

# Improving Biomass Productivity, CO<sub>2</sub> Uptake and Pest/Pathogen Resistance of Short Rotation Energy Willow and Poplar by Polyploidy and Heterosis: Genome Optimization

Ferhan Ayaydin

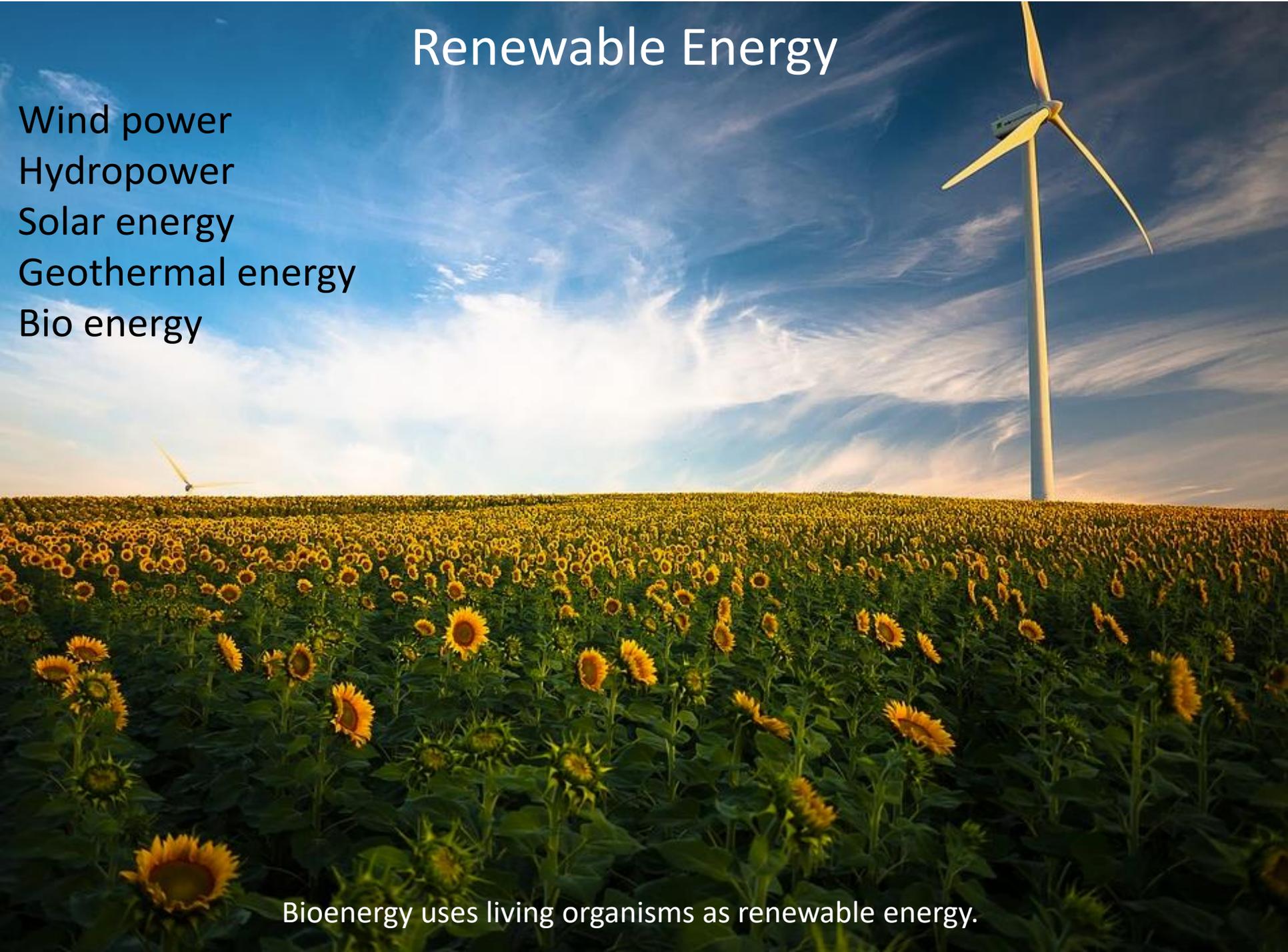
*Biological Research Center, Hungarian Academy of Sciences, Szeged*



Improvement of energy plants as renewable energy source

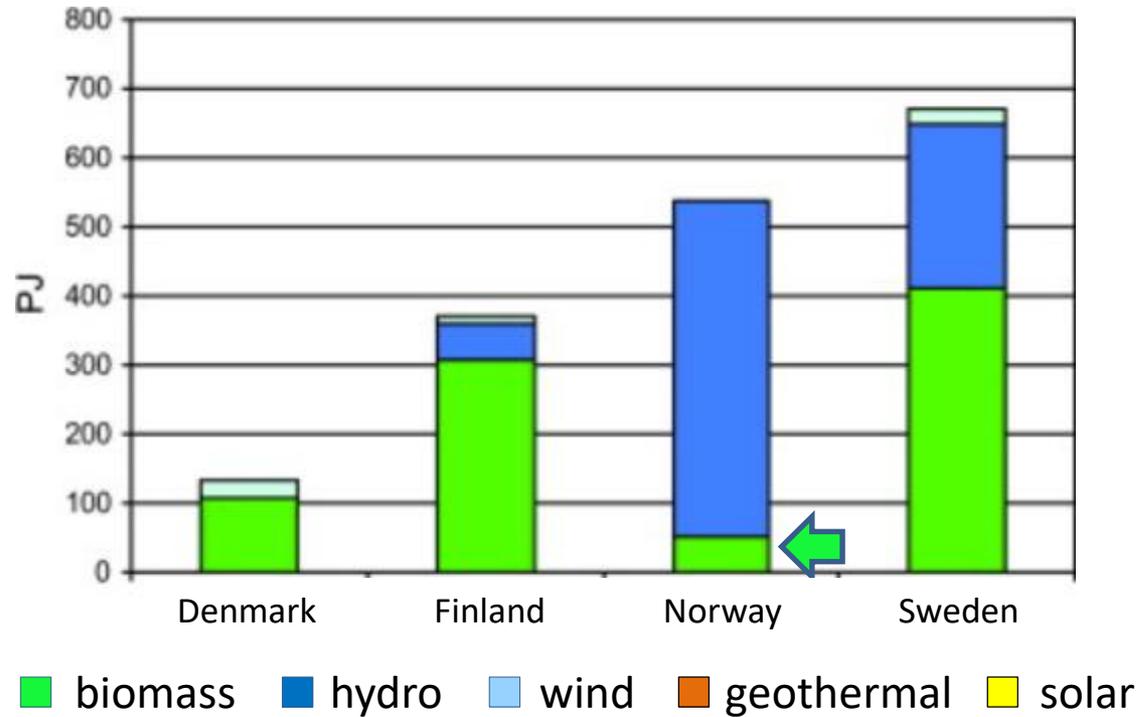
# Renewable Energy

Wind power  
Hydropower  
Solar energy  
Geothermal energy  
Bio energy



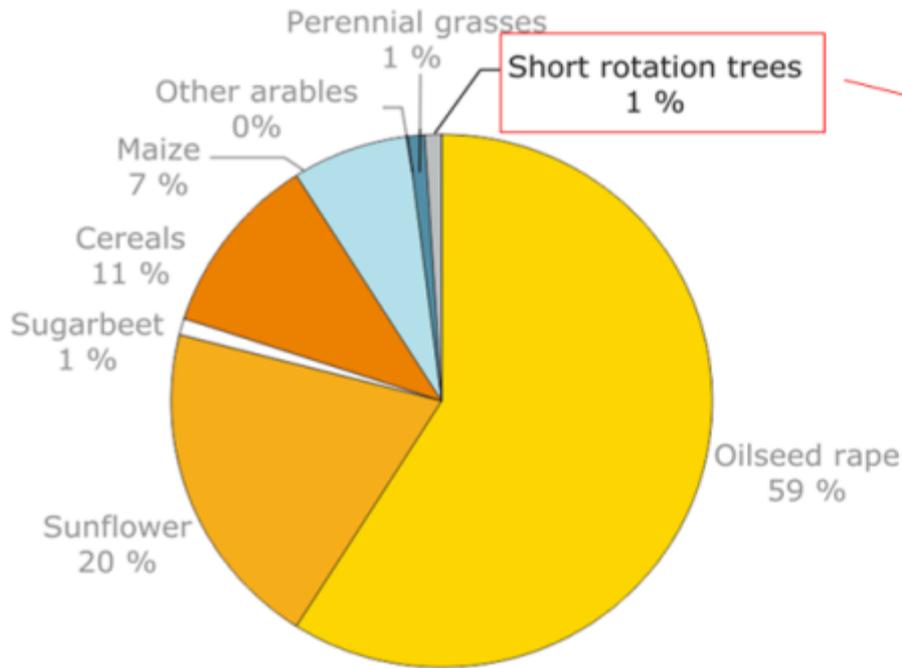
Bioenergy uses living organisms as renewable energy.

# Distribution of Renewable energy sources in Nordic countries

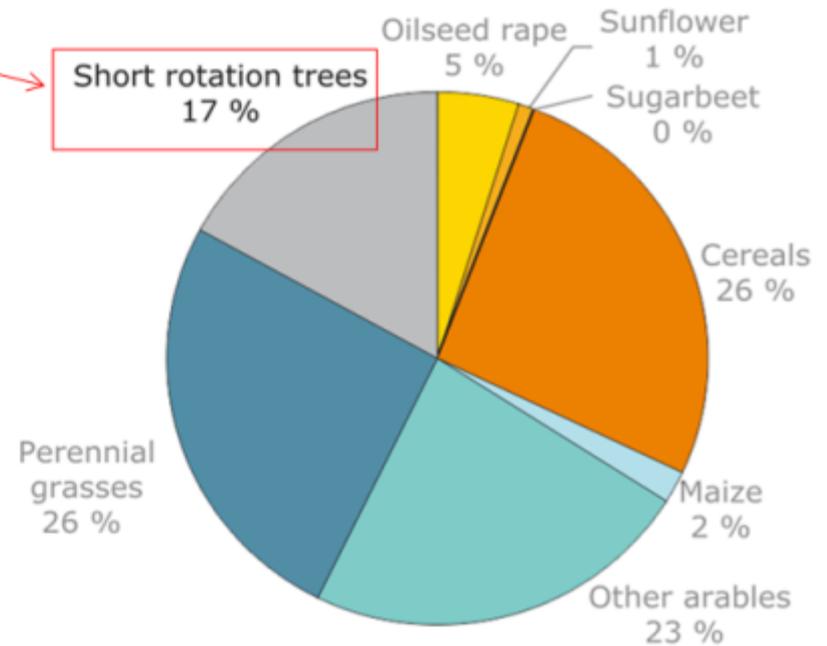


Emphasis on bioenergy can help Norway to elevate overall renewable energy production

# European Environment Agency projects increase of short rotation trees



2006-2008 data



EEA's projection for 2020

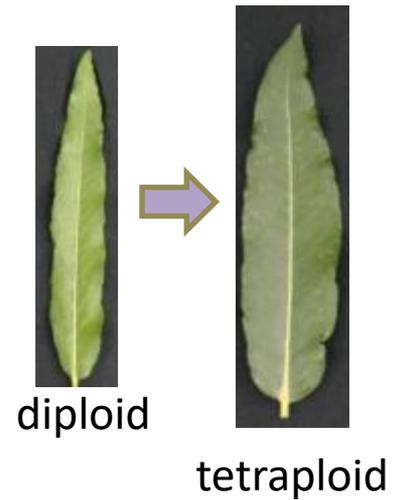
# Energy willow (*Salix viminalis*) as short rotation trees



Willows at greenhouse

willow and poplar  
are used as short rotation coppices  
harvested 2-4 years

Willow can produce 19MJ/kg energy  
which is equal to ~4500 liters of  
oil/hectare



Tetraploid willow nursery, Szeged

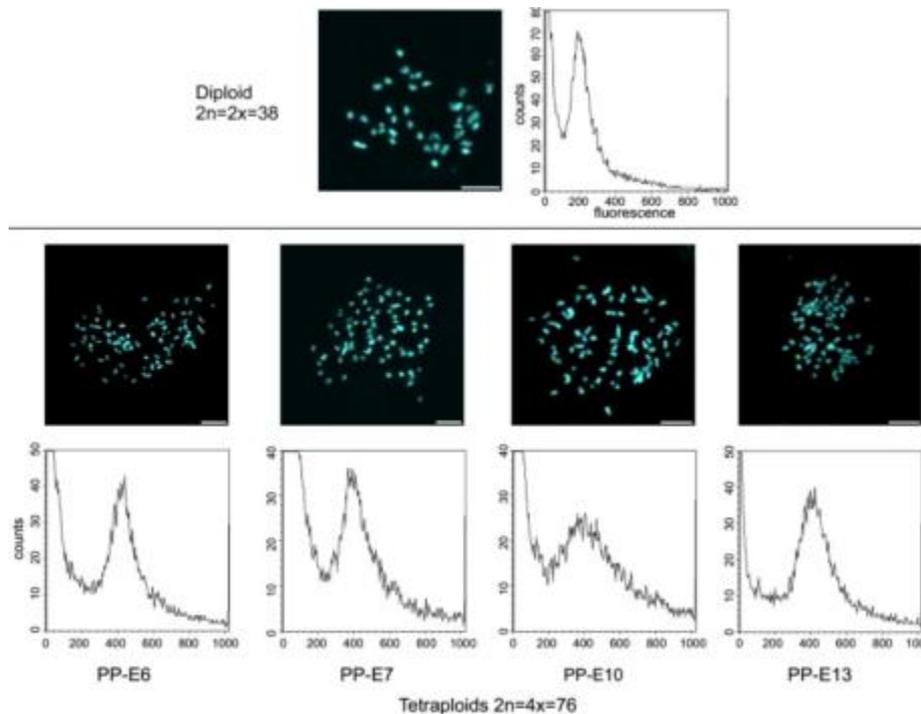
# Tetraploid willow: Doubling the chromosome number

## Plant Physiology

### Response of Organ Structure and Physiology to Autotetraploidization in Early Development of Energy Willow *Salix viminalis*

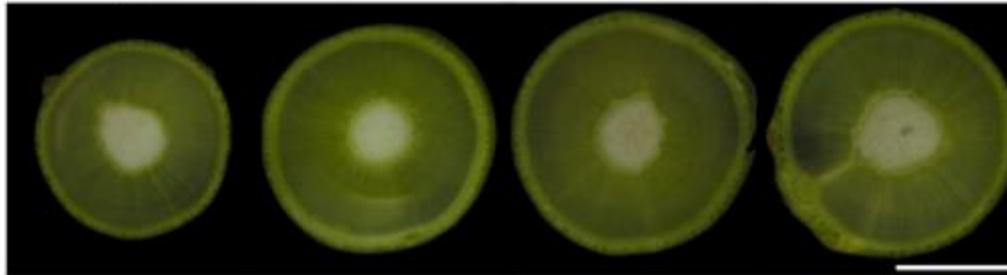
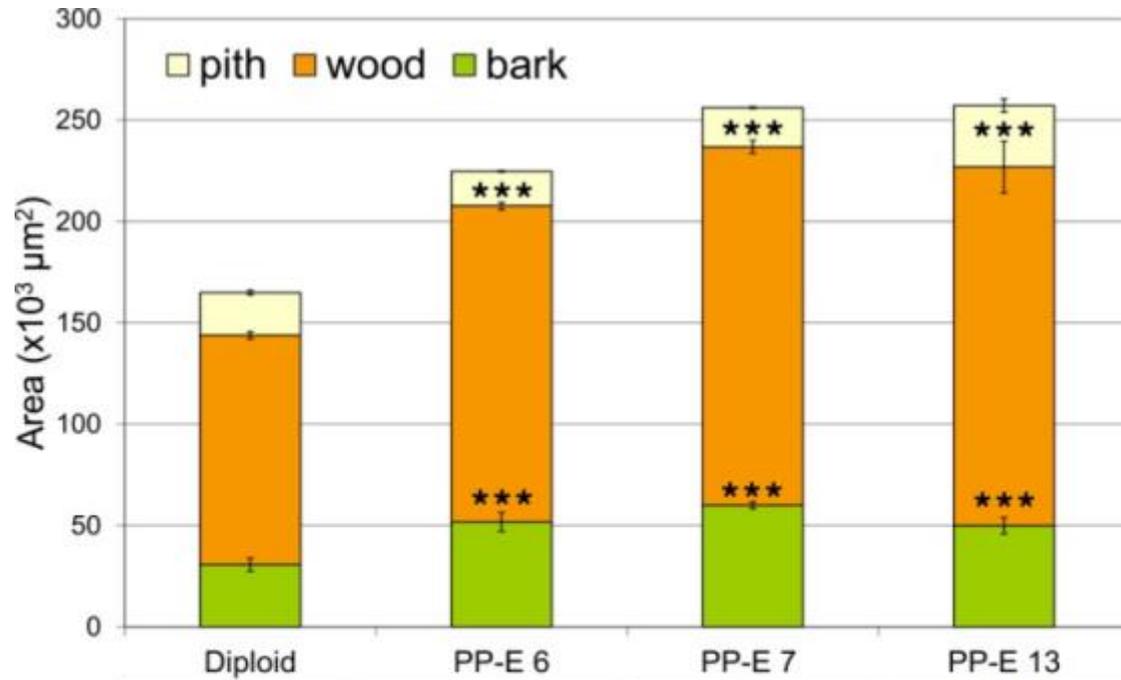
Dénes Dudits, Katalin Török, András Cseri, Kenny Paul, Anna V. Nagy, Bettina Nagy, László Sass, Györgyi Ferenc, Radomira Vankova, Petre Dobrev, Imre Vass, Ferhan Ayaydin

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Using a chemical inhibitor (colchicine) we obtained tetraploid willow plants with doubled chromosome number

# Tetraploid willows have thicker stems



tetraploid lines

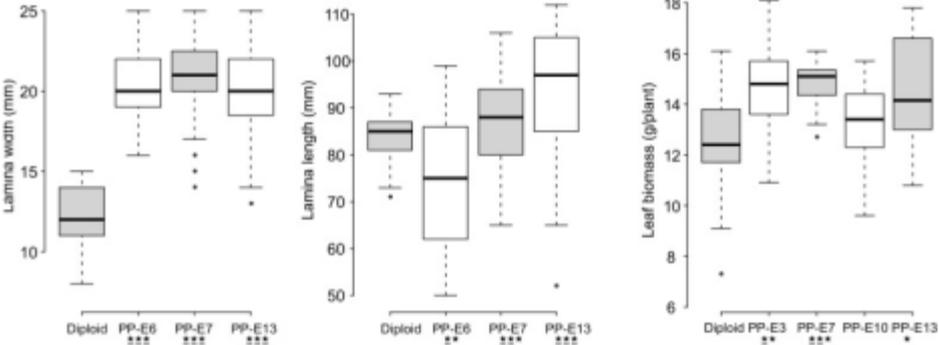
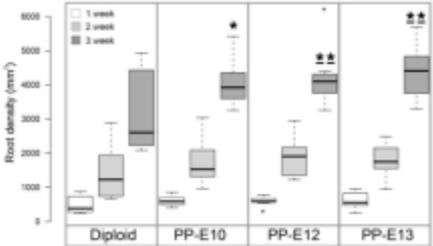
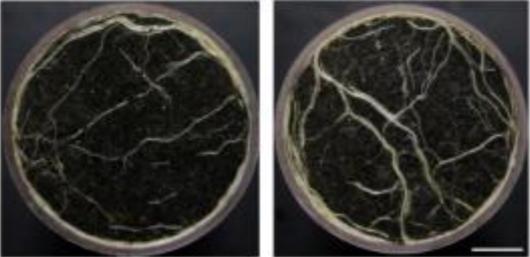
# Tetraploid willows have higher root density and larger leaves

Diploid      Tetraploid

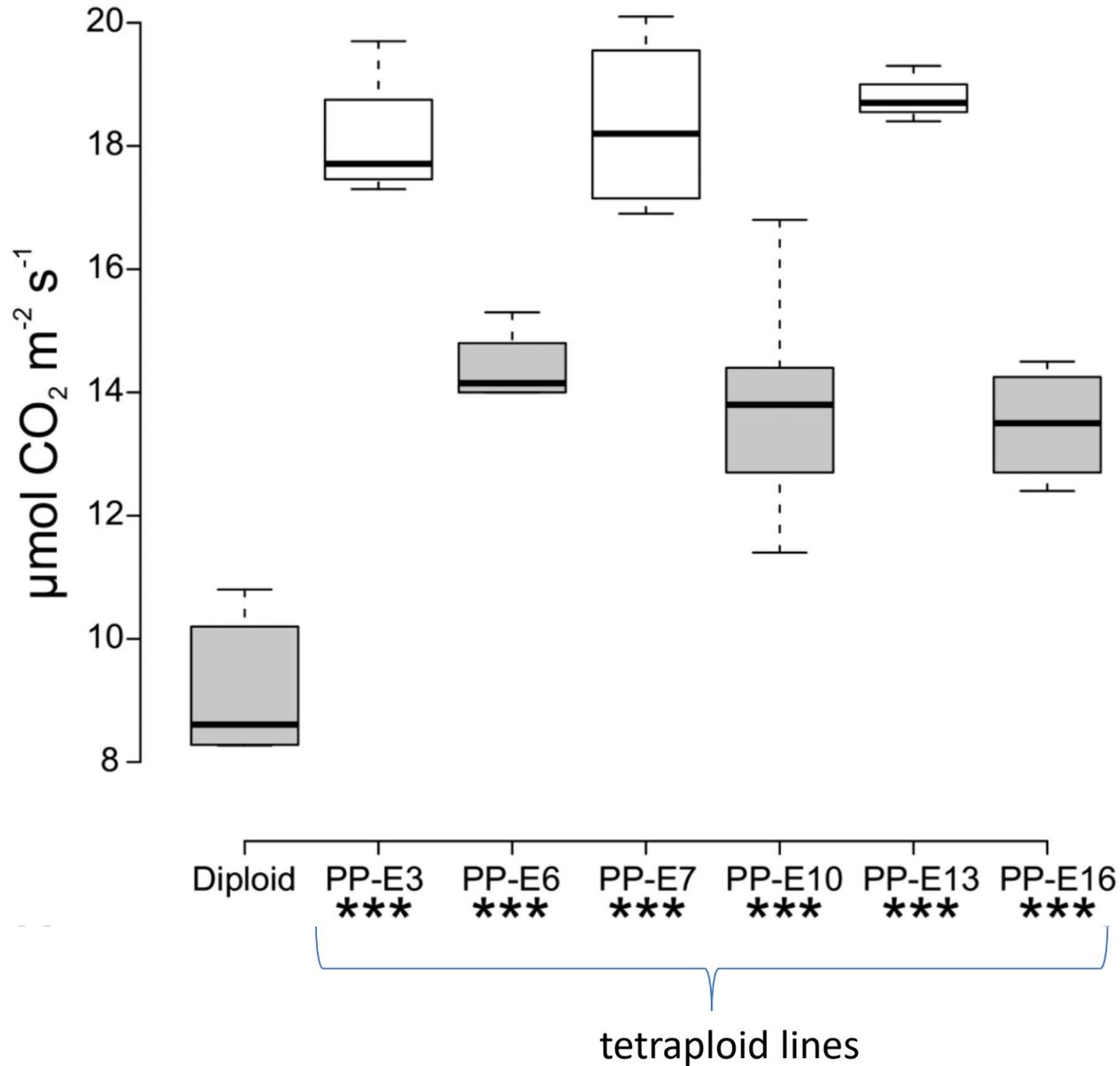
Side view



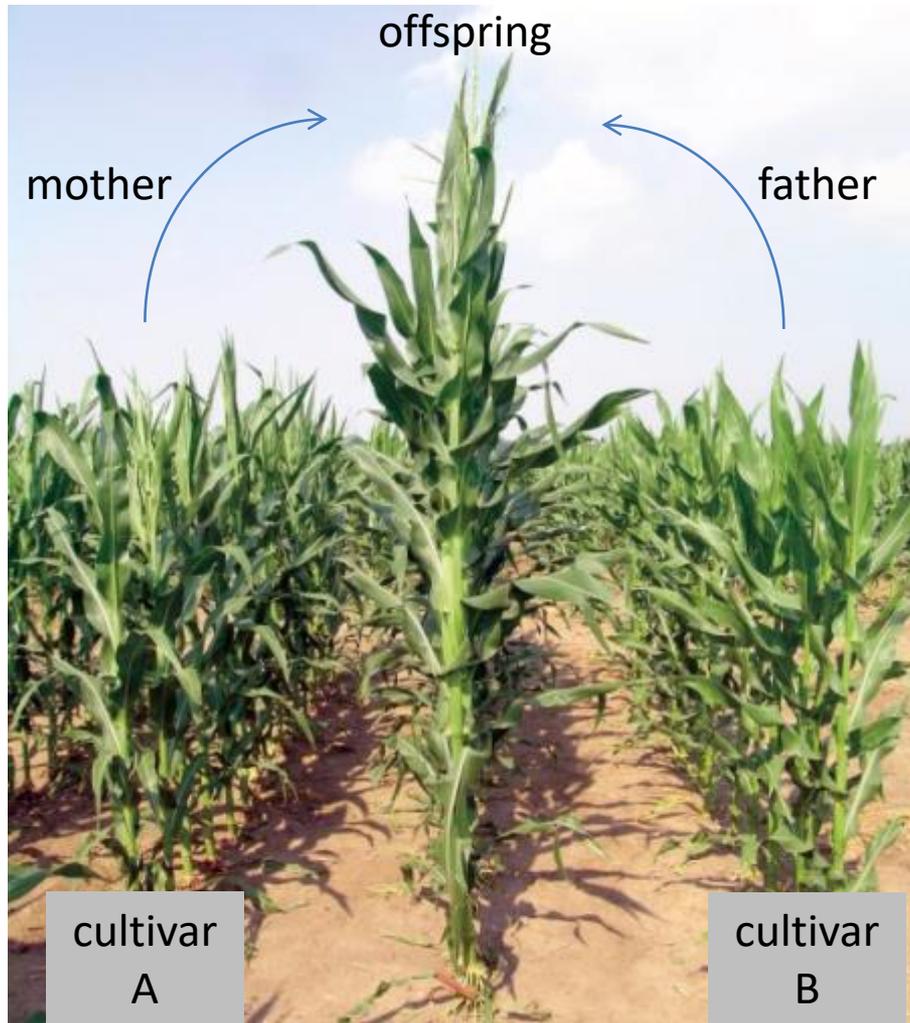
Bottom view



# Tetraploid plants absorb CO<sub>2</sub> more efficiently from the atmosphere

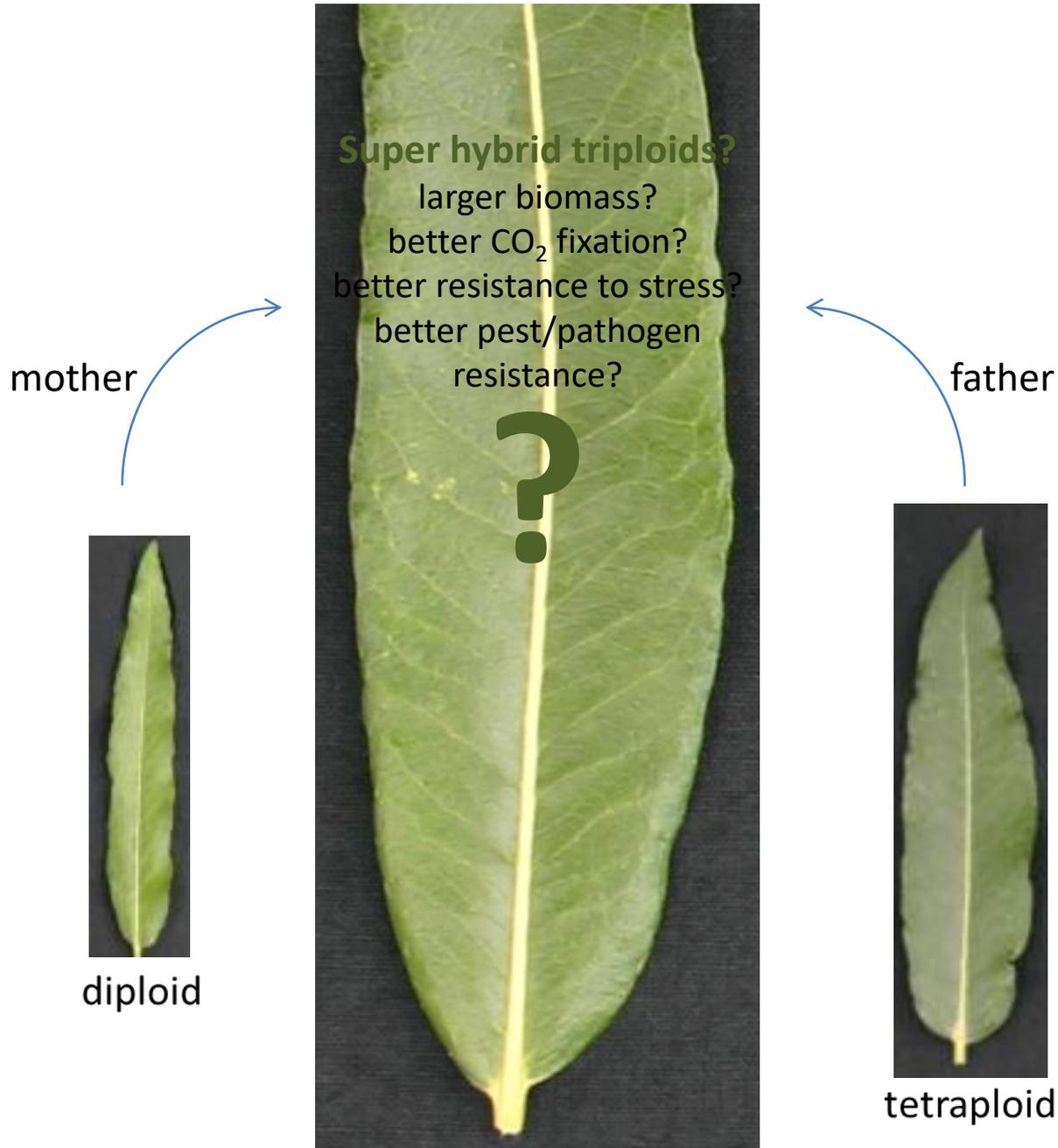


# Super maize by heterosis



**Heterosis:** Improved or increased function of any biological quality in a hybrid offspring

# Can we make Super Willow Genotypes by heterosis?



# Can we identify genes responsible for better traits?



Tools: transcriptome analysis: RNA sequencing, next generation sequencing

# Precision breeding by gene editing (a non-GMO approach)

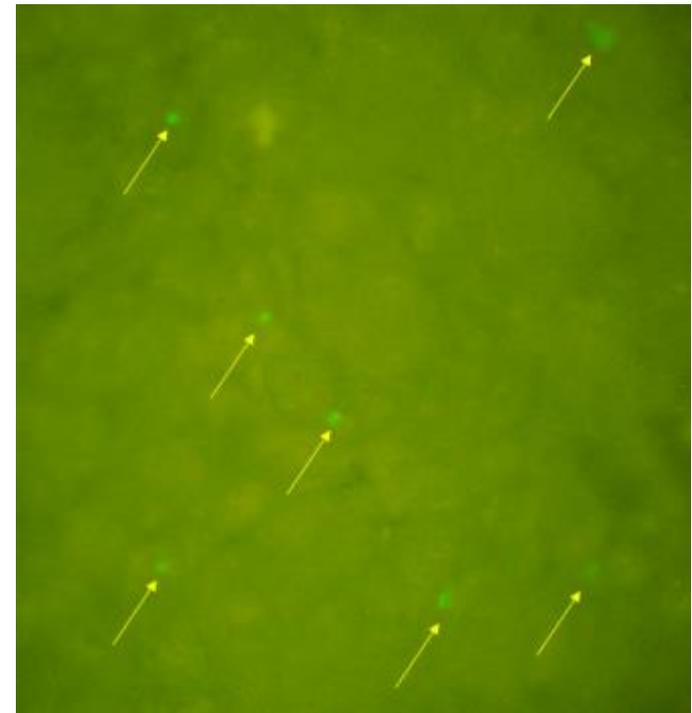
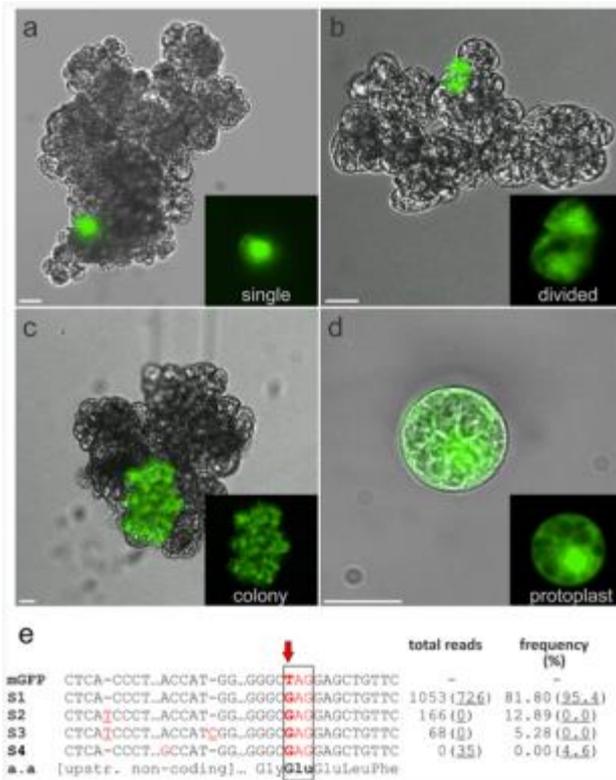


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## Relaxed chromatin induced by histone deacetylase inhibitors improves the oligonucleotide-directed gene editing in plant cells

[Tiricz H](#)<sup>1</sup>, [Nagy B](#)<sup>1</sup>, [Ferenc G](#)<sup>1</sup>, [Török K](#)<sup>1</sup>, [Nagy I](#)<sup>2,3</sup>, [Dudits D](#)<sup>4</sup>, [Ayaydin F](#)<sup>1,5</sup>.



Gene editing on maize cells (Tiricz et al, 2018)

Gene editing on rice cells (unpublished data)

# Collaborations with Norwegian partners

## Competences offered

Plant molecular/cell biology and tissue culture; Establishment of polyploidy in tree species; growth monitoring by phenotyping platform; morphological characterization of polyploid tissues by state of the art confocal laser scanning imaging facility; plant gene editing using oligonucleotides and CRISPR/Cas9 system; oligonucleotide synthesis laboratory; flow cytometry analysis of polyploidy; CO<sub>2</sub> uptake analyses to quantify carbon fixation

## Competences needed

Experience in molecular biology and tissue culture of tree species; Expertise in tree diseases, pests, pathogens and disease resistance; competence in transcriptomics analysis and bioinformatics of tree species

Norwegian Institute of Bioeconomy Research | NIBIO  
Forest Health  
Oslo

Current position  
Head of Department Forest Health, Research Professor

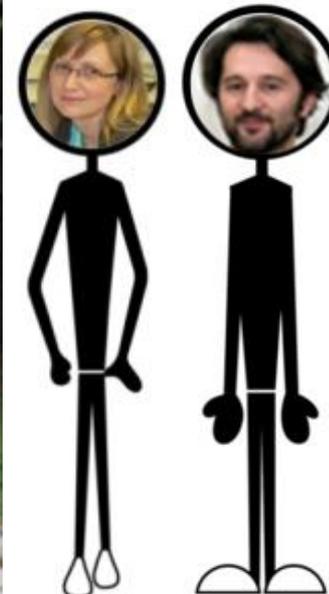
### Skills and Expertise



**Carl Gunnar Fossdal**

Head of Department/Head of Research

# Acknowledgements



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Tusen takk for din oppmerksomhet!  
*Köszönöm szépen a figyelmet!*



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of Norway



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