crucial step was to establish a joint understanding of the e-learning formats to be produced (MOOCs) and to define a sequence which would fit the specific TG. This process should not be underestimated even for very experienced teachers. During the workshop, the knowledge transfer on e-learning formats, didactics, and technologies (learning management systems, how to produce audio- and video content) was professionally provided by experts from the department of media didactics (ProLehre) at the Technical University of Munich. A train-the trainer action with support from professionals (or experienced peers) is important to start the journey into e-learning as the involved tasks are multi-faceted and difficult to oversee for beginners.

Fig. 4 Sequence of the three hybrid trainings

As shown on in Fig. 4, podcasts were made available as part of the online courses (MOOCs), while the webinars where either placed *before* the on-site event or *afterwards*, allowing participants of the on-site event to discuss specific and individual questions related to the practical training as a conclusion. For the original „test" audiences of the first implementation of the hybrid trainings, the webinars had to be held in German. When transferring the trainings to the English online courses, the recorded webinars were translated and included.

The discussion of the TG among the CWE hub experts identified main characteristics and needs of the respective audiences:

1 Forestry contractors – meeting the digitalization challenge

Focus on data flow, Decision Support Systems (DSS) and resource efficiency in mechanized timber harvesting

2 Private forest owners in need of reforestation after calamity

Focus on climate-stable forests - considering economic, social and ecological aspects of reforestation

3 Women in forestry – a new, urban type of forest owner

Focus on basic knowledge and skills to integrate active forest management into the daily life of participants

Based on the TG analysis, storylines were developed, and teaching contents and media for the trainings defined. The teams for the production of the training materials were set up but had to be soon adapted, as the COVID-19 pandemic did not allow a joint production of digital content with all CWE hub partners. For that reason, trainings were produced separately: at the FBZ for TG 1 and TG 2, with input from the Centre Régional de la Propriété Forestière de Nouvelle-Aquitaine (France) for TG 2, and in Styria (Austria), coordinated by Holzcluster Steiermark in cooperation with the Styrian forestry education center FAST Pichl for TG 3.

It is important to keep in mind that the task that the ROSEWOOD4.0 consortium had set itself is complex: to meet the needs of the defined TG (which are partly comparable in Europe, but partly defined by local conditions) while addressing digital best practices in forestry in the trainings (which may be only locally or even not available for the respective TG).

For ***forestry contractors*** *(TG 1)*, many digital solutions are available (softwares, apps) and are not used to the full extent as there is still a significant lack of knowledge and therefore mistrust among forestry contractors. The training therefore aims at informing this TG and convincing them of possible gains in economic and resource efficiency. The storyline for the training was developed following the logistics chain of a timber harvesting business case, starting from order placement, to planning, harvesting of the logs, and forwarding, measurement and transport of the harvested timber. As the teaching content was focused on digital solutions available at the FBZ which are explained in the MOOC, analyzed as to their resource-saving capacities during the webinar, and then fully demonstrated in the forest during the on-site event (cf. Chapter 2, p. 9). Regarding the replication activities, the presented best practices may be understood as an example (if they are not available in other regions) and the onsite event organized building on the overview provided in the MOOC / webinar and presenting own digital best practices (cf. events organized in Sweden and Norway, p. 52).

In case of *TG 2,* ***private forest owners in need of reforestation***, the training was conceptualized to combine both, presenting a digital tool for decision support which is publicly available in NRW, and providing lectures on important questions that forest owners (or managers) face in view of climate change and the growing threat for their forest stands. In the context of the replication, the presentation of the web portal Forestinfo.NRW (www.waldinfo.nrw.de), provides additional information about this public service which is unique in Germany. As the Forestinfo.NRW web portal is only available in German, the lectures on this digital best practice (it can also be found in the ROSEWOOD4.0 Knowledge Platform) give a better idea of its practical use by forest owners. Complementing the „digital“ teaching content, additional lectures on forest site

conditions, silviculture concepts, climate-stable tree species and implementation of reforestation provide useful content which is applicable in other regional contexts.

For *TG 3, **new (often urban) forest owners with a special focus on women**,* the task was not so much to convey the advantages of specific digital solutions, but to finding a way of communicating it that would appeal to this TG, and a topic which was considered to be of special interest for this TG, their everyday life and expectations of forest management. As considerations of ecological forest functions and the recreational value often dominate the economic expectations in this TG, the training was focused on the integration of forest management into everyday life and on the management of hardwood.

During the process of developing and implementing the initial trainings in Germany and Austria, the consortium started to discuss the options to start the replication of the trainings with a transfer into local languages which was originally not foreseen in the Grant Agreement (cf. Chapter 3).

1.3 Implementation of the trainings

The production of the *digital teaching contents* will be discussed in more detail in D3.4. Here, we present the implementation of the hybrid trainings with their first test audiences in Germany (TG 1 and TG 2) and Austria (TG 3). It is important to note that these test audiences are well known to the executing forestry education centers (FBZ as WP 3 coordinator and FAST Pichl as invited collaborator). Therefore, the first implementation of the full hybrid trainings in their original language in local conditions represents an ideal case.

Three physical trainings have been carried out with test audiences in the CWE hub:

- → TG 1: Seminar: **Digital solutions for resource-saving forestry machine use** (November 2021, FBZ)
- → TG 2: Seminar: **Reforestation in times of climate change with digital support** (September 2021, FBZ)
- → TG 3: Seminar: **Forest management for beginners** (November 2021, FAST Pichl)

These trainings have concluded the blended learning activities and allowed to discuss the combination of digital and practical training elements with the participants, which will be referred to in Chapter 4.

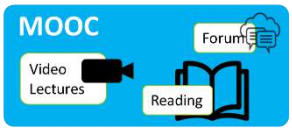
All online trainings (MOOCs including the webinars and podcasts are publicly available at https://rosewood-network.eu/resources/training/ .

2. Reports on CWE hub „original“ hybrid trainings

The following reports are based on audio files and photographs taken at the on-site events. Audio-files have been transcribed, carefully adapted, and revised by the experts (in German) while taking care to improve clarity in some places and, at the same time, preserving the spoken language. After translation, the reports are intended as additional training material which can serve as inspiration, complementing the materials which are available online (MOOCs, podcasts webinars). As will be discussed in the next chapter on replication, other hubs chose their own topics and strategies for the implementation of the trainings, based on local interest and available resources.

2.1 Seminar: Digital solutions for resource-saving use of forestry machines

Sequence of the full hybrid event for forestry contractors at the FBZ NRW, Germany:



MOOC: Digital support for efficient harvesting operations

User registration on 28.9.2021

Webinar: Decreasing the fuel consumption of forestry machines

October 8, 2021, 10:30 - 11:30 h, 17 participants. Recording included in the MOOC.

On-site: Digital solutions for resource-saving use of forestry machines

November 2, 2021, 10 -16 h, Forstliches Bildungszentrum NRW
17 participants (forestry trainers, contractors, forest machine industry, research)

AGENDA

10:00 Welcome and ROSEWOOD4.0 project presentation

10:15 Digital solutions in stand preparation

11:00 Digital solutions in mechanized timber harvesting

11:30 Digital support in the training of forestry machine drivers

13:00 Departure to the forest

- Data entry via LogBuch (trees and area)
- Logistics software using the example of TimberMaps
- Further processing of the production data
- Photo-optical stack measurement with FOVEA

15:45 Final discussion

Podcast: Data flow in highly mechanized timber harvesting

Embedded in the MOOC

Making better use of potentials to increase efficiency

The event starts in the classroom with a short presentation of the ROSEWOOD4.0 project by Thilo Wagner.

After the introduction, the trainings are presented by Olaf Müller with support from Robert Lehde. The following text is based on *audio transcripts which have been only slightly adapted and translated*.

Fig. 5 Introduction in the classroom

How can businesses recognize the benefits that a digital solution provides, how they can use it and communicate it to their working staff?

One can prove the advantages with facts. The Efficient20 project (KWF, Kuratorium für Waldarbeit und Forsttechnik e.V.) demonstrated that the training of drivers of forestry and agricultural machines can result in fuel saving of up to 30%. Even with top drivers, it is still possible to tap an optimization potential with the help of digital solutions and train them accordingly. We call this training "Operant Training". This means: the driver determines the potential for improvement for himself. And when a driver gets better, there is a side effect: he becomes more satisfied! That is what you must achieve with the training: drivers work with more satisfaction *and* with a high performance.

For the forestry and timber industry, we broke down the resource savings potential further and found that the right choice of equipment also saved up to 5 to 8 %. In addition, optimal equipment settings can save up to 30 % fuel. For this purpose, manufacturers offer so-called tuning days or efficiency checks. We advise every entrepreneur to do this at least once a year. Otherwise, incorrect settings will lead to wear processes, which will reduce the efficiency. In addition, engine maintenance plays a key role. If, for example, the air filter is dirty, which can happen within a few hours on a dusty day, engine performance will decrease, and diesel consumption will increase.

We have guided the drivers through the TimberSkills learning environment. This allows us to determine where each driver's potential lies and then train them specifically. For drivers who are *not trained,* the potential for efficiency gains is even higher than 30%. Far too often there is still "training on the job". Talking to forestry contractors shows that there is a lack of trained personnel. One should rejuvenate the driver pool in *time* and *keep* renewing it with experienced drivers who pass their knowledge on to the next generation.

What we want to show today is the possibility of using driver assistance systems. Logistics programmes, timber harvesting simulation tools, and the on-board computer settings help to achieve the optimal value for products through optimization according to price list. After the introduction of StanForD 2010, the question today is: how many machines work according to the new standard? Do they use the possibilities that this standard brings in the optimization of on-board computers? One must conclude they do not.

It is important for businesses to know when the use of digital solutions is worthwhile!

In education and training, we look separately at lack of knowledge, lack of motivation and lack of skills. It is important to remember that decisions are not necessarily made at the driver level. If we look at the decision-making levels of a company, we must consider three levels. On the first level, we have the management of the company, where, for example, sales contracts are concluded that may prevent it from working optimally. On the second level we have the strategic management of the machines, e.g., the operations manager of a state forest, a municipal operation, or a forestry company. And on the third level we have the drivers. They also see potential for optimization, but they usually do not pass it on to the top level.

Fig. 6 Decision-making levels
Source: Olaf Müller

So, it is primarily important to identify *where* a problem lies.

The operations manager will not determine whether the chain of the harvester working outside is blunt. If the chains are not optimally sharpened, the working time will increase considerably. The operations manager can send the saw chains to different suppliers for sharpening, after which they are assessed, and then the company is selected accordingly. This is up to the drivers who know how to assess the saw chains!

All three levels, management, operations management, and the drivers must sit down together to increase the efficiency of the operations. To do this, one must look at the entire process chain in every single step.

Simulation with the Virtual Classroom for Decision Support

In order to use digital support for optimization, we have designed the "Virtual Classroom" together with the R.I.F. Institut für Forschung und Transfer e.V.. This enables us to combine data bases and simulation options in order to first elicit problems and then develop solutions for more efficient and resource-saving work. With the "Virtual Classroom", decisions in level 1, 2 or 3 can be consistently evaluated.

Our software builds on the foundation developed in the "Virtual Forest". In 2010, a start was made on visualizing the forests in NRW and recording them at the individual tree level. For each tree there is a so-called „tree business card“, i.e., identification number, tree species, trunk circumference, exact tree height – all relevant data are available in digital form.

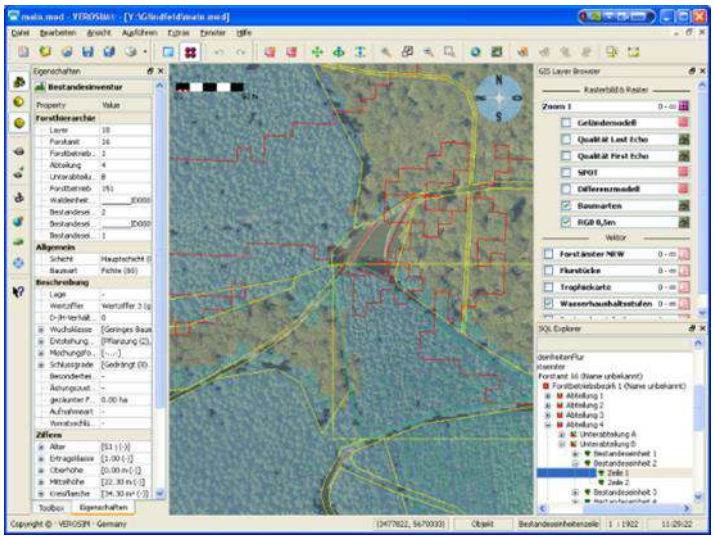


Fig. 7 The Virtual Classroom: forest stand and site data

This allows us to run through various scenarios for preparing the stand. Determining landing sites for log stacks, marking trees, creation of skid trails - we can simulate and work through all of this in advance. Decision tools are not meant to take a decision away from us, but to help us better understand the conditions for decisions and consider alternatives. We have found that small decision errors can add up to a loss of about

€60,000 over the year. This might be about choosing a different place for a log stack, or a different machine, or a different machine size. Maybe not using a big machine with a 15 m long crane, but a wheel harvester with a feeder. The path of the long crane in and out of the stand takes much longer and costs more, the wheeled machine on the other hand can work faster. On the first level, the decision is made as to which machines are purchased. Mistakes can already be made on that level, the effects of which are often not considered.

Different machines and their data sets are stored in the virtual classroom software. Depending on strength, size, motorization or payload, different costs per hour are incurred. The user can update this data repeatedly. In addition, the production data and the different costs per work process are stored. The fluctuating timber prices are also particularly important to consider.

In the system, skid trails can be entered with a GPS tracker. However, it is also worthwhile to simply use the predefined trails and only determine the log stack positions individually. This allows the opportunity to play through variations. If the choice of the log landings is already unfavourable, we will have significantly longer distances, longer driving times and higher costs. The intensity of driving plays a role here, as well as the distances to the landings, the quantities that are stacked there and the sorting for transport. The question is, of course, how free one is in the choice of the log landings – perhaps the forester predetermines the sites. If this is the case, he/she must be involved in the decision-making process.

In the programme it is also possible to select diverse types of thinning. For the assortment selection as well, there are diverse options, e.g., through B-Dat, a programme for assortment specification, or by input of individual data.

And then we have a wide choice of working methods. Motor-manual felling, forwarding, tractor or horse, large and small forwarders or harvesters, payload, with or without traction winch: everything can be adapted including the costs per machine. Once we have gone through it, it is displayed like this: We see the stand colored, the “future trees” (F-trees) that must be protected in blue, removal trees red, and the assortment: each yellow line represents a cut (cf. Fig. 8). You can see exactly where the skid trails and forest roads run and the intensity of traffic (cf. Fig. 7). As soon as you get into the red area, it means that forest roads need to be repaired.

We can now change individual parameters in our planned felling operations to make variant comparisons. We can choose one or two log landing sites and see the fuel consumption changes, the distance, the time efficiency, or even the consumption (liters per solid cubic meter) in relation to the produced timber. If the figures seem low to you, just calculate what a machine like this produces in a year! We can also easily compare the use of different machines. One would expect the big forwarder to be more efficient, but a look at the figures shows that this is deceptive: the fuel efficiency of the smaller machine is better for this application.

The digital tool thus helps to make the best decision objectively: this can be the landing site, the working method, the position of skid trails, or even the machines. The principle applies: you should not just do what you've always done.

Virtual Classroom Demonstration

We see the selected area; we have predefined the skid trails. Now we create a timber harvesting measure and assign a name so we can compare it later.

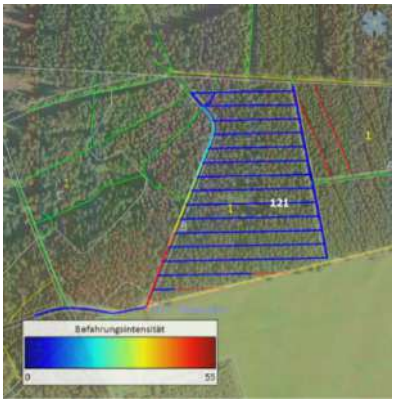


Fig. 8 Timber harvest simulation - driving intensity

Then we set "single-assortment forwarding" and see the outer frame of the preset area, the skid trails, and the trees can be selected. We also see terrain features, hiking paths, or a slope where the harvester cannot drive, which is shown in the map with shading. Then we determine the log landing locations. The system then automatically selects the optimal route.

As already mentioned, skid trails can be entered schematically via GPS data or with a defined distance. Based on the shape of the terrain (slope etc., backed up by cadastral data), the programme suggests a sketch of the skid road. The next step is the marking of the trees, where you can make specifications, e.g., only harvest spruce. The stored data comes from the forest inventory that we have available for this stand.

Now we see the first simulation, i.e., all trees that we can take out are visualized. The “Silva” forest growth simulator is active in the background, so you see 2065 trees here, 481 of which are future trees that must be preserved.

We have stipulated that one competitor tree is felled per future tree, so that 464 trees have been marked here for felling. You can see the marked trees in red. And you can take a closer look at individual trees, also in a 3-D representation (see Fig. 8).

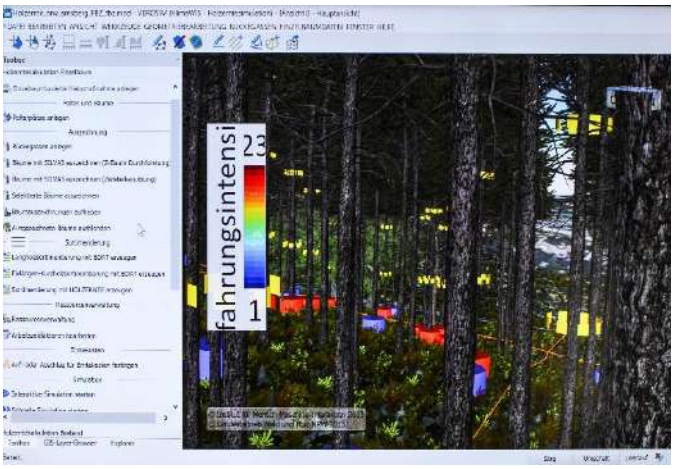


Fig. 9 Timber harvesting simulation 3-D representation

After the selection, the next step concerns the assortment. The programme asks for the quality of the trees – we set quality „B“. All assortment specifications can be chosen freely.

After clicking OK, each individual tree is sorted. After that, the resources to be used are defined: all machine systems and procedural processes can be entered here.

Next, we select the harvester. Light, medium, and heavy machines, with or without belts or chains, or traction winch - all these elements are deposited as cost factors. The same applies to the choice of forwarder. In addition, you can – e.g., if you choose a larger spacing between skid trails of 40 m – select motor-manual felling. If this is not selected, a large part of the trees would remain in the middle area.

Finally, we can enter surcharges and deductions for timber harvesting costs and then start a simulation that shows us the estimated time for timber harvesting, just over 30 h. You see, almost all the trees marked in red are gone except for one. The reason may be that it could not be felled because of its location as the harvester could not reach it. The system also considers in the calculation that the future tree should be protected - if it is endangered, the removal tree remains.

Now we can look at the driving intensity. We can see that by choosing only one log landing site we quickly get into the red zone, i.e., this piece of road here would need a major overhaul after the timber harvest.

The result is a data set that can be divided into harvesting costs, total costs and harvesting cost-free revenue. Here you are free in the design because cost data such as harvester costs per hour or output per hour have been stored, based on performance data of the machines and machine costs (provided by the KWF).

If you only want to look at one factor, such as the landings for the log stacks, change only this one element and look at the change in efficiency and driving intensity. Or another factor, depending on the question: all decisions can be checked and optimized in this way, such as purchasing decisions for machines. For a single timber harvesting measure, the difference may not be great, but extrapolated over the year, the effect is significant. This always involves CO2 savings and the protection of forest soils.

It turns out that optimal work does not only depend on the driver - operational planning and strategic management also make decisions, the effects of which can be easily visualized in the virtual classroom.

Training effects - Operant learning

But how do you motivate the driver to implement the training and achieve an increase in productivity? To do this, we work with sensors. By reading out the sensor data, we can determine when peak hydraulic performance is deployed. A video camera is running in the cabin which allows to see what action the driver took to call up the peak value. At the same time, video browsing software is running on the on-board computer, i.e., the performance data is synchronized with the video sequences. We can see, for example, that a driver always lowers the whole crane without using the telescope. When he raises the crane again, engine peak is reached so that the power of the hydraulic system can be called up during filling. Therefore, this is the work area for which the driver must be trained.

Fig. 10 Operant training on the simulator

The first question is: How do I tell the driver that he is making this mistake? It is inconvenient to train mechanically, with the trainer telling the operator what to do or not to do. He should be given a task in which he will not reach the goal if he does it the way he has always done it. He will not get anywhere without changing and will have to repeat the same exercise over and over again. To move forward, he must first reach the exercise goal. This motivation will allow him to switch to "Operant Learning". He looks for a way to get the award points and tries to drive out the telescope ONCE. In this way he will acquire the practice of learning through his own success.

In newer harvesters, a decision support system is available via sensor control for telescopic operation, such as the Intelligent Boom Control (IBC) in John Deere harvesters. This is a response to the fact that the telescope is usually used ineffectively because the kinematics of the process are not understood. Such a system increases

productivity, and at the same time the work becomes calmer, more relaxed, and the operators are more satisfied. For us, it is important to make use of the digital tools that are available on the machines and perhaps make sure to include such tools in the next choice of machines. At the same time, the performance of the operators should be evaluated appropriately and not only the "solid cubic meters per hour" should be included in the evaluation. It is always about the resource-saving use of machinery!

Operational learning needs an innovative feedback system. No one will tell the operator what to do, but once he has optimized the process through trial and error, he will achieve the goal of the exercise. The best solution is then one that he has found himself. The feedback from operators during our trainings confirms that the learning success is considerably greater with such self-found solutions than with following instructions. Such training tools are available on the market, and it is worthwhile to train your operator pool on them occasionally. Supervision and further training are appreciated and strengthen the motivation.

How does teaching on the simulator work?

Through access to the server, the teachers are networked with each other, they can develop and exchange their own exercises. Exercises are stored chronologically on the server in the so-called course manager and are retrieved by access. We call a game e.g., "handling log bundles", and the sub-point "correct grasping point". Here, the student is assessed on the approach of the timber grapple to the stack, the grab point in the bundle, and the loading and merging of the bundles. This results in a point score with a resulting total score. But before the operator despairs, he gets the opportunity to look at a comparative performance.

Fig. 11 Simulator training in the network

However, we do not provide this comparative performance BEFORE trainees have tried to find their own solutions. If the student gets stuck, he or she must first communicate with the trainer. Spatial distance does not matter – student and teacher can be sitting in completely different regions, the student at the simulator, the teacher watching the student at the PC. Via a comment function, the student can ask questions and the teacher can give further instructions. The exercises are not meant to frustrate the students. Most of the time, however, students rather forget to take a break!

The last step in operant learning is that the trainees generalize and thus consolidate what they have learned. In concrete terms, this means that the exercise is only run briefly and with less timber at the beginning, and the sequences are then automated in a long exercise. Only when an exercise has been completed and the goal has been reached can the learner move on to the next exercise – this corresponds in principle to a level in a computer game. The distance covered by the crane tip is measured and this must be reduced. The advantage lies in the individual support of the operators depending on their learning level and ability. Like this, even advanced operators are usually motivated to improve. However, we also train operations managers here: it is important to motivate them to use digital solutions and tools.

Practical demonstration of digital solutions in the timber harvesting chain in the forest

Out here, we are again concerned with digital solutions which can help us to make mechanized timber harvesting more efficient. We have brought many screens with us to show the entire process.

For this purpose, we have selected a stand that will be recorded using the LogBuch programme. This means that the operations manager or the forester digitizes the area or the trees with his mobile phone and then transmits them as an overlay to the harvester via the web portal.

Fig. 12 Practical demonstration in the forest

Fig. 13 On the left the Harvester's on-board computer, on the right the LogBook web portal.

The harvester records the data set and visualizes at the same time. We see that on the screen, and we will also show the on-board computers on the machine in parallel.

While the harvester is felling the trees, the telemetry devices connect with each other, the machines are always in contact through updates every three minutes. As soon as the harvester has felled any trees, they are digitally recorded, first into a production file, which we need later for further processing of the data sets. In addition, an overlay is created for the map data set, which is visible in the forwarder's on-board computer. This allows the forwarder to optimize its route.

The type of forwarder is stored in the software and thus the content of the load bunk is known. In the route, the forwarder first specifies the so-called load type, i.e., which assortment he wants to load. Then the so-called strip road, the route, is entered. As soon as the forwarder is full, the programme stops entering anything.

The forwarder can then drive into the area, load the logs, drive out and stack the logs in a landing at the forest road. The operator transfers the timber in the programme to the stack and it disappears from the map.

This means that the harvester keeps entering the logs on the map: The dots you see on the left screen are contracted dots of timber assortments that are already deposited nearby (see Fig. 14). If you enlarge the picture, you can see that the dots get smaller until they represent individual assortments. You can also see the route of the machine, i.e., the skid trails are tracked and plotted on the map. The forwarder knows exactly where which assortment is located and in what quantity. When it loads up, its route is emptied of assortments and the stack begins to grow.

Fig. 14 Site overview: already harvested wood assortments

The third partner is the TimberManager software in the office, which always receives the status of both machines (see Fig. 15). It sees what the harvester is producing and what the forwarder has already harvested: both columns are starting to grow, the manager sees in his scheduling how the forwarder is stacking the logs, whether he already must remove something, or whether he can forward specific timber quantities.

Fig. 15 Machine locations in Timbermanager

We thus avoid double driving because we know exactly where which assortment is – the forwarder does not have to constantly drive back and forth and look. When everything is completed, only the production file is needed. Today, this is mostly still done in analogue form: the entrepreneur gives the production file as a PDF or even printed out to the forestry manager, who then must enter the data into his timber accounting programme.

For our own operations, the harvester production file is read directly into the ABIES software via a converter. The converter displays everything that is not readable for ABIES and asks for a correction (e.g., for names for assortments that do not match the accounting software). To check whether all the timber has been moved, we make a comparison via piece count, as well as by photo-optical measurement of log stacks.

What does the forwarder do? For example, he sees 10 m^3 and next to them another 14 m^3. If he wants to go further, the programme says: That is not possible because the load bunk is already full. The programme does not allow it. But I should only select exactly those assortments I want to forward, then all the others disappear from the visualization. The route appears marked in green, and if the load bunk becomes full on the way, the route is not displayed until the end. However, if there is still space in the load bunk after loading one assortment, more assortments can be loaded and then sorted at the landing. The driver can add a second load type if there is still space in the load bunk. When he arrives at the landing for the stack, the driver must select "transfer to stack". Then the masses at the stack add up and the assortments disappear from the map.

Manual updating is quite simple. Whenever the machine is stationary, the driver sees TimberMaps, and as soon as the harvester is working, TimberMatic runs, and he will see his load and the loading cycle. The forwarder always sees both, his own position, and the position of the harvester. In the future, optimization via grid is also conceivable, where the best route to the harvester (out of the front of the lane, or back) is calculated, depending on the position of the machine and the landing.

The colleague now walks out and marks individual trees via LogBuch using his mobile phone with an accuracy of at least 3 m, often better. The marked trees appear in the LogBuch web portal, are exported, and sent by email to the harvester. The harvester uploads the marked trees into TimberMaps and displays on the on-board screen.

Fig. 16 Left: The marked trees in the LogBuch web portal;

Right: Display in TimberMaps as red dots

In the harvester, all data is shown on *one* screen, TimberMaps when standing, switching to TimberMatic when working. Two screens lead to overstraining the operators. At the FBZ, we are currently working with the AVATAR project on an interactive display, a head-up display, which will make driver assistance information visible in the windscreen. Eye-trackers are currently being used to investigate how high the mental strain on drivers is when they must constantly look down at the on-board computer.

In another project with the University of Göttingen (Prof. Dirk Jaeger) we are working on the data availability of the harvester information. The bottleneck here is the can-bus, which is internally signed. If we knew the signature, we could read out all the data. We are not talking about the production data, but sensor data from the hydraulics, data from the electronics, etc. The IBC system has been developed based on such data. Although this data would be important for research and development, it is unfortunately not usually released.

Now we see the extraction trees that have been marked, recorded with the mobile phone using the voice function in LogBuch and transmitted as shape files to the on-board computer by e-mail. The on-board computer shows TimberMaps, where the shape files are now uploaded. So, we see the skid trail and next to it the trees that the harvester is to cut. At the same time, an assortment is entered in TimberMatic, via APT or ENV file, depending on the standard. The colleague now starts to harvest these trees, then we will show how this appears in the forwarder screen. The data is transferred via a cloud.

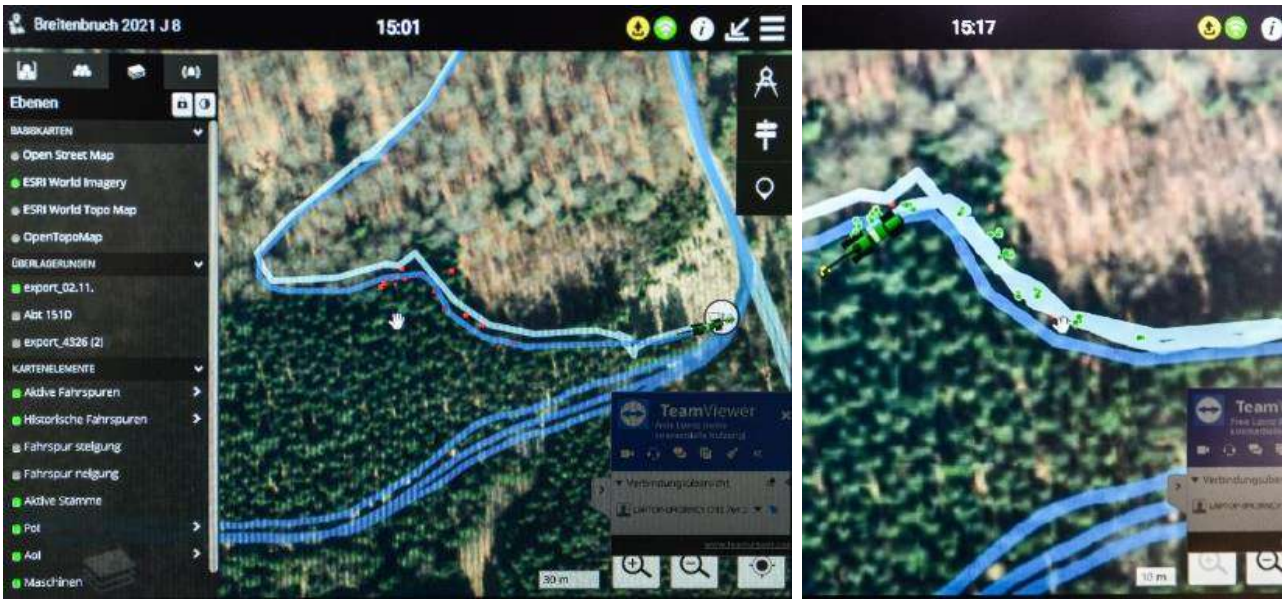


Fig. 17 Left: TimberMaps, harvester. The marked trees were transferred with a shape file via email from LogBuch and can be seen as red dots; right: the harvester is working, green dots show trees that have already been processed.

You can see how the harvester starts harvesting, the harvested timber shown as circles (cf. Fig. 19). This continues and the different load types add up. This is how the data arrives on the forwarder.

Usually, we let the harvester drive for half a day at the beginning and record the STM files, which we run through a simulator. Then we know if the assortments we have made are OK. In the simulator, we have different options for optimization. If, for example, an assortment is completely omitted, then we set the price steering slightly differently and send this adjusted assortment back to the harvester.

The optimization is fact-based: After sorting, the programme gives a monetary value for each individual log, which is why the real prices must be stored. However, the best sorting is not automatically provided by the programme but must be set. Therefore, half a day at the beginning is important to optimize the sorting.

Fig. 18 The harvester starts to work

We see on the screens that the harvester has completed its task, and in parallel we see the screen of the forwarder where the colleague now creates a so-called load type to establish the loading route.

First, he creates the log landing and then names it the same as the assortment that is to be stacked there - this is how the stack can be seen in TimberManager. Then he calculates how much cubic meter of the selected assortment are present in the selected route.

Once that is narrowed down, the operator creates the route, which is shown in green (Fig. 19). Now all the trees that are in the possible loading zone are shown. With this, he can drive into the area and load the logs along the loading route.

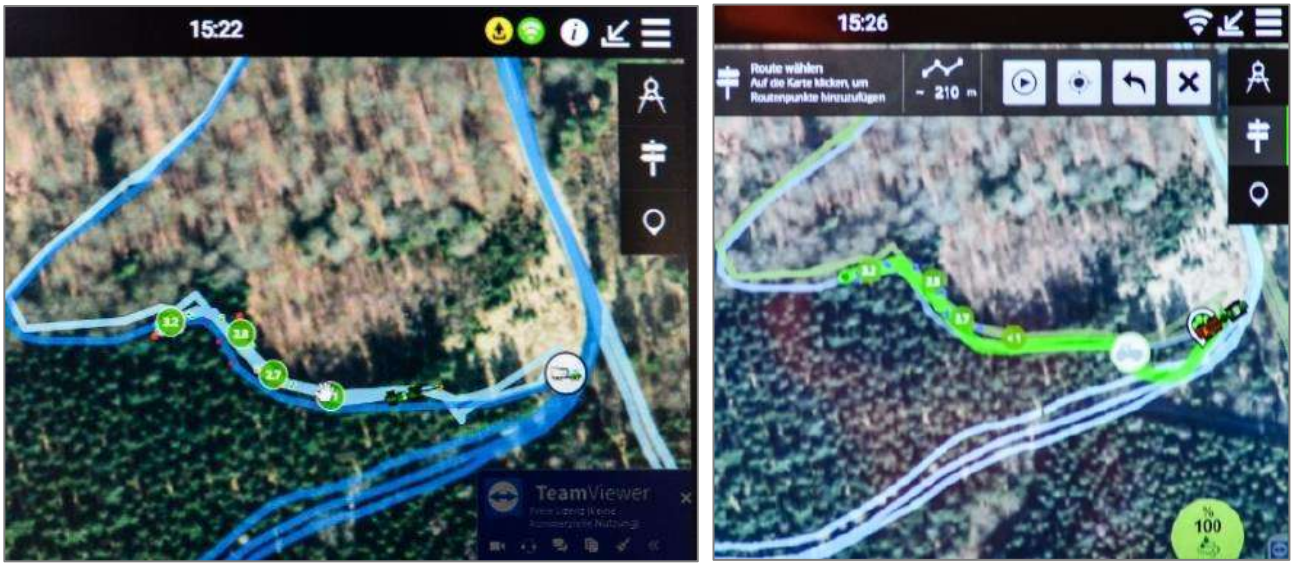


Fig. 19 Left: all processed assortments are shown as green dots, the numbers show m^3 ; right: forwarder route, the loading route is selected for all assortments

We can see that the programme is waiting for a transfer. First, the loading cycle is needed now. As soon as the logs are loaded onto the stack, the driver clicks on "hand over". Then the timber data disappears from the map and appears in the stack.

How is the individual assortment assigned to the right stack? At best, the driver has sorted in the load bunk, 4 m timber on the right, 5 m timber on the left. He can therefore unload everything onto two stacks and then transfer the two different load types to the stacks.

Fig. 20 View of the planned log stack in Timbermanager

The unloading site is already located; if there are two assortments, one stack can be made into two. It is noted with a "2" in the map if different assortments are close to each other. But it is important that the load type is assigned (=transferred) to the stack.

Updating the TimberManager takes longer than communicating between the two machines (where the MTGs - Mobile Telematics Gateways - are closer together) because of the distance.

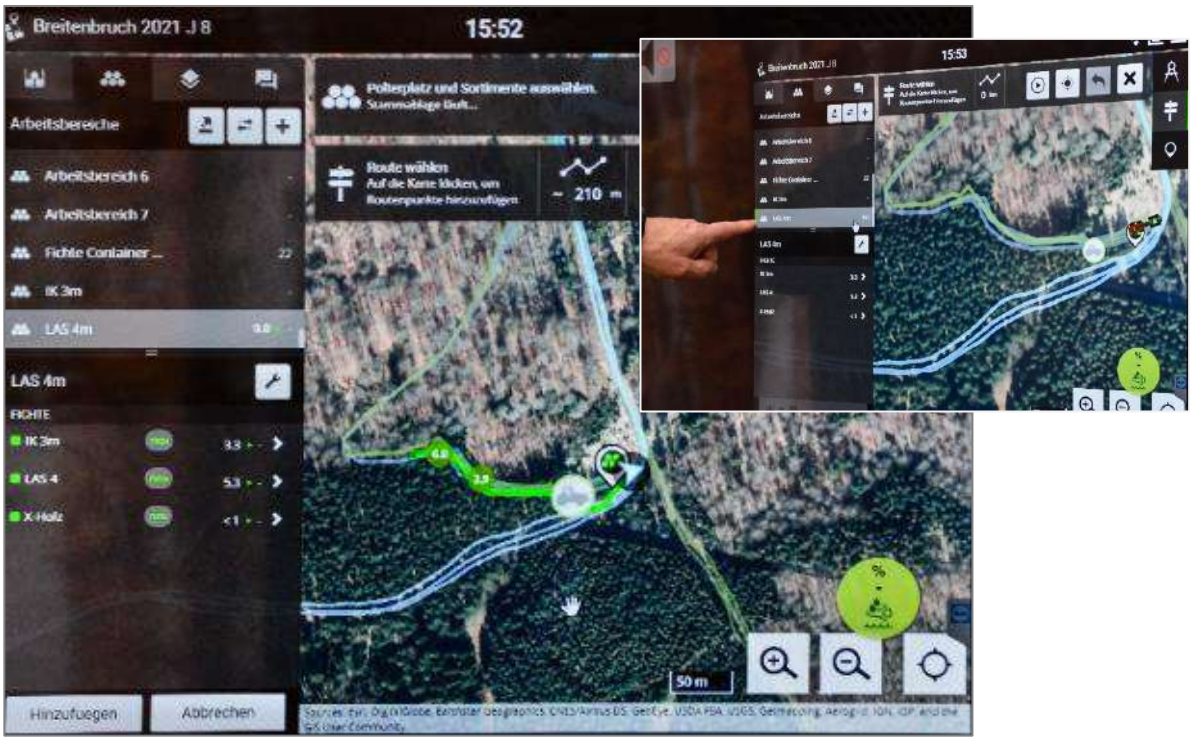


Fig. 21 Left: the (pile is selected (LAS 4 m), with "Add" the wood disappears from the area and is transferred to the pile yard; right: wood is no longer visible in the area, in the display on the right (behind LAS 4) the processed 9 m^3 are shown.

Here we can see how the dispatcher sees the stacked timber in TimberManager (Fig 21). On the forwarder's on-board computer, we see how the timber has disappeared from the map (Fig. 21, right). Now the next loading route would be determined, and finally the number of pieces and - if photo-optical methods are used - the quantity is determined.

Both the production file and the quantity determination are transmitted to the district manager. If the stack is recorded with Fovea, this data can be transmitted to the truck and the pile can be approached with NavLog or similar navigation softwares. This way we also have the forest control measurement on the tablet at the same time, as you can see here. Whether these measurements are used for invoicing must be agreed between the forest owner and the timber buyer. The harvester measurement is currently not recognized in calibration law, so it cannot be used in court. The harvester measurement can be used for advance payments, but the accuracy of the measurement should be checked regularly.

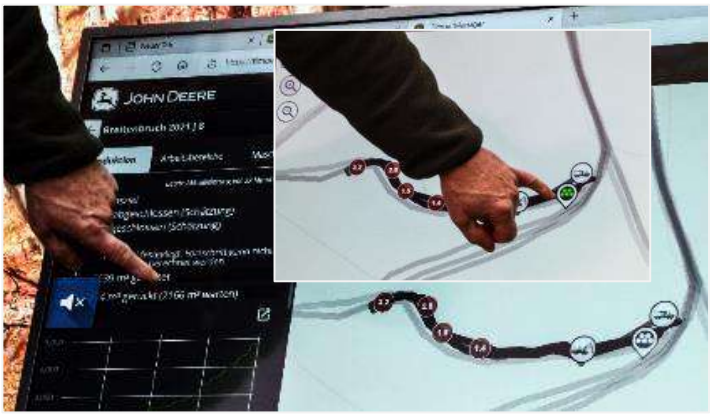


Fig. 22 Representation of the stacked timber in TimberManager

So, we have now closed the entire logistics chain with digital solutions. We have planned the timber harvest digitally, we have digitized the communication between harvester, forwarder and dispatcher and thus avoided many time-consuming telephone or written communication channels. All the solutions we have demonstrated here today are exemplary and are also available from other manufacturers. An important future perspective for us would be that different manufacturer systems communicate with each other and can be combined.

Fig. 23 Photo-optical polter measurement with FOVEA

The expert teams

Introduction
Thilo Wagner, head of the Forestry Education Center, State Enterprise Forestry and Timber North Rhine-Westphalia (NRW), Germany

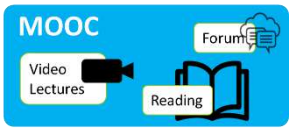
Trainings
Olaf Müller, Forestry Education Center NRW, Germany

Trainings
Robert Lehde, Center for Forestry and Timber Economy, Germany

Images: FBZ

2.2 Seminar: Reforestation in times of climate change with digital support

Sequence of the full hybrid event for forestry contractors at the FBZ NRW, Germany:



MOOC: Digital tools for climate-adapted reforestation

User registration on 25.8.2021

On-site: Reforestation in times of climate change with digital support

September 2021 10 - 16 h, 18 participants (forest management, private forest owners, forestry education and research)

Topics: Initial situation of the area, forest site, stand establishment, planting and quality assurance, protection and maintenance, and pioneer forest as an opportunity for cost-effective and climate-stable reforestation.

Webinar: Reforestation in times of climate change with digital support

13 September 2021, 14-15h, 17 participants

Expert group discussing the audiences' questions following the on-site event and based on inputs which had been sent in advance by e-mail. Recording included in the MOOC.

Podcast: Using apps to assess climate vulnerability and species to plant: the French example of BioClimsol

Embedded in the MOOC, available in English and French

Morning session

All participants had been registered to the learning management system in advance to allow them to prepare for the on-site event using the MOOC lectures. The day at the FBZ began in the teaching room with a project introduction to ROSEWOOD4.0 and an overview of the online information portal Waldinfo NRW, its most essential functions and the practical benefits for forest owners in NRW.

Afterwards, the participants were driven to the selected area for the practical demonstrations, a windthrow area with birch and spruce natural regeneration, and blackberry growth.

On the area, **nine stations** had been prepared to discuss the selected topics with the participants in combination with practical demonstration of the related procedures, tools, materials, and forest situations.

Station 1: Initial situation, procedure, and goals of the event

After arriving at around 11:30 a.m., an overview on the concept and goals of the event was given at the first station.

The forester in charge, Ms. Trompeter, explained the development and condition of the area, followed by a brief description of the topics of the following stations and the planned group work.

Fig. 24 Introduction to the demonstration area

The following report is based on audio recordings of the demonstrations, which have been shortened and slightly adapted. The expert team is introduced on the last page.

Station 2: Map application Waldinfo.NRW

Following up on the previous presentation on functions and applications of the web portal Forestinfo NRW (https://www.waldinfo.nrw.de/), participants were encouraged to use their own smartphones to identify the on-site demonstration area and to retrieve relevant information.

Additionally, the corresponding pages in the web portal were called up on a screen for all to see and the available forest site information regarding soil condition, nutrient, and water supply, as well as climate scenarios, was discussed in the group.

Fig. 25 Participants practice with the web portal Forestinfo.NRW on mobile devices

Station 3: Site conditions

From here on, texts are based on transcripts from audiofiles which have been slightly adapted and translated.

The basis for the soil maps in Forestinfo.NRW is the mapping of the entire forest area in a grid of approx. 50 x 50m by the Geological Service of NRW. Soil mapping is carried out by taking soil samples with hand drills, here in the forest and also on agricultural land. This allows to assess how the soil is structured and to deduce, among other things, how much water it can store. Another important criterion is the nutrient content. Problems, but also opportunities for our trees can be identified in this way.

Looking at this sample, it is first important to establish what colors we can identify. Can you describe the colors you see here? (Answer from a participant) From yellow-ochre to grey, it gets lighter towards the top, the top 15-20 cm are completely dark.

The dark part at the top is warped because humus is dragged along during the drilling procedure, below that is the original sample.

- yellow-ochre in the upper area, as is often found in the forest
- towards the bottom there is a change of color, sometimes grey, sometimes reddish next to each other, this is called marbling.

The red coloring is always oxidized iron, the greyish areas are reduced areas, here water plays a role. In this case, there are two potential causes: either groundwater or rainwater that is dammed up, also called waterlogging. In this case, we can rule out groundwater because we are quite far up the slope.

Fig. 26 On-site demonstration of taking and testing a soil sample

If it is waterlogging, we must find a layer in the soil sample that acts as a dam. We pierce the sample with the knife and find that at a certain point we can only get through with the blade with greatest force. This means that the soil down here is clearly more densely deposited and/or has a higher clay content. Therefore, the rainwater accumulates here, especially in the winter months. This leads to the visible color spectrum, the marbling effect.

In general, the key factors are: how much water can the soil store, what is its composition, how many stones does it contain and what does the fine soil consist of. And here we can say that we distinguish between three grain sizes:

- Sand - relatively coarse grain with large voids, water seeps through quickly.
- Silt - with medium grain size, rarely seen in its pure form. If you grind the soil sample between your fingers, a floury residue remains, showing the presence of silt.
- Clay - with the smallest grain size. Clay has very many small pores, so it can hold water well against gravity, but it binds it very strongly. This means that the water is not available for the roots.

The more silt in the soil, the better, the more sand or clay, the worse for the water balance of our trees. It is easy to determine whether sand is present by taking a finger sample: you can usually see and feel it. The silt content, on the other hand, is difficult to determine. The clay content can be assessed by rolling out the sample between two fingers: the further I can roll, the more clay is contained. In this case, you can roll the sample out to the thickness of a knitting needle, it is clayey silt.

In general, the following can be said regarding the soil in this area:

- The upper area is relatively free of stones, which is pleasing.
- The silt content is comparatively high, i.e., this soil can store water quite well.
- However, waterlogging is problematic - especially in spring the water can stand high here.

The next important topic is the nutrient balance, which can be well assessed using indicator plants for the topsoil. Better, however, is an evaluation as made by the Geological Service as part of soil mapping with a portable pH meter. In the map in Forestinfo.NRW we have seen that this site is moderately alkaline: the upper part is relatively low in bases, the base content increases towards the bottom. Now we want to check this. We

take a sample from above and one from below and carry out the analysis here on site. The result shows that we have a pH value of 4.6 at the top - that is in the acidic range, but not yet catastrophic. For the lower sample, we are at a pH value of 5.25.

We have thus confirmed the mapping results of the Geological Service NRW given in the web portal: it is a moderately base-rich site, which is base-poor at the top; but downwards, as the clay content increases, the pH value also increases and with it the base supply and the nutrient content for our trees.

In summary: the Geological Service has mapped a moderately alternating wet soil, matching the layer which holds back water, and the nutrient determination also fits well.

We can also see the presence of waterlogging here on this fallen spruce: Rust spots alternating with greyish parts. This picture on the root plate is a sign of waterlogging. The spruce rejuvenates well on such areas but does not grow stably because the waterlogging causes it to root even shallower than it already does. Such areas with waterlogging are the first to be affected by windthrow.

Fig. 27 Rust spots on the root plate as a sign of waterlogging

Mr. Tennhoff will now show you what can be planted on such a moderately alternating wet area with a mesotrophic, i.e., medium base balance.

Station 4: Climate-stable tree species versus Flora Fauna Habitat (FFH) Directive

We need tree species that can root through such waterlogged layers, which can cope with less oxygen in the soil, and which anchor deeper in the soil.

I have brought some tree species, each with a wood sample, because after all we also want to produce valuable timber. When you take such a piece of wood in your hand, please note how different the weights are, i.e., the density of the wood and thus of course the possible processing options and uses.

Here we have the **pedunculate oak**, representative of the pedunculate and sessile oak, our two native species. Oak usually needs a serving tree species, so here we have hornbeam, the hardest and densest wood in all Central Europe. It can be used to make beautiful workpieces. Hornbeam in combination with oak because the oak needs a tree species to sheathe the trunk. In addition, hornbeam or also lime - especially littleleaf lime - are tree species that provide particularly good litter decomposition. This sets the nutrient cycle in motion, as oak leaves have a mediocre litter decomposition and produce a lesser humus – in mixture with hornbeam and lime, on the other hand, the humus quality gets much better.

Let's move on to the conifers. You have seen the reaction of the **spruce** on the root plate: it does grow, and if there are no storms, it performs well. It rejuvenates very well, but it does not develop stability because it is a shallow rooter. If it survived waterlogging and storms, it would suffer massively in periods of drought.

This tree species with the conspicuously thick bark was seen by many forest owners as an alternative for spruce: **Douglas fir**, originating from North America, but present in Central Europe for over 100 years, a beautiful timber. But even here we should bear in mind: there is not THE foreign tree species that will save everything, we can only strive to mix well! Where the spruce has disappeared, the spruce beetle attacks the Douglas fir as well. But much worse is that in the last 7 or 6 years a new pest group has been introduced to Central Europe: the Douglas fir gall midge, three distinct species that bore into the youngest needles and make the Douglas firs look rather grey than green. This means that large-scale Douglas fir plantations must be questioned.

What else do we have? In recent years, the focus has increasingly been on a tree species with very inconspicuous wood that can hardly be distinguished from spruce. This is the native **silver fir**, which occurs in Central Europe and in Germany, although not naturally in NRW. As early as the Stone Age, man probably intervened to regulate the silver fir to its disadvantage, and the return migration northwards did not reach this region. The silver fir has excellent qualities. Like the oak, the taproot that can open dense layers. In addition, it shows good litter decomposition. Why has it never been used until now? There are two answers: on the one hand, silver fir was for a long time the tree species worst affected by acid rain. And on the other hand, the fir, together with the oak, is an absolute delicacy for roe deer and stag, these are quite specifically sought out and browsed.

Fig. 28 Tree species and their wood samples

With the present high game populations, this is increasingly significant. In addition, spruce and fir cannot be cut and dried together. Fir has a higher water content, and many sawmillers did not want to make the additional effort. As long as they got enough spruce, they did not have to, but this may now change. Freshly felled firs often have a wet core, which means that the inner area has a water content that is perceptibly higher. This does not look nice and sometimes smells a bit musty, but as soon as it has dried, it is no longer perceptible to the eye and nose. The wood has excellent properties, in some cases better than spruce, so it can be used as construction timber. It is the most valuable and sought-after conifer in the Black Forest.

Now we also come to exotics – some of you know it from hedges or from the cemetery: Thuja plicata, the **Western Red Cedar**, coming from the west of North America - USA, Canada, Oregon, British Columbia. A tree species that should only be mixed in with small groups. Although it is a conifer, it has a litter that improves the soil. We oversee the Burgholz Arboretum, where more than 400 tree species have been planted, and we were also able to fall back on soil tests that were made more than 30 years ago: it was clearly proven that this tree species enriches the entire topsoil with magnesium, sodium, and calcium. This positively stimulates the entire topsoil, earthworm life and other soil organisms, and decomposition and root penetration are clearly more intensive. The wood itself is one of the most sought-after woods, the core is reddish when fresh. It is quite

easy to work with and – an advantage like with Douglas fir – it does not need any impregnation. This saves a lot of chemicals, you can make exterior paneling or garden furniture out of it, but you can also use it for interior finishing. A beautiful wood, noticeably light: please compare how light the wood is, about 20 percent lighter than spruce.

And lastly, a well-known local, for many a forestry "unwood"! Birch? It is considered as weed by foresters! As you can see from this plank, it is a very stable wood. Birches are important for nature conservation, many rare butterfly species feed on them. Targeted management with birch means: it comes free of charge, without planting costs, it comes blown in by the wind and we can use it in a targeted way. As a light-demanding tree species, it lets through enough light for many other tree species. Even another light-demanding tree species as the oak can grow under birch. And of course, this also applies to semi-shade-tolerant tree species such as spruce, a shade-tolerant tree species such as silver fir, or others.

Here we have one last tree species, introduced by the Romans, many of you are probably more familiar with the fruit, the sweet chestnut. Heat-loving, drought-tolerant, particularly good root penetration, excellent litter decomposition, and a wood that is almost indistinguishable from oak wood. Only connoisseurs know this: if I take this oak plank here, I see shiny bands, which are wood cells that have been filled by the oak with storage substances, and then reflect depending on the incidence of light. The sweet chestnut also has this structure, but smaller, and therefore the human eye cannot perceive it. When cut, the wood is the same as that of the oak. You all know that oak is good as a fence post, but sweet chestnut is even better. An oak fence post lasts about 20 years, one made of sweet chestnut 30 to 35 years - that is why the sweet chestnut was introduced by the Romans as a vine post. It is a tree species that tolerates drought and does not require a large supply of nutrients; on the contrary, it does not want chalky soil. For slightly acidic to acidic sites, it is a tree species that can be used very well.

Station 5: Expert opinion - group work

Task:

Define the sub-areas to be planted. Consider, if areas are to be left out of the planting or to be planted later.

Develop a planting plan for the sub-areas (proposals for tree species selection/ forest development types, planting association and any necessary forest protection measures).

Soil condition / competing vegetation sub-areas	Forest development type(s) you favour	Tree species-specific planting associations	Forest protection measures specific to tree species
Needle litter			
Logging waste			
Grasses / herbs			
Blackberry bushes			

Birch natural regeneration			
Spruce natural regeneration			

Discussion and conclusion of the group work (after presentation of results by the groups):

Several participants said correctly: if I have 200 or 2000 hectares looking like this area, I leave it alone and wait. A lot is coming here naturally, not only spruce and birch natural regeneration and alder, but also European larch and some oaks. And there is far too much deer on this area – with adapted hunting only we could achieve a lot here, without other forest protection measures.

Fig. 29 Group work

Regarding the **forest development types (WET)***:* WET number 12 has often been mentioned, *oak-hornbeam*. It always works. When it is young, the hornbeam may cause problems for the oak, in which case we must cut its top, or introduce it later. The littleleaf linden was also mentioned, a highly interesting accompanying tree species to the oak. The nutrient supply here at the site is still just sufficient for it, and the littleleaf linden is not eaten by mice! Hornbeam and oak, on the other hand, are massively damaged by short-tailed mice.

With the small-leaved lime tree, therefore, one would have a tree species that has good litter decomposition, breaks up the soil well in combination with the oak, but does not have any forest protection problems.

Douglas fir - coastal fir. We will have no problems with Douglas fir here if it is only brought in in small groups. Otherwise, it falls just like the spruce, this has been shown by the forestry research institute in Baden-Württemberg in storm damaged areas. One sentence about the coastal fir: it copes well in this location and has an excellent growth performance. However, in the first, second and third thinning, you must massively take out the dominant trees: they shoot upwards, have wide annual rings, and get a wet core. Because of the width of the annual rings, they cannot be marketed as construction timber, but only as pallet timber. This results in a price loss, which is absorbed by the volume performance, but our aim should be to produce high-quality timber that can be used as construction timber.

Of course, one should make use of the existing natural spruce regeneration, it is there for free. Seedlings that come from natural regeneration are better rooted than a root that was pressed into the soil when it was planted. Every seedling, whether oak, beech, or spruce, must find its own way with its main root. And only those that anchor firmly and quickly find a connection have a chance of surviving, because the competition is fierce. So, the one or other spruce will be better anchored in the soil than the one we would have planted.

And lastly, it was noted: no plastic in the forest! The tree protectors contaminate everything, they are still lying in the forest decades later – that is a disaster, it all becomes microplastic. Even the ecological version disappears only for the human eye, but is not decomposed by soil organisms, it simply becomes microplastic. That is why there are now alternatives, which we would like to show you after the break.

Station 6: Planting and quality control

All considerations about the area that you have just made start with the planning and stop when the culture is secured. It is important that the person ordering the plants knows what such an assortment looks like, what it means for the planter and which technique is used for planting.

Plant assortments

On the left side we see plant assortments. Here we say: as small as possible, as large as necessary, large plants only in exceptional cases, because we know that a small plant can establish itself better in the new location.

In terms of age, we are usually in the 2-to-4-year range, with the 1- or 2-year-old seedling being the best choice to get the plant to grow successfully.

You see from left to right:

- Silver fir, four-year-old, in assortment 2-2, 15/30
- Douglas fir, annual, container plant
- Douglas fir, biennial, bare root, assortment 1-1
- European beech, biennial, classic assortment 50/80
- English oak, annual, assortment 50/80
- English oak, biennial

Fig. 30 Plant assortments (see left)

Container assortments

As an alternative, there are container assortments, which now have a share of 8.5 % in Germany; nurseries are also switching to container plants in our region. There are several cultivation variants: pressed peat pots with jute bags, or durable plastic containers, in varied sizes and shapes. They all have a wall that is open at the bottom and sometimes a wall that is open at the side. When growing, the containers must not be in contact with the soil, but must stand higher, otherwise the seedlings would grow into the soil. Growth is supported by guiding furrows.

Fig. 31 Container assortments, one year old (details in the text to the left)

To be seen in the picture on the right: On the left the larch, coastal fir, Douglas fir, and as also exotics like we have just seen.

Container plants are no longer twice as expensive as bare-root plants. To give figures: larch, Douglas fir, coastal fir are around 90 cents, about 10 cents more expensive than bare-rooted seedlings.

When the goods are delivered, we must assess the quality. In the container all roots should lead downwards, there should be no „duck feet“ (see fig. 32). To do this, knock out a plant, do not buy a pig in a poke!

Fig. 32 Root defects - so-called duck feet and compressed roots (the lath shows the draft)

There must be enough roots for the root ball to hold together - sometimes the seed has been grown elsewhere and has only survived a week in the container!

Plant freshness is also a critical issue with bare-root plants. You can tell that you have active plants by looking at the root tips, both bare-rooted and pot-grown. Here you see white, active root tips, the root growth is clearly visible.

Planting time

To minimize operational risk, the time of planting is important. Several factors play a role in this:

- The tree species - which tree species at which time?
- The vegetation situation - what was the rainfall like this year and last year?
- The different root growth cycles – root growth increases from end of April to the beginning of June, then it declines, and the plant invests in the shoot. We can take advantage of this growth phase by planting well in advance.

Which scenarios come into question? With the current weather, one could already start planting in mid-September, for example spruce, until the beginning of October. In October-November, one can start planting bare-rooted larch - starting with woody conifers - as soon as the needles have fallen. Then, depending on the

weather, you can move on to the hardwood sector. If the weather is open, you can start early, in January or February, with bare-rooted deciduous trees and continue with containerized coniferous trees.

The planting techniques depend on the root sizes - there is no one method that is used across all assortments and sizes!

With the lower bar (cf. Fig. 33) we have shown what depth the different planting tools have. As a manager of the forest, you need to know what it means when you order a certain size!

What is important when planting?

The „green side up, brown side down" is not enough! We have some criteria that must be observed and recorded during quality control:

- The tree is planted deep enough, up to the area that was in the ground in the nursery.
- The plant stands firm, it stands straight.
- And, what most people forget, the root must be planted in such a way that it keeps its shape so it can grow downwards sucessfully.

In recent years, planting methods have moved increasingly towards devices where the planting hole is guided steeply downwards with greater muscle power, because we want to get the root *straight* into the ground. We only use pounding and pulling methods when we must deal with accompanying vegetation problems, with grass for example.

You already know the **devices** we brought (see picture on the right). I would like to show you the second one from the left, which is one of the newer achievements, it comes from Canada (Canadian Tree Planting). The principle is the same as with the Neheim method, you make half a molehill to loosen the soil, and then you go down once or twice to the bottom, this opens the planting gap, then you put the spade down: we now have a large square hole, the planter has the possibility to look into it from above without having to adjust anything.

Fig. 33 Planting tools, from left to right: Junack hollow spade, IsiePRO, Neheim planting spade, Göttingen bicycle handlebar, hoopoe hoe

Depending on how big the plant is, you must switch to the bigger tool. That is where the Göttingen bicycle handlebar (second from the right) would be the tool of choice.

About **drill planting**, the following should be said: If the drill hole is too small and not drilled cleanly, the results will be as shown in the picture below. In addition, due to time constraints, the drilling site is often not cleared to preserve the excavated soil, then branches etc. get into the bottom of the borehole and the nutrient supply is not provided at the root. In the case of drill planting, the ratio of root to shoot is greater than 1 to 4. So, if the plants have no contact due to incorrect planting, larger plants can initially compensate for this, as they store nutrients in the root.

A well-set plant shows a clear terminal shoot in the first year, regardless of size, only then do we have a successful planting. And no drill planting in very clayey soils!

Detail from Fig. 32: Too small a borehole leads to poor root development

Quality control

Quality assurance starts with plant selection, ordering and control. You need to meet your supplier on a fair level and let them know what you want before you make any sanctions regarding plant quality later. Finally, a note on **remuneration**. We know that – if you plant on your own and do not have this done by a service provider – in most forest operations (municipal and state, or private), the time wage is common. However, the business basis in tenders always uses piece rates per plant.

We recommend that you systematically use the **accoding system** for planting procedures that we developed with the University of Göttingen in the 1990s as a basis. There, basic information is recorded, from plant size to the condition of the area, as well as minute values, which can be individually adjusted.

The result is a certain value in euros and cents for a certain assortment on a certain area. We have made the experience that this accoding system is suitable for arbitration in case of differences and leads to a reasonable cooperation.

Fig. 34 Practical demonstration planting / quality control

Station 7: Forest protection

At this station we would like to discuss with you whether mechanical forest protection is a necessary part of forest management. Due to persistently high game populations in recent years, forest protection is often indispensable to enable successful reforestation. The densities of cloven-hoofed game are exorbitantly high, and due to the massive bark beetle calamity, a further increase in game density is to be expected in the next five years. These excessive game populations endanger the desired forest conversion into near-natural mixed

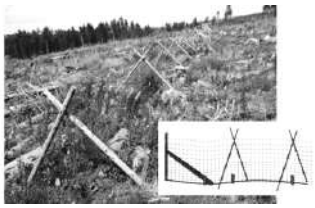
forests. In addition, forest protection measures result in high costs for forest owners. Although the legal basis and certification guidelines for avoiding damage caused by game have been in place in Germany for years, there is still a lack of sufficient implementation.

We would like to give you an overview of different protection methods. There are three options for safeguarding regeneration, forest growth and biodiversity: 1. Integrative wildlife management, 2. Area protection and 3. Individual protection.

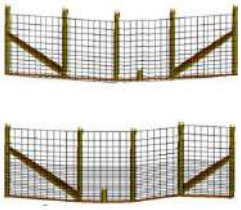
Option 1: **Integrative wildlife management** incorporates factors such as flora/fauna, landscape ecology, habitat structure, silviculture, hunting/feeding and disturbances in the forest ecosystem to reduce wildlife populations. If this is not sufficient, mechanical forest protection measures must be used.

Option 2: **Area protection by fencing** is possible by means of a

(i) wooden fence,



(ii) a „scissor fence“ or



(iii) a mounted mesh fence.

The costs for a wooden fence are 13 € / LM or 5,200 €/ha, for a „scissor fence“ 9.00 € / LM or 3,600 €/ha, and for a mounted mesh fence 11.00 € / LM or 4,400 €/ha. The costs are calculated with material requirements and labour costs of 30 €/hour with a construction height of 1.60 m for roe deer, including dismantling costs and disposal.

Wooden fences, scissors fences or mounted mesh fences offer effective protection against browsing, fraying and impact damage and are suitable for securing regeneration. However, disadvantages of area protection must also be considered:

- With a high proportion of fenced areas, game is forced onto the remaining areas and game pressure increases
- Fence construction is cost-intensive; dismantling costs can also be remarkably high and are seldom considered in calculations
- Regular controls are essential, especially with high wild boar populations
- A fenced area of more than 3 ha cannot be kept free of game; areas of less than 1 ha cannot be fenced economically or only to a limited extent
- Fences can be destroyed by forest visitors

Option 3 - Individual protection against browsing and fraying damage

Tree protectors effectively protect plants from browsing and fraying damage. Soft covers are available in assorted colors, heights, diameters, and shapes. The plastic material (PU) decomposes after approx. 10 years. The cover is held in place by a wooden pole made of acacia; ventilation holes regulate the interior climate.

Today, wooden tree protectors are offered as an environmentally friendly alternative - they do not have to be dismantled. We recommend the use of tree protectors especially for rare mixed tree species such as service tree, Norway maple, cherry, sweet chestnut, and tree hazel.

There are also other mechanical methods against browsing damage that must be checked or reapplied once a year. The costs for material and labour vary from € 1.00 for plastic cuffs, € 0.50 for tree tape and € 0.15 - 0.35 for sheep's wool.

Fig. 35 Forest protection demonstration

In addition, numerous options are available for chemical browsing protection, depending on the agent and the season:

- Certosan is made based on blood meal in powder form, it must be mixed and sprayed. We recommend Certosan for the first spring application at the start of the vegetation period.
- Another option is to use the agent Epsom, which can be used down to minus 10 degrees and can also be sprayed in damp conditions, e.g., dew.
- Towards autumn you can use Trico, the basis here is sheep fat, and the treatment lasts for half a year. It protects against browsing and fraying. It is not easy to apply, because you do not use a backpack sprayer, you spray the terminal shoot and the side shoots with a hand pump. Trico can be applied at temperatures as low as zero degrees C°.

For all means, the labour costs of 10 - 15 cents per plant must be calculated, and the agents, in the most favourable case at one cent per plant (Certosan), up to a maximum of 4.5 cents.

In conclusion we can state that to ensure forest regeneration and growth as well as biodiversity, the options of individual and area protection versus the option of integrative wildlife management must be evaluated:

- The costs of individual and area protection depend on the number of plants/area and on the materials used: whether environmentally friendly such as wood, or the use of plastic and wire, which entails additional costs for dismantling and disposal. If the number of plants/hectare to be protected exceeds 1,500, area protection is more favourable than individual protection – otherwise chemical browsing and fraying protection is the most favourable option.
- Successful integrative wildlife management allows the regeneration of tree species, successful sowing, or planting without technical protection measures.
  There are currently many approaches to achieving a functioning wildlife management, especially hunting, aiming at improving measures in terms of effectiveness, economic efficiency, and ecology.

Station 8: Culture maintenance

Accompanying vegetation is everything that does not serve timber production, so we must decide if we must intervene or can let it develop a bit further. But accompanying vegetation can also serve the forest plants, it

protects them from direct sunlight, it reduces frost and wind movement on large deforested areas. On the other hand, it can also impair the development of forest plants, especially blackberry or bracken.

Various devices are available to carry out maintenance works (from right to left):

- ✓ Sickles, one or two-hand forestry sickle, suitable for individual and small procedures
- ✓ Scythes
- ✓ Brush cutters (larger volumes)
- ✓ Blackberry rake, a novelty that is used when you want to work selectively. It has a metal reinforcement on the side to push the grass down.

Fig. 36 Tools for the treatment of accompagnying vegetation

You must distinguish between selective cultivation (cutting free) of the individual plant, and the so called classic "path cutting". Depending on the number of plants and the vegetation, you can schedule between 10 and 15 hours per hectare for the treatment of individual plants. With „path cutting“, the row of planted trees is cut free on the left and right at a certain distance. The time required increases to 15 to 20 hours for more intensive cultivation, and for complex situations as the extensive cultivation of a bare area, we are talking about 20 to 30 hours per hectare.

First have a careful look at the areas: what is there? If we have such areas as here with grass (Calamagrostis) in full bloom, then leave it alone. Every mowing, every cutting causes a lawn effect – it becomes even denser! Clamagrostis roots up to two meters deep. The leaves, which are still green now, form a straw that takes about 4 years to decompose, and this straw carpet serves as a shelter for the short-tailed mice, which attack your hornbeam, oak, silver fir, larch, and Douglas fir from there. The more often you mow, the denser the carpet becomes, the more straw accumulates and the more comfortable the mice feel!

The modified blackberry rake has been developed in Bavaria by a forest owner, the blades have a blunt and a sharp side, and it is excellent for bracken and for blackberry. With the sharpened side the tendril is slashed, not cut off, otherwise it would come back immediately. The advantage is that you have no vibration, no exhaust fumes, and no noise: you hear every wasp nest which may be hidden somewhere in the grass!

We summarize: You observe and decide whether a cultural maintenance measure is necessary, always keeping your silvicultural goal in mind.

Station 9: Pioneer Forest

We are now standing here in the middle of the birch forest: it is all free – why not use it? The first task with such areas, which are sometimes several hectares in size, is the structural development. You must establish straight maintenance paths that only need to be one meter wide. The angle and the layout should be chosen

so that you can use them later as skid trails: that is, at intervals of 22 to 24 m, because the maintenance path will later be cut open to a width of 4 or 5 m. Then you have blocks in which you can work systematically.

Fig. 37 In the „green hell" of the pioneer forest

Then have a look: what do I have here? You see birch, here and there also an aspen, in the wetter areas you may also find alder. Alder and birch, both extreme light-demanding tree species, both pioneers, and frost-hardy. They can easily be treated, and both provide valuable timber.

One more point: the birch that we see here, the sand birch, also called warty birch or hanging birch, Betula pendula, is not browsed. The downy birch, Betula pubescens, is browsed just like the oak, it is a delicacy for roe deer and red deer, and it needs specifically wet sites. So here I am always talking about the Betula pendula!

Birch is usually compared with softwoods such as willow and poplar, but in terms of wood density it is only just below beech wood. But nobody knows that! The average density per cubic centimeter for birch is 0.64 g, for beech it is 0.65 to 0.66 g/cm3. This means that you can easily use birch as construction timber, or for furniture production. In Austria, a process for gluing solid birch wood panels was developed and patented. This is used to produce load-bearing walls and ceiling elements. Here in Olsberg, we have tested laminated birch timber and achieved a higher load-bearing capacity with a lower thickness for these beams. In addition, birch can be processed in any coloring.

So, when I have created blocks by cutting free the maintenance paths, I pick out the best trees and mark them. Please do not mark them in green or yellow, but with a thick blue color ring; this always stands out best on the white bark. By the way, the bark color is an adaptation to the extreme light conditions in the open space, and to the pioneer tree character. White reflects the sun's rays optimally and thus also the heat.

We select, mark and prune at the same time up to reaching height, the aim is to finally have 6 meters free of branches. And during the first operation, we cut the largest competitors in the immediate vicinity.

Please select birch future trees (F-trees), as with all other F-trees, only if it really is a "future tree"! Only the fine-branched, two-stranded, straight, and dominant ones should be selected. In the initial phase, we must carry out maintenance (pruning, cutting competitors) intensively, usually every 2-3 years. When we have reached the six meters free of branches, then all the green leaf mass, the crown, must remain there for the next 40 years.

And especially important, a distinctive feature of birch cultivation: here, timber is not produced reaching a DBH of 70 to 80 cm, as is the case with oak. The birch is already relevant for the market when it has a thickness of 38-40 cm in the breast height range. Then, if properly felled, it is highly interesting for buyers of veneer wood. But it achieves this goal only with continuous maintenance: initially every 2 or 3 years, then every 5 years, and afterwards at intervals of 10 years, until the green crown is mature. This can be achieved within 50 to 60 years on moderate sites.

The more competitors of F-trees you take away during maintenance in a birch forest, the more sunspots emerge, the lighter reaches the ground. You have already noticed areas here that are brighter. There is also a beech tree in there, and it is already quite high. To intervene now would be a disaster! If you cut competitors for this beech away now and provide it with more light, it has no incentive to grow upwards. For a shade-tolerant tree like the beech or for a silver fir, the light is always sufficient. If we have sun patches and only blackberry grows there, we can introduce semi-shade tree species. And in such areas, you will always find oak. The oak is sown by the jay and can easily cope here. And of course, we can also promote theses oaks in a very targeted way.

In the first maintenance action, we focus on identifying the future trees, and at the same time we prune them with a hand saw. There are hand saws with Japanese ARS teeth, they are extremely sharp, and can be carried like a colt on the belt. We take out the competitors and that is it. And the next time, the third time at the latest, these trees are so far ahead by the support through extraction of competitors that they stand out just by their breast height diameter and the enormous green crown. Then we go through the stand in a very targeted way because we usually have a F-tree at intervals of 10 x 10 m, maybe only every 15 m.

The whole area in between these F-trees is of no interest at all! If there is no oak there that we want to take care of, then we do nothing. The competition in this phase is so extreme that the mass of birch dies anyway in the next 2 or 3 years without costing time or money. When we have done this during 3 to 4 maintenance interventions, we will already have a completely different structure. Then we can selectively bring in silver fir, or beech if it is not there naturally, or even coastal fir, in lighter areas a Douglas fir.

You should not encourage the **beech**: It gets enough light, and it must always strive to keep the connection at the top. An oak, on the other hand, should see the sun at the top, i.e., have a small peephole. In this way you can intervene in a regulating way depending on the light requirements of the tree species. This is relaxed work with the handsaw. For larger areas, you work with the spacer, or a small chainsaw. With young birch trees you can also easily prune the branches with a stick, they clean themselves anyway. With alder, you can do dry pruning, but also green pruning. And like this you work with a tree species that has been brought in without incurring costs and time, and you also do not

have to have a guilty conscience about not having worked the area after the calamity. Let it grow! And then work in a very targeted way, first the stand development, then select the F-trees, and selectively support the F-trees.

Another pioneer tree species is the **rowan**, which is even firmer than the birch in terms of wood. However, it is subject to browsing and fraying, and does not show the same growth performance as birch. But if you are afraid of accompanying vegetation, of bracken or blackberry, then pick the rowan berries in early autumn and scatter them over a large area. 50 % germinate in the first year, the rest rests for a year and comes after that. This forms a beautiful pioneer forest! The rowan has a soil-improving effect, even better than the birch, it has a very quickly decomposable litter, and you can handle it quite easily. When it gets competition, it always loses, it always retreats! And it has a „lightning conductor function“ when there is fraying, because its special scent makes it popular with game, which then perhaps spares a valuable tree. The higher you get in the low mountain ranges, the more you should use rowan instead of birch. Above 500 m NN, this is the tree species of choice - if it is not there, as I said, simply collect and scatter the berries.

Question: What period with the birch tree are we talking about here, until you say the timber is ready, or before it would go into a decay phase?

50 to 60 years, I would not go beyond that. The great danger is that wood discoloration, browning, occurs, which then very quickly turns into rot. Unlike oak or sweet chestnut, birch has no agent in the wood that works against fungi. And then it is worthless. Like cherry, it can become rotten within 5 to 10 years, the rot does not reach 10 m right away like red rot, but it is a significant risk. That means you go into these 10 to 15-year-old stands, selectively support F-trees, taking out 5 to 6 competitors at a time is normal, intensive maintenance in short intervals. When you come back 2 years later, all the neighbours will be back on their toes. Once the 6-metre branch-free threshold has been reached, no more branches should be lost, the trees need a full green crown to produce timber. And the aim is to reach at least 4 or rather 5 mm annual ring width. Otherwise, we will not get the necessary strength at the age of 50.

The competition in the gaps is getting bigger, more and more light is coming in and then you plant the actual main tree species that you want on that area – whether it is silver fir, oak sown by jaybirds, beech pre-cultivation under the canopy as described before, or something else. The birch provides frost protection, protection from the blazing sun, it is a habitat for many, especially very rare butterfly species, the Schiller butterfly, the kingfisher, which also exists as a butterfly, the mourning cloak, all species that have become rare, and there is an incredible number of songbird species, the siskin species, the redpoll, the alder siskin, they feel right at home here. The warbler species, blackcap, whitethroat. Birches provide nature conservation, too.

Question: When would be the time to bring in these other tree species, fir, beech, because the pressure of competition is exceedingly high, and I think that we must spread the time out a bit.

Yes, we must not bring in the silver fir too early. It must not grow into the crown of the birch, the birch future trees, then the birch always loses, it is sensitive. So, we can start around the birch's age of 30 to 35 years, it needs that head start. Unless we have areas where there are gaps due to the poor quality of the birch, then we can of course work selectively with other tree species.

Question: *What is the legal situation, according to state forestry law one is obliged to reforest in 2 years, what is the situation with calamity areas?*

Reforestation is normally obligatory after two years; in the case of Kyrill, the legislator extended this to 4 years due to the disaster. In recent years, the situation has worsened, but the legislator has not yet decided on a change. But if you look at the areas: what is really in the ground vegetation? If you have 5 cm high birch seedlings, or natural spruce regeneration, or larch, mostly the tree species that are blown in by the wind and have the character of pinon trees, that are frost-hardy and can cope with the blazing sun, then there is forest and you have fulfilled your reforestation obligation! It must be forest in the sense of the law, and an area with natural birch growth is forest in the sense of the law. But in areas where nothing grows up at all, only bracken, I must try to introduce something initially.

Final discussion

Finally, the participants discussed their experiences with the new format of the hybrid event in the group. The discussion was particularly interesting in that different age groups (from pupil to retired senior forest owners)

as well as different perspectives on silviculture were represented among the participants. Among those present were professional forest managers from the communal forest as well as private forest owners with either rather small areas or else large forest holdings. For all participants, this was a first approach to blended learning in forestry.

Especially the possibility of flexible, time-independent preparation of the on-site training from one's own computer was consistently seen as positive and efficient. There were no barriers perceived in dealing with the digital media. The brevity of the individual video lessons was also highlighted as helpful. The online course was seen as an ideal supplement through which the content could be efficiently conveyed in condensed form. Overall, the discussion revealed that a continuation and further development of such learning formats would be desirable.

The event was accompagnied by a journalist and an ensuing article published in a local agricultural journal, with the title “Reforestation4.0” (Wochenblatt für Landwirtschaft und Landleben, no. 38, 2021).

The expert teams

Station 1: Overview and goals of the event
Elke Hübner-Tennhoff, Forestry Education Center NRW

Station 2: Map application Waldinfo.NRW
Lars Bittis, Forestry Education Center NRW

Station 3: Forest site conditions
Alexander Weller, Center for Forestry and Timber Economy

Station 4: Climate-stable tree species versus Flora Fauna Habitat (FFH) Directive
Norbert Tennhoff, Center for Forestry and Timber Economy

Station 5: Plantation planning - group work
Elke Hübner-Tennhoff, Forestry Education Center NRW
Norbert Tennhoff, Center for Forestry and Timber Economy

Station 6: Planting and quality control
Martin Nolte, Forestry Education Center NRW

Station 7: Forest protection
Elke Hübner-Tennhoff, Forestry Education Center NRW

Station 8: Forest stand maintenance
Martin Nolte, Forestry Education Center NRW
Norbert Tennhoff, Center for Forestry and Timber Economy

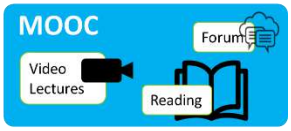
Station 9: Pioneer forest
Norbert Tennhoff, Center for Forestry and Timber Economy

Final discussion
Thilo Wagner, Head of the Forestry Education Center NRW

Images: FBZ

2.3 Seminar: Forest management for beginners

Sequence of the full hybrid event for forestry contractors at the FAST Pichl, Styria, Austria:



MOOC: Managing hardwood – perspectives for new forest owners

User registration on 25.10.2021

Webinar on the production of quality hardwood, presented in the MOOC in three parts:

Part 1 - Timber auction

Part 2 - Value adding timber characteristics

Part 3 - Production of quality hardwood

On-site: Forest management for beginners – a forestry walk with Martin Krondorfer

November 12-13, 2021, FAST Pichl, St. Barbara im Mürztal, Austria
22 participants, private forest owners (11 of them women)

Podcast

Podcast "Forest in Women's Hands". Kathrin van Zeist talks about her experience as a career changer in forest management in Styria.

The valorization of deciduous trees

The lecture on forest management for beginners was conducted as a forest walk, discussing the topics in the order in which they are encountered. The topics were therefore not arranged in a thoroughly systematic way as in a textbook. The lecture rather strives to appeal to curiosity and joy of discovery and provides knowledge in a problem-oriented way. The following text is based on an audio transcript which has been slightly adapted and translated. In some parts, topics have been rearranged and headlines have been added (bold) to facilitate understanding without the practical demonstration being present.

Fig. 38 Start of the forestry walk at the FAST Pichl

Pruning

Shape pruning means shaping a young deciduous tree that we think are not growing in the desired direction using a saw or shears. We can only do this up to a height of max. 3 meters. This means cutting down twigs or steep branches that could be a problem in terms of quality.

Another type of pruning ("Wertästung" in German) is done to *increase the quality* and therefore the *value of the timber*. Branches are removed from the bottom upwards so that the trunk is knot-free at the bottom. Knots are known to be a problem especially in a veneer log and must be removed in time.

How far up may I prune?

When determining the height of the pruning, one must consider the maximum height the tree can reach. For a total height of 20m, about 6m of knot-free trunk is sufficient, leaving about two thirds of the crown green. How far up can we prune an oak like this? That depends on where we are. If we are in the forest, where there is the so-called "green hell" all around shields off the light, we can cut the branches off up to *two-thirds of the tree's current height*. One third is enough for a green crown, because it is dark at the bottom anyway. But in the case of a free-standing oak, we can only prune up to half of the tree's height, so that it does not form new shoots, the so-called water sprouts.

When to prune?

Outside the "sap season" when sap is flowing. It is best to do it in June/July, when growth is intense, and the wound can heal quickly. In early spring it is also unfavourable because the sap flow starts then, and water could leak out of the wounds. So: *don't go on holiday, but prune trees*!

Branch thickness

How thick can the branches that we cut be? *3 cm branch thickness is the maximum*, preferably green and not already dead, as green branches overgrow better. In the case of oak, individual branches can still be cut when they have reached a thickness of 4 or 5 cm.

Water sprouts

Why have not we taken down the smaller branches on this trunk? If we cut down too much, we take away *assimilation mass*. Then the tree reacts with replacement shoots, the water sprouts. The oak, especially in Austria, tends to get a lot of water sprouts. A genetic aspect also plays a role here. Water shoots should be pushed down, the earlier the better. We did this every year with this sycamore here because the tree stands freely in the park. We can save ourselves the work if there is forest all around that provides shade.

When do you have to have completed pruning?

When the trunk has reached the so-called *beer mug thickness*, i.e., 15 to 18 cm, pruning should be completed. The decisive factor is that two thirds of the knot-free wood shaft can still grow. So, if you prune until a thickness of 20 cm, the target thickness with two thirds extra will be 60 cm, which is quite a big diameter.

When is pruning worthwhile?

From an economic point of view, a *50% higher added value* should be achievable through pruning *compared to the not pruned product*.

An example calculation: you can sell **spruce** as mixed quality A-C, currently, for €100, as pure A-quality for €120. This increase in value is not enough to make pruning worthwhile if you calculate the labour and compound interest over 100 years.

With *larch and pine*, there is a clear price difference between knotty larch, i.e., C larch, and knot-free A/B larch. Value pruning therefore makes sense with larch and also with pine.

In the case of *oak*, timber that is not pruned can fetch €70 to €80 as firewood, whereas a veneer log might fetch €500 at a tender.

What tools are used?

Pruning shears

For shape pruning, a pair of *pruning shears* with a *pulling cut is* used here. There are cheap pruning shears that are blunt on one side and have a cutting edge on the other. If you look at the cutting pattern, you can see that you are bruising on one side, so they are not recommendable. The size of the scissors depends on the size of your hand.

Fig. 39 Pruning

Pruning saw

As soon as the branches are a little thicker, you need a *pruning saw* with a *maximum tooth spacing of 4 mm*, otherwise you will end up with tearing the bark. You would also tear with a chainsaw, which would result in a poor sealing of the wound.

Fig. 40 Pruning saw with blade for

Telescopic saw

Another tool we have here is a *telescopic pruning saw*, which can be used to *prune up to 6m*. A telescopic pole made of aluminium has the advantage that it is light, but it also gives way easily. You must consider that the higher up you go, the less secure the cut becomes - a good cut should be nice and clean, smooth and without tears or stubs. Ladder systems would compensate for this disadvantage, but they are difficult to set up in a stable way on steep terrain.

Extra blade for undercuts

To prevent tearing, you can use the *special blade*. When cutting a thicker branch, you can use it to cut the first annual ring briefly from *below to prevent the* bark from tearing when sawing down from above.

Caterpillar shears

With *caterpillar shears*, the cut is made from the bottom to the top using a so-called *pulley system*. This has the advantage that there is no tearing from below. With hardwood or thicknesses over 3 cm, however, the caterpillar shears reach their limits.

Fig. 41 Caterpillar shears

Assess and maintain the forest

An example of planting wich is not appropriate to the forest site

Please always *analyze the forest site* first: what is suitable for the site at all? Here we are close to a stream, usually rich in nutrients, influenced by groundwater. Spruce does not belong there, but the holm oak would fit here, the sycamore maple, the ash, the elm, even the fir would still be better than the spruce.

Fig. 42 Resin on

Diseases as a sign of unfavourable site conditions

But now the spruce is there. Planted at a distance of 1 m to 1.5 m. We know that the spruce needs a distance of 6 m, so the trees here have been planted much too densely. And you can see it here, it is easy to read in nature: all spruces start to ooze

resin at the bottom, you can see the bluish-white resin here. This is a typical sign of *root rot, a fungal pathogen*. This means that the wood will be rotten in a few years. It is not even suitable for the paper mill anymore, you can only make wood chips out of it.

Silvicultural goals and forest conversion

What can you do here? Harvest the spruce as soon as possible because it is not going to get any better! We can also take away two thirds of the trees and plant firs under the protection of the old wood. But if we want to convert to sycamore or oak, we must take away all the spruce.

Structural development

The development of the area with forest roads and skid trails is important. Compared to Austria, we have 64 meters of forest roads/skid trails per hectare in the Pichl forest estate, compared to the average of 30 meters per hectare in Austria. This has the advantage that we can work with a *small-sized structure*. This means *short logging routes, careful single-trunk forest management and no large-scale utilization.*

Natural regeneration and late thinning

What do you do with a stand that has a very unfavourable *HD value (height to diameter)*, as here? The green crown is only a quarter of the tree length, all spruces are unstable and on a site that is dense, clayey and groundwater-influenced.

If you look at the *natural forest community*, this would be a sycamore-ash-elm mixed forest, the classic *ravine forest*, in the lower slope area and water-influenced. But ash and elm are unfortunately no longer possible because of the threat of disease.

On this site, *natural regeneration* was used: the stand was thinned, a *late (too late) thinning*, which is not done as a selection thinning, but intervenes in the canopy while never taking out more than 10% of the volume. This late thinning does not result in “future trees”, in German it is also called “High Thinning” (Hochdurchforstung).

What characterizes a *future tree (F-tree)*? The HD value should be around 80, it should be *vital and stable*. The spruce here has a HD value of 120, so there are no more F-trees to be found here.

The stand here comprises around 550 m^3, which means that 10% = 50-60 m^3 can be removed every 10 years and thus a slow stabilization of the stand can be achieved. This also has the advantage that natural regeneration can develop underneath.

The fir has only been able to develop here because it has rejuvenated under the green canopy using its shade. The spruce is a semi-shade tree and is only now producing strong shoots due to the thinning.

The aim on the site is to have more fir because, as a *taproot*, it can break up dense, groundwater-affected soils and produces a good timber. Please bear in mind: the fir needs 15 to 25 years of *shade pressure*! It will thank you for this by growing vigorously. If it does not have this pressure, it will eventually fail due to various diseases.

Harvesting operations

Here we harvested with one of the biggest harvesters we know - in winter, when the ground was frozen. You do not see any damage because it was done with a machine that can lift every trunk out of the natural regeneration and then process it in the skid trail. A small harvester cannot do that, it must be a big machine!

This measure here is *not clear-cutting,* this is a thinning in which the old wood was cleared in favour of natural regeneration.

Oak afforestation

In some places we have inserted trees because we assumed that the natural regeneration was not sufficient. This would not have been necessary, but you can *reintroduce rare tree species*, like copper beech and oak. Here, 25 trees were planted in small groups in 16 m^2 (4 by 4). And one of these 25 trees will hopefully grow up here over the next 100 years as a beautiful oak and produce seeds over the next 70 years, which in turn will also benefit animals. In addition, the oak, as a taproot, also brings stability to the site.

Maintenance failures

In this stand, we take a closer look at the maintenance failures in spruce using the annual rings for the assessment. How fast have they grown? In principle, this is one of the best sites we have on silicate soil in the Pichl forest estate, as you can see from the fir shoots. With an annual ring width of the spruce of 1 mm, you can clearly see what resources have been *wasted* here through *incorrect management and inactivity.*

Checking annual increment in the stand

The increment borer cuts the annual rings at right angles, so you can count them easily. This is always done at breast height (1.3 m). Now we look at how much the tree has grown in the last 10 years. We count to 10: it has grown about 7 mm. The growth rate depends on the size of the crown!

Fig. 43 Using the increment borer

Does drilling damage the tree? We know that the tree has the bast as its life layer, under the bark cambium, bast, and sapwood. I have now taken out a fraction of it, it is like a little pinprick for the tree. But I must be careful not to transmit any diseases and must disinfect the borer with Lysoform. In a stand, you only have to *drill individual trees at random.*

Tree crown

The crucial target for any forest owner is to build up *large-crowned trees*, which are much *more stable and more likely to grow.* Here we can see what a large crown really means for the growth of the trees. Here the crown is two-thirds green, and you can see from the annual rings that this tree has grown considerably more in 10 years and brings correspondingly more money when sold – the quality is the same.

Are narrow annual rings good or bad?

For the house builder, narrow annual rings are good, they mean high stability and low susceptibility to fungi. However, the sawmill does not pay more for narrow annual rings. There is *no classification* for this. A forest owner with areas on high altitudes produces the wood more slowly, the quality is high, but he does not get more money for it.

Selective thinning

Selective thinning ("Auslesedurchforstung") means that I first have to *determine* my *F-trees* (and mark them) and then *remove their direct competitors*. Everything that does not directly oppress the F-tree can remain. Before the crown becomes smaller than 50%, it is time for the next thinning. We look into the crowns to identify the competitors for our F-tree. The competitor also must be marked, and the colors must of course be communicated precisely.

Structural thinning

During structural thinning ("Strukturdurchforstung"), we want to leave *small trees*. For this I have my magic stick with me. A simple marker is attached to the end of the stick, the width of which is one 16th of the stick length.
With this stick (cf. Fig. 44), the possible competitors are targeted at eye level: *if they appear stronger than the measuring mark, they are competitors and are removed*. 10 years later we repeat the *structural thinning.*

Fig. 44 Measuring competiting trees with a marked stick

Plenter forest

In the *structural forest,* the *distance from F-tree to F-tree is much greater*, here in the spruce forest it is approximately 10 m. In between grows the natural regeneration, which slowly but surely grows into the gaps. And like this, we slowly get a gradation, a *multi-aged plenter forest*.

This silvicultural concept targets at *maximizing increment*. But this also includes *natural regeneration and structuring*. If we take out only small trees, it causes costs, but brings no economic benefit. In a structured forest, we always take out individual, thicker trees and get something out of it. Firs also grow naturally here if they are not taken out or browsed by game. In the past, people believed that natural regeneration was not possible for fir and copper beech. As soon as we doubled the shooting here at the Pichl forest estate, fir and copper beech came quite naturally.

Hardwood management

Hardwood management is quite different from softwood management. In hardwoods, it looks like chaos compared to the row upon row of spruces, *but that is completely planned*. We see that the *spacing* here is *quite different from that of conifers*. F-trees, here sycamore maple, stand 10 to 12 meters apart, and in between there is just the so-called green hell, especially in summer.

With this beautiful maple, the *qualification phase is complete*, which means pruning, if necessary, is finished, it just needs to grow thicker. What does it need for this?

A big crown! And it must not have any competition, which is why it has been cut free. The tree is now 27 cm thick and grows 1.5 cm every year, the target dimension is 60 cm. That means it still needs about 20 years, then it could be put up for auction if the maple price is good, but one must take fluctuations into account. In total, the tree is then not even 60 years old. With hardwoods, the time periods are quite decisive because we have far fewer trees in the area: *it is all about cubic meters, about the value of the individual tree.*

Length or thickness?

For comparison, we have a tree here with 44 cm that is the same age but has a deeper crown base. This means that it has been less heavily pruned, has a larger crown and has become thicker more quickly. As a forest owner, it is up to you how quickly the tree becomes thick. *More crown = less valuable wood length, but faster growing in thickness. With hardwoods, it is not the length but the thickness that decides the value!*

Be lazy!

So here is a planned "jungle", here is a group of five sycamores, *group afforestation*, the best one will then be promoted further at reaching a top height of eight meters. Apart from that, we do not have to do much here now, *everything that stands around here and gives shade automatically qualifies the sycamore for me. Be smart and lazy!*

Natural beech regeneration

Now let's look at beech regeneration. Beech is rejuvenated by making a so-called *umbrella cut*. What we see here of beech regeneration comes from these three old beech trees - it would be better if there were more. The denser the regeneration grows up, the better for the quality. *Thinning – initiation of natural regeneration – then a clearing cut of the old wood when the natural regeneration has reached knee height*. I do not need to do any pruning. Just let it grow densely up to 8 m top height, then select a F-tree every 10 m and continue to promote it. The rest of the jungle remains jungle, and its done.

With beech, pruning is not recommended because air pockets are created when larger branches are broken off or cut. The air pockets oxidize with the tannic acid of the beech wood and become stained, and this can lead to browning. The dense stand ensures that the knots remain thin, and that air entrapment and brown staining do not occur.

Robinia

On this hardwood trial area there are beautiful black locust trees, 6 to 8 m tall, here the variety Apalachia, which grows very straight. The tree species is *considered invasive*, however, and has competitive advantages on poor sites, where it is at its best and can hardly be removed. *The wood properties are particularly good*, but that is a question of origin. In the past, no attention was paid to the wood quality. The Graz University of Technology did a study that showed that spans could be achieved with Robinia laminated beams that would not have been possible with native tree species. Added to these qualities is the enormous durability of the wood.

Oak reforestation

A small digression on the reforestation of oak. *Oak must grow up densely, with a maximum spacing of 1 m*. The growth behaviour of oak can be truly diverse. One cannot predict in advance whether two trees of the same origin will grow nicely next to each other or not. Therefore, many must be planted in a small area to have as much choice as possible. The close spacing of the oaks is also necessary so that they push each other upwards and branch-free trunks are achieved. In the case of the oak, it is only at 8 m that I decide whether the tree is to be further developed as a valuable tree. By the way, in the Middle Ages there was mainly oak forest here in the Mürz valley. Now the oak is displaced, firstly because of cooling periods, but mainly because man has promoted the spruce. Here on the young growth, you can see how the *jays spread the oak beautifully*.

Forest protection

Oak, like fir, is a delicacy for game, it contains a lot of nutrients. That is why the trees here are fenced in. A *wooden fence* was used because it is cheaper to produce than a wire fence. In addition, the removal of a wire fence is much more time-consuming than with a wooden fence. The wooden fence is sufficient for *roe deer*, but it is *not rabbit-proof.*

What has been done so far? When planting, it is sufficient to trample down the competing vegetation once, not to mow it! In Europe there are 2,000 distinct species of blackberry, with quite different growth dynamics.

When the blackberry is mown, growth is stimulated, when it is trampled down this is not the case, and the top of the tree can quickly grow out of the blackberry. For blackberry species that grow taller than 1 m, you may have to do more. A useful tool is the so-called blackberry rake which is used to press down the blackberries and thus free the small trees.

Planting trees: planting methods

Planting tube

When planting *container plants* with the planting tube, it is important that the tube fits the size of the container – *no air should be left under the plant!* In addition, you should always pull away the humus first, everything that lies on top of the mineral soil. There is more water in the humus, this could push the little tree out like a champagne cork when it freezes. The freezing water needs space, and if the soil on the left and right is also frozen, there is only one direction: upwards!

Fig. 45 Demonstration of planting methods

Then step firmly on the planting tube, turn it over once, lift out the cylinder, take out the little tree and press it into the prepared hole, and as a last step pull the humus over it again. This protects against evaporation in spring and serves as frost protection in winter. The planting time in November is not a problem, the soil should not be frozen yet and remain open for about two weeks.

Digging a planting hole

For the so-called hole planting, pull away the humus again, then *dig a hole as deep and as wide as the root ball* is. You work in pairs; one digs and the other plants. Here I use the cross hoe as tool. The time and effort required for planting with digging holes is greater. But if I have very heavy, dense soil, where turning out the cylinder causes lateral soil compaction, I will need to dig holes. With 100 trees we can work with hole planting in any case, with 20,000 the planting tube makes more sense if the soil fits.

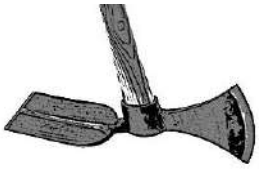


Fig. 46 Cross hoe

A nice root picture means: *all roots point downwards*, none stand up or rotate. If they are taproots, the roots can strangle themselves if they rotate. We put the soil material next to the hole, mixed and crushed, and can now push it back in around the root. It is *important that only mineral soil and no humus-rich topsoil* gets into the hole, *humus contains no plant-available nutrients!*

Rhoden planting method

The advantage of the Rhoden planting method is that you do not have to pull away the humus. We can *work from the hip, not from the back*. We drop the hoe with gravity and then we can lever it. With this we loosen the subsoil. After the first chop, the ground is loosened once, then the second chop is placed 10 to 15 cm further forward (away from the body). One or two more chops may be needed, the soil is broken up a little. Then the *hoe is struck again and pressed down, creating a hole in front*. The material around it is now nicely loosened. I have both hands free to put the plant in, pull out the hoe, push the soil from the back to the front and feed soil around the roots up to the root neck. Then we push the hoe in again at the back and press the soil against the roots. Here it depends on the technique: I stand as if chopping wood, left hand in front of the hoe, right hand behind, swing up and chop the hoe in next to the foot.

(The method can be seen demonstrated by Martin Krondorfer: www.youtube.com/watch?v=FZpp2us-8wE)

Why is *hitting in at an angle* so important? If I do not hit at the right angle of 120°, I have the *vibrations all over my body*: hands, spine, and neck: you can see it in my hat. If the soil is right, the method is amazingly fast. With

the Rhoden planting method, we can only plant smaller root balls, but efficiently and independently of the soil.

The *three methods must be used depending on the soil and the tree species*. With these three methods, we have the right planting method for every soil variant.

The expert teams

Training: Martin Krondorfer
Head of the forestry education center FAST Pichl, Styria, Austria

Assistance: Kathrin van Zeist
Trainer at the forestry education center FAST Pichl, Austria

Images: Fast Pichl

3. Replication in the ROSEWOOD4.0 hubs

At the consortium meeting in Mimizan, France (September 2021), the implementation of the physical trainings with test audiences (in German language), and the English versions of the MOOCs were presented to the consortium. Based on this, a discussion of the following questions was started in the Northern Europe (NE), Southern-West Europe (SWE), Southern-East Europe (SEE) and Central-East Europe (CEE) hubs:

- → Choice of MOOC (or parts) for the respective hub or region
- → Translation of MOOCs needed, in which languages (individual choices possible)
- → Identification of the target group: The initial targeted audience (forest owners or forestry contractors), or others as: e.g., intermediaries, associations, or parties interested in the establishment of e-learning
- → Choice of topic for the replication event – based on the online material, but adapted to local interests and needs
- → Potential adaptation of MOOCs (recombination or adding of content)

Under the impact of the COVID-19 pandemic, many partners decided to put effort into the translation of the available online materials. In a first step, partners selected full MOOCs, parts of MOOCs (specific video lectures) or new combinations of lectures from different MOOCs. In the next step, the selected materials (texts, subtitles and slides shown in the video lectures) were pre-translated using a professional automatic translation system at the FBZ (if the respective language was available) and provided to partners for editing. Even with the support of automatic translation, the editing step still caused significant effort as forestry practice varies from region to region and the terminology may vary even within the same language. Finally, all translated content was implemented by FBZ into the LMS on the following levels: texts (guiding structures and questionnaires), subtitles and presentations shown in the video lectures.
The wish for translations exceeded the regionally planned on-site events, and the translation process is still going on. Only in the Northern hub (Norway, Sweden, Finland), the English version of the MOOCs was seen as directly usable by the intended TG without any language barriers.

The following overview presents the selection of MOOCs for translations, the implementation is expected to be completed until end of May:

Language	Topic	MOOC	Status
French	Reforestation	MOOC 2 & 3; 14 video lectures	*available*
Spanish	Harvesting	MOOC 1 complete	*available*
Italian	Harvesting / reforestation	MOOC 1 & 2 complete	*available*
Portuguese	Harvesting / reforestation	MOOC 1, 2 & 3 complete	*MOOC 1 & 3 available*
Croatian, Greek, Slovenian	Reforestation, transport	MOOC 1, 2 & 3; 8 video lectures	*available*
Polish	Reforestation	MOOC 2 & 3	*MOOC 3 available*
Ukrainian	Reforestation, harvesting	MOOC 1 & 2; 32 video lectures	*ongoing*
Romanian	Reforestation	MOOC 2; Modules 2,3,6, and 7	*ongoing*

Tbl. 1 Overview on the translation of MOOCs into local languages

Based on the available online trainings (with recorded webinars and podcasts embedded into the MOOCs) the ROSEWOOD4.0 hubs planned their own replication events.

To implement as many on-site trainings as possible, some of these events have been planned for May 2022 (when the infection risks are expected to have decreased due to the season) and will be reported on in D3.4.

The following overview shows the status of replication event planning and implementation:

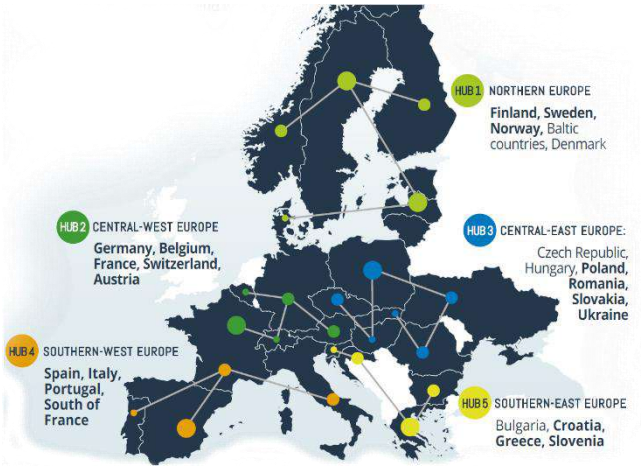


Fig. 47 Overview of the ROSEWOOD4.0 hubs

CEE hub

In the CEE hub, led by FORZA, Ukraine, the replication event was scheduled and prepared for March 17, 2022, the title being "Ask a German forester". The concept had foreseen to provide selected parts of MOOC 2 in Ukrainian and to hold a webinar with one of the experts from the State Enterprise Forestry and Timber North Rhine-Westphalia (Norbert Tennhoff) on working with pioneer forests, answering questions from participants collected prior to the workshop. Due to the onset of the war in Ukraine, the organization of the event was taken over by the Polish partner, the Łukasiewicz Research Network – Poznań Institute of Technology and the schedule adapted to the local audiences.

Date: 29th April 2022

Place: Forestry Research Institute, Sękocin Stary, Poland

Language: Polish

Expected no of participants: 24 incl. 6 forest owners, 11 representatives of public administration and 11 others (some of the participants represent more than one target group)

Topic(s): Legal determinants of private forest management in the context of climate change

Summary:

Fig. 48 Replication event Sękocin Stary

The event started with short presentation of the ROSEWOOD4.0 project and its results, paying special attention to the Knowledge Platform and the MOOCs, delivered by Dobrochna Augustyniak-Wysocka from Łukasiewicz-Poznań Institute of Technology. Main presenter in the next part was Marek Geszprych, PhD (law), an expert in forest, agricultural and environment protection law and Vicepresident of Polski Związek Zrzeszeń Leśnych (forest owners association). This part of the event included four main topics: legal determinants of forest management in Poland, legal aspects of environmental conservation activities in forests, planning of forest management and support for private forest owners in the framework of common agricultural policy,

including reforestation measures. The presented knowledge focused on practical aspects of private forest management in the context of national and international law. The training ended with a summary and invitation to familiarise with the MOOC materials, including the incoming course in Polish language.
The response from the participants was very positive. They were active and had many questions after each thematic part of the training, especially regarding specific interpretation of legal requirements. The overall conclusion was that these kinds of events are much needed, as right now there is a gap in educational activities related to private forests in Poland.

NE hub

In the NE hub, **two events** have been organized regarding digital support for efficient timber harvesting operations

Norway:

Date: 2nd May 2022, Norway (9-12:30h)

Place: Norway: Sønsterud School of Forestry, Sønsterud, Norway

Language: English (MOOC) and Norwegian

Expected no of participants: 20 (forestry students and lecturers/teachers)

Topic(s): Data standards and interfaces in mechanized timber harvesting (MOOC 1)
(Datastandarder og grensesnitt i mekanisert tømmeravvirkning)

Summary:
Joar Stensløkken (Paper Province) and Ståle Nordgaard (Tretorget) representing the project.

Isak Hasselvold (FeltGis), 2 Teachers and 14 students attended.

Prior to the event, Isak Hasselvold had installed FeltGis to one of the harvesters giving us the opportunity to operate with "fresh" data during the event.

Due to practical reasons the data was collected prior to the event eliminating the need for the outdoor session in the program. The attendees were all very familiar with the practical aspect of harvesting.

Fig. 49 Joar Stensløkken (Paper Province) presenting ROSEWOOD4.0

Ståle Nordgaard starts by welcoming the attendees and introducing the project including the digital resources available, encouraging the attendees to register as users to gain access to the MOOC material and helping those who needed help to register during the breaks.

Joar Stensløkken lectured on forest data standards in general and StanForD in particular. The Power Point material used was adapted and translated from the original MOOC1 material developed by the project. Joar Stenshagen exemplified by using data provided by the FelGis's green box.

Isak Hasselvold/FeltGis (BPI) talks about FeltGis and its ability to support data communication in an efficient way, (i) "data in and out of machinery", and (ii) communication between FeltLog (cloud based) and computers onboard the forestry machines. The green box works as a router, distributing data to predefined sources and to the FeltLog app. The practical as well as the technical benefits of using FeltGis were demonstrated. Hasselvold also introduced FeltGis's new product, FeltPlan, a complete solution for forest managers, and concludes by pointing out that *the goal is to only register data once and then share and reuse them*.

Local press, Østlendingen, attended to report on the event. (ostlendingen.no)

Sweden:

Date: 7th May 2022, Sweden (9-13h)

Place: Sweden: Södra Viken forest school, Sunne, at the "Södra Viken dagen"

Expected no of participants: 100 forestry contractors, forest owners and managers

Agenda:

- Presentation of Rosewood4.0
- Presentation of BPs especially Taigatech
- Group discussion between representatives from 2 forest schools about the possibilities of digitalization
- Presentation of the digital sawmill, Moelven.

SWE hub

Date: 23th May 2022

Place: Online

Language: English

Expected no of participants: 20-30 stakeholders of the South-West Hub from the forestry and wood industry value chains and in particular: students of the Forestry faculties at the involved Universities.

Topic(s): Presentation of the training courses and learning materials developed by ROSEWOOD4.0 with the aim to promote innovation in the EU forestry sector and to bring to different stakeholders all the tools to acquire new skills and help consolidating the digital transformation of the wood value chain.

Agenda:

- Moderator: Andrea Argnani (AIEL) – Welcomes & Introductions.
- Riccardo Castellini (Cesefor): Presentation of the ROSEWOOD4.0 project and main results (15')
- Stefano Grigolato (University of Padua): Scope of the workshop in the framework of the Department of Land, Environment, Agriculture and Forestry (15')
- Marie Charlotte Hoffmann (Wald und Holz NRW): The ROSEWOOD4.0 MOOC Training Programme & the Learning management system "ILIAS" (20')
- Questions & Answers time and closure of the Workshop

SEE hub

Date: 31st March 2022, 10 – 11:30 h

Place: Hybrid Event - online and in-person at the Competence Centre, Ambarine 8, Gradište, Croatia, with participants from Croatia, Greece, and Slovenia

Language: MOOC in Croatian, Greek and Slovenian, event language English

No of participants: 22 (i.e., public, and private forests managers, cluster of wood processing companies, research institutes, education sector (high school and faculty, VET center), public administration, forest advisory service, consulting company, cooperative of producers)

Topic(s): South - East Europe hubs' Training on Massive Open Online Courses (MOOCs)

Agenda:

- Presentation of ROSEWOOD4.0 project and results (15')
- Scope of the workshop (5')
- Introduction of participants (10')
- ROSEWOOD4.0 MOOC Training Programme - learning management system ILIAS
- Discussion and closure of the Workshop

Summary: The SEE hubs' MOOC Replication Training, was an opportunity to present the ROSEWOOD4.0 project and its results, with special emphasis on the knowledge platform and best practice factsheets and videos available for public use, roadmaps, business idea development, as well as the MOOC materials. The event invited participants to visit the ROSEWOOD4.0 project web site and social networks and to register to the learning management system. Prior to the event, the selection of lectures by the SEE hub had been made available as a MOOC in Croatian, Greek and Slovenian.

The MOOC development process was presented from initial evaluation of available e-learning/hybrid programmes, assessment of training needs and concept development, production of e-learning material resulting in three online courses (MOOCs), the experiences with the local implementation of three hybrid trainings in Germany and Austria, up to the replication in other hubs/languages.

After explaining the applied methodology, Marie-Charlotte Hoffmann (FBZ) focused on the replication of MOOC materials in the SEE hub through presentation of the three original MOOCs ("Digital Support for Efficient Harvesting Operations", "Digital Tools for Climate-adapted Reforestation" and "Managing Hardwood - Perspectives for New Forest Owners") and the adaptation process. Recommendations for the development of e-learning content, based on experience gained through ROSEWOOD4.0 MOOC development, were given to the participants along with detailed inputs on time and human resource demands.

Participants discussed digital teaching in forestry and agreed that blended learning programmes are necessary and suitable for these challenging times and applicable for support of the forestry sector for digital transformation, if it is a combination of online and practical teaching methods. For the development of blended learning programmes in local or regional level, it was seen as crucial to closely related topics of the learning programme to the local situation and circumstances, and to include high level experts as lecturers. The advantage of a LMS with user registration run by a public authority was pointed out, as this helps to create trust into the level of expertise in contrast to freely available online content.

4. Conclusion

The implementation of the three hybrid trainings with the original target audiences in Germany and Austria allows a first assessment of potential bottlenecks or challenges, as well as key factors that must be observed to reach TG successfully.

Based on face-to-face discussions during the on-site events, it can be stated that the combination of digital and practical training was explicitly well received by the participants for whom this was the first encounter with e-learning in forestry. Aspects of hybrid training that were specifically mentioned are:

- Registration on the LMS and the course navigation is perceived as simple and unproblematic.
- The fact that registration is needed, and the platform is hosted by a public authority enhances trust into the provided contents.
- The online course was intensely used by participants for preparation of the on-site event. As already discussed, it must be kept in mind that this was supported by the seamless combination of online and physical training using local language and topics.
- It was pointed out that the short duration of video lectures supported flexible learning well.
- During the on-site event, participants had requests for additional learning material which was included in the respective MOOC after the event.
- Blended learning in forestry is still a novelty, which allowed to attract a publication in a local agricultural journal (topic „Reforestation in times of climate change with digital support").

For the physical replication of the trainings, partners in the other four ROSEWOOD4.0 hubs have developed creative solutions on many levels, i.e.:

- Connecting a German expert online to deepen a specific message from the online course (topic reforestation with pioneer forest; CEE hub, planned in Ukraine and cancelled due to the war)
- Taking up the topic of the MOOC (reforestation) and focusing on local issues (legal aspects) which are presented by local experts (CEE hub, Poland)
- Moving the focus towards a discussion of e-learning itself: methodologies, bottlenecks and low-hanging fruits, motivation, efforts needed, options for cost reduction (SEE hub)
- Presenting local best practices while using the didactical frame and overview provided by the respective MOOC (digital solutions for efficient timber harvesting; NE hub, Norway, and Sweden)

The presentation of the hybrid course concept at a national event (KWF Thementage 2022) has generated interest and concrete demand for further trainings. A further expansion of the training concept has already started at institutional level, initiated by the ROSEWOOD4.0 project and additionally motivated by the difficult teaching situation at the height of the pandemic.

Together with CWE hub partners and collaborators, a project application was submitted which could allow to build and share further digital teaching competencies in vocational and adult forestry education in Europe.

At the State Enterprise Forest and Timber NRW, the LMS receives increasing recognition by the management and has currently been updated. Therefore, it can be assured that the platform will stay accessible after the end of the project and further use of the contents is possible.