Report for annual networks

Submit the report to sns@slu.se by 24:00 CET, 1st of March the year after the network period.
The report should not exceed 2000 words.

Please adjust the size of the boxes to the length of your answer.

1. Title of the network:	"Production of ash cuttings to increase efficiency of breeding activities to maintain full range of ecosystem services provided by this keynote species"
2. Network number:	N2020-1

3. Main applicant:	Mateusz Liziniewicz
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Activities

4. Place of the activities:	Dublin, Ireland; Copenhagen, Denmark and online participation
Duration of the activities (start date, end date):	2022.05 – 2022.07

5. Provide a short network summary, including:

a) The purpose of the network/main problems/background

A cheap and efficient method of vegetative propagation of European ash would be beneficial for effective establishment of genetic trials and mass-testing of a wider range of candidates that reveal resistance traits in natural conditions.

In network activities funded under this project, we discussed appropriate methods that might be used for cloning ash, breeding strategies and efforts of different research groups to produce resistant ash populations as well as future threats for ash in Europe.

Among the propagation methods discussed, grafting has been most often used among participating institutions to deliver plants for genetic tests. The methods work well and deliver good plants for the genetic trials. Main drawbacks of the method are cost and heavy workload. Later, there is a need to follow up plants to check if rootstock did not overgrow the grafted scion.

Plants propagated from seeds (ex. progenies of identified resistant trees) could be cloned by rooted cuttings. However, there is weak evidence about age and size of the donor plants that is needed to obtain a desired number of replicates. There is no protocol concerning timing of cutting and substrate to use for rooting. Air-layering, i.e., the rooting of branches of a living tree, has been found to work well but the number of replicates that can be obtained from one propagated plant is rather limited. Propagation of ash seedlings by tissue culture showed that it is possible to replicate seedlings by embryo and shoot culture and subsequently transplant them to soil substrate.

Cloning of old trees showing resistance in a field would require its rejuvenation in tissue culture and subsequently propagation of rooted cuttings. However, such method has not been tested elsewhere.

There are also new threats that might affect ash population in Europe. Some of them include Emerald Ash Borer (EAB) which is already well recognized globally and has affected different ash species in other parts of the world, but not yet in Europe. Moreover, there are other pest and pathogens that serve as a future risk to ash.

b) A description of the main activities of the network

We organized a research meeting in Denmark that gathered researchers from Sweden, Denmark, Norway, and Lithuania. In this one day meeting, we discussed the ongoing breeding efforts in Denmark and visited several genetic field trails testing different ash material.

In addition, we organized a two-day workshop in Dublin, Ireland hosted by Teagasc. The workshop was a mixture of indoor presentations and field visits. The themes of the workshop were vegetative propagation of European ash, ongoing breeding activities and potential future threats on European ash.

Outcomes

6. Published outputs achieved as a consequence of the network (peer-reviewed articles, other publications)

We have written an internal summary of the workshop in Ireland. The summary, attached to this report, was sent to all participants of the workshop.

7. Other practical outputs of the network (workshops, conferences, scientific meetings, policy recommendations, conferences, large-scale project applications, websites or databases etc.)

In the network, we organized the following activities:

1. Two days' workshop in Dublin, Ireland
2. A scientific meeting in Copenhagen, Denmark

8. How and within which areas was the network beneficial for the Nordic region (Denmark, Finland, Iceland, Norway, Sweden and the autonomous areas of the Faroe Islands, Greenland and Åland Islands)?

The scope of the project clearly relates to the focus area "maintenance and increased utilization of ecosystem services". The new techniques that were discussed at the workshop can eventually help to conserve ash as an important component in Nordic forests thereby maintaining critical biodiversity associated to ash. Such propagation techniques are known but have never been applied for ash in Nordic. The discussions stemming from the two meetings have stimulated interest in trying new techniques on ash and further the collaborative efforts to save ash.

The network gathered several research groups from Europe interested in breeding and conservation of European ash. These research groups are likely to cooperate in the future and benefit from their experience. The potential cooperation might concern exchange of test material and common genetic trials, exchange of resistant material, and a common procedure for measurements, evaluation, and selection. The development of the cloning methods has been highlighted and might lead to an acceleration of work across different participants of the network benefiting others.

9. Provide a popular science piece for dissemination in SNS' various channels (maximum 700 words) *with emphasis on application of results and benefits for the Nordic society.*

Provide pictures (size at least 500x500 pixels and resolution at least 72 pixels) as separate files (.jpg). Include caption to each picture, including the name of photographer.

Natural populations of European ash in Nordic countries and in Europe as a whole have been vanishing since the last 20 years because of ash dieback (ADB) – a disease caused by the fungus *Hymenoscyphus fraxineus* that was accidentally imported to Europe from Asia through global plant trade. Currently, there is a high risk that ash might disappear from the landscape, eventually causing a cascade of extinctions of several organisms that depend on ash. In the future, the values forgone by not being able to utilize ash will likely become even larger and pose a high risk to the provision of ecosystem services that are so important for temperate broadleaved forest ecology.

Photo 1. A damaged ash stand in Säffle, Sweden (Michelle Cleary, SLU)

A large genotypic variation and high genetic control (heritability) of resistance has been shown in several European studies (Photo 2). Consequently, conventional breeding for resistance has been recognized as a feasible method that can be applied to counteract the decline of ash. Conventional breeding identifies individuals in the field that are revealing resistance traits (candidate trees), propagate (replicate) them to establish genetic field trials and evaluate trials to confirm the resistance observed in natural conditions. After evaluation of the trial, a genetic selection of the best individuals for further breeding and for use in forestry practice is usually done. The length of this so-called breeding cycle is between 15 and 20 years long.

Photo 2, Resistant and susceptible genotypes in the seed orchard at Trolleholm established in 1995 before a first record of ADB in Sweden in 2001. (Mateusz Liziniewicz, Skogforsk)

The confirmed and selected resistant genotypes are used to deliver (by controlled crossings) a new generation of ash for testing and selection of even more resistant individuals. The new generation is created from resistant parents. Eventually, the best genotypes might be used for an establishment of seed orchards that will be producing seeds for establishment of new ash stands in forestry practice. Hopefully, such stands will contain a greater share of resistant individuals that will survive over long time.

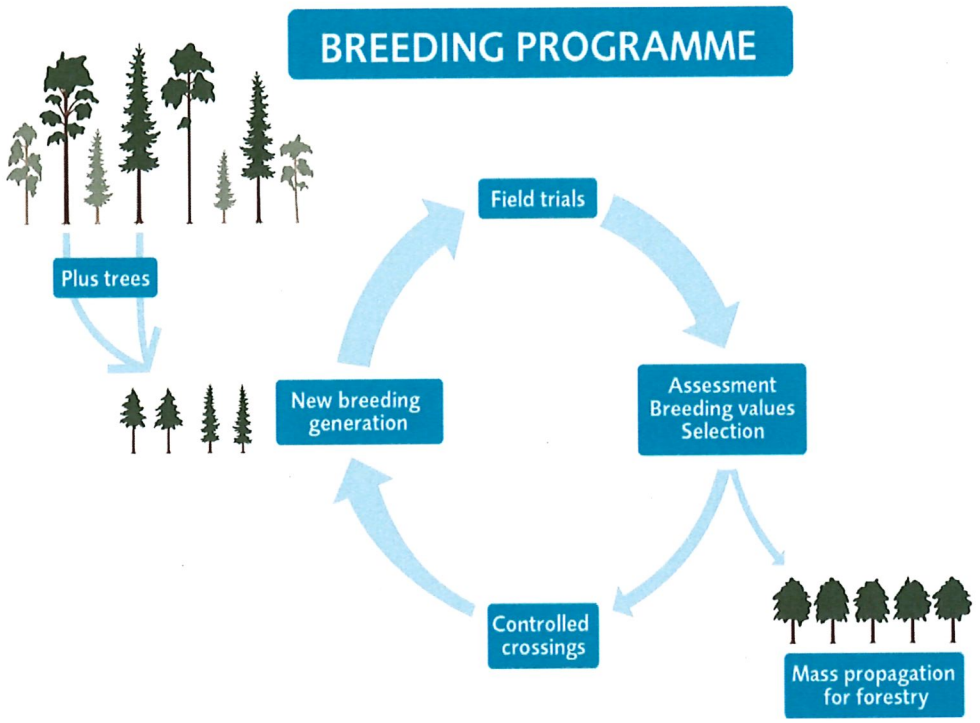

Photo. A conventional breeding program starts with plus-trees (candidates) selection in natural conditions, propagation, and establishment of genetic field trials. Later assessment and calculation of breeding values is done and create information for a new breeding cycle (controlled crossings) as well for a use in practice that is often seed orchard (mass propagation). Skogforsk

An important bottleneck in conventional breeding of ash is the propagation of identified candidates that show resistance in the landscape. Most commonly, these trees are grafted which is time consuming and expensive. Often, grafts require a careful follow up as rootstocks might take over the dominant role in the plant and confound the results.

Photo. A grafted ash plants that will be planted in genetic field trials (Mateusz Liziniewicz, Skogforsk)

Thus, new methods of propagation are desired by breeders to obtain more secure results and speed up the progress in breeding. UK researchers have showed that vegetative propagation by shoot cultures can be generated with some efficiency from a wide range of ash trees, and that these can also be successfully rooted and transferred to nursery growing conditions with ease. In this UK study, seedlings (young plants) were subjected to propagation. Propagation by summer or winter cuttings, and air layering i.e., rooting of branches of a living tree, have been tested and initial results are positive. So far, these methods have not been used for ash breeding in Nordic countries but might become an important option to pursue in the future.

Photo. Micropropagated ash shoot cuttings (Trevor Fenning, Forest Research, UK).

On-the-horizon for ash are other threats that might additionally worsen the status of ash populations in Europe. Emerald ash borer (EAB) is a well-recognized insect that caused the mass decline of several ash species in USA, driving at least six to the brink of extinction. EAB is on the fringe of invading Europe as it has been observed in western part of Russia and in eastern Ukraine. Apart from EAB, there is a range of other pests and fungi that have been observed on ash that have not caused such an important risk so far but might evolve in the future and become new important threats.

Photo. Emerald ash borer (Donnie Peterson, SLU)

Participation and inclusion in the network activities

10. Participants								
Country	PhD students & Post-docs	Other researchers	Stakeholders	Communication officers	Gender			Total
					Women	Men	Other	
Denmark		2	2		2	2		4
Norway		1			1			1
Sweden	2	2			2	2		4
Poland		1				1		1
UK	2	1			2	1		3
Ireland	1	3	9		7	6		13
USA		1			1			1
Lithuania	1				1			1
Total	6	11	11		16	12		28

Economic report

11. Received grant from SNS (SEK):

185 000

12. Costs	SNS funding	Co-financing	Total
Travel and accommodation	122 279		122 279
Meeting costs	17 200	50000	67 200
Communication			
Other costs (salary)	45 521	520 000	565 521
Total SUM (SEK)	**185 000**	**570 000**	**755 000**

13. Allocation of SNS funding

Country	Partner organization	% of total
Denmark	35 000	19
Lithuania	~10 000	5.4
Sweden	~82 800	44.8
Norway	0	
Poland	~10 000	5.4
Ireland	~10 000	5.4
United Kingdom	~20 000	10.8
Common costs	~17 200	9.2
Total SUM	**185 000**	**100**

14. Economic result (deficit or surplus)

The whole granted sum was spent for the network activities.

Optional: Comments to the economic reporting

The participation in the workshop took on an average of 3 working days for each person from each organization that participated. There were 28 people present with working cost of 5000 sek per day (low taxa at Skogforsk) that is ca 420 000 sek. Additionally, Mateusz Liziniewicz and Dheeraj Rathore spend on average ca 10 working days for planning and organizing a meeting.

Facilities at Teagasc was available free of charge and the estimated value of that was 50 000 kr including the involvement of the staff and the provided services (coffee breaks, field lunch).

The dietary allowance was paid by the organizations involved in the network – not included in the cost table.

Most of the flights and hotel bookings were coordinated by Skogforsk so money was not directly transferred to the involved partners.

Photo: Participants of the network meeting in Dublin, 14th – 15th of June 2022.

I hereby declare that the above statements are true to the best of my knowledge

Signature of the main applicant		
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Signature	Organization	Date
Mateusz Lizinewicz		
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Signature of the department head at the department of the main applicant		
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