

# INTERNATIONAL POPLAR COMMISSION – FAO

## Working Party on Poplar and Willow Genetics, Conservation and Improvement

(WP4)

### Report to 47<sup>th</sup> Executive Committee Meeting

*Vancouver, British Columbia, Canada*

*20 July 2014*

#### **Officials**

Dr NB Singh (India) was elected in the 24th Session of IPC in Dehradun as the Chairperson for the 2012-2016 period;

Dr Sasa Orlovic (Serbia) as Vice-Chairperson;

and Ms Teresa Cerrillo (Argentina) as Technical Secretary.

Ian McIvor (New Zealand) had played the role of Chairperson from 2008 to 2012.

#### **Mandate of the Working Party**

The mandate encompasses conservation of natural genetic resources and ecosystems, as well as genetic improvement by conventional breeding and application, molecular genetic tools and techniques, genetic transformations and new cultivars for a range of purposes.

#### **Key recommendations agreed at the meeting of India to the secretariat of IPC**

- Sustainability criteria of Poplars and Willows balance the dimensions between production and economics, livelihoods of people and communities and the ecological factors, including the conservation of genetic diversity;
- Reinforce the need for greater genetic diversity and new genetic materials in planted Poplar and Willow breeding programmes (particularly commercial plantations) to spread biological and economic risks;
- Strengthen the understanding, linkages and information flows between traditional breeding programmes and molecular genetic tools and technologies for Poplar and Willow integrated breeding programmes, and help to develop stronger links between researchers to promote the use of genomics research in poplar and willows improvement activities that are carried out.

#### **The programme of action for the next four years, to 2016**

(proposed in the 24th Session of IPC in Dehradun)

- To host a Working Party meeting in association with another working party (possibly Pests and Diseases) to share progress and successes in incorporating knowledge and techniques gained from molecular genetics into classical breeding programmes (e.g. DNA fingerprinting to identify specific poplar or willow clones, DNA fingerprinting of *Melampsora* rust disease races). *Leadership in this project will be provided by Dr NB Singh.*
- Update the data-base about the breeding programs and pollen collections. *Leadership in this*

*project will be provided by Ms. T. Cerrillo.*

- Prepare a data base of clone collections and a gene banks. *Leadership in this subject will be provided by Ms. Teresa Cerrillo – Activity with Lorenzo Vietto, Sub-Committee on Nomenclature and Registration.*
- To advance the project about standart experimental designs for poplar and willows breeding programs. *Leadership in this project: Ms. Teresa Cerrillo - Activity with Francisco Zamudio, Genetics Working Group of IUFRO.*

## **Progress with the programme of action**

- **To host a Working Party meeting in association with another working party**

The activity had been proposed in the 24th Session of IPC in Dehradun. The Secretariat of the WP4 (Genetics, Conservation and Improvement) has not received information about advances

New Zealand hosted the WP6 'Environmental uses of poplar and willow' of IPC meeting in Gisborne New Zealand, in March 2014, with international and local attendees. There were presentations and field tours. Ian Mc Ivor, member of the Genetics WP4 has worked in the Conference Organization, has informed about the meeting.

The Argentinian NPC hosted the Fourth International Congress of Salicaceae in Argentina - "Willows and poplars for regional development", at La Plata, Argentina, March 2014. Presentations and field trips covered aspects of poplar and willow breeding, among other issues. Teresa Cerrillo was on the Organising Committee. In Iguazú (Misiones), Argentina, was held in October 2013 the V Congreso Forestal Argentino y Latinoamericano, with participation of papers about poplar and willow breeding, among other issues and species. The VI Meeting of GeMFO (Genética y Mejoramiento Forestal de INTA) was held from 7 to 10 April 2014 in Campana (Buenos Aires) Argentina; different working groups presented papers about the main productive forest in Argentina (*Pinus*, *Eucalyptus*, *Populus* and *Salix*) and native species (of *Araucaria*, *Prosopis*, *Nothofagus* and *Cedrella*).

We have not been informed by IPC colleagues of any other member countries, or groups of countries, holding workshops or symposia focussed on breeding or poplars or willows for specific purposes.

- **Update the data-base about the breeding programs and pollen collections**

*(Annexes at the end of this report: Table 1: poplars; Table 2: willows)*

On the basis of: a) the information collected until 2012; b) new information received in 2014 from colleagues of eleven member countries; and c) reviewing the documents presented at the meeting of India, it has been possible to perform an upgrade of the database (that is non exhaustive and in progressive construction).

Some highlights of this update are summarized in the following comments and tables.

- . The programmes were mostly well established or advanced, and had commonly been operating for at least 15 years.
- . Most of the programmes are from government-owned institutes; however, here are some examples of private participation in poplar and willow research. In France, a scientific consortium linking a private (FCBA) and 2 government institutions (IRSTEA and INRA), with 5 staff involved in a poplar breeding programme and has working since several years. In U.S., Netherlands and Argentina, private programmes are developed. In New Zealand, the research programme is being funded by local government and commercial sponsorship, with a separate programme related to climate change funded by central government to 2015. In some cases, the programmes are part of broader projects, as in Finland, where the poplar breeding programme is part of "Forest Tree Breeding 2050", the Finnish national long-term tree breeding plan.

- . Poplar: almost all of the programmes use *P. deltoides*, *P. nigra* and *P. xcanadensis* in their crosses. The other most commonly used species are: *P. alba*, *P. maximowiczii* and *P. trichocarpa*. There are advances on the study and experimentation of a wide range of native poplars in China and India; this subject, concerning the conservation and development, highlighted in several papers presented at the last Session of IPC in India. E.g., in China *P. ussuriensis* (naturally distributed in Changbaishan Mountain and Lesser Khingan Range area of northeast China, and characterized by good wood quality and excellent hardiness) and *Populus caspica* (a genetic reserve). In India *Populus gamblii*, that grows naturally within an extremely restricted area in the lower hills of North Bengal.
- . Willow: *S. alba*, *S. matsudana* and *S. fragilis* were the most commonly used willows. Regarding other species -for biomass improvement goal-, *S. amygdaloides*, *S. viminalis* and *S. eriocephala* are frequently used. Advances on the study of native willows in India were reported in the 24th Session of IPC in Dehradun.
- . Willow breeding programs are addressed mainly to biomass production (as Croatia, Italy, US, Spain, Canada, Serbia, Sweden and UK). Instead, the main goal of the *Salix* breeding program in Argentina is to obtain tree willows clones for sawing and pulp for newsprints; as second aim, to develop new clones for biomass and shrub willows clones for basketry.
- . Objectives and methodologies: the focus of most programs is on the evaluation of inter-specific hybrids. However, some within-species testing is carried out, e.g., the evaluation of salt tolerance in progeny from open-pollinated natural stands of *P. alba* in Spain, and the testing of native intra-specific. In several cases, selection of foreign gemoplasm, as a main step in breeding programs.
- . Most programmes apply as “typical schedule” (from collection and crossing to release): collection, provenance and progeny testing of breeding population; selection of parents; controlled crossings; nursery scoring for diseases, branch habit, leader dominance and vigour; field testing for site adaptability, growth rate, form and stock/pest resistance. Application of tools of genomics can promote faster results by means a better understanding of between- and within-species and how best to recombine the variation in both intra- and inter-specific breeding programs.
- . In some cases, genetic transformation for useful traits is reported, as from Italy and France; mostly as a research tool to identify candidate genes of interest, but not to create specific clones for commercialization.
- . Released new clones: most programs released new clones or varieties after 16-20 years from the initial cross. However, there are cases in which the release of new clones occurs more rapidly (as in some private programs in U.S. and Italy which made selections after 10 years).
- . Traits selected for included: survival, fast growth rates, branch habit, leader dominance and vigour, site adaptability (e.g. tolerance of short summers and extreme winter temperatures, droughts, flooding (specially, in willows), wind, growing season frosts), insect and disease resistance stock resistance, high water-use-efficiency and nutrient-use-efficiency. In some countries combine adaptation to the wide range of environmental conditions in different regions of the territory, tolerance to pests and insects, volume production and various wood quality traits, are reported as a significant goal for poplar (e.g in France) and willow (e.g. in Argentina) breeding programs.
- . Wood: pulp/fibre production and quality log and peeled veneer production were the main industrial uses of new released poplar cultivars. Spain reports the evaluation of environmental factors affecting quality and quantity of wood, and about analysing the expression of genes involved in wood formation. In Argentina, willow wood quality for dual purpose (sawing pulp and paper industries) is an important goal in the *Salix* breeding program (because of their implications for the

entire production chain); in this sense, four new willows clones (registered in 2013) have this double characteristic for the wood application; in addition to good adaptation -to the environmental conditions of the Paraná River Delta-, forest health and performance (yield and stem form).

The use of near infrared spectroscopy for determination of cellulose, lignin, contents, specific gravity, calorific value, etc is reported from US.

- . Environmental uses: several countries report environmental uses and reasons for poplar and willow breeding, which include: soil restoration and conservation, afforestation of agricultural or marginal land, shelterbelts, phytoremediation, riparian and riverbank protection, carbon sequestration, stock shade and fodder, amenity and landscaping. The development of new willow cultivars both for biomass production and environmental applications (phytoremediation and environmental restoration) represents an important issue in Europe, North America and Argentina).
- . Bioenergy: clear advances about the role of willow and poplar for bioenergy applications are observed in North America and Europe, where the Breeding programs have important progress, reaching clones released that were selected for this aim (as shown in point e). An increased emphasis about that it's observed in recent years (mostly, those comprising the last two Sessions of IPC).  
Some breeding programs are working in the exploration of the diversity of poplar and willows from natural stands, and produced through controlled hybridization, to identify and to apply species and individual genotypes that display traits well-suited for environmental engineering and bioenergy applications.
- . Difficulties: some breeding programs have many experimental varieties being tested, but there are some resources limitations, in terms of adopting new screening techniques and accelerated flowering of parent material.
- . Collaboration: efforts are made to share evaluation between breeding programs of several countries. In Europe, field experimental networks including clones developed, in Italy, France, Belgium, Croatia, between others, have been established the last 5 years; to develop networks before registration of material is an important aim. In France specific efforts have been deployed also to the enrichment of the *P.nigra* breeding population thanks to recent studies about geographical distribution in natural populations in France.

**Released and emerging clones in the last seven years** (*based on the current information available at the present*)

**Argentina:**

Poplars:

*P. deltoides* 'Carabelas INTA' (2008)

Recently, a pool of 6 *P. deltoides* clones for wood industry was characterized (also by the best plasticity of growth, stem straightness and canopy architecture) and will be proposed to the National Register of Cultivars of the National Institute of Seed (INASE).

Willows:

*Salix matsudana* × *Salix alba* 'Agronales INTA-CIEF' (2013)

*Salix matsudana* × *Salix alba* 'Los Arroyos INTA-CIEF' (2013)

*Salix matsudana* ×? 'Géminis INTA-CIEF' (2013)

*Salix matsudana* × *Salix nigra* 'Lezama INTA-CIEF' (2013)

*Salix alba* ×? 'Yaguareté INTA-CIEF' (2013)

*Salix nigra* ×? 'Ibicuy INTA-CIEF' (2013)

More recently, other 2 *Salix matsudana* × *Salix alba* new clones will be proposed to the National Register of Cultivars of the National Institute of Seed (INASE). The release of five new clones is expected within the next 5 years.

### **Italy:**

#### Poplars:

*P. deltoides* 'Baldo' (2007)

Recently, a pool of 9 *P. × canadensis* clones for wood industry and biomass production were characterized (also by the best plasticity of growth, stem straightness and canopy architecture) were proposed to the National Poplar Commission and further evaluated in three different sites on the Po Valley with the aim to get information on the quality and technological wood characteristics

#### Willows:

*Salix matsudana* ×? 'Drago'(2007)

*Salix matsudana* ×? 'Levante' (2007)

### **France**

#### Poplars:

New commercial clones from the *P. deltoides* intraspecific recombination programme have been released in 2013.

More than 150 new interspecific clones are presently at final stage of selection. The release of ten new clones is expected within the next 5 years.

### **Germany:**

#### Poplars:

Hybrid Aspen (*P. tremula* × *P. tremuloides*) Clones: Esch 2, Esch 8, Se 1, Th 1291 (all 2013)

Hybrid Aspen (*P. tremula* × *P. tremuloides*) F1 Juwel 1 ;Juwel 2 (2013)

### **Croatia:**

#### Willows:

Four clones for biomass production is now second year for DUS testing (distinct. uniform, stable) in Poland: *S. alba* V 95; *S. matsudana* × unknown V 578; *S. matsudana* × (*S. matsudana* × *S. alba*) V 461 and *S. matsudana* × (*S. matsudana* × *S. alba*) V 374.

### **New Zealand**

#### Poplars:

*P. deltoides* × *P. ciliata* 'Kaimai' (2011)

*P. deltoides* × *P. ciliata* 'San Rosa' (2011)

*P. deltoides* × *P. ciliata* 'Rotorangi' (2011)

### **US**

#### Poplars:

*P. x generosa* selections: 203-92-3056; 445-95-13062 (2014)

*P. deltoides* × *P. maximowiczii* selections: 605-97-19163 (2009)

### **Sweden and the UK**

Willows (short rotation coppice (SRC))

*Salix dasyclados* ×? 'Klara'  
(2008)

Discovery (*S. schwerinii* Hilliers × Björn (*S. schwerinii* 79069 × *S. viminalis*

Orm) × Quest (*S. viminalis* Pavainen × Björn (*S. schwerinii* 79069 × *S. viminalis* Orm)) 'Roth Chiltern' (2013)

*Salix viminalis* 'Meteor' (Possibly in 2014)

*Salix viminalis* × (*S. schwerinii* × *Salix viminalis* Björn ) 'Advances' (Possibly in 2014)

*Salix redheriana* × *Salix dasyclados* 'Endurance' (Possibly in 2015)

➤ **Database on Poplar and Willow clones collection, pollen collections and gene banks**

The data received from individual countries is been compiled into a single spreadsheet which has been provided to IPC for inclusion on the website. In many of the member countries, clonal collections (mostly of poplar) are held though no breeding activities are currently occurring.

Activities about conservation/collections of *Populus* and *Salix* were reported by colleagues from several member countries.

In Spain, there are some different collections: a) *in vitro* germoplasm collection of *P. tremula* (25 clones), representative of the genetic diversity in Castilla-León; the aim is the conservation and restoration and reforestation use. b) *P. alba* collections (442 clones), c) *P. x canescens x P. alba* (61 clones) and d) *P. deltoides x P. alba* (106 clones). Institutions involved: University of Málaga; University of Valladolid, ETSI Agrarias, Campus de Palencia; Centro Nacional de Recursos Genéticos Forestales El Serranillo (MAGRAMA); Centre for Biotechnology and Genomics in Plants (CBGP) and INIA-CIFOR).

Regarding pollen collection procedures, are largely the same across all institutes, with only small differences in storage temperatures:

In France,

Main objective is for use in controlled crosses. *Populus deltoides*, *Populus trichocarpa*, *Populus nigra*, *Populus deltoides x P. trichocarpa*, *Populus deltoides x P. nigra* pollen.

Methodologies in use for collection and conservation: dehydration and storage at  $-18^{\circ}\text{C}$ .

Pollen exchange with other organizations: exchanges of *P. nigra* donor pollens for controlled crosses with INBO-Belgium (one every two years according to demand)

In Germany, *P. tremula*, *P. tremuloides*, and their hybrids pollen is storage under vacuum at  $-18^{\circ}\text{C}$  (very efficient). Pollen exchange with other organizations: on demand.

In Italy, flowering branches collected and placed in water culture under heat and light; after that, mature pollen collected from the catkins, then placed in vacuum dryer for one day and then stored at  $+4^{\circ}\text{C}$  for several months or at  $-40^{\circ}\text{C}$  for up to one-five years.

*P. nigra* pollen and has been supplied recently to Potlatch Corporation (Oregon-USA) and Westvaco Forest Resources (Kentucky-USA) in order to start with breeding program.

In New Zealand, pollen collection is part of breeding program.

Flowering branches collected and placed in water culture under heat and light. Mature pollen collected by agitation of the flowers, pollen placed in vacuum dessicator for one day and then stored at  $4^{\circ}\text{C}$  for several months or at  $-70^{\circ}\text{C}$  for up to one year.

Poplars: *P. deltoides*, *P. nigra*, *P. x canadensis*, *P. ciliata*, *P. maximowiczii*, *P. szechuanica*, *P. trichocarpa* and *P. yunnanensis*.

Willows : *S. alba*, *S. matsudana*, *S. pentandra*, *S. fragilis*, *S. lucida* spp. *lasiandra*, *S. lasiolepis*, *S. purpurea* and *S. nigra*.

In Serbia, *P. deltoides* and *P. nigra* pollen collections are apply as part of breeding program only. Flowering branches collected and placed in water culture under heat and light. Mature pollen collected by agitation of the flowers, pollen placed in vacuum desiccators for one day and, then, stored at  $4^{\circ}\text{C}$  for several months.

In US, *P. deltoides*, *P. trichocarpa*, *P. nigra*, *P. maximowiczii* and *P. simonii* species are considered for their pollen collections. Mainly collecting from superior clones growing in breeding arboreta; forcing male inflorescences indoors on detached branches, pollen collected from dehiscing anthers and also from anthers that shed pollen after being detached and dried overnight. Pollen dried over desiccant for 24 hours and stored either at  $0^{\circ}\text{C}$  (short term) or  $-18^{\circ}\text{C}$  (long term). Some pollen exchange is operating with international cooperators, e.g. *P. maximowiczii* pollen from several Asian sources; other exchanges: with Alasia Franco Vivai,

Northwest German Forest Research Institute, The Directorate of Forest Research, Quebec Ministry of Natural Resources.

➤ **Standard designs for Poplar and Willow breeding programmes**

The last advances were done in 2012-2013 by contacts between Teresa Cerrillo and Francisco Zamudio, who have produced a table of contents (chapter headings) for a future publication. Activity will be continued, as part of the action plan for the next two years

**Difficulties encountered, corrections suggested, acknowledgment and final comments**

It's clear that it's necessary a more participation, communication, emailing and encouragement by the working party officers. However support and action from the leaders of breeding programs is required also. Will be welcome the proposed reviews of the working party structure, and the possibility of developing new activities for the common interest and benefit of the member countries.

The capacity of the working party to gather, exchange and share information from member countries about expertise, breeding activities, and germplasm resources held by other member countries is seen as a strength of this WP of the IPC. In this sense, and specifically regarding the updating of the data base about Breeding Programs, there has been active collaboration from our colleagues from different member countries, who have sent their information to share (in some cases, asking other colleagues in their countries).

Ian Mc Ivor (New Zealand)  
Sasa Orlovic (Serbia)  
Brian Stanton - Carlos Gantz (United States)  
Lorenzo Vietto (Italy)  
Davorin Kajba (Croatia)  
Catherine Bastien (France)  
Hortensia Sixto (Spain)  
Francisco Zamudio (Chile)  
Georg von Wuehlich (Germany)  
Konstantinos Spanos (Greece)  
Egbert Beuker (Finland)

Future new contributions from other countries will be valuable for the WP. It would be useful to have the information from the website of IPC for allow other member countries to see where current expertise lies and where complementary work exists or collaborations can be sought.

Teresa CERRILLO

Technical Secretary  
*Buenos Aires, Argentina*  
*18th July 2014*

Annexes:

- . **Table 1:** INSTITUTIONS AND CONTACTS
- . **Table 2:** POPLAR SPECIES AND HYBRIDS INVOLVED IN BREEDING, CONSERVATION AND/ OR IMPROVEMENT
- . **Table 3:** WILLOW SPECIES AND HYBRIDS INVOLVED IN BREEDING, CONSERVATION AND/OR IMPROVEMENT

## **Table 1: INSTITUTIONS AND CONTACTS**

### **ARGENTINA**

Instituto Nacional de Tecnología Agropecuaria (INTA) (<http://www.inta.gob.ar>)

- . Poplar Breeding Program: Silvia Cortizo ([cortizo.silvia@inta.gob.ar](mailto:cortizo.silvia@inta.gob.ar))
- . Willow Breeding Program: Teresa Cerrillo ([cerrillo.teresa@inta.gob.ar](mailto:cerrillo.teresa@inta.gob.ar))

Centro de Investigaciones y Experiencias Forestales (CIEF). Private research institution, involved in a poplar and willow selection program.

- . Guillermo Bunse ([guillermo.cief@gmail.com](mailto:guillermo.cief@gmail.com))

### **BELGIUM**

Instituut voor Bosbouw en Wildbeheer (Institute for Forestry and Game Management) (<http://www.ibw.vlaanderen.be>)

- . Michiels Boudewijn ([boudewijn.michiels@inbo.be](mailto:boudewijn.michiels@inbo.be))
- . Pierre Van Peteghem ([pierre.vanpeteghem@inbo.be](mailto:pierre.vanpeteghem@inbo.be))

Universiteit Gent - Bioenergy Group

- . Wout Boerjan ([wout.boerjan@psb.vib-ugent.be](mailto:wout.boerjan@psb.vib-ugent.be))

### **CANADA**

Willows: Natural Resources Canada, Canadian Forest Service – Atlantic Forestry Centre, P.O.

### **CHILE**

Centro Tecnológico del Álamo, Universidad de Talca (<http://ctalamo.otalca.cl>)

- . Francisco Zamudio ([fzamudio@otalca.cl](mailto:fzamudio@otalca.cl))

### **CROATIA**

University of Zagreb, Faculty of Forestry, Department of Forest Genetics and Dendrology,

- . Davorin Kajba ([davorin.kajba@zg.htnet.hr](mailto:davorin.kajba@zg.htnet.hr))
- . Sasa Bogdan ([sasa.bogdan@zg.htnet.hr](mailto:sasa.bogdan@zg.htnet.hr))

### **FINLAND**

Finnish Forest Research Institute

- . Egbert Beuker ([Egbert.beuker@metla.fi](mailto:Egbert.beuker@metla.fi))

### **FRANCE**

Scientific consortium : GIS Peuplier linking FCBA (1), IRSTEA (2) and INRA (3,4

- . 1-Catherine BASTIEN, present head of the GIS consortium, INRA Unité AGPF, Orleans Cedex ([Catherine.bastien@orleans.inra.fr](mailto:Catherine.bastien@orleans.inra.fr))
- . 2-Alain BERTHELOT, FCBA, Charrey-sur-Saône
- . 3-Patrick BALDET, IRSTEA, Nogent-sur-Vernisson
- . 4-Bénédicte FABRE, INRA Unité IAM, Champenoux

Type of institution: 1,3,4: Government/State; 2: Private

### **GERMANY**

Federal Research Institute for Rural Areas, Forestry, and Fisheries- Thuenen-Institute for Forest Genetics

- . Mirko Liesebach ([mirko.liesebach@ti.bund.de](mailto:mirko.liesebach@ti.bund.de))
- . Georg von Wuehlisch ([georg.vonwuehlisch@ti.bund.de](mailto:georg.vonwuehlisch@ti.bund.de))
- . Matthias Fladung ([matthias.fladung@ti.bund.de](mailto:matthias.fladung@ti.bund.de))
- . Volker Schneck ([volker.schneck@ti.bund.de](mailto:volker.schneck@ti.bund.de))

## **GREECE**

National Agricultural Research Foundation (N.AG.RE.F), Forest Research Institute (F.R.I.) - (<http://www.fri.gr>)

- . Konstantinos Spanos ([kspanos@fri.gr](mailto:kspanos@fri.gr))

## **ITALY**

Consiglio per la ricerca e la sperimentazione in agricoltura- Unità di ricerca per le produzioni legnose fuori foresta (CRA-PLF) [www.populus.it](http://www.populus.it)

- . Lorenzo Vietto ([lorenzo.vietto@entecra.it](mailto:lorenzo.vietto@entecra.it))

Alasia Franco Vivai (Italian private company carrying out an activity of poplar breeding. Has collaborations with University of Tuscia in Viterbo and CNR of Porano; Green Wood Resources, Portland - OREGON and the Joint Research Centre (Institute for the Environment and Sustainability) and Science Department of the Environment and the Territory (University of the Studies of Milan Bicocca).

## **SERBIA**

Institute of Lowland Forestry and Environment ([www.ilfe.org](http://www.ilfe.org))

- . Sasa Orlovic ([sasao@uns.ac.rs](mailto:sasao@uns.ac.rs))

## **SPAIN**

Centre for Forest Research, Spain (<http://www.inia.es>)

- . Hortensia Sixto ([sixto@inia.es](mailto:sixto@inia.es))

Other institutions involved: University of Málaga; University of Valladolid, ETSI Agrarias, Campus de Palencia; Centro Nacional de Recursos Genéticos Forestales El Serranillo (MAGRAMA); Centre for Biotechnology and Genomics in Plants (CBGP) and INIA-CIFOR.

## **US**

Poplars:

Greenwood Resources ([www.greenwoodresources.com](http://www.greenwoodresources.com))

- . Carlos Gantz ([carlos.gantz@gwrglobal.com](mailto:carlos.gantz@gwrglobal.com))

Willows: Department of Horticulture, Cornell University, New York State Agricultural Experiment Station, Geneva, NY 14456, USA

**The Netherlands** Alterra Green World Research, (private research institution involved in an established poplar and willow breeding programme) ([www.altera.wageningen-ur.nl](http://www.altera.wageningen-ur.nl))

- . Sven de Vries ([Sven.devries@wur.nl](mailto:Sven.devries@wur.nl))





**Working Party on Poplar and Willow Genetics, Conservation and Improvement**  
**Table 3. WILLOW SPECIES AND HYBRIDS INVOLVED IN BREEDING / CONSERVATION / IMPROVEMENT ACTIVITIES**

Country			
			<i>S. alba</i>
			<i>S. alba</i> var. <i>calva</i>
			<i>S. alba</i> var. <i>coerulea</i>
			<i>S. alba</i> var. <i>vitellina</i>
		x	<i>S. matsudana</i>
	x		<i>S. fragilis</i>
			<i>S. jessoensis</i>
			<i>S. x rubens</i> ( <i>S. alba</i> x <i>S. fragilis</i> )
		x	<i>S. babylonica</i>
		x	<i>S. babylonica</i> var. <i>sacramenta</i>
		x	<i>S. humboldtiana</i>
		x	<i>S. nigra</i>
	x		<i>S. amygdalina</i>
		x	<i>S. amygdaloides</i>
		x	<i>S. bondpalndiana</i>
	x		<i>S. viminalis</i>
			<i>S. pentandra</i>
			<i>S. purpurea</i>
			<i>S. lasiolepis</i>
			<i>S. lucida</i> spp <i>lasiandra</i>
			<i>S. sachalinensis</i>
	x		<i>S. sitchensis</i>
		x	<i>S. eriocephala</i>
			<i>S. acmophyla</i>
		x	<i>S. bebbiana</i>
		x	<i>S. discolor</i>
		x	<i>S. interior</i>
		x	<i>S. humilis</i>
		x	<i>S. petiolaris</i>
			<i>S. tetrasperma</i>
			<i>S. udensis</i>
			<i>S. S. dasyclados</i>
			<i>S. schwerinii</i>

