



Giuseppe Nervo and Sara Bergante

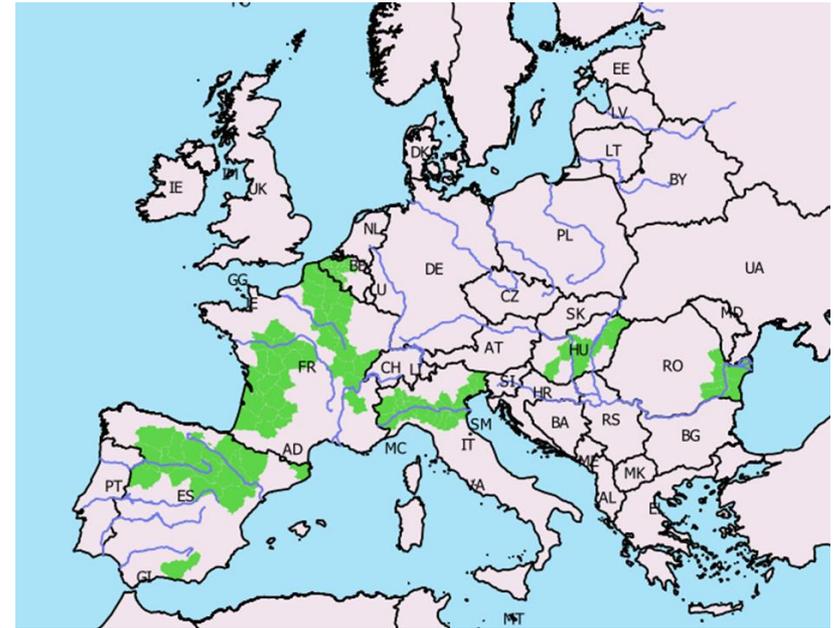
Sustainable clonal forestation for the production of quality poplar wood in the Po Valley: cultivation models and future scenarios.

CREA – Research Centre for Forestry and Wood (Italy)

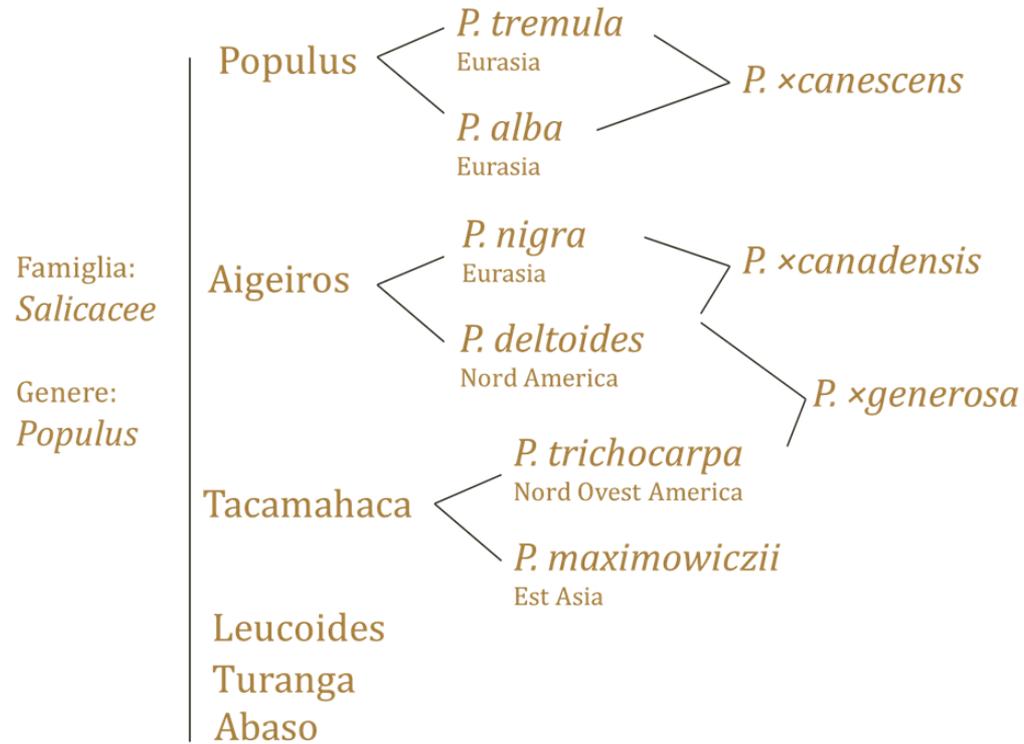
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Forestation with poplar clones: pure species and hybrids

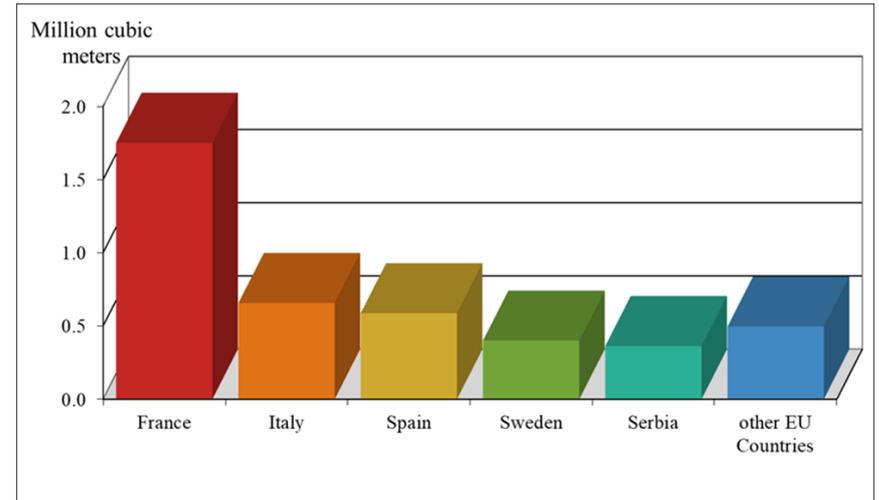
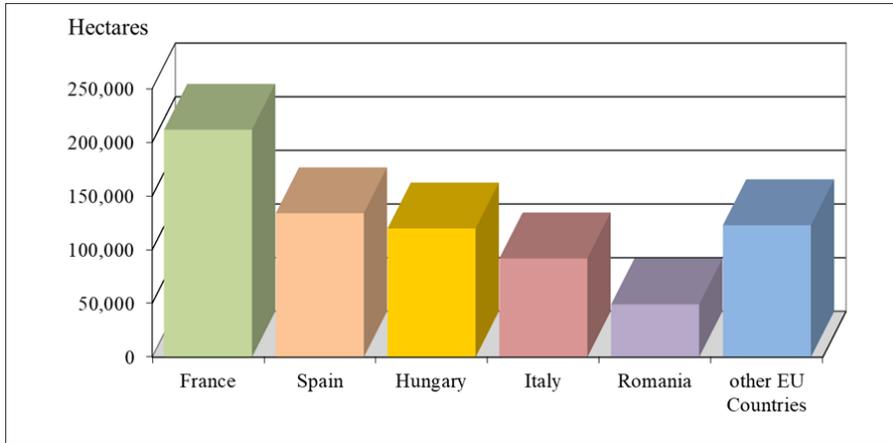
The plains of Spain, France, Italy, Hungary and Romania are the main poplar cultivation areas



Best



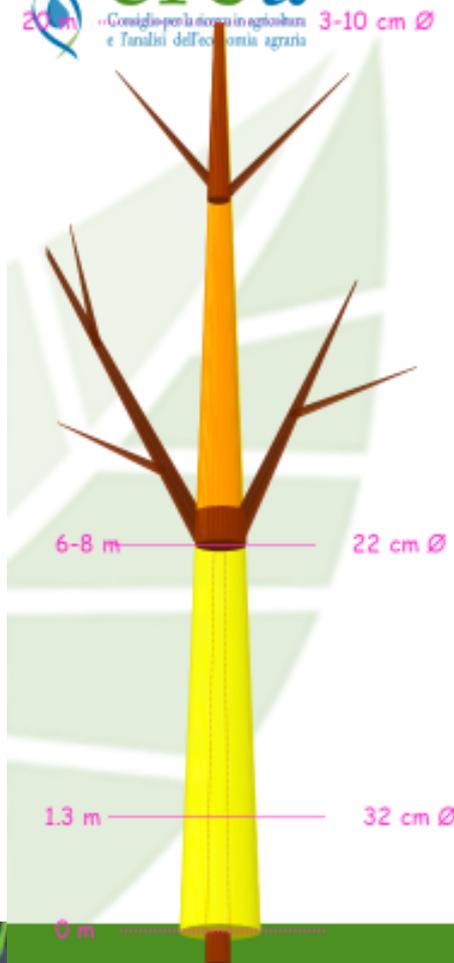
Poplar cultivation in the main European countries



Poplar wood production in the main European countries



Wood utilization for industrial purposes



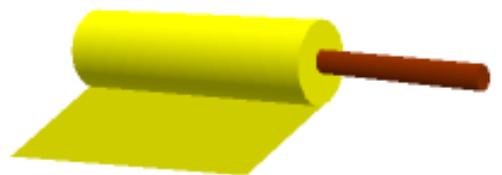
Cips wood

10 – 60 %



Sawnwood

20 – 40 % del volume



Veneer

40 – 70 % del volume

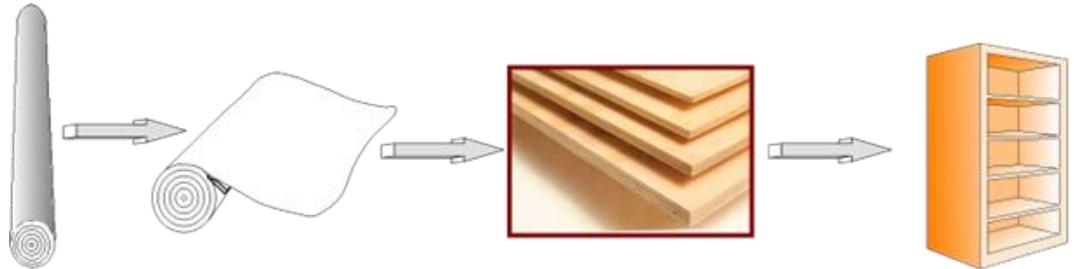
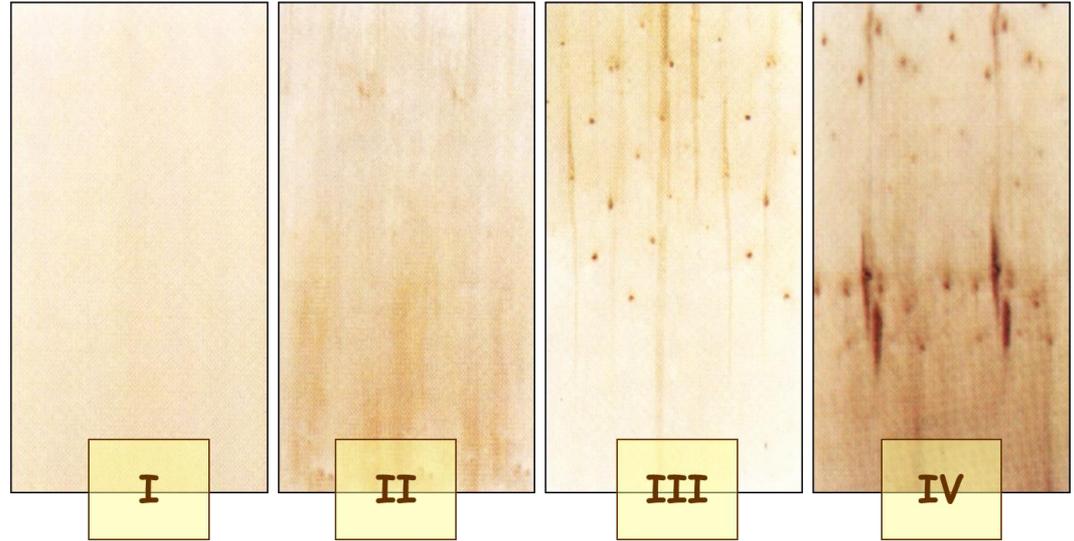
16/09/2022

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Main uses of poplar wood in Italy



The high density nursery

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Density: 60.000 trees/ha

Life cycle: 2-3 years

Harvest: annual

Goal: production of cuttings for nurseries and vegetative material for reproduction and biomass plantation



The nursery for plant production

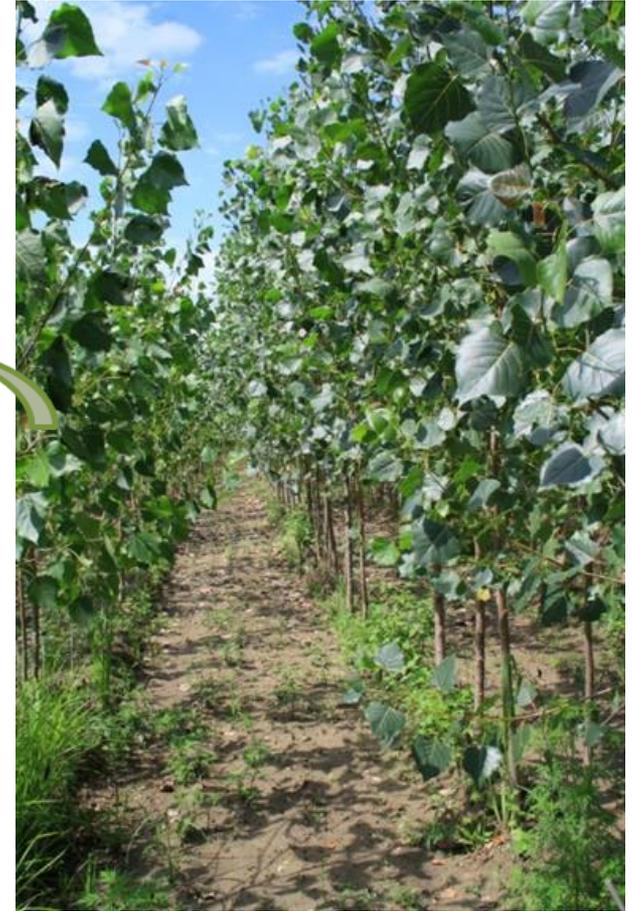
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Cutting plantation: about 7.000 tree/ha

Lyfe cycle: 1-2 years

Harvest: annual/biennial

Goal: production of poles for traditional stand poplar cultivation



Planting of the poplar stand

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Plantation with live poles 1-2 year old

Density (270 – 330 trees/ha)

Life cycle: 10-12 years (Italy, Spain), 12-18 (France)

Harvest: at the end of cycle

Goal: production of high quality poplar wood.

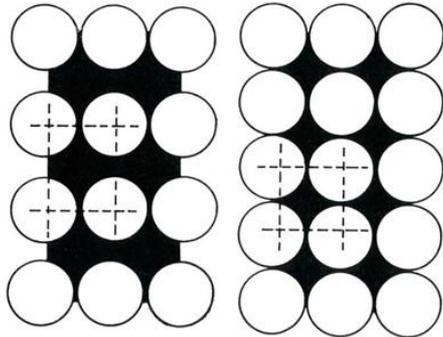


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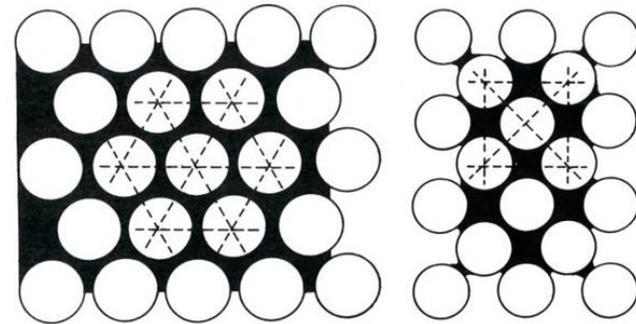


Planting of the poplar stand

Layout e spacing



Square: 6 x 6 or 7 x 7 or ... meters
 Rectangle: 6 x 5 or 7 x 5 or meters

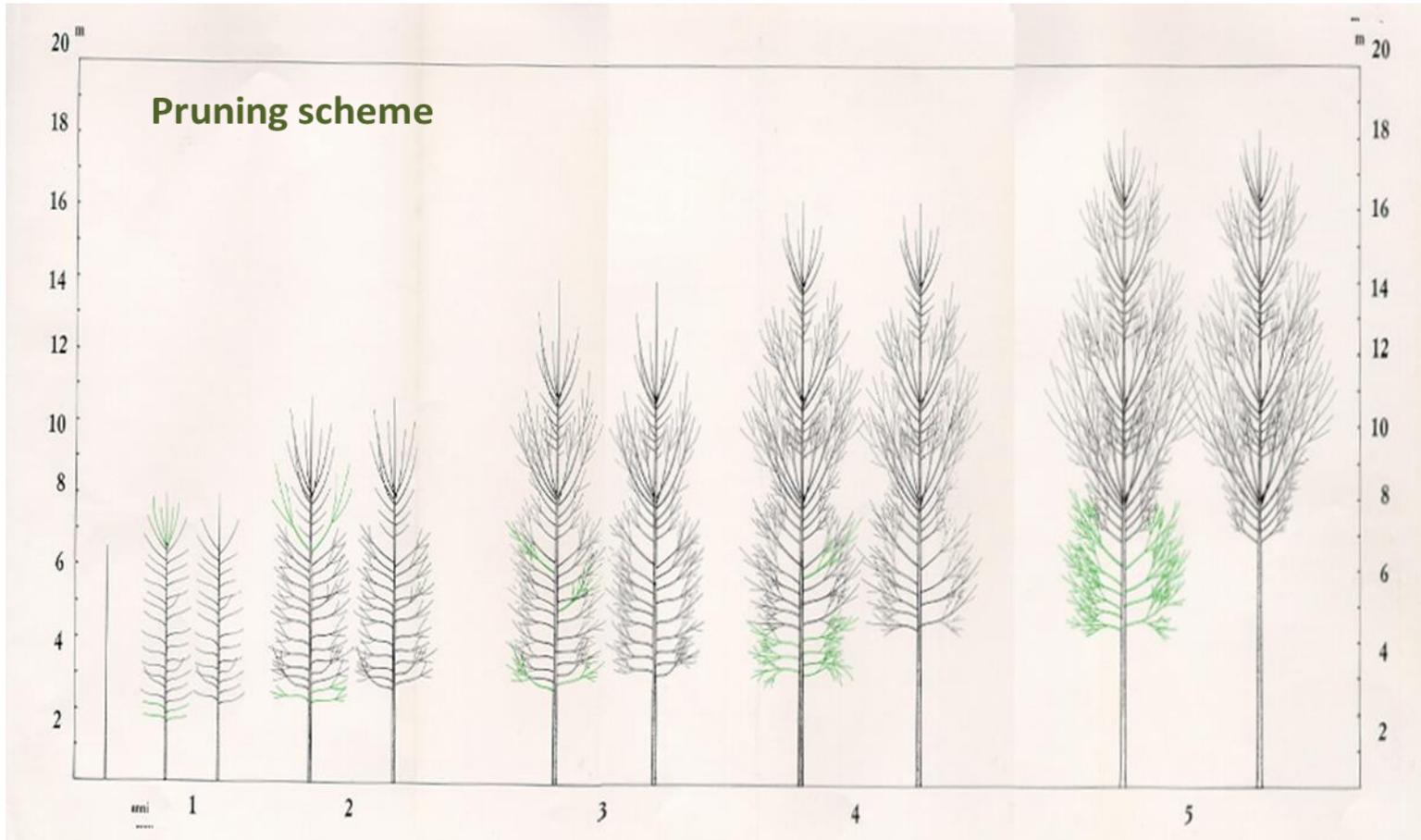


Quincunx system



Best 4





Best 4

Plant density	=	250-330	trees per ha
Rotation	=	10	years
Timber production	=	200	m ³ /ha
Mean annual increment	=	20	m ³ /y
Tree volume	=	0.7	m ³
Annual plantations	=	6-8,000	ha





Products:
saw, pallets,
OSB panels,
particle panels,
pulp for paper,
chips for energy
purposes.

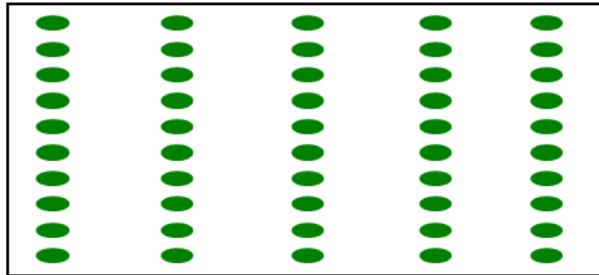


Short rotation system

Density:: 5'700-10'000 p/ha (0,5 x 2)

Harvest: 2 – 3 year

Productio: 12-. 15 t ss/y



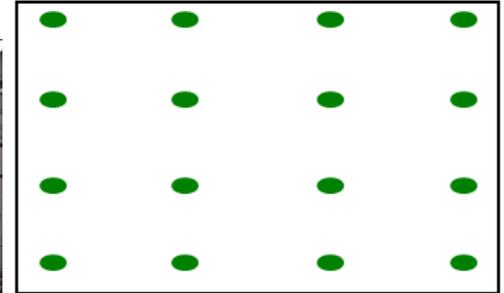


Medium rotation system

Density: 1'100-1'600 p/ha (3x3m)

Harvest: 4 -5 -6 years

Production: **15-18 t ss/y**



Selected clones for biomass production

Clone	Name	Registration date	Patent right	Originator	Species	Sex
83.148.041	Orion	2011	granted	CRA (PLF)	<i>P. ×canadensis</i>	M
83.160.029	Imola	2011	granted	CRA (PLF)	<i>P. ×canadensis</i>	F

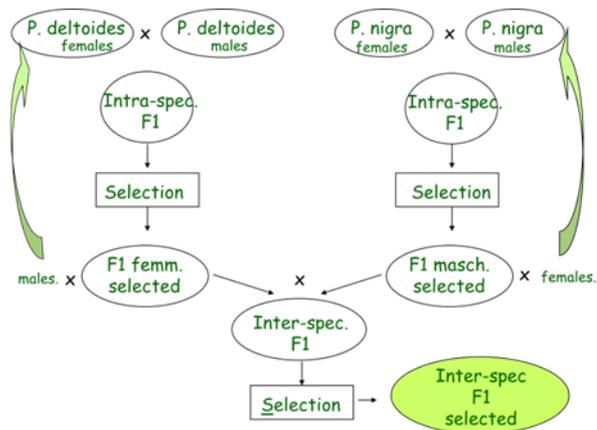


Sustainable clonal forestry

- ✓ Monoclonal vs. polyclonal plantations
- ✓ Sustainable cultural practices
- ✓ Alternative / innovative plantations



Poplar breeding and selection



- ✓ Rooting capacity
- ✓ Growth rate
- ✓ Stem shape and branches distribution (Canopy)
- ✓ Resistance to diseases and pest
- ✓ Wood quality

CLONE	SPRING LEAF AND SHOOT BLIGHT	LEAF RUSTS	MARSSONINA LEAF SPOT	WOOLLY APHID	GENETIC ORIGIN
I-214	****	***	**	**	<i>Populus × canadensis</i>
1 AF8	****	****	****	****	<i>Populus × generosa × Populus trichocarpa</i>
2 ALERAMO	****	****	****	****	<i>Populus × canadensis</i>
3 BRENTA	****	***	****	****	<i>Populus × canadensis</i>
4 DIVA	****	****	****	****	<i>Populus × canadensis</i>
5 DVINA	****	****	****	****	<i>Populus deltoides</i>
6 ERIDANO	****	****	****	****	<i>Populus deltoides × Populus maxmowiczii</i>
7 HARVARD	****	****	****	****	<i>Populus deltoides</i>
8 KOSTER	****	****	***	****	<i>Populus × canadensis</i>
9 LAMBRO	****	***	****	****	<i>Populus × canadensis</i>
10 LENA	****	****	****	****	<i>Populus deltoides</i>
11 LUX	****	****	****	****	<i>Populus deltoides</i>
12 MELLA	****	***	****	****	<i>Populus × canadensis</i>
13 MOLETO	****	****	****	****	<i>Populus × canadensis</i>
14 MOMBELLO	****	****	****	****	<i>Populus × canadensis</i>
15 MONCALVO	****	****	****	****	<i>Populus × canadensis</i>
16 OGLIO	****	****	****	****	<i>Populus deltoides</i>
17 ONDA	****	****	****	****	<i>Populus deltoides</i>
18 SAN MARTINO	****	****	****	****	<i>Populus × canadensis</i>
19 SENNA	****	****	****	****	<i>Populus × canadensis</i>
20 SILE	****	****	****	****	<i>Populus deltoides × Populus ciliata</i>
21 SOLIGO	****	****	****	****	<i>Populus × canadensis</i>
22 STURA	****	****	****	****	<i>Populus × canadensis</i>
23 TARO	****	****	****	****	<i>Populus × canadensis × Populus × generosa</i>
24 TUCANO	****	****	****	****	<i>Populus × canadensis</i>
25 VILLAFRANCA	****	****	****	****	<i>Populus alba</i>

LEGEND

*	highly susceptible
**	susceptible
***	tolerant
****	resistant



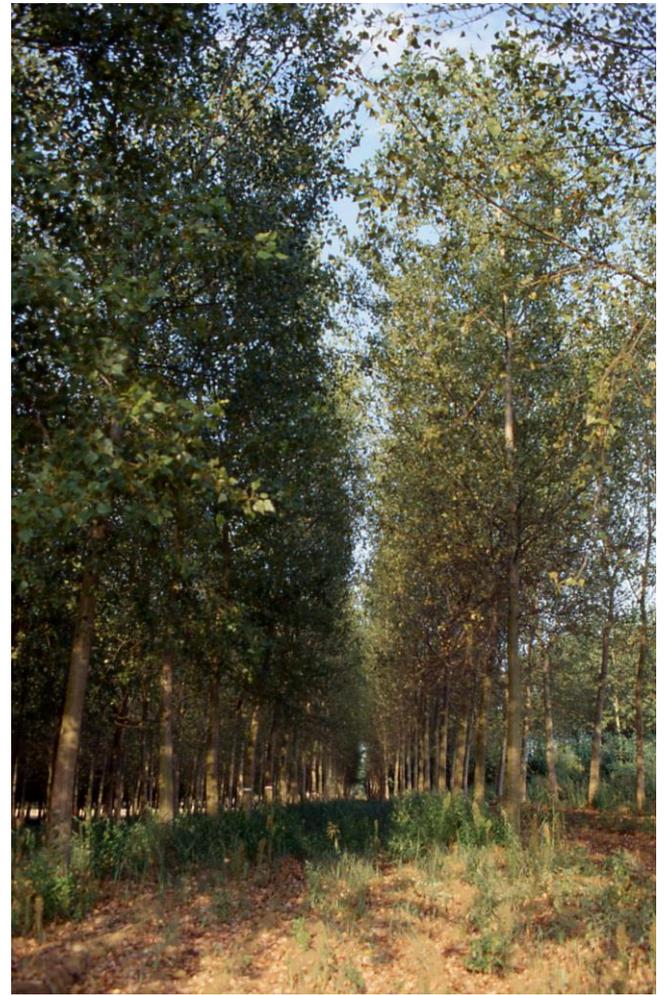
Problems faced and solved ^{Best}4

- Spring leaf and shoot blight (*Venturia populina*)



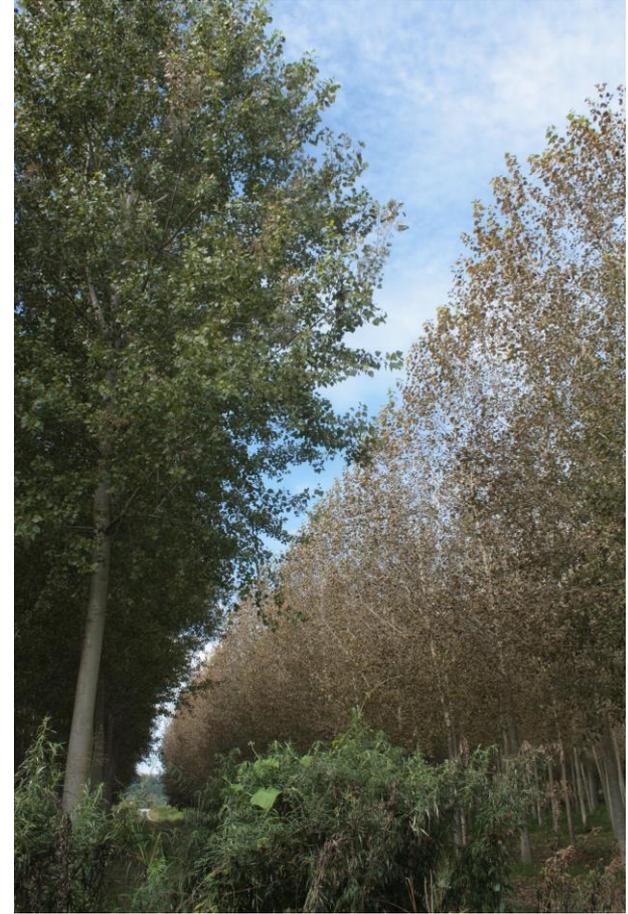
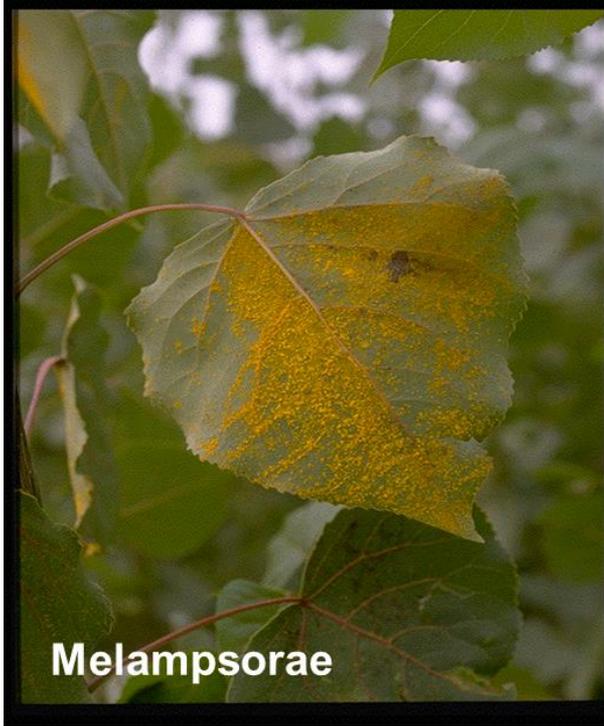
Problems faced and solved ^{Best}4

- Marssonina leaf spot (*Marssonina brunnea*)



Problems faced and solved

Leaf rusts (*Melampsora* spp.)



Problems faced and solved ^{Best}4

Woolly poplar aphid (*Phloeomyzus passerinii* Sign)



Best
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Basis of Standards of Forest Management adopted by Forest Certification schemes



FSC (*Forest Stewardship Council*)

PEFC (*Programme for the Endorsement of
Forest Certification schemes*)



Only in Italy and in Chile exist
the specific standard for poplar.

Certification of Sustainable Poplar Plantation
Management (ITA 1004-1)



Sustainable clonal forestry

- ✓ Monoclonal vs. polyclonal plantations
- ✓ Sustainable cultural practices
- ✓ Alternative / innovative plantations



Sustainable cultural practices: integrated production regulations

Weeds control: chemical or mechanic, is important at least during first 4 years!

Fertilization: only the start after plantation, fertilization (with NPK) could be important in poor soils, than not mandatory !!

Irrigation: very important in dry condition for high quality wood production

Pest and diseases control: very important using resistant clones
also for progressive reduction of available chemical products



Sustainable clonal forestry

- ✓ Monoclonal vs. polyclonal plantations
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Alternative and sustainable cultural models.

**Today we try to move towards more sustainable cultivation systems,
and often this involves abandoning monoculture.**

**Two alternative models allow to growth noble hardwood species obtaining a
periodic income and with more sustainable cultivation methods.**

1) Polycyclic model with other noble hardwood species;

2) Agroforestry



Towards a mixed models

The evolution of models starts from a pure plantation with accessory trees (shrubs) and continued to mixed plantation (ex: walnut + cherry tree and others) with accessory trees.

The mixed plantation demonstrated to allow higher performances, compared with monospecific ones.

The researchers experimented new models, named Polyciclyc, with a consociation of different species with different cycles and products target.

With this new model, choosing the spacings carefully, it is no longer necessary to thin out the plants

The introduction of poplar in such planations allows an income during the first 6-10 years of growth, ensuring a more stable market of wood for plywood.



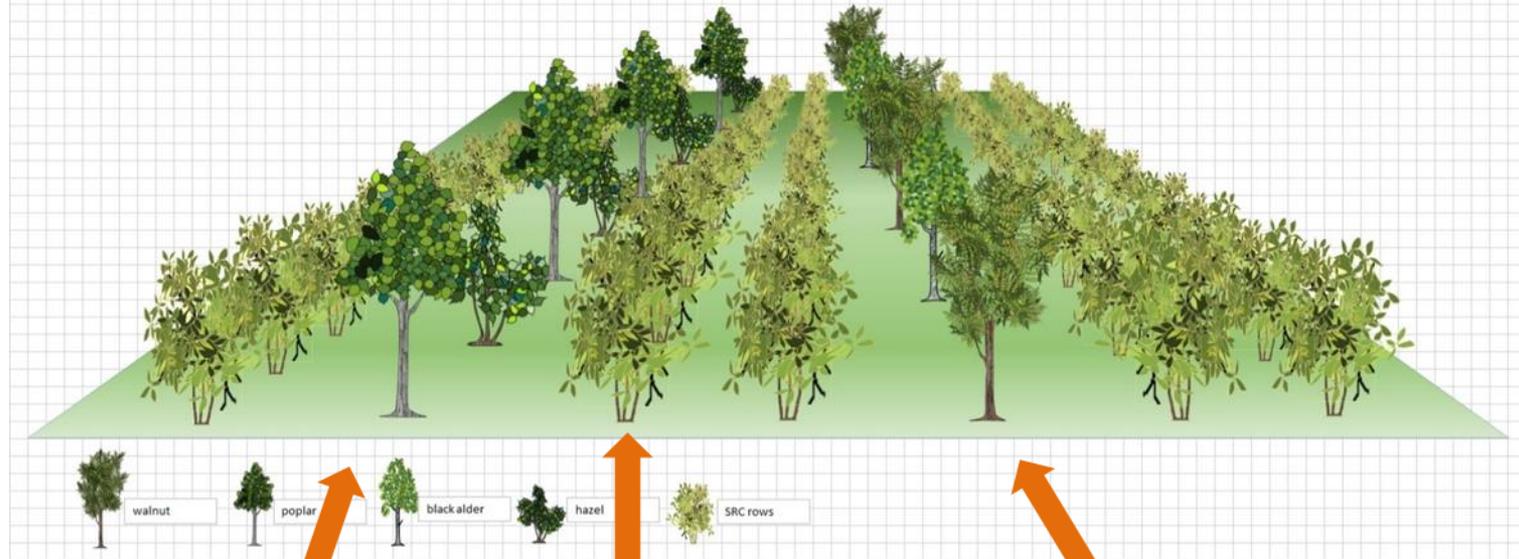
The polycyclic model

Multispecific , multicycle and multiproducts plantations composed by:

- **Principal trees** for wood production with possible different cycle:
 - ❖ Brief poplar
 - ❖ Medium-long noble hardwood
- **Trees with double role:** principal + shelter able to influence the structure of principal tree and to produce commercial assortments (different cycles):
 - ❖ Very brief SRC
 - ❖ Brief poplar clones
- **Accessory trees**, able to produce at least one of the following services:
 - ❖ Growth education of principal trees;
 - ❖ N-fixing;
 - ❖ Weeds control.



The polycyclic model



Poplar alternated to hazel

SRC rows with different species

Walnut (*J. regia*) alternated to black alder



The polycyclic stand



• **Benefits**

- Resilient plantation
- Less energy inputs: (irrigation, fertilization, diseases and weed control)
- **Water saving** due to:
 - Reduced number of poplars;
 - Plantation of species more drought tolerant;
 - Faster soil cover (shade)
- A reduction of about 60% of cultural inputs was demonstrated!
- **Higher biodiversity**, due to different species, structures, fruits....
- Higher environmental value: similar to natural forest
- Higher CO₂ sink ability

The polycyclic model

Disadvantages

- Expensive and complex design;
- **Complex management** (different times and species needs);
- **Complex harvest organization**, needs of specialized enterprises.



Agroforestry systems

Linear systems



Sylvo-arable systems

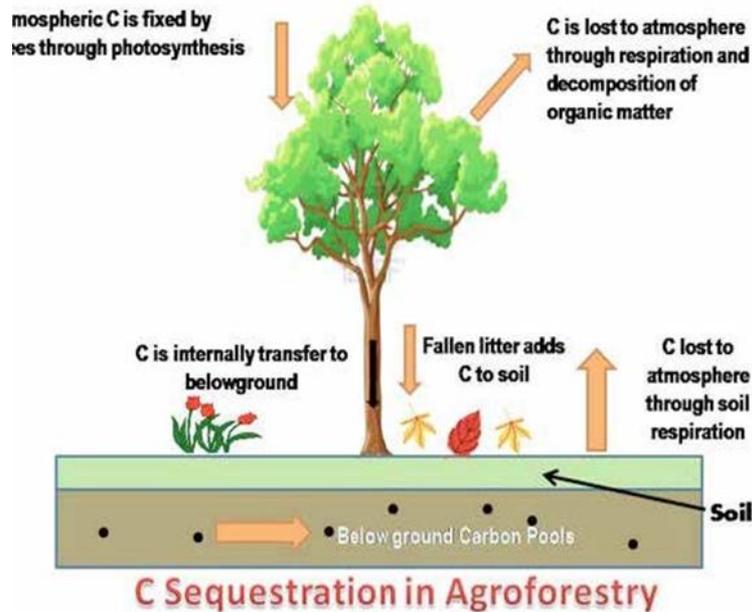


Agroforestry systems

- 1 – Shading effect on other crops → small leaves, columnar shape.....
- 2 – Water use/competition → evaluation of different roots shape, different irrigation methods (wastewaters,...)
- 3 – Chemical compounds for weeds and diseases resistance → poplar has a higher sensibility, the new clones are resistant to principal diseases.



Agroforestry systems



Carbon farming:

- GHG sink in the biomass and in the soil
- **In the World the Agroforestry systems currently adsorbe about 5,6% GHG**
- New systems on 10% agrarian fields (+ 7,6% GHG)
(Chapman et al, 2020, Global Change Biol.)

In Italy:

New systems on 10% of agrarian fields (1,6 Mil ha):
28 M t CO₂ eq.,
the Forests (11,5 Mil ha): 43 M t CO₂ eq.
(Kay...Paris et al, 2020, Land Use Policy)





Emerging risk

- Biotic stress
 - Diseases
 - Brown spots (*Discosporium populeum*)
 - Poplar root-rots (*Rosellinia necatrix*)
 - Pest
 - Brown marmorated stink bug (*Halyomorpha halys*)
 - Japanese beetle (*Popillia japonica*)
- Abiotic stress (Droughts, storms ..)



Emerging risk

Brown spots

(*Discosporium populeum*)



Emerging risk

Poplar root-rots (Rosellinia necatrix)



Emerging risk

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Brown marmorated stink bug (*Halyomorpha halys*)



Emerging risk

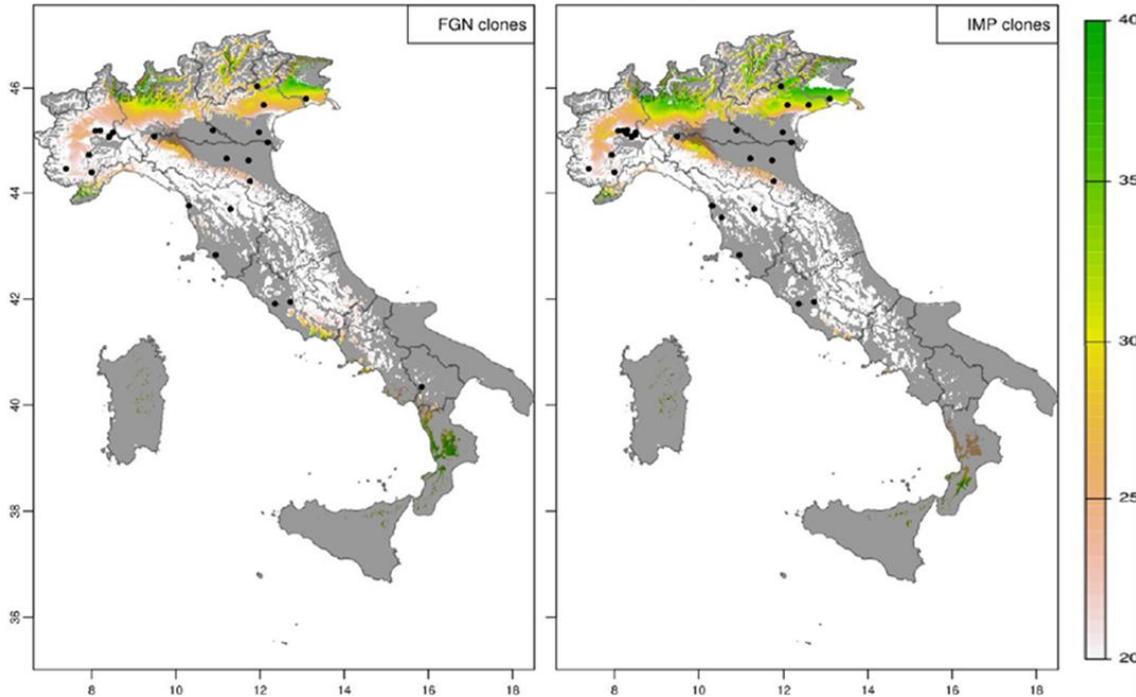
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Japanese beetle (*Popillia japonica*)



Emerging risk

Abiotic stress (Droughts..)



Predicted DBH in cm at age 10 for the two groups in 2040s under RCP8.5 using the variant21. The experimental sites used for modelling the group are shown as black dots and the statistical extrapolation outside the ecological domain is shown as shaded area.





Thanks for your attention

