



INTERNATIONAL POPLAR COMMISSION

23rd Session

Beijing, China, 27 – 30 October 2008

POPLARS, WILLOWS AND PEOPLE'S WELLBEING

Synthesis of Country Progress Reports

**Activities Related to Poplar and Willow Cultivation and Utilization,
2004 through 2007**

October 2008

Disclaimer

Nineteen member countries of the IPC have provided national progress reports to the 23rd Session of the International Poplar Commission. A Synthesis has been made by the Food and Agriculture Organization of the United Nations (FAO) and summarizes issues, highlights status and identifies trends affecting cultivation, management and utilization of Poplars and Willows in temperate and boreal regions of the world.

Comments and feedback are welcome.

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Web references:

For details relating to the International Poplar Commission as a Technical Statutory Body of FAO, including National Poplar Commissions, working parties and initiatives, can be viewed on www.fao.org/forestry/ipc, and highlights of the 23rd Session of the International Poplar Commission 2008 can be viewed on www.fao.org/forestry/ipc2008.

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ACKNOWLEDGEMENTS

This Synthesis of Country Progress Reports is the product of close collaboration between National Poplar Commissions' personnel and FAO consultants and staff. The major scope and diversity of information available on natural and planted forests and trees of poplars and willows is reflected by the range of authors from a diverse range of International Poplar Commission Member Countries.

It is with appreciation that the efforts of the National Poplar Commissions' personnel are recognized for having submitted Country Progress Reports and Statistics in compliance with the general textual and statistical guidelines, which facilitated preparation of the global synthesis. Ms Paule Têtu, Mr Alberto Del Lungo, Ms Lei Chen and Ms Michèle Millanès, FAO Consultants, provided professional services in authorship, statistical compilation and editing services respectively. The communications with the National Poplar Commissions were efficiently coordinated by the IPC Administrative Assistant, Ms Graciela Andrade (FAO).

To all who contributed to this publication, we express our grateful thanks.

FOREWORD

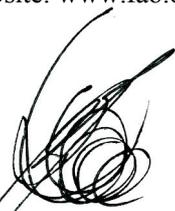
The area of poplar and willow resources reported includes about 80 million hectares of indigenous forest associations and about 8 million hectares of planted forests and trees outside forests. Poplars and willows are managed as indigenous and planted forests, agroforestry and tree resources for both productive and protective purposes across temperate and boreal landscapes. They can provide valuable investments for Government, private sector, corporate and smallholder owners that provide goods and services that benefit the well-being of communities in their environments.

Poplars and willows provide a wide range of goods (wood and non-wood) and services (social and environmental) that impact sustainable land-uses and peoples' livelihoods. They provide raw material supplies for industrial processing for pulp, paper, engineered wood products, plywood, veneer and other boards, sawn timber, packing crates, pallets, furniture and increasingly bioenergy. They can also provide valuable non-wood products such as livestock fodder, medicinal extracts and associated food products. However, poplars and willows are increasingly valued for their provision of social and environmental services including shelter, shade and protection of soil, water, crops, livestock and dwellings. They are more and more used in phytoremediation of severely degraded sites, rehabilitation of fragile ecosystems, combating desertification and in forest landscape restoration (often integrated with agriculture, horticulture, viticulture and apiculture). As fast growing species, they are effective at sequestering carbon and as carbon sinks thus can be effective in both adaptation and mitigation of the effects of climate change. Poplars and willows have become a significant resource that supports employment and contributes to socioeconomic development and sustainable livelihoods in many parts of the world, particularly in rural areas.

Country Progress Reports for the period 2004 through 2007 were submitted by Argentina, Belgium, Bulgaria, China, Croatia, Egypt, Finland, Germany, India, Italy, the Republic of Korea, Morocco, New Zealand, Romania, Serbia, Spain, Sweden, Turkey, and the United States of America. Most reports provided detailed information on topical issues, statistics, innovations and trends in poplar and willow culture and use. Canada and the Russian Federation provided only statistical tables.

This Synthesis highlights status, innovations, issues and trends in regards to cultivation, management and utilization of poplars and willows in temperate and boreal regions of the world. A secondary purpose is to draw the attention of IPC members, policy makers, scientists, producers and other individuals to the rich diversity of expertise, knowledge and leadership documented in the various Country Progress Reports.

This Synthesis of Country Progress Reports: Activities Related to Poplar and Willow Cultivation and Utilization, 2004 through 2007 (Working Paper IPC/6) should be read in association with Publications Listed in Country Progress Reports (Working Paper IPC/7), a comprehensive listing of reference documents released during 2004-2007. These documents are to foster and facilitate transfer of new knowledge and technology around the world. They also aim at strengthening capacity and capability for lesser developed countries to define new roles and take actions to make greater contributions of poplars and willows towards sustainable forestry and socioeconomic development. Working Papers IPC/6 and IPC/7 are available on the FAO website: www.fao.org/forestry/ipc.



Jim Carle
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HIGHLIGHTS AND ISSUES

The present document offers information on status, research advancements and issues concerning poplar and willow cultivation and use during the period 2004 to 2007, as reported even more extensively by member countries of the International Poplar Commission for the 23rd Session of the IPC. This meeting, entitled Poplars, Willows and People's Wellbeing, is taking place in Beijing, China, from 27 to 30 October 2008. Various general observations can be highlighted. Some of these are similar to what was reported in the 2000-2003 Synthesis, which indicates either longer-term tendencies or, in some cases, the fact that, for various reasons, there have been inabilities to address these key issues.

- In the vast majority of countries reporting, poplar and willow cultivation and uses are well established in the national economy and most countries express objectives towards an increase of those activities.
- Government policies are generally positive towards poplar and willow cultivation and use.
- The cultivation of poplars and willows is seen in many countries as part of the integrated rural landscape in which it can contribute to sustainable livelihoods and integrated rural development, including agriculture, with livestock and cash crop production, horticulture and viticulture. Agroforestry systems using intercropping, mostly with poplars, are common and generally seen as very positive for the farmers because they provide regular and relatively secure economic returns.
- Many countries still experience organizational and technical challenges. For example, the regulatory mechanisms to ensure a supply of certified nursery planting materials to the growers are reported to be insufficient in some cases. This has major effects on growth and yield performance and a significant impact on wood quality for the processing industries.
- Whereas poplar has been grown and used for a longer period of time, interest for willow cultivation and wood processing is definitely gaining momentum. In some countries, it is noted that farmers are still hesitant to plant willows, as future demand is uncertain and prices difficult to predict.
- There is continued awareness regarding the value of natural stands and species of poplars and willows for tree improvement possibilities.
- Programmes for the conservation of natural poplar and willow stands are generally strong in most countries, but are proving difficult in some.
- Insect and disease infestations and damages continue to have major impact on forest health, growth and stem quality for both poplars and willows.
- Programmes concerning the genetic modification of poplars are being actively pursued, both with developed and developing economies, and the poplar genome has been mapped. Many countries report significant progress in genetic characterization and manipulation to provide resistance against pests, diseases and other stresses, namely drought or flooding, improve technical properties as well as growth and yield.
- The utilization of poplars and willows is diversifying into a wide range of solid and engineered wood and fibre products.
- The use of poplars and willows as a source of renewable energy is accelerating in several countries.
- The contribution of poplars and willows cultivation systems and products to carbon sequestration is also gaining major interest.
- Phytoremediation of polluted soil and water using poplars and willows is being implemented in several countries, essentially on all continents.
- Poplars and willows are increasingly used for forest landscape restoration, rehabilitation of degraded lands, and combating desertification.
- Forest certification has been applied to poplar cultivation in some countries to demonstrate social, environmental and economic sustainability.
- Research has continued to be very active although financial constraints are identified by most countries.
- The great amount of literature produced in the last decade on willow and poplar cultivation and use indicates not only research interest (and gaps) but also that many countries see these species as

valuable solutions to major issues such as sustainable social and economic development, energy needs, biodiversity protection, etc.

- The number of contacts and exchanges between and within member countries of the IPC confirm strong interest in the growing and utilization of poplars and willows and the need for strong transfer mechanisms, both from a technical and policy-making perspective. In this context, the IPC continues to provide value for participating countries.

The following attempts to identify various issues and trends affecting the future cultivation and use of poplars and willows around the world, obviously at various levels in different countries. The vast majority have been highlighted in one or a few Progress Reports produced by member countries. They are presented as food for thought and elements to consider in future technical or policy making developments.

- In some countries, innovative policies are needed to better integrate the development of technology-based poplar and willow plantations and wood-based industries, as a means to increase social benefits, including employment opportunities, environmental protection and economic returns.
- Some countries are clearly in a transition period towards a significant increase in poplar and willow cultivation and use. One of the key conditions for success will be in the quality and level of training all along the value chain.
- The development of agroforestry opportunities using poplars and willows will need to overcome certain barriers, namely the absence of tradition for such projects, poor knowledge and technical transfer, restricted financial support (major investment costs are upfront whereas returns occur some years later) or unorganized markets for the wood produced, often in rural areas.
- The pathways to establish compatibility between poplar and willow cultivation and protected areas networks have not yet been clearly identified in most countries.
- The current precarious status of *P. nigra* points to the importance of establishing and maintaining global monitoring systems to ensure that genetic biodiversity is protected. The use of non-indigenous poplar and willow species will in all likelihood continue, at least in most countries, but increasingly, the recourse to indigenous species will be favoured, particularly in areas presenting high biodiversity or ecological sensitivities.
- Genomics is generally seen as the key for making poplars and willows a feedstock of choice for bioenergy. New findings are occurring and communicated frequently. One of the challenges, from a global perspective, will be in ensuring that the gains from energy consumption using such biomass will not be overshadowed by unforeseen negative environmental, social or economic benefits. For example, striking the balance between using hectares for biomass production and for agricultural purposes has already become a global issue. It must be ensured that poplar and willow cultivation is part of integrated solutions.
- Biosafety issues are being raised in the context of genomics research and applications. Given that an increasing number of transgenic poplar and willow plants are being tested and produced, much work is needed to examine their short and long effects on the environment, including gene flow with other species, gene stability, etc. Additional efforts are also essential in regards to containment strategies.
- In many countries, social opposition to genetically modified organisms remains high. All local and global strategies to further develop poplar and willow cultivation systems will need to address these concerns, provide solutions and identify scientifically-sound responses in guiding forest management policies. This has become particularly important in today's globalized world.
- The role of poplar and willow cultivated systems within carbon credit equations is still unclear. The carbon mitigation potential coming from willow and poplar plantations, for instance in restoration of degraded lands or unused agricultural lands, is immense. The fact that poplars and willows can be used as substitutes to greater carbon emission sources for energy purposes also holds tremendous promises to support greenhouse gas emission reductions. Adaptation to climate change was rarely mentioned as such in the various national progress reports but the fast-growing profile of poplar and willow short-rotation plantations would appear to be a significant asset because practices and approaches can be more easily changed in response to climate, over short periods of time. For the vast majority of countries, there is a strong need for policy development support in these areas.

- Bioenergy producers are now competing with more traditional industries for the same fibre material. Some countries mentioned that this may already be creating an imbalance between supply and demand as well as additional pressures on price. It can also have a profound effect on how forest stands are tended because wood product manufacturing and biomass production do not necessarily require the same approach and the value chains can be quite different.
- In all likelihood, the emerging industries of nano-materials and nano-enabled products offer tremendous potential for poplar and willow. This area is just beginning to be explored. Here again, genomics may play a significant role.

I. INTRODUCTION

The main purpose of this Synthesis is to identify issues, innovations and trends in regards to Poplar and Willow culture and use as reported by countries participating in the International Poplar Commission (IPC). A secondary objective, nonetheless important, is to draw the attention of IPC members, policy makers, scientists, producers and other individuals to the rich diversity of experience and leadership documented in the various Country Progress Reports, which are available on the IPC website www.fao.org/forestry/site/ipc. In total, 19 member countries of the IPC and one non-member country reported for the 2004-2007 period (21 in 2004, 24 in 2000). An additional member country sent only statistical data.

In developing this document, only activities actually carried out during the period since the last IPC Session (Santiago, Chile, 29 November – 2 December 2004) have been included. With few exceptions, future plans reported by the various countries have not been included.

The Synthesis follows the format of the National Report Guidelines, except that the list of publications in each national report has been extracted and published separately as Working Paper IPC/7. The Synthesis will be presented to the 23rd Session of the IPC in Beijing, China, 27-30 October 2008, and will also be posted on the IPC website.

II. POLICY AND LEGAL FRAMEWORK

Most countries, many of which are also members of the European Union (EU), described their continual efforts in applying the EU Regulation 1257/1999 and the subsequent Regulation (EC) 1698/2005 concerning community support for rural development.

Spain indicated the adoption in 2006 of a new regulatory framework for agriculture and silviculture supporting rural development, competitiveness, innovation and economic diversification. The progress report also refers to a 2007-2013 Rural Development Plan and notes that the country's different Autonomous Communities have the responsibility to regulate the support programmes, determine the technical requirements and establish the list of species allowed for afforestation efforts. A 2003 Decree had already been adopted for the production and commercialization of forest reproductive materials. A new 2006 National Strategy for the conservation and sustainable use of genetic forest resources identifies the native species and hybrids of native *Populus* as priority targets for the implementation of conservation plans.

Italy reported the publication, in 2004, of a new Decree that, among other aspects, assigns to its Regions and Autonomous Provinces the responsibility of the marketing and quality of forest reproductive materials. Its Poplar National Commission has also been given key responsibilities with respect to poplar clones regulations.

China noted that a 2004 Special Plan was adopted to better connect the establishment of raw material supply with the needs of the pulp and paper industry, a key area being the development of fast-growing and high-yielding (FGHY) timber plantations, notably with poplar. The goal is to establish 13.3 million ha of FGHY plantations by 2015, meeting 40% of domestic timber demand. A 2007 National Economic and Social Development Plan has also been adopted to endow farmers with stable long-term forestland management contracting rights and the ownership of the produced wood. The goal is to reach 167 million ha of such "collectively owned forestlands" which would represent 60% of China's total forestland.

As indicated in the previous synthesis report, the **Republic of Korea** reiterated that, given various free trade agreements already signed or underway, it expects that more of the "set aside" agricultural land will be used for fast growing trees such as poplar.

Croatia reported the adoption of a National Forestry Strategy and Policy (2003), the enactment of a new Law on Forests (2005) and a Law on Forest Seed and Plant Material (2005), the establishment of a Forestry Extension Service (2005) and a new Chamber of Forestry and Wood Technology Engineers (2005).

Serbia noted the adoption of a Law on Forest Reproductive Material, harmonized with EU Directives and OECD Schemes, as well as a new National Forest Action Plan.

In **Bulgaria**, a 2007 Decree created an independent State Forestry Agency that answers directly to the Council of Ministers. In addition to a new National Strategy for Sustainable Development of the Forest Sector 2006–2015 and changes to the Forestry Act, the progress report mentions key regulatory amendments in regards to the production and trade of forest reproductive materials, to the development of forests, lands and hunting areas, to felling practices and to the production of saplings in state-owned forest nurseries. The new legislation also has provisions for stimulating poplar cultivation by non-state land and forest owners. The report also indicates that the adoption of a new Biological Diversity Act in 2002 is in fact limiting the work with artificial hybrids because many habitats for poplars and willows fall in the “humid zones” of the country’s protected areas network.

In **Belgium**, both the Walloon region and the Flemish region have implemented changes to their granting schemes towards afforestation and reforestation with poplars. The Walloon region also indicated that policies promoting the emerging use of poplars and willows for bio-energy, carbon sinks and other environmental uses are in preliminary stages. The Flemish region noted that 43% of its poplar plantations are now located in its Ecological Network where afforestation with poplars is not allowed because these are considered as exotic species. A 2006 Decree of the Flemish Government determined that short rotation forestry can now be considered as an agricultural crop, a measure which should support poplar cultivation in the future. The country’s progress report also mentions another recent Flemish Decree which requires the certification of forest reproductive materials of poplar species and hybrids.

Various policy changes have also been implemented in **Romania** between 2004 and 2007, namely in regards to the introduction and spreading of organisms harmful to plants or plant products, the establishment of a national system for the estimation of anthropic greenhouse gases from sources or from the sequestration of carbon dioxide, the utilization of poplars and willows within field protection shelterbelts, the regime of protected areas, under which large areas of poplar and willow forests have now been included, and the control of producers, traders and users of forest reproductive materials.

Some countries reported on the emphasis now given to bioenergy and the role that willows and poplars, as well as other species, will play, particularly on agricultural lands. **Sweden** indicated the introduction of two new taxes in 2004, one on Electricity for Households and Services and the other on Reduced Combined Heat and Power Plant, as key tools to guide the development of biomass as a renewable energy source. In 2007, the President of the **United States of America** issued a national challenge to reduce gasoline consumption by 20% by 2017, an objective said in the country’s progress report to be achievable by focusing on non-grain cellulosic material. A recently enacted 2008 Farm Bill increases funding for conservation programmes; financial incentives are provided for retiring cropland and planting trees to prevent soil erosion and agricultural chemical runoff, enhance wildlife habitat and provide alternative bioenergy and wood products for the rural economy.

India, which has established a national goal of 33% effective forest and tree cover, indicated no specific changes in state or central government legislation. However the country’s progress report mentions a change of policy by the State of Himachal Pradesh whereby farmers can now sell their forest produce in other parts of the country after obtaining permits from local authorities. This liberalization is said to have contributed to an increase in biomass production in the state, particularly of poplars. **Turkey** indicated that it is looking to have its entire poplar plant production overtaken by the private sector but that the state would be providing the planting material to the growers to secure clonal control. **Egypt** noted that it has a

programme to foster intensive plantation of poplars and willows for governmental and non-governmental organizations. In some cases, poplar seedlings are distributed free of charge.

III. SUMMARY STATISTICS

Statistics related to poplar and willow cultivation and management are detailed in tables provided in Annex 1. These were drawn from the most current information provided by IPC member countries. For those that were not able to produce an update or others that provided only partial data, assumptions had to be made and data collected for the 2004 Synthesis Report was also used to extract a reasonable trend for the 2004-2007 reporting period.

The following tables are available:

Table 1	Areas of Poplars and Willows by Forest Categories
Table 2	Main Poplar and Willow Cultivars Used
Table 3	Main Trends in Poplars and Willows Area
Table 4a	Poplar and Willow Area by Ownership: Public
Table 4b	Poplar and Willow Area by Ownership: Private
Table 4c	Poplar and Willow Area by Ownership: Small Holders
Table 4d	Poplar and Willow Area by Ownership: Others
Table 5	Poplar and Willow Forest Product Production
Table 6	Average Import/Export of Poplar and Willow Roundwood or Wood Chips

1. Areas

As indicated in Table 1, the overall area of poplars and willows in 2007 is estimated at 79.1 million ha (as compared to 76.6 million ha reported in 2004), of which:

- The vast majority (70.6 million ha) consists of indigenous poplar forest formations.
- Some 444,000 ha consist of indigenous willow stands and 38,400 ha represent mixed indigenous poplar and willow formations.
- Poplar and willow plantations represent 5.3 million ha and 133,400 ha respectively. Mixed plantations of poplars and willows cover 4,200 ha.
- 2.6 million ha of poplars are part of agroforestry systems or as trees outside forests. Few agroforestry projects or trees outside forests were reported with willow (4,200 ha) or a mix of poplars and willows (4,100 ha).

Indigenous poplar forests cover significant areas in some countries, notably **Canada** (28.3 million ha), the **Russian Federation** (21.5 million ha), the **United States of America** (17.7 million ha) and **China** (3 million ha). Natural willow forests are mainly found in the **Russian Federation** (242,100 ha), **France** (66,600 ha) and **China** (60,000 ha). Mixed stands of indigenous poplars and willows are reported mostly in **Croatia** (14,000 ha) and **Spain** (12,000 ha).

The major countries for poplar plantations are **China** (4.3 million ha, which represents an increase from 3.9 million ha in 2004), **France** (236,000 ha), **Turkey** (125,000 ha), **Italy** (118,500 ha), **Germany** (100,000 ha) and **Spain** (98,500 ha). **China** is also the country that reports the largest area for willow plantations (43,200 ha, although this represents a decline from the 79,000 ha reported in 2004). The other countries with major areas of willow plantations are **Argentina** (39,000 ha), **Romania** (20,400 ha) and **Sweden** (15,000 ha). **Croatia** and **Romania** respectively reported 2,000 ha and 1,800 ha of mixed plantations of poplars and willows. **China** also accounts for the largest area of poplars used in agroforestry systems as well as trees outside forests (2.5 million ha in 2007 as compared to 1.0 million ha in 2004).

2. Uses

As indicated also in Table 1, forest products remain the main purpose for poplar and willow cultivation, with 53.0 million ha reported globally, of which:

- 52.7 million ha consist of poplars.
- 308,500 ha consist of willows.
- 15,200 ha consist of mixed poplar and willow formations.

Some 21.3 million ha of poplars and willows are reported as being used for various protective systems, of which:

- The vast majority consists of poplars (21.0 million ha).
- Willows cover 270,300 ha.
- Mixed stands of poplars and willows represent 30,700 ha.

3. Trends in Poplar and Willow

Table 3 provides an indication of area trends reported by the various countries regarding both poplars and willows. A “positive” trend means increasing in area; a “stable” trend means no increase or decrease, and a “negative” trend means decreasing area trend.

For indigenous poplar forests, five countries reported a positive trend (**China, the United States of America, Spain, Romania** and the **Russian Federation**). Nine countries are described as stable, including **India, Croatia, Belgium** and **Turkey**, and three countries (**Bulgaria, Morocco** and **Serbia**) are reporting a negative trend.

For poplar plantations, eight countries show a positive trend, including **China, Bulgaria, Germany**, and **Sweden**. A stable situation is noted for **Italy, Spain, Morocco, Serbia** and **India** whereas a negative trend is reported by seven countries, including **Argentina, Belgium, Croatia, the Republic of Korea** and **Romania**.

For indigenous willow forests, four countries reported a positive trend (**Belgium, Bulgaria, China** and **Spain**) whereas three are showing a negative trend (**Croatia, Serbia** and the **Russian Federation**). A positive trend is also noted in five countries for willow plantations, including **Belgium, Bulgaria** and **China**, while the same number of countries reported negative trends (**Argentina, Croatia, Romania, Spain** and the **Russian Federation**).

For poplars and willows used in agroforestry systems or as trees outside forests, many countries indicated positive trends, including **China, India, Spain** and the **United States of America**. Negative trends are reported by only three countries (**Belgium, Bulgaria** and **Morocco**).

4. Ownership

Table 4 provides details, for each country, on the total area for poplar and willow under cultivation and management by ownership categories. For the period 2004-2007, the total area is 78.7 million ha, of which:

- 51.9 million ha are part of public forests (compared to 52.2 million ha in 2004).
- 26.8 million ha are private forests held by companies and large landowners (16.0 million ha as compared to 14.2 million ha in 2004), smallholders (10.8 million ha as compared to 9.8 million ha in 2004). In 2004, private forests, large corporation and smallholders combined, accounted for 24 million ha.
- Other forms of ownership cover an area of 3,300 ha, almost same as 2004.

Indigenous poplar forests represent large areas of public lands in many countries, as represented by **Canada** (22.6 million ha), the **Russian Federation** (20.3 million ha) and the **United States of America** (3.4 million ha). Some countries also have large areas of indigenous poplar forests owned by the private sector as estimated for the **United States of America** (14.3 million ha), **Canada** (5.7 million ha) and the **Russian Federation** (1.1 million ha). Increases are noted in **China** for both public and private lands; in 2007, the country reports 750,000 ha of private indigenous poplar forests (as compared to 525,000 ha in 2004) and 2.3 million ha of public indigenous poplar forests (as compared to 1.6 million ha in 2004).

For poplar plantations, the total area reported for 2007 is 5.3 million ha (as compared to 4.8 million ha in 2004). **China** is indicating the largest area (4.3 million ha) out of which 1.6 million ha are public and 2.7 million ha are owned by private interests (including smallholders for 600,000 ha). Smallholder ownership is also common for planted poplar production in **France** (116,800 ha), **Italy** (94,800 ha), **Spain** (32,800 ha), **Belgium** (27,600 ha) and **Argentina** (20,300 ha).

In regards to indigenous willow forests, about the same proportion belongs to public (105,200 ha) and private interests (45,700 ha for private and 50,000 ha owned by smallholders). For willow plantations, smallholders (74,800 ha) come first, followed by private companies (38,700 ha) and public (16,300 ha) forests.

As indicated in Table 4, publicly-owned poplar forests are largely used for protection purposes (10.7 million ha), with a combination of indigenous forests (9.3 million ha), planted forests (490,000 ha) and trees outside forests and agroforestry systems (930,000 ha). The vast majority of publicly-owned poplar forests are however used for production purposes (34.0 million ha). Most private poplar forests (including private and smallholders categories) are also managed for wood production (14.1 million ha) as compared to protection purposes (6.5 million ha). The largest proportion of poplars reported for protection purposes in private forests are with indigenous trees, accounting for some 3.2 million ha, out of which 2.4 million ha are located in the **United States of America**.

5. Forest Products

Table 5 describes the main products derived from poplars and willows in each country. Plywood and veneer still represent the largest portion of poplar products with 59.9% of the total production. The remaining products are reconstituted wood panels (21.7%), pulp, paper and cardboard (11.7%) and sawnwood (5.6%). Fuelwood and biomass for energy still represent a very small portion (0.9%).

6. Imports and Exports

As indicated in Table 6, **Italy** is the main importer of poplar roundwood and/or wood chips, with 457,000 cubic meters, followed by **Belgium** (228,000 m³), **Bulgaria** (almost 46,000 m³) and the **Republic of Korea** (41,428 m³). **Belgium** is the main exporter of poplar roundwood with 209,000 m³, followed by **Romania** (44,429 m³) and **Spain** (12,886 m³).

IV. TECHNICAL INFORMATION

1. Identification, registration and varietal control

Many countries have reported new registrations, mostly for poplars but also for willows.

Italy's National Poplar Commission has registered 11 new clones of *P. ×canadensis* × *P. ×generosa* (1) and *P. ×canadensis* (10) in its National Register of Forest Clones (RNCF) for timber production. Provisional registrations have also been obtained for two new clones of *P. ×canadensis* and these are destined as short rotation crops for energy.

After having registered 14 new *Populus* clones in 2003, **Spain** registered an additional one in 2006, bringing the total to 29 clones of *P. nigra* (3), *P. ×deltoides* (2), *P. ×canadensis* (18), *P. ×generosa* (5) and *P. deltoides* (1). The progress report also mentions the adoption of specific regulations regarding the cataloguing of forest reproductive materials, by the National Committee on Improvement and Conservation of Genetic Forest Resources, as well as the approval of a procedure, valid for the period 2007-2009, for the production and commercialization of non-catalogued materials.

In **New Zealand**, four new *Populus maximowiczii* × *P. nigra* clones have been approved for commercial propagation and use (their official naming and release is scheduled for November 2008). These clones will be used in a range of climates for erosion control.

Argentina reported having four new registrations of *Populus deltoides* (3) and *P. ×canadensis* (1); another new *P. deltoides* clone is in the process of being registered. Work will begin in 2008 for the registration of five clones of *S. babylonica* var *sacramenta* (1), *S. babylonica* × *S. alba* (2), *S. matsudana* × *S. alba* (1) and *S. nigra* (1). The country's progress report also mentions clonal selection results from molecular identification with various poplar and willow commercial clones.

Two new poplar varieties have been released in **Belgium** since 2005 and registered at the European level. These are the result of an intensive selection between the progeny of a controlled crossing of *P. trichocarpa* × *P. maximowiczii*. The progress report indicates that short-term release of new varieties is foreseen.

Turkey also noted that a new clone of *P. deltoides* was soon to be presented for registration. The progress report mentions that varietal controls have been continuously conducted in all state-owned nurseries but that the increasing number of private nurseries is creating some difficulties even though these are provided with improved and controlled plant material.

In **Germany**, seven *P. tremula* clones and seven *P. tremula* × *P. tremuloides* hybrid clones have been recommended for approval. The country also pointed out that clonal identification methods have been enhanced by biochemical methods (isozyme analyses and molecular-genetic methods).

In **China**, since the genera of *Populus* and *Salix* were included in the second National List of Plants Open for Application for Plant Variety Rights by the State Forestry Administration in 2000, a total of 35 new varieties of *Populus* were granted variety rights up to September 2007. In 2003, 2005 and 2007, three sets of new *Salix* varieties were certified in the province of Jiangsu, including 7 improved arbour willow varieties (2 for ornamental purposes and 5 for timber production) and 8 improved shrub willow varieties (6 for ornamental purposes and 2 for basketry products).

Sweden stated that two new *Populus* cultivars were registered. One is hybrid aspen multi-clonal variety (KB-002) consisting of 15 clones, the other is a mixture of poplars (KB-003) also consisting of 15 clones. The document also indicates that all commercial breeding of *Salix* in Sweden is done by one company which has registered four willow cultivars during the period from 2004 to 2007: ((*Salix schwerinii* × *S. viminalis*) × *S. viminalis*) × *S. burjatica*, *S. dasyclados*, *S. burjatica* × *S. viminalis*, ((*S. burjatica* × *S. viminalis*) × *S. burjatica*) × (*S. viminalis* × (*S. schwerinii* × *S. viminalis*)).

India reported that there is yet no mechanism in place for certification of seeds, cultivars or clones in the forestry sector although a Plant Variety (Protection) and Farmers' Rights Act (2002) has been enacted. The report however indicates that taxonomic details for 200 clones introduced in the country have been monographically prepared as a ready reference for authentication and to support certification. The

document also points to the importance of morphological markers for clone identification and the fact that leaf protein profiling of the ten clones of *P. deltoides* has revealed a distinct banding pattern in each clone.

Croatia mentioned that 16 poplar clones and 17 willow clones have been registered so far. The progress report also notes that over the last years, the selection, breeding and testing of local *P. nigra* clones was intensified to obtain quality seed material for the restoration of riparian forests and the gradual replacement of Euro-American poplar plantations.

Romania stated that three *P. ×canadensis* cultivars are currently registered by the IPC-ICRA. During 2004-2007, there were no proposals for registration of new cultivars.

Serbia provided a list of the 17 poplar – *P. deltoides* (6), *P. ×canadensis* × *P. deltoides* (1), *P. ×canadensis* (1), *P. deltoides* (2) - and 9 willow – *S. alba* - cultivars and clones that are registered both nationally and by the IPC and/or by the former Yugoslav National Commission (as reported in 1992).

The **United States of America** indicated that it does not have a poplar and willow certification/ registration programme although there appears to be movement towards such a programme. The progress report again referred to the book *Poplar Culture in North America* by Dickmann, D.I. *et al.* (2001), which provides an overview of the genus *Populus*, its taxonomy, and the characteristics of commercial poplar clones and cultivar, as well as to the overview of willow taxonomy and clones planted in the country.

2. Production Systems and Cultivation

As was the case in the previous synthesis, few major developments in nursery, propagation and cultivation technologies, techniques and management practices were highlighted for the 2004–2007 period. Nevertheless, many countries reported at length on experiments and trial applications. Some of these are also described in Section III.3 of the present document.

2.1 Nursery Practices and Propagation Techniques

Italy noted the development of a prototype for the reproduction of vegetative material that allows increasing the working capacity by 45% and the planting cost by 50%. Other work is also being done to automate the cutting, the sorting based on diameter, the bagging of the cuttings as well as the transplanting operations in the nursery.

The **Republic of Korea** emphasized the fact that with recent developments of genomics tools, large-scale gene expression profiling is being applied with poplar. The results from a *P. alba* × *P. tremula* var. *glandulosa* study reveal that significant gene expression changes occur with functions related to protein synthesis, cell cycling, hormonal responses and cell wall biosynthesis, as plants progress from initiation to senescence, that are highly correlated with observed developmental and physiological changes in the cells. Other key papers are mentioned on the functional characterization of poplar genes as well as on the transformation of poplars by heterologous genes.

Serbia noted that besides the variability of rooting characters and their dynamics, high heritability of shoot characters has been demonstrated; this implies the possibility of mass selection processes without plant damaging. Other research was conducted to examine the effect of date of cutting preparation and planting, type of storage and differences among genotypes on the rooting, survival and growth of rooted cuttings of *P. nigra* on different soil types. This work emphasized the significance of avoiding late dates of cutting preparation and planting and the advantage of storing the cuttings in cool chambers rather than trenches. It also provided scientific support for the design of nursery technology that takes into consideration specificities of genotypes resulting in the design of cultivar technology, particularly for *P. deltoides*. Other research looked at the efficiency of weed control with a combination of herbicides in *Populus* nursery production.

Underlining the basic principle of “matching clones to the right site”, **China** provided some details on recent research regarding the impact of different cuttings density and cutting quality on the success rate, leaf area, biomass and growth of key cultivated poplar clones. Another study on the impact of continuous cropping of successive harvests of poplar nurseries revealed a decrease in the average height of seedlings of the second and third harvests as well as a decrease in DBH and biomass of individual trees. Other research provided insight on the chemical control in poplar nurseries as well as the impact of plastic mulching and water retention agents on the physical feature of soil and seedling growth.

Turkey explained that with black poplars (and hybrids) and Euramerican hybrids, commercially propagated by hard-cuttings, no pruning is performed in the first year, except for the removal of surplus shoot. Double leaders are removed during the second year and all branches except leaders are pruned before final planting in order to maximize root establishment and growth. Poplar plantations are generally established by using two-year-old plants with roots, although recent research has shown that one-year-old rooted saplings and one-year-old rootless saplings of *P. deltoides* showed the best results on height and height increment. The report also notes that a key issue for poplar nurseries in Turkey is the physical characteristics of soils. Improvement trials have been conducted by mixing chopped corn stalks into the soils. It was found that bulk density, porosity and saturation capacity of corn mixtures were better than those of the sand mixtures which, on the other hand, offered better available water capacity than those of the corn compost mixtures.

India indicated that control tests have demonstrated a lower performance, in terms of timber volume and product manufacturing, from poplar nursery stocks raised through tissue culture and sold to growers and farmers with the assurance of faster growth. Other nursery work concluded that the application of fertilizers even at higher doses had little effect on growth and net returns from poplar plants in the absence of efficient weed control. Another study looked at the effect of initial size of *P. deltoides* planting stock on their height, diameter and volume growth; it showed that the large sized stock attained significantly greater diameter and volume growth at all ages but that their superiority in plant height was noticed only for the first three years.

For the reporting period, **Belgium** indicated that the production of clonal plants of *P. trichocarpa* and interamerican hybrids dropped drastically due to the breakdown of their rust resistance. This decrease was however compensated by an increase in production of new Euramerican clones. It also specified that no GMOs are produced. **Spain** provided a list of the various clones that were produced by nurseries in each region. **Argentina** noted that, in the last three years, there has been an increase in the use of 2-year-old planting materials because of the need to allow cattle as rapidly as possible in the plantations.

Based on promising results obtained in experimental plantations and the increased demand for poplar wood, **Morocco** has established two nurseries which provide plants, particularly of *P. nigra*, *P. xcanadensis*, *P. alba* and *P. euphratica* for farmers, agricultural agencies, communities and municipalities. These are mostly used for windbreaks and hedges.

Romania described how reproductive material is collected within protected seed reserves for *P. alba* and *P. xcanescens* whereas for *P. nigra*, for poplar hybrids and for selected willows, mother plants cultures from local nurseries are used to obtain big sets and branch cuttings. The first cultures for the production of poplar big sets (of one- and two-year-old) were established between 2004 and 2007.

Bulgaria noted that no particular new technologies and techniques had been used, although it did report that in experimental areas, the application of combined drop irrigation had shown advantages with respect to growth and saplings' condition, and from an economic perspective. Aside from describing the general and current production practices, the country's progress report notes that the practical application of selective herbicides and the technical provision with specialized equipment have yet to be implemented. Furthermore, it indicates that EU requirements have brought Bulgaria to re-evaluate the use of domestic origins of *Populus nigra*, *P. alba* and *P. canescens*.

Germany did not report any particular changes but mentioned that demand for poplar, aspen and willow seedlings for short rotation cultivation has been so great that domestic nurseries have been unable to respond; during the reporting period, plants had to be imported from Austria, Hungary, Italy, France and Sweden. **New Zealand** indicated that no significant change had been made in current practices for stoolbed production of unrooted poles and cuttings. **Finland** reported having no poplar nursery production at the moment.

2.2 Planted Forests

In **Croatia**, two-year-old poplar sapplings (2/2, 2/3) are mainly produced and their use in the field is conditioned by the planting depth and the possibility of protection from animals. One-year and two-year-old plants are used in willow production with root (1/2, 2/2) or without root (2/0). From 5 to 10 clones are generally used and mechanized deep planting (2-3 m) is predominant, depending on climatic, pedologic and hydrologic habitat characteristics. Aside from soil preparation, soil tending and pruning, the report also mentions that inter-row seeding of agricultural crops is not largely used, nor are irrigation and dressing of plantations. No thinning is performed (except sanitary ones). Croatia also mentions that when intensive cultivation plantations are established after the clear cutting of previous plants or in natural stand sites that were not naturally reforested, various tending practices are used, namely weed elimination, inter-row weed control in the first two years (to protect from low fires), branch pruning and thinning. In some cases, mixed cultivation is used (*S. alba* and *Alnus glutinosa*). Row plantation afforestation along canals and roads is not very common.

Turkey also provided insight on current plantation practices. Whereas black poplars are cultivated using traditional methods in the Central Eastern and South-eastern regions, modern techniques have been practiced for some time on the coastal regions where hybrid clones are intensively cultivated. The report mentions that the use of inorganic fertilizers is not recommended. It also indicates that shallow cultivation (no deeper than 30-35 cm) has created problems that can be resolved through deep ploughing or ripping or disc harrowing. A new mechanization demonstration programme has therefore been launched in target areas that benefit from a state-supported poplar development plan. Turkey also points out the importance of irrigation and invasive weed control in some areas. From an operational perspective, trimming of epicormic shoots is generally done in the first year while the shaping and removing of leaders occurs in the second year following planting. Pruning ought to be performed during the second and third years; a new hydraulic pruning system is now helping farmers to prune their stand more economically. As in other countries, thinning of poplar plantations is not regarded as economically viable. An investigation was also carried out to see the effects of intercropping on diameter and height growth of poplar trees and annual yields of crops. Some effects were noted on the growth of *P. canadensis* but none for *P. nigra*.

Bulgaria reported that conditions of existing poplar and willow plantations have worsened as compared to preceding years, due essentially to a lack of technical means for soil preparation and cultivation, funding constraints and biophysical factors such as drainage and drought. Research efforts were implemented to address these issues. Experimental work has also begun for the reclamation of river adjacent habitats with a set of 10 poplar clones. With regard to afforestation activities, different techniques have been used, such as deep planting with one-year-old saplings, treated saplings, the use of absorbents in planting sites, fertilization, partial soil preparation, etc. The report also indicates that a full inventory of poplar habitats along the Danube River was conducted, followed by an analysis of growth indicators from one-year to mature for felling (15-18 years) trees. Through this work, some areas that were not cultivated were then selected to verify their potential for certain poplar clones. Other experiments have been carried out with narrow-crowned poplars with finer and thinner branches to see if the expenses associated with pruning could be avoided.

Romania indicated that in selecting the land for plantation, attention is given to soil fertility, flood risk, water table level and station requirements of the specific species and cultivars. For both willow and poplar, field preparation is usually done by destroying the stumps of the cut trees, scarifying (up to 50 cm), deep ploughing (35-40 cm) and disc harrowing. Seedlings of hybrid poplars are planted in deep holes (60 cm in depth, 60 cm in diameter), whereas for white, grey or black poplars, the holes are

somewhat smaller. Planting schemes differ with species, expected production quality, site attributes and biological characteristics of the used cultivars. The progress report notes that in the last three years, poplar big sets have been used with good results. The main tending practices for poplars are pruning (until the age of 7-9 years old), trimming (the objective is a clean trunk at least 7 m from the ground) and thinning. Willow tending works is generally achieved through two selective thinnings.

Morocco described how poplar plantations should be established starting with species and cultivar selection, site preparation, planting techniques, including timing and spacing, fertilization and irrigation, pruning and thinning. It mentioned that since 1972, plantations have focused on species that are more drought resistant, namely of *Eucalyptus* and *Pinus*, which has led to a severe decline in poplar plantation.

Egypt reported plantations of *P. euphratica*, *P. alba*, *S. alba* and *S. babilonica* in the northern part of the country. *P. nigra* and *S. tetrasperma* are planted from the north to the south and some hybrid clones are being used for provenance trials.

Germany provided information on the cost of establishing a poplar plantation, including harvesting and transport, and commented on various risks associated with planting on agricultural marginal soils, biotic damages and market factors. The country's progress report also mentions that a study is underway to better understand how poplars and certain soil fungi coordinate their physiological activities in ectomycorrhizal symbiosis. Another study looked at the composition of endophytic bacteria colonizing the aerial parts of poplars grown under field conditions; these bacteria are known to be important for plant health and other ecological functions of poplar trees.

Sweden noted that poplars and willows do well under its climate due to the fast growth rate in combination with good cold hardiness of these trees. The progress report indicates that production systems do not appear to be much different from other regions in the world although there are some climatic peculiarities (e.g. high-latitude photoperiodic conditions in combination with cool and oceanic climate) which affect choice of the genotypes/varieties, the production systems and management actions. For both poplar and willow, much of the research is geared towards production biology, ecology and pest control. An example is a study that looked at the use of nutrient-rich residues as an alternative cost-efficient fertilization method for willow culture as a source of biomass for energy purposes. Under another project, management regimes that combine early harvests and thinning with conventional forestry techniques are being tested for *P. tremuloides* × *P. tremula*. The development of biomass equations for *Populus* stands and the effect of the rotation period on poplar biomass production have also been studied.

The traditional intensive poplar cultivation in Italy, which was based on ten-year cycles and essentially for plywood production, has undergone difficulties over the years, mainly due to diseases. It has now adapted to farming models for better productivity, wood quality as well as flexibility during the cycle. If prices are low, the farmer is able to postpone the sale of the poplar plants for one or two years without loss of wood biomass. The country also reports that new protocols for poplar sustainable cultivation were developed, based on the Forest Stewardship Council (FSC) and the Programme for the Endorsement of Forest Certification Council (PEFC) standards, which limit the use of chemical products and reduce ordinary tillage, especially for environmentally sensitive areas. Successful tests have also been conducted using mixed plantations of poplar with noble broadleaves (namely walnut) and shrubby species, through cycles of about 20 years, to obtain high quality wood, reduce the risks associated with single-crop systems and provide an initial income to the farmer during an intermediate phase of the cycle.

Serbia reported on stand productivity research, namely experiment results analyzing the effect of spacing on diameter and height structure of *P. deltoides* plantations. The country's progress report also described how the Weibull model has been used successfully to define the diameter structure of poplar plantations, which enabled to calculate stand wood volumes with an error margin of less than 2%. For black poplars, research suggests that productivity depends on two dominant site factors: edaphic (soil properties), which affect general growth, and hydrological (flooding and drying of the physiologically active layer), which affect the annual dynamics of growth.

Plantation productivity research was also noted by the **United States of America**. Aside from the identification of fast-growing poplar clones for alluvial sites, work on the identification of optimal management regimes for such sites in the North Central and the Southeast regions have led to lower fibre costs. Other work on chemical weed control has reduced the use of mechanical cultivation. For willow, a large research programme, underway since 1995, has so far generated a collection of over 600 clones from across the mid-west and northeastern states.

In regards to planted forests, **Belgium** provided details on specific research led to understand the mechanism of nutrient cycling in poplar plantation. Among various results, this work suggests the potential of poplar stands for nitrogen retention and thus for preserving underground water quality. According to the progress report, it also leads to recommending that less valuable parts of the tree, such as the crown, would best be left *in situ* during harvesting to avoid high exports of base cations.

Of particular interest is the work reported by **China** on mixed poplar forests. For example, research showed that reasonable mixing of poplars with *Robinia* could accelerate tree growth, increase timber production, decrease the occurrence of pests and disease, and improve stand stability; at the same time, soil fertility could be best used and improved, and the ecological environment could also be enhanced. Similar positive effects were noted in mixed stands of poplars with sea-buckthorns (*Hippophae*), a xerophyte with rhizobia in its roots that fix nitrogen. China also reported on research relating to the effect of various practices on poplar plantation growth, namely moisture management, fertilization and pruning. For willow, the country's progress report indicates that large scale plantations have been established in recent years in the wetlands along the middle and low reaches of the Yangtze River and around the five biggest lakes. These are fibre forests, ecological forests (wind breaking and soil fixing) and shrub forests for basketries. Research has been conducted on cultivation, grading and selection of plant stocks, selection of site conditions, planting density, silvicultural measures and rotation control.

Argentina explained that analytical work is done on a continual basis in various poplar demonstration sites, particularly through universities and sometimes in partnership with the private sector. In one case, specialists are currently looking at new promising techniques for site preparation, planting (one-meter) and cultural treatments (cold storage of seedlings for spring replanting, herbicides and mechanical weed control, fertilization with chemicals and with macronutrients and micronutrients, etc.). Clones of *P. deltoides* are also being compared at different thinning intensities. Furthermore, work is underway to study the effect of various vegetation control techniques, both chemical and mechanical, during the establishment phase of willow plantations.

Spain indicated that in the last four years, much attention was focused on hybrid poplar trial plantations, particularly in relation to high density and short rotation, for the energy sector. The objective is to maximize the environmental benefits as well as the adequacy between the characteristics of the produced biomass and the energy it can generate, while ensuring that the chosen plantation areas do not interfere negatively with food production in the country. A network of clonal trials is also maintained for poplars destined to wood production.

The annual poplar plantation area in the **Republic of Korea** is reported to have declined drastically, from a peak of 4,244 ha in 1993 to 16 ha in 1996, and there has been practically no poplar planting since 1997. This decline is attributed to a loss of price competitiveness to imported wood on domestic markets. The country's progress report also indicates that during the early '80s, legislation in the Republic of Korea had prohibited poplar planting along riverbanks. Since 2000, yellow poplar (*Liriodendron tulipifera*) has been recommended for planting and many seminars have been held to foster widespread dissemination of this species.

New Zealand summed up its situation by stating that there has been no change in plantation practices, indicating that poplars and willows are not used significantly in the country's planted forests. **India** also reported that planted poplar forests are very uncommon. One *P. deltoides* stand (about 100 ha, for the production of industrial wood) and one *P. gamblei* stand (less than 100 ha) have been established.

Finland indicated that no poplar plantations had been established in recent years although there may soon be developments with the inclusion of hybrid aspen in the production of biomass for energy purposes.

2.3 Indigenous Forests

Few countries reported on specific management practices in natural poplar and willow stands, because in many cases, these forests are either uncommon or of relatively small size.

In **India**, *P. ciliata* is mentioned as the most extensive indigenous poplar distributed throughout the Himalayas. The progress report also indicates that with this particular species, maximum initial growth and outplanting success have been obtained with the use of entire transplants (with initial shoot length of 225-275 cm and a planting depth of 105 cm). India also underlined a strong need for conservation and afforestation of *P. euphratica* and *P. alba*, both indigenous species occurring in the Western Himalayas, because these do not regenerate readily.

Romania has *P. alba*, *P. nigra*, *P. xcanescens* and *Salix* natural forests located especially in the Danube Meadow and Delta. The progress report indicated that replacement of natural forests by hybrid poplar and selected willow plantations have severely diminished the areas previously covered by natural poplar and willow forests, although the *P. tremuloides* forests in hilly and mountainous areas have suffered no significant change. Some conservation measures have been taken to preserve the genetic resources and also to rehabilitate natural ecosystems, mostly with *P. alba* and *P. nigra*.

Italy reported that poplar and willow are used as pioneer species to accelerate the natural evolution towards mixed natural forests. As part of this work, plantations of *P. nigra* and *P. alba* are monitored to assess the performance of different genotypes in relation to site conditions and cultivation techniques. Results highlight that poplar and willow are good species to recover riparian forests on sandy soils which are frequently subject to partial or total flooding. Other work has also demonstrated that because *P. alba* can produce a lot of root suckers able to cover large areas, it is possible to plant this species using wide spacing to recover degraded sites.

As other countries, **Bulgaria** is looking at replacing or restoring planted or semi-natural forests into “new” natural forests using indigenous species, particularly in the Danube’s floodplain. Natural forest communities in this area are represented by different associations, dominated by willows (especially *S. alba*) along with *P. nigra*, *P. alba*, field ash (*Fraxinus oxycarpa*), field elm (*Ulmus minor*) and white elm (*U. laevis*). The progress report mentions that plantations of *P. nigra* have strongly decreased because of felling.

In **Croatia**, some natural forests originate from the seeds, particularly in riverbeds or alluvial deposits. When under management, these receive regular tending and cleaning, followed by thinning, with a rotation up to 60 years. In other cases, sucker forests appear after cutting, particularly with *P. alba*. These stands are managed similarly to natural stands, with a rotation of up to 40 years. A third scenario is reported when mixed stands are derived from repair planting in natural stands after clear cutting, using selected poplar and willow clones. In natural forests, together with *Populus* and *Salix*, there is white elm (*Ulmus laevis*) and, later in the succession process and depending on the region, such species as narrow-leaved ash (*Fraxinus angustifolia*), common oak (*Quercus robur*), black alder (*Alnus glutinosa*) and white alder (*Alnus incana*). Introductory experiments have been conducted to lessen the monocultural effect with ashleaved maple (*Acer negundo*) and white ash (*F. americana*). Some non-indigenous species have also adapted well, namely black locust (*Robinia pseudoacacia*) and mulberry tree (*Morus sp.*). Furthermore, research has shown possible cultivation of selected clones of white willow in association with black alder.

P. tremuloides is the most widely distributed native poplar species in the **United States of America**. A very common silvicultural prescription for aspen allows vegetative regeneration of stands in small mosaics across the landscape. This involves clear cutting small patches and leaving connected reserve areas to protect genetic diversity. There is also an increasing awareness that all stand ages of aspen are

needed for wildlife such as ruffed grouse, deer, elk and wild turkey. Over the last few years, there has been a die-off of native *P. tremuloides* forests in North America which has been attributed variously to climate change, intense elk browsing, and anthropogenic factors including fire suppression. Indigenous *Salix* forests in the United States occur primarily in riparian zones and although they are not utilized commercially to any great extent, they represent important wildlife habitats.

The **Republic of Korea** reports having five native poplar species (*Populus davidiana*, *P. maximowiczii*, *P. glandulosa*, *P. koreana* and *P. simonii*), among which the last three are distributed only in a few specific areas. It is generally hard to find any stands of these species as they mostly occur sparsely as single trees. Willows are also present, growing naturally along rivers and valleys, although there are no large natural forests or plantations. However, *Salix* is still being used for studying the prevention of soil erosion or water quality purification.

2.4 Agroforestry and Trees Outside Forests

Since 2006, **Argentina** has established a technical working group to determine the scientific basis for the design and management of agroforestry systems in temperate-humid areas using *Salix* plantations. Elements such as planting densities, tending treatments (pruning and thinning), the impact of grazing on forest production and on the structure and functioning of the herbaceous layer are all being looked at.

Bulgaria mentioned the production of handbooks, issued in 2003, to assist agricultural farmers. A film entitled “Agroforestation – Tradition and production, practices for rational land utilization” was also produced. On the research front, experiments have shown that the mixing of a row of poplars with cultivated farm plants (especially nitrogen-fixing) has a positive impact, particularly in diameter growth. Other advantages for such mixes are the use of agrotechnical activities (fertilization, irrigation), regular tending (weed control, pruning, etc.) of the poplar trees as well as enhanced pest and disease control. The progress report also mentions the contribution of poplar and willows in mixed forest shelterbelts, indicating that with such protection, the yield from the farm crop could be increased by 30%.

In the irrigated plains of Northern **India**, *P. deltoides*, which was introduced in the late 1950s, constitutes the backbone of agroforestry. With the recent rise in price for poplar wood, planting supplies have been insufficient. Agricultural crops such as sugarcane, wheat, potato, mustard, maize, pulses, vegetables, fodder crops, medicinal plants etc. (but not rice) are often grown in the inter-spaces. Such intercropping provides for essential food production besides ensuring higher growth rate of poplar due to frequent irrigation and hoeing operations for agricultural crops. In addition to wind protection, an early benefit to the farmers is fuelwood from pruning. An interesting approach noted by India to deal with mortality is that poplar plants in the extreme south row of the plantation can be uprooted and used to replace dead plants. The entire uprooted row is restocked with fresh plants, which allows 95 to 100% stocking at the time of harvest. In its progress report, India also described various productivity benefits obtained by associating poplar with wheat, soybean as well as medicinal and aromatic plants (mint, eucalyptus, turmeric, ginger, etc.) and flowering plants. *P. nigra* is planted only as avenue plantation in the Kashmir Valley although it does not contribute significantly to the wood supply. *P. ciliata* is often planted near villages in mixture with other hardwood species; it has also been recommended for agroforestry plantation around orchards. *S. fragilis* is reported as the most common willow species grown extensively under the indigenous agroforestry system in the cold desert of Lahaul (Western Himalayas) and a significant contributor of fuel and fodder. The country’s progress report mentions that the tax exemption of poplar cultivation as an agricultural income has considerably promoted large-scale planting of poplars in appropriate regions.

Intercropping using poplars has been broadly applied in agroforestry compound management in **China**. Extensive research has been conducted on the impact of this model of crop yield and quality as well as the content of CO₂ at the crown of crops, namely with rice. Various results are provided including the fact that, contrary to reports from experiments in other countries, crop yield using intercropping with poplars was shown to be reduced as compared to traditional mono cultured crops.

Morocco indicated that agricultural crops such as beets, peas and corn can successfully be associated with poplar plantations. However, when the stands reach 5-6 years and with the increasing closure of the canopy, forages are preferable, except alfalfa which creates competition.

Belgium indicated that a state-funded 2-year project for promoting agroforestry was started in 2007. **Germany** also reported plans to develop the use of fast-growing tree species in agroforestry systems, namely through alley cropping cultivation techniques. One particular project is examining if the economic efficiency of the overall system in three different farming landscapes can be sustainably and positively influenced by the interactions between trees and agricultural crops. Effects of the trees on the nutrient and hydrological regimes, on erosion and on biological diversity are also being studied. The country's progress report also points out the major conclusions of an intensive study on poplar plantations established on former farmland sites in regards to soil ecology, silviculture, phytodiversity, zoodiversity and landscape ecology.

New Zealand reported on research regarding root development in unpruned wide-spaced *P. xcanadensis* trees growing on erodible hillslopes. This work concluded that the main factors affecting tree performance are thought to be available soil depth, soil moisture and exposure to prevailing winds. Whereas tree effectiveness for erosion control has previously been identified with a particular age, this work also showed that structural root biomass and length were better correlated with tree DBH rather than age.

3. Genetics, Conservation and Improvement

Genetics, conservation and improvement activities are now central to most country's strategies around poplar and willow cultivation. Traits such as yield, stem structure and wood quality have always been important but there is growing interest and increasing concerns about biotic (mostly insects and diseases) and to a lesser extent abiotic (drought, frost, wind, etc.) factors. In this context, most IPC members reported extensively on their efforts to preserve the genetic resources of poplars and willows and their work to improve the attributes of planting materials, mainly in terms of productivity and resistance to damaging pests, while considering biodiversity and biosafety issues. Much of this work is being achieved under the European Forest Genetic Resources Programme (EUFORGEN).

Genomics research has also been very active in the last years, particularly with the sequencing of *Populus* species genomes, involving experts from many countries¹. On this front, both **Sweden** and the **United States of America** noted that the close taxonomic relationship between *Populus* and *Salix* renders the *Populus* genome sequence a valuable tool also in *Salix* breeding, for which less information is available. The United States of America also mentioned that the many similarities of the poplar genome to the classic model plant species *Arabidopsis* continue to be exploited and that the commonalities promise many future genetic possibilities for poplar including male sterility, insect and disease resistance, carbon sequestration and wood quality improvement.

Belgium also highlighted multinational collaborations such as the POPYOMICS Research Project² (financed from 2003-2007 within the EU 5th Framework Programme), TREEBREEDDEX³ (financed

¹ The International *Populus* Genome Consortium Project's main objective is to sequence the genome of *P. trichocarpa* and provide access to the sequence database.

² As part of its many achievements, the POPYOMICS Research Project developed the databases PHYSIO-TRAIT and DISEASE-TRAIT, each with a comprehensive data-set of traits in *Populus* with respect to species and site, aligned the molecular genetic maps of *Populus*, and determined the map position of QTL for up to 50 morpho-physiological, structural and biochemical traits related to yield.

³ TREEBREEDDEX aspires to create a Virtual Tree Breeding Centre (VTBC) to produce meta-databases of tree breeding infrastructures (biological collections and facilities, focusing on five coniferous species and four hardwood species, among which cultivated poplars) and facilitate access to these infrastructures.

within the EU 6th Framework Programme, the Project was set off on 1 June 2006 for four years) and the Transpop Project⁴ (part of the European INTERREG III Programme).

3.1 Aigeiros section (e.g. *P. nigra*, *Populus deltoides*, *P. canadensis*)

Given the precarity of *P. nigra*, many countries described their *ex situ* and *in situ* conservation efforts relating to this species. Although black poplar is of limited commercial interest, it is very important for breeding purposes because of its adaptability to different environments and soil conditions, its excellent rooting ability and its resistance to some of the most important diseases namely bacterial cankers, brown spots and viruses.

Serbia emphasized the fact that between 2004 and 2007, activities around the renewal of its gene banks and stoolbeds were essentially conducted with a conservation perspective. Following studies across the country, it was established that large natural populations of *P. nigra* could only be found in the Upper Danube region while in other areas, only clusters or single trees are present. In fact, the country progress report concludes that the above-mentioned populations currently represent a significant part of the European gene fund for *P. nigra*. As part of its breeding programme, Serbia proceeded with the selection of superior clones. Other experiments showed the possibility of including shoot characters in the breeding process towards good rooting potential for cuttings. Work was also done to rank clones according to their degree of spontaneous infection from leaf pathogens (*Marssonina brunnea* and *Melampsora* sp.) and bark canker (*Discosporium populeum*). Clonal tolerance to the leaf beetle (*Phyllodecta vitellinae*) and the leaf-mining moth (*Leucoptera sinuella*) was examined.

Croatia also described its conservation activities regarding *P. nigra*, particularly through the selection and autovegetative propagation of adult trees, the establishment of fenced clone archives and the permanent protection of natural poplar stands. Special attention is being given to *P. nigra* spp. *caudina*, the hairy type of black poplar growing along the Neretva River (Bosnia and Herzegovina) which differs in morphological traits from the black poplar found in riparian populations in Croatia. Research is also underway to determine the biomass production capacity in juvenile years of some poplar clones commonly used in long rotation forestry (25-30 years); results have so far indicated great potential as well as significant interclonal variability.

Bulgaria indicated that a new methodology for the selection of *P. nigra* trees with valuable attributes is being prepared. It was noted that what were thought to be pure old *P. nigra* trees proved in fact to be a mixture from the parental participation of *P. deltoides* in neighbouring areas afforested over the years with *P. euroamericana* hybrids, highlighting the importance of genetic determination of pure specimens within conservation efforts. The progress report also mentions that research has been underway since 2007 to identify modern means for long-term storage of germplasm from *Populus* sp., including cryopreservation.

As part of its *ex situ* conservation approach, the *P. nigra* clonal collection in **Spain** currently holds about 430 clones, out of which 325 are indigenous. These have all been subjected to characterization and genetic analysis, also using molecular markers. A relatively new accomplishment is the duplication in another location of a 265 *P. nigra* clones collection, to which was added 60 clones from yet another region of Spain. On the same site was also installed a duplication of the core EUFORGEN collection of *P. nigra* which integrates 39 clones from 20 countries. Spain also has a collection of 94 clones of *P. deltoides* and 195 hybrid clones of *P. ×canadensis*. A new project was initiated in 2007 for the *in situ* and *ex situ* conservation of genetic resources associated with *P. nigra*, for its entire distribution area across the country.

P. nigra is also one of the main tree species in central and eastern **Turkey**. The country's strategy between 2004 and 2007 mostly concentrated on *ex-situ* conservation activities, with the establishment of two plantations and the transfer of selected individuals to the nursery. Nursery trials were also conducted

⁴ The Transpop Project aims at encouraging cross-border exchanges of knowledge and plant material, namely poplar.

using *P. xcanadensis* and *P. deltoides* to study growth performance as well as some morpho-genetic traits such as branchness, position of leader shoot and stem form; these have led to field trials in 2007-2008.

Romania provided detailed results from comparative tests both in nurseries and in the field for specific Aigeiros and Tacamahaca cultivars, reporting on preservation ratio, height ratio, resistance to foliage diseases and other adversities, and physical and mechanical characteristics. **India** provided results on various field trials of poplar clones, particularly *P. deltoides*, designed to examine the variability and heritability of characteristics such as plant height, DBH, clean bole height, crown diameter, branchness, wood volume, wood defect parameters, etc.

There have also been conservation activities relating to *P. nigra* in **Belgium**. Individuals were collected and analysed with DNA markers to determine the genetic diversity and complete the gene bank. Efforts are also devoted to the restoration of riparian woodlands using black poplar. Frequency of hybrid formation, pollen interactions affecting the success of *P. nigra* and potential gene flow in *Populus* are being looked at. In regards to its breeding programme, Belgium reported that between 2004 and 2007, the emphasis was put on intraspecific crossings using *P. deltoides*, *P. nigra*, *P. trichocarpa* and *P. maximowiczii*. Overall, 122 crossings were achieved and 85% were successful. Experiments are also underway using non-classical poplar cultivation approaches, essentially controlled intraspecific crossings, as a means to increase tolerance against pathogens. Collections of *Populus* genotypes are continuously being expanded under international exchange programmes and experimental trials are set using the most valuable clones. This has led, among other results, to the release of two new *P. trichocarpa* × *P. maximowiczii* commercial cultivars. Furthermore, biotechnology work is underway for the development of a gene marker selection protocol to accelerate the evaluation of wood quality and disease resistance. Promising results have also been obtained with *P. xcanadensis* clones as a source of green energy.

Only few natural stands of *P. nigra* are reported in **Italy**. In line with conservation objectives, stands with a pool of black poplar genotypes selected within the country's *P. nigra* reserves have been established, particularly in fluvial areas. These genotypes could be further utilized for poplar cultivation in case of any restrictions on the use of hybrids in protected natural areas. As part of its breeding programme, Italy indicates that more than 1 700 poplar genotypes (including over 700 of *P. nigra* from 26 countries) are currently maintained in a germplasm collection. Intraspecific crossings using *P. nigra* and *P. deltoides* are underway and performance is being examined for growth rate, branchness, rooting ability and resistance to *Marssonina brunnea* and *Melampsora* sp. Interspecific hybridization using *P. xcanadensis*, *P. nigra* and *P. deltoides* is also important and the country's progress report mentions that the breeding programme for commercial purposes will resume in 2009. Breeding biotechnology is also being applied to introduce new desirable traits. As an example, the genetic transformation of *P. nigra* and *P. alba* with *Bacillus thuringiensis* and proteinase inhibitor genes was investigated. Other transgenic poplar work has been done to enhance growth and yield production, also looking at various factors such as stability of the transgenic expression, susceptibility to diseases, tolerance to herbicides, occurrence of horizontal gene transfer and use of poplars as a potential source of pharmaceutical compounds. The application of molecular markers is also being examined.

Through a nation-wide inventory in **Germany**, some 283 *P. nigra* populations were found but only 19 of those had more than 500 pure black poplar trees and most were over-mature and categorized as dying or at risk. Efforts are therefore underway to preserve the species through *ex situ* and *in situ* measures. Various gene banks contain black poplars of certified origin for local renaturation activities. *P. nigra* stands have been approved for harvesting generative reproduction material for genetic conservation purposes. An environmental support project was carried out for the conservation and propagation of this endangered species. A five-hectare stand in which many pure *P. nigra* trees of individual genotypes were found was discovered and protected. Rehabilitation work of a riparian forest in a national park was accomplished. Furthermore, isozyme analysis was used to discriminate species and hybrids kept in *P. nigra* gene banks from nine countries. A model plantation was established to safeguard the basis of varieties and to maintain varieties.

Following massive losses in *P. deltoides* and *P. ×canadensis* plantations in the '90s due to infectious agents, **Argentina** has also stepped up its activities to select clones that offer good productivity and disease resistance. A genetic improvement programme was put in place in 2007 focusing on survival, growth, disease resistance, form and wood quality. This work has already led to the registration of one *P. deltoides* clone in the National Registry. To increase the genetic pool, hybridization efforts with *P. deltoides* and *P. ×canadensis* were reinitiated and the programme to introduce new species and hybrids was reactivated. A project was also started to develop induced genetic mutation techniques, as a means to improve specific traits, disease resistance in particular, by modifying one or a few genes and maintaining the rest of the genotype unaltered. In regards to genetic transformation, a project was started in 2006 to develop *in vitro* regeneration protocols for promising clones; since then, micropropagation methods have been established for one *P. ×canadensis* clone. The country's progress report also provides details about organogenesis work.

China noted having a gene bank of 114 clones of *P. deltoides* (52), *P. ×canadensis* (56) and *P. nigra* (6) which are assessed on a continual basis for genetic variations using eight traits including growth, wood properties and phenology. A collection of 150 *P. nigra* clones from 15 countries has also been established. As part of its breeding activities, intraspecific and interspecific crossings have been performed between Aigeiros and Tacamahaca, with over 200 hybrid combinations produced, including with *P. deltoides*, *P. cathayana*, *P. purdomii*, *P. nigra* and *P. xiaohai*. China also reported on its breeding work related to selection for specific traits such as growth, wood properties, stem form and crown form. Research results are presented for the use of *P. ×canadensis* as a fast-growing resource for pulp production. Studies were also carried out with *P. deltoides* and *P. ×canadensis* to analyse gene expression in relation to resistance to *Marssonina sp.* Transgenic *P. ×canadensis* plants (with Bt and cowpea trypsin inhibitor genes) were produced and proved to be very resistant to *Micromelalopha troglodyte* larvae. Insect-resistant transgenic *P. nigra* clones have also been obtained and their commercial release has been authorized in 2002; as part of this work, the country's progress report provides the results of various investigations related to biosafety issues, including the existence and stability of the Bt gene, the impact of transgenic poplars on non-targeted insects and soil microorganisms as well as gene flow of the transgenic *P. nigra* through pollen and seeds.

In the **Republic of Korea**, genetic transformation work was reported on *P. koreana* × *P. nigra*. Attempts are also being made to identify poplar clones using molecular markers. Although markers that could differentiate different poplar species and their hybrids have been identified, none were found to be unique to one clone.

Morocco noted that 36 local clones of *P. nigra* were examined, out of which two were subsequently selected. It also provided as a general comment that given the fact that experimental plantations had been established on good sites, it was now difficult to extrapolate performance results to different ecological conditions across the country. The progress report also mentions that about 120 clones of various *Populus* have so far been introduced in Morocco, namely from Spain, Italy, France, Iran and Syria.

The **United States of America** provided a list of recent publications regarding selection and breeding activities, many of which deal with the use of *P. deltoides*, *P. trichocarpa* and *P. maximowiczii* hybrids for fiber production, solid wood products and bioenergy.

Bulgaria indicated that given various constraints, large-scale activities for genetic improvement work on poplars were limited during the reporting period.

3.2 Leuce section (e.g. *Populus alba*, *P. davidiana*, *P. tremula*)

The **United States of America** indicated that the genome sequencing of *P. tremuloides* was nearly completed

A number of interspecific cross breeding experiments have been conducted in **China** in recent years, using more importantly *P. alba*, *P. ×canescens*, *P. tomentosa*, *P. hopeiensis*, *P. davidiana* and *P. adenopoda*, which have led to the selection of super clones. Work has also allowed the identification of superior trees from the crossing of various *P. davidiana* and *P. tremuloides* provenances. As part of a distant hybridization experiment, the use of *P. alba* as maternal plant and *Ulmus pumila* as paternal plant led to a hybrid progeny (closer to the female parent) that demonstrates drought and pest resistance. It should also be noted that China has constituted a gene bank of *P. tomentosa* and conducted various studies using that particular species, namely on the identification and manipulation of genes involved in wood formation, flower development and disease resistance. Work was also done to analyse genes involved in the development of adventitious roots, although the species used were not specified. Furthermore, China reported a lot of scientific activity around poplar genetic linkage mapping, namely with *P. tomentosa*, *P. bolleana*, *P. deltoides*, *P. cathayana*, *P. ×canadensis* and *P. trichocarpa*. In the field of genetic engineering, work was achieved with *P. alba* where the transgenic plants showed excellent resistance to the larvae of *Apocheimia cinerarius*. China also indicated that manipulation of fatty acid desaturation genes had provided a new way to enhance cold tolerance of plants in *Populus* tree breeding.

The rooting behaviour of about 25 *P. alba* provenances was examined in **India** and variances were observed in the number of secondary and tertiary roots, as well as length, diameter and weight of the roots. This information is useful to determine which provenances would perform better under different soil moisture conditions.

As in many countries, *P. alba* is mostly present as part of river ecosystems in **Spain** and its adaptative characteristics hold special interest. A new collection was established in 2005 with 15 clones for each of the 25 families maintained. Work on genetic analysis was performed as a basis for a conservation strategy as well as the management of natural populations. Interesting studies were conducted on hermaphrodite *P. alba* individuals which occasionally occur in the southern part of the country, particularly in regards to germination performance. Other work is underway with *P. tremula*; following phytosanitary problems, the conservation collection was restored in 2006-2007 using *in vitro* propagation. In genetic engineering, gene transfers in relation to nitrogen and carbon metabolisms are being examined with a hybrid clone of *P. tremula* × *P. alba*.

Belgium indicated that more recently, the scope of its selection programme was expanded to *P. canescens*, a natural hybrid between *P. alba* and *P. tremula*. Although *P. ×canescens* has low rooting capacity, the objective is to examine if it could be used as an alternative to commercial poplar cultivars.

Germany listed a number of key projects associated with poplar physiology and genetic engineering. One of these studies looked at the influence of potassium and calcium on poplar wood formation and the xylem/phloem physiology while another analysed the seasonal regulation of ion and metabolite transport in poplar stem tissues, with respect to nutrition, hormone status and stress. One experiment was also led to investigate salt-stress as well as drought responses from transgenic plants. Another project funded between 2002 and 2007 examined the biological safety in genetically modified plants, including poplar. As part of this project, the feasibility and some methodologies of genetically engineered induction of male and/or female sterility were analysed. More specific work with *P. tremula* × *P. tremuloides* was also done on so-called jumping genes which, when used in genetic transfer, are known not to deactivate the plant's own genes and thereby trigger mutations. Other scientists are currently looking at the overexpression of regulatory genes, particularly associated with early flowering, from *Betula pendula* to *P. tremula*. Yet another project was conducted to test the expression of foreign genes under comparative stress conditions (temperature and UV light) with *P. tremuloides*. The country's progress report also provides information about the mapping of molecular markers to identify and characterize gender-determining genes in *P. tremula*. Other research is underway to identify the genes that play a possible role in processes of adaptation and adaptedness and to ascertain the sequence variability of these genes within populations or species.

Sweden explained that although no long-term poplar breeding programme has been established so far, major progress has nevertheless been made. Some 140 poplar clones, mainly collected from the

Netherlands and Belgium, have been tested in southern Sweden and from this, 15 clones were selected for mass propagation and commercial use. In the same part of the country, hybrid aspen breeding work has also resulted in 15 clones recommended for commercial use. In 2007, test trials of various *Populus* genotypes were established along a latitudinal gradient from southern to northern Sweden; evaluation of growth and other parameters have started only recently. From a more specific perspective, scientists have looked at phenological traits (e.g. autumn senescence) that are responsible for climatic adaptations in *P. tremula*. Other foci of the Swedish research efforts are on the processes of wood formation and the functional genomics of plant-pathogen relationships.

Between 2004 and 2007, three more stands/populations of *P. alba* and *P. ×canescens* have been identified in **Romania** and analyzed by phenotype. Work was also done to experiment the vegetative reproduction through branch cuttings with bio-stimulators and grafting. Growth monitoring is continuing for cultivars of *P. tremula* and *P. tremula × tremuloides* of German origin.

Serbia indicated that major work was done in assessing the tolerance of interesting genotypes on nickel, lead and cadmium contamination.

As part of its breeding programme, **Morocco** mentioned that 123 local clones of *P. alba* and 18 local clones of *P. euphratica* were chosen, out of which 15 and 3 were respectively selected for experimental plantations. **Croatia** indicated that experiments to revive selected clones of *P. alba* are currently being carried out.

The **Republic of Korea** described some recent results from its intensive research on *P. davidiana* which has been underway for over 20 years. Two-year-old progenies derived from artificial crosses were compared for growth characteristics, morphology and disease resistance; the progenies showing good height growth appeared to be less susceptible to leaf rust *Melampsora larici-populina* and leaf spot *Cercospora populina*. Interspecific crossings were also tested using *P. alba*, *P. glandulosa*, *P. davidiana* and *P. sieboldii*, leading to the selection of superior individuals for growth and resistance to fungal pathogens. Other work with *P. alba × P. tremula* var. *glandulosa* involved the development of transgenic plants for phytoremediation of polluted soils.

The **United States of America** noted that the genome sequencing of *P. tremuloides* was nearly completed. The country's progress report provides a list of recent publications regarding selection and breeding activities associated with *P. tremuloides* and *P. grandidentata*.

3.3 Tacamahaca section (e.g. *Populus ciliata*, *P. trichocarpa*, *P. ussuriensis*, *P. suaveolens*)

The **United States of America** noted that in September 2004, the International *Populus* Genome Consortium has announced that the genome of *P. trichocarpa* pedigree had been sequenced.

New Zealand noted that various crossings were conducted in 2007 using clones from *P. trichocarpa* with *P. nigra*, and *P. maximowiczii* with *P. trichocarpa*. **Serbia** noted that *P. nigra × P. maximowiczii* hybrids were included in phytoremediation experiments.

In northeast **China**, *P. ussuriensis* is considered one of the major species for establishing fast-growing high yield plantations and experiments have already led to the selection of super clones. Triploid breeding research has also been undertaken in 2001, leading to *P. ussuriensis* plants with 55 chromosomes that, at the seedling stage, present greater height and ground diameter, larger leaf width but shorter leafstalks; investigation is continuing. Super clones of *P. suaveolens* have also been selected, their growth value being about 30% higher than the normal clones.

Spain indicated that the only activities within this section are related to the conservation of clones received from other countries in the '80s and '90s.

3.4 Other sections

Spain mentioned that an arboretum was being maintained with Turanga materials originating from the Euphrate Valley in Syria and planted in 1994. No other country provided information.

3.5 Willows

In most countries with an active willow cultivation programme, the implementation and commercialization of willow clones is being followed by a number of research projects dealing with all aspects of production biology, ecology and pest control.

The major species used in Sweden's breeding programme are *S. viminalis* and *S. dasyclados* (the others are *S. schwerinii*, *S. burjatica*, *S. triandra*, *S. caprea*, *S. daphnoides* and *S. ericocephala*). During the last years, research has increasingly focused on breeding activities in relation to environmental stress. For example, plant physiological traits for shoot biomass production in young pot-grown plants compared to mature field-grown trees are being identified. In recent work, quantitative trait loci (QTL) analysis has been used to map *Salix* frost resistance and phenology, growth, water-use efficiency and drought tolerance. Laboratory studies have also focused on the physiological effects of heavy metal treatments on willow and demonstrated great genetic differences in heavy metal sensitivity and accumulation among genotypes.

A genetic improvement programme for *Salix sp.* has been pursued in **Argentina** since 2003. Some 245 clones are currently in different stages of the selection process, mostly through controlled hybridization using *S. alba*, *S. amygdaloides*, *S. babylonica*, *S. bonplandiana*, *S. humboldtiana*, *S. jessoensis*, *S. fragilis*, *S. matsudana* and *S. nigra*. The major selection parameters are health, growth, form and branchness. Some clones have also undergone preliminary wood quality evaluations to determine their potential for pulp and paper production. As with poplar, Argentina has developed micropropagation methods using internodal segments for various *Salix* clones.

Italy indicated that more than 700 willow genotypes and hybrids are currently maintained in its germplasm collection. Its *Salix* breeding programme, which started in the '90s, has now resumed.

In **Romania**, various cultivars of *S. alba*, *S. alba* × *S. fragilis* and *S. fragilis* × *S. matsudana* were compared for height and diameter growth during the flooding periods of 2005 and particularly 2006 followed by a long drought in 2007.

Croatia indicated that the selection of arborescent willows has been carried out in natural populations. Intraspecific and interspecific hybridizations have also been performed; in the latter case, the Chinese willow (*S. matsudana*) was partnered with white willow (*S. alba*). Research is also underway to produce arborescent *Salix* clones that offer high potential for biomass production in short rotations.

Serious defoliation and death of trees by the willow sawfly *Nematus oligospilus* between 1998 and 2004 spurred **New Zealand** to increase genetic diversity in its breeding programme. Various combinations of crossings were done using *S. viminalis*, *S. lasiolepis*, *S. reichardtii*, *S. opaca*, *S. purpurea*, *S. daphnoides*, *S. matsudana* and *S. lasiandra*.

Over the years, **Belgium** has established a collection containing about 800 clones of *Salix*, as a basis for its breeding programme. Since 2004, many interspecific and intraspecific crossings (mainly with *S. alba*, *S. xrubens* and *S. fragilis*) have been done to produce seedlings showing a combination of fast growing ability, good form characteristics and resistance to *Brenneria salicis* (watermark disease).

Turkey reported that studies were conducted to compare growth performance, bole straightness and survival of *Salix* clones. In **Serbia**, physiological and growth characteristics of *S. alba* were also examined, as well as tolerance on the leaf beetle (*Chrysomela populi*).

The **United States of America** mentioned a study on the selection and breeding of *Salix* species for bioenergy production, phytoremediation and fundamental genetic studies. **Germany** also reported on a project launched in 2005 to establish and manage fast-growing willow plantations in one region, using four different varieties from Sweden. The country's progress report mentions specific studies on rust fungi in willow clones suited for biomass production. The interest of this research lies in the fact that, contrary to what was found in the United Kingdom and Sweden, the results show high genetic diversity within the *Melampsora* rust population. This may explain why very different reactions to the pathogen were observed between the willow clones, from highly susceptible to highly resistant.

As was the case for poplar, **Bulgaria** indicated that due to various constraints, genetic improvement work on willows was limited during the reporting period.

4. Forest Protection

This Section reports on the incidence and impact of damages in poplars and willows from biotic and abiotic factors. Although some commonalities exist, these vary significantly in nature, scope and distribution between countries. The Section also describes research activities to mitigate these damages, some of which may also be described in Section III. 5 as they relate to genetics work.

4.1 Biotic factors

4.1.1 Insects

The **Republic of Korea** reported that no major outbreaks of specific pests are underway. Nevertheless, boring insects such as Japanese swift moth and willow borer have caused severe damage to young poplars in established plantations as well as in experimental forests.

In **Turkey**, important pests observed in nurseries are *Gypsonoma dealbana*, *Sciapteron tabaniformis*, *Byctiscus populi*, *Melasoma populi* and *Nycteola asiatica*. Damaging insects active in plantations are *Hyphantria cunea*, *Pygaera anastomosis* (for which a study was published), *Leucoma salicis*, *Sciapteron tabaniformis*, *Melanophila picta*, *Agrius sp.*, *Aegeria apiformis*, *Lepidosaphes ulmi* and *Chionapsis salicis*.

In **Croatia**, major defoliators are recorded each year, namely *Operophtera brumata*, *Melasoma populi*, *Phyllosecta vitellinae*, *Phyllobius sp.*, *Polydrosus sp.*, *Rhabdophaga salicis*, *Helicomyia saliciperda*, *Phyllocnistis suffusella* and *Lithocoletis populifoliella*, but they are in latency or under control. Other damaging insects are the Dusky clearwing (*Paranthrene tabaniformis*), the hornet moth (*Aegeria apiformis*) and, to a lesser extent, *Trypophloeus sp.* It is reported that some sites have become unproductive for poplar due to changes of habitat (extended dry periods are particularly stressful for young poplars) and the subsequent outbreak of thrips (*Lisothrips crassipes*).

No substantial large scale damages to either poplar or willow were experienced by **Bulgaria** from 2004 to 2007. However, a progressive population growth is noticed for the small poplar clearwing moth (*Paranthrene tabaniformis*), inflicting damages on sapling stems in some nurseries and young poplar plantations. Protection measures have often been unsuccessful and since 2007, the use of phosphororganic insecticides which had previously showed some effect has been prohibited. One of the most spread and dangerous pests on the poplars in Bulgaria is the poplar twig borer (*Gypsonoma aceriana*).

In **Romania**, *Lymantria dispar* continues to be the most important defoliating insect in poplar and willow stands. In 2006, the infestation represented 4,400 ha as, much less than the peak of about 28,000 ha reached in 1998-1999. Aerial spraying was used during the reporting period although in the stands located in the Danube Delta, where flood water levels vary, some difficulties were met in determining the appropriate treatment time. Other reported pests are *Hyponomeuta rorellus*, *Stilpnotia salicis*, *Nycteola asiatica* and *Clostera anastomosis*. In young poplar and willow plantations on higher grounds less exposed to flooding, infestations were noted from *Saperda populnea*, *S. carcharias*, *Paranthrene tabaniformis*, *Aegeria apiformis*, *Melanophila decastigma* and *Agrilus suvorovi*.

Damages from pests varied in range and intensity during the reporting period in **Serbia**. The most significant is the gypsy moth *Portetria dispar* with a peak presence in 2004-2005; mechanical and chemical treatments were applied. Other pests causing important defoliation in poplar plantations are from the Geometridae family (*Eranis defoliaria*, *Lycia zonaria*) and the Noctuidae family (*Orthosia incerta*, *O. gotica*, *O. populi*). Insects from the Chrysomelidae family (*Chrysomela populi*, *C. tremulae*, *Phyllodecta spp.*) were found both in young and old poplar plantations as well as nurseries. Research was also conducted to investigate the predilection of *Chrysomela populi* for feeding on 16 clones of *S. alba* and *S. nigra*. Furthermore, aphids are considered a serious threat in poplar plantations; so far, 22 species have been identified. Among them, the presence of *Chaitophorus populicola* is very important because this aphid is treated as an invasive species in Europe and its occurrence in Serbia is the first finding in 20 years. The presence of the cotton bollworm *Helicoverpa armigera* was also noted in one nursery; due to its spreading potential, the country mentioned that monitoring will be significantly increased.

Belgium reported on a study to assess the impact of drought on insect – tree relationships, using poplar and the leaf beetle *Chrysomela populi*. The experiment suggests that drought had a negative impact on the insect's survival and feeding performance.

As part of its research activities on the dynamics of pests and diseases in willow plantations, **Sweden** mentioned studies on the induction of certain types of insect resistance as well as on factors affecting palatability of willow leaves for herbivores. Work has also been done on the factors affecting willow leaf beetles (*Plagioderma versicolor*) with particular focus on plantation management practices and the possibilities for biological control. Another field of research addresses the possibility of a combined effect of frost and bacterial disease resulting in the severe dieback of trees observed in some commercial *Salix* plantations. Of special interest are monitoring experiments of pests and diseases on leaves of willows fertilized with wastewater, urine and sewage sludge which revealed variable results when compared to untreated willows.

Spain experienced various levels of losses and growth effects from the leaf beetles *Phratora laticollis* and *Melasoma populi*, the poplar clearwing moth *Paranthrene tabaniformis*, the poplar and willow borer *Chryptorhynchus allii-populina*, the poplar shoot-borer *Gypsonoma aceriana*, the moths *Leucoma salicis* and *Dicranura iberica*, and various species of aphids. In various regions, an important infestation of the poplar woolly aphid *Phloeomyzus passerinii* occurred, particularly in 2007, causing significant damage. Chemical insecticides were applied successfully whereas in untreated stands, high levels of mortality were noticed in the spring of 2008. One region (Castilla and León) also reported new and preoccupying damages caused by the winter moth *Operophtera brumata*, which required chemical treatment.

New Zealand indicated that the major willow sawfly (*Nematus oligospilus*) infestation mentioned in the previous report is now very sporadically observed. Although the reason is not clear and has not been scientifically investigated, it is thought to be linked to passerine birds feeding on the larvae.

The most important pests noted by **Italy** are the poplar and willow borer (*Cryptorhynchus lapathi*), which captures about 30% of the whole cost of poplar protection in the country, the large poplar borer (*Saperda carcharias*) and the goat moth (*Cossus cossus*). The presence in a restricted area of Central Italy of the American pest *Megaplatypus (=Platypus) mutatus* is also considered a major threat as it is able to feed on a large number of broadleaf trees, causing severe damage to trunks; investigations to find eradication

strategies are advancing in order to reduce damage and to avoid chances of spreading. Other important pests in plantations and/or nurseries are Buprestid beetles, particularly *Agrilus suvorovi populnaeus* and *Melanophila picta*, the poplar clear-wing moth (*Paranthrene tabaniformis*), the poplar twig borer (*Gypsonoma aceriana*) and the poplar woolly aphid (*Phloeomyzus passerinii*). The polyphagous leafhopper *Empoasca decedens* is recorded in poplar and willow nurseries in Northern Italy and the country notes that despite the current absence of reports, the danger of virus or phytoplasma transmission by the pest has to be investigated more thoroughly. Furthermore, massive attacks of *Byctiscus populi* occurred in the Po Valley and high population levels of *Chrysomela populi* L. were recorded throughout the period. For the major pests, various control strategies using chemical and biological means are used both in nurseries and plantations.

Over 132 insect pests affecting poplars have been recorded in **India**. One of the major ones is the stem borer (*Apriona cinerea*) and no genetic variation in resistance of poplar clones has been noted so far. Damages from defoliators are also important, namely *Clostera cupreata*, against which two indigenous egg parasitoids (*Telenomus colemani* and *Trichogramma poliae*) have proven to be effective bio-control agents. *Clostera fulgurita* is also causing problems to poplar and willow and for this pest, a predatory bug (*Canthecona furcellata*) and a larval parasitoid (*Aleoides percurrens*) have been recorded as biocontrol agents. Other important pests to either poplar or willow or both are the stem borer *Apriona cinerea*, Gypsy moth (*Lymantria spp.*), willow scale (*Chionaspis salicis*), tent caterpillar (*Malacosoma spp.*), willow leaf beetle (*Altica spp.*), goat moth (*Cossus cossus*), ermine moth (*Yponomeuta rorellus*), poplar petiole gall insect (*Pemphigus spp.*) and willow apple gall (*Pontania spp.*). Chemical pesticides have been tried to protect poplar plantations against the leaf hopper (*Kusala salicis*). *S. × fragilis* is reported to be under severe pest attack in the Punjab region and given such level of vulnerability, scientists have recommended that locally available wild species and other varieties of willow growing in similar regions of the Himalayas be introduced on a trial basis. Willow trees have also been affected by *Pontania spp.* which induces galls in leaves and, under severe infestation, leads to stunted branches and slower growth.

Although there are many species of poplar pests in **China**, only about ten are reported to cause serious damage. Defoliators include *Clostera anachoreta*, *Micromelalop troglodyte*, *Clostera anastomosis*, *Apocheima cinerarius*, and *Lymantria dispar*. Insect borers include *Anoplophora glabripennis*, *Apriona germari*, *Batocera horsfieldi*, *Xylotrechus rusticus* and *Cryptorhynchus lapathi*. For a few of these species, the country's progress report provides information about occurrence, distribution area, research and control technologies. A special note is made on the fact that four different populations of the insect borer *A. glabripennis* have been found, from north China, south China, United States and the Republic of Korea. Studies also showed that there were little differences between *A. glabripennis* and *A. nobilis*, which support the findings that the two may in fact be one single species.

In **Argentina**, the main pest issue in poplar plantations is linked to the ambrosia beetle (*Megaplatypus mutatus*), which causes serious economic losses. Various research projects are underway to better understand its life cycle and infestation patterns, estimate population levels, implement regional monitoring, associate risks with climatic conditions and evaluate the effect of natural insecticides. In willow plantations, the most significant defoliation threat comes from the willow sawfly (*Nematus oligospilus*) which can reduce annual growth by 60% and, with repeat infestations, kill the plantation altogether. Willows are also attacked by leafcutter ants (*Acromyrmex spp.*), although less significantly.

The cottonwood leaf beetle (*Chrysomela scripta*) is probably the most important forest insect affecting *Populus* plantations in the **United States of America**. Other insects ranking in the top five are a suite of woodborers: the poplar borer, the cottonwood borer, the poplar gall *Saperda*, and the poplar branch borer. These are important not only for their damage, but also for the fact that they create infection courts for highly damaging pathogenic fungi such as *Hypoxylon* and *Cytospora* cankers.

In **Morocco**, the main pests attacking poplars are the dusky clearwing (*Paranthrene tabaniformis*), poplar twig borer (*Gypsonoma aceriana*), the beetle (*Melanophila picta*), the goat moth (*Cossus cossus*), the small poplar longhorn beetle (*Saperda populnea*), the Asian gypsy moth (*Lymantria dispar*), the satin moth (*Stilpnotia salicis*), the eyed hawk moth (*Smerinthus ocellatus*), and the puss moth (*Dicranura vinula*).

4.1.2 Diseases

China reported having at least 70 species of pathogens that can cause harm on poplars. The main ones include *Valsa sordida*, blister canker (*Botryosphaeria ribis*), *Discosporium populeum*, *Cerocospora populina*, *Fusicladium tremulae*, crown gall (*Agrobacterium tumefaciens*), and *Helicobasidium purpureum*. It noted that the occurrence and extent of infectious diseases show new characteristics and tendencies: seedling diseases such as crown gall and poplar canker increased, trunk diseases such as canker and bark rot occurred commonly and damaged more seriously, leaf diseases such as black spot disease was common in some areas, and unknown etiological new diseases such as poplar canker with flow liquid and chlorotic disorder occurred in some areas. The progress report mentions that rapid detection and identification of *Agrobacterium sp.* was realized by PCR technology, thus playing a key role in plant quarantine and seedling inspection. China has also conducted research on resistance determination of introduced varieties, resistance comparisons of main poplar cultivars, biochemistry and molecular mechanisms of resistance as well as molecular markers for disease resistance. Results revealed remarkable differences on the resistance among 31 hybrid poplar clones to leaf rust (*Melampsora larici-populina*). Other research looked at the interaction between *Marssonina brunnea* elicitor and poplar as well as a series of reactions which occur during the expression of disease resistance between host tissues, cells and *Melampsora*. Research also occurred on the relationship between the damage of *A. glabripennis* and the physiological and anatomical features of six species of willows. Furthermore, China reports having made significant progress related to biological control of poplar diseases. For example, the inhibiting effects of toxic mushroom strains and their toxin on *Cytospora chrysosperma* were studied and results showed that the strains of *Penicillium sp.* had the strongest antifungal effectiveness on the pathogen. Other research showed that sodium bicarbonate was an effective, economic and pollution-free inorganic chemical fungicide.

Although the **Republic of Korea** reported no severe disease outbreak, some damages were noted from *Marssonina* leaf blight and poplar leaf rust. **Turkey** observed that some pathological problems have originated from the physiological weakness of the poplar plants. *Cytospora* has been seen in unhealthy poplar nurseries. Since 2001, *Melampsora* rust attacks have begun earlier, causing severe defoliation in poplar nurseries in part of Anatolia. A research study selecting resistance poplar clones to *Melampsora* rust fungi has been started.

In **Croatia's** poplar nurseries and plantations, the brown leaf blight (*Marssonina brunnea*) has constantly been present in the last four years. The rust disease on poplar and willow leaves (*Melampsora sp.*) appears in the second half of the vegetation period, especially in the fall, and therefore represents no more significant danger. Since 1999, bark cancer (*Discosporium populeum*) has also been occurring in poplar clones that were previously thought to be very insensitive. In central Croatia, *Glomerella miyabeana*, which attacks the bark of willow seedlings, is considered a serious threat since it can destroy a complete plantation in two weeks. Besides the preventive sprinkling of the seedlings in the nurseries, there are no other known protection measures; the infected seedlings should be cut and burnt. *Pollaccia saliciperda*, which damages willow sprouts, is also present. The progress report mentions that phytosanitary examination in the nurseries is performed twice a year by an authorized state organization.

As in many other countries, the brown leaf blight on the Euroamerican poplars (*Drepanopeziza punctiformis*, *Marssonina brunnea*) is common and spread in all parts of **Bulgaria**. Preventive measures, namely with systemic fungicides, have been successful. Systematic sanitary controls and monitoring processes are applied for *Xanthomonas populi*, *Melampsora medusae* and *Hypoxyylon mammatum*.

During the reporting period, poplar canker caused mainly by *Xanthomonas populi* spread on large areas of hybrid poplar (*P. xcanadensis*) plantations in the meadow of inland rivers of **Romania**, essentially due to favourable climatic conditions. Other reported diseases are poplar sprouts and branches drying (*Discosporium populeum*, *Cryptodiaporthe populea*), poplar and willow leaves and shoot necrosis (*Pollacia spp.*, *Physalospora spp.*) and leaf blight (*Marssonina brunnea*). Poplar rusts were also produced by *Melampsora larici-populina*, *M. alni-populina* and *M. populnea* and it is noted that the vigerous races that occur in Western Europe have not yet been encountered in Romania.

The most significant mycoflora problems on poplars in **Serbia** are associated with *Discosporium populeum*, *Melampsora sp.*, and *Marssonina brunnea*. The progress report also describes results obtained from a study on the susceptibility of five poplar clones to the fungus *Cryptodiaporthe populea*. For willows, the most significant infectious agents from an economical damage point of view *Phyllosticta salicicola*, *Colletotrichum gloeosporioides*, *Fusarium oxysporum*, *Sphaeropsis malorum*, *Valsa salicina*, *Marssonina salicicola*, *Melampsora capraearum*, *Fomes fomentarius*, *Phellinus igniarius* and *Trametes suaveolens*.

Belgium reported the development of an artificial infection method with the bacteria *Brenneria salicis*, a vascular parasite responsible for the watermark disease; this development has already facilitated the selection of resistant clones. Results have also been obtained from studies on the possible effect of abiotic and site-specific factors that could trigger the watermark disease. Belgium also provided detailed results on resistance tests of poplars to the rust *Melampsora larici-populina*. The work is in line with the fact that, following the breakdown of resistance to this rust of several commercial clones in the '80s and '90s, Belgium changed its poplar selection strategy from complete resistance towards tolerance. The progress report also indicates that signs of mortality were observed in 2005-2006 in young poplar plantations located in the central agricultural zone of the country. In addition to *Phoma sp.*, which causes approximately 40% of the cankerous formations, and already known *Fusarium solani*, the analyses revealed three new species of *Fusarium* still not described on poplars.

Among its most significant disease agents on poplars, the Aragon region of **Spain** noted important defoliation from *Marssonina brunnea* as well as the presence of the leaf and shoot blight *Venturia populina*, both having a negative effect of tree growth. In addition to these two, other regions of the country cited the rust *Melampsora allii-populina*, various cankers caused by *Dothichiza populea*, *Fusarium sp.* and *Cytospora chrysosperma*, and root rot linked to *Armillaria*. Although present, these were considered to have remained at an acceptable level during the reporting period. In August 2004, one region (La Rioja) observed a strong attack in a *P. alba* var. *pyramidalis* stand from the shoot blight *Venturia tremulae* even though the stand had been treated with a fungicide a few months earlier. Important damage was also reported in two regions from the bacteria *Brenneria sp.* (watermark disease) which spreads rapidly and, in most cases, kills the infected trees.

The dry climate conditions which prevailed in **Italy** in the period 2004–2007 greatly influenced the phytosanitary situation of poplar plantations. On the drought-suffering plants, attacks by *Phomopsis spp.* and, sporadically, by *Cytospora spp.*, were observed, mainly in the central and southern districts. In adult plantations suffering from water stress, cortical necrosis was noted. Although the development of the leaf disease *Marssonina brunnea* was not favoured by the previously described droughts, the rainy conditions of spring 2008 caused a resurgence of this disease, which brought intense defoliation in the eastern areas of the Po Valley. Attacks of the rust *Melampsora larici-populina* are frequently reported in nurseries and chemical treatments are necessary. Damages caused by root rot from *Rosellinia necatrix* are constantly increasing and the spreading has been associated with the common practice of immediate replanting and of leaving the roots and wood residues on the soil.

As in other countries, research in **India** has shown that poplars are prone to a number of fungal, bacterial, viral and phanerogamic parasites, causing significant losses. The major soil borne diseases are Botryodiplodia set rot (*Botryodiplodia palmarum*), white root rot (*Dematophora necatrix*) and other root rots (*Ganoderma lucidum*, *Rhizoctonia solani*). Among the foliar diseases, leaf rust

(*Melampsora ciliata* and *M. populina*), various leaf spot agents (*Alternaria* sp., *Cladosporium humile*, *Cercospora populina*, *Septoria populi*, *Myrothecium roridum*, *Phyllosticta adjuncta*, *Sphaceloma populi*), powdery mildew (*Uncinula salicis*), leaf blight (*Bipolaris maydis*) and leaf blister (*Taphrina aurea*) are all important. Pink disease (*Corticium salmonicolor*) and bark burst (*Botryodiplodia palmarum*) are the major canker diseases. The attack of mistletoe (*Viscum album*) is serious in the hills. Selection of proper site for plantation, selection of disease-free propagation material, sanitation, raising plantations in mixtures and use of biocontrol agents are all used to reduce forest tree diseases. Soil solarization and use of chemicals for seed or propagation material treatment, soil treatment and sprays are preferred in the nurseries.

Argentina also noted severe problems in *P. deltoides* plantations with leaf rust, particularly *Melampsora medusae*, and research is underway to identify tolerant clones. Genetic diversity within the *M. medusae* population in a specific region is also being examined. Another important infectious agent is *Septoria*, causing leaf spot; current studies are looking at the susceptibility of various poplar clones. In **Morocco**, rusts are more frequent on black poplars. *Pollaccia radiosa* attacks mainly white poplars on the coast and in valleys.

The **United States of America** reported that its primary fungal diseases in poplars are linked to *Septoria*, *Melampsora*, and *Marssonina*. *Venturia* can also be a problem in certain years. The fact that native cottonwoods are for the most part resistant to *Septoria* provides opportunities for breeding for resistant hybrids.

4.1.3 Other biotic factors (animals, etc.)

Although few countries reported on damage caused by animals, a few points are worth noting.

Spain noted some damage in plantations from browsing by rabbits and small rodents although it is recognized that these animals also contribute by feeding on competing vegetation. Some damage is also reported from woodpeckers.

Germany reported that protective measures had to be taken, particularly in the first year of planting, against browsing by game (with fencing), rodents and competing vegetation.

In **Croatia**, damages to poplar plantations are also reported from red deer (*Cervus elaphus*) while the hare (*Lepus europaeus*) feeds on the bark of willow seedlings.

4.2 Abiotic factors

Few countries provided information on abiotic factors having affected poplar or willow production and cultivation between 2004 and 2007.

Bulgaria indicated that long droughts and summer temperatures higher than usual had been typical of the period under review and that disastrous floods in 2005 and 2006 had caused major damages. In several poplar nurseries located in the northern part of the country, saplings were also severely affected by hailstorms.

Spain noted that in one region, strong winds had caused serious losses and led to wood salvaging operations. Hailstorms also caused considerable damage and poplars had to be pruned for reshaping and, in some cases, a preventive treatment with fungicides was applied. In one region, foliage damage is now observed and linked to soil micro and macronutrients deficiencies. Late frost events are also cited as having resulted in the death of an important part of the buds and shoots in affected plantations, also causing the emergence of numerous shakes and cracks in the trunks, in some cases soon colonized by bacteria.

China reported on willow research relating to adaptability to water stress and salt tolerance. These studies showed that with the increasing of salt concentration, the seedling height and biomass of plants above and under ground were all restrained; both chlorophyll and praline content were significantly affected. It was also noted that the growth of adventitious roots was significantly inhibited when certain salt concentrations were exceeded and differences were significant among different species.

The **United States of America** provided information on research examining the effects of higher CO₂ levels on nutrient cycling and below-ground systems as well as on competitive interactions. It also noted the development of an exposure-based standard for evaluating ozone risk to aspen forests and its application to estimate growth decline. Results indicated a range of no effect to 31% growth decline, depending upon clonal sensitivities.

Romania indicated that following serious flooding in some areas, mature plantations of hybrid poplars and white willow resisted longer than a year in stagnant water, starting to dry afterwards. Water stress and its incidence on various poplar clones are also being examined in **Argentina**. Results have so far indicated detrimental effects on height and diameter growth, foliage area, stomata conductivity, photosynthesis and senescence. **Germany** noted that in years with extreme spring aridity, mortality rates have been higher in young seedlings; supplementary irrigation is recommended to safeguard successful regeneration.

5. Harvesting and Utilization

This Section provides a broad picture of some of the techniques, issues or current research efforts reported by IPC participating countries in regards to harvesting poplars and willows. It also indicates status and trends for product manufacturing and describes, particularly through research efforts and applications, the world-wide increasing interest for poplars and willows as bioenergy sources.

5.1 Harvesting

Croatia pointed out that improvements were necessary in the organization of harvesting operations, more so than in the technical improvement of the equipment. Most of the cutting is done with chainsaws, individually, using log assortment methods and presenting longer wood for industrial processing.

Bulgaria's progress report mentioned that the existing form of logging could not secure the process both technically and technologically.

Studies with *P. deltoides* in **India** have revealed that coppice shoot length and shoot collar diameter growth decreased after the tree had reached about 25-30 cm in stump diameter; this information is valuable to optimize harvesting timing. Other experiments have shown the nutrient depletion associated with whole tree harvesting techniques, leading to the recommendation that foliage, twigs and roots be left on harvesting sites in fast growing plantations.

In the **United States of America**, most of the poplar harvesting is done for pulpwood purposes. The most common species, *P. tremuloides*, is typically logged by chain saw, hydraulic shears and/or mechanized saws. Other harvested species are *P. deltoides* and *P. trichocarpa*. Whole tree chipping with stationary chippers is also common. The country's progress report describes a research project conducted to address the additional challenge of harvesting willow given the numerous small diameter stems.

Harvesting of poplars and willows in **Argentina** is essentially done through manual means, although one enterprise has now incorporated harvesters in its operations. Given market conditions, increased mechanization is foreseen.

Italy has conducted surveys to acquire an up-to-date picture of harvesting systems used in traditional poplar cultivation. The study led to the identification of a series of factors (use of modern machinery, required skills, work organization, etc.) as well as technical and economic factors useful to optimize these

operations and identify possible measures of rationalization. One of the conclusions is that almost one third of the harvesting enterprises have already started to use more modern and specialized equipment. Another is that such modernisation imposes a series of bonds which are linked towards a transition to more organized activities in the field.

Germany indicated that poplars and willows grown in conventional rotation periods are exploited according to normal forestry practices and **Belgium** provided preliminary results on a system for the fast evaluation of standing trees in terms of their peeling quality. In a context of multiple sourcing, such a system would be helpful to associate sheets of various clones and thickness.

Spain mentioned that one region had proceeded with the forest management certification of more than 6,000 hectares of plantations. **Romania** and the **Republic of Korea** both reported that no new harvesting experiments had been conducted during the reporting period. **New Zealand** indicated that neither poplar nor willow plantings are grown or managed for timber. However, small shipments of poplar were exported to China.

5.2 Utilization - Products

Most countries reported a lasting tendency towards an increase in the demand for poplar and willow wood from all categories.

Bulgaria pointed out the application of poplar and willow wood as massive elements in the production of furniture and linings. Demand has also begun for willow sided wood for products such as beehives and floor planking. A misbalance is noted between supply and demand for round poplar wood.

The application of various poplar clones in pulpwood production was studied in **Croatia**. It was determined that all the examined clones were suitable and that the storage time of the harvested material for up to a year did not influence the quality of pulpwood fibres.

Serbia explained how the increasing use of short-rotation fast growing species has brought new challenges associated with the fact that raw materials now include a high percentage of juvenile wood and bark, which require significant corrections of technological parameters and the adjustment of manufacturing processes. For example, the progress report provides detailed results gathered from long-term research on the use of both common assortments of *Populus* and *Salix* and also of whole trees, including branch wood and bark, for the production of semichemical pulp and sulphate pulp using.

More than 80% of *P. nigra* wood in **Turkey** is used as roundwood in rural areas for construction purposes and daily needs. Poplar consuming industries have also developed during the reporting period, mostly for fibre and chip boards, particle boards, plywood, furniture, packing and matches, using essentially Euramerican hybrid poplars. As far as wood properties are concerned, studies in the country have shown that *P. nigra* has better strength properties than hybrid poplar wood.

It is estimated that about 80% of commercial poplar wood produced in **India**, which mostly consists of exotic poplars, is consumed by the plywood industry and that the rest mainly goes to the match industry. The country's progress report indicates that *P. ciliata* has good potential for the production of packing crates, plywood and hard boards. It is currently in great demand for the match industry and is used for construction purposes and as fuel; its leaves serve as fodder for goats. The wood from *P. gamblei* is also suitable for plywood, matches and packing cases. *P. euphratica* and *P. alba* are used as fodder. Wood densification experiments have also succeeded in improving the working and carving properties with poplar (particularly the reduction of wooliness) which make it more suitable for the handicraft sector. Successful results have also been obtained in surface colouring, for the furniture industry, using bark extracts and ammonia. For the plywood sector, combinations of *Eucalyptus* and *Populus* have also been developed. Although the use of poplar in paper making is currently non significant in India, progress has been made since 2005 to develop a heavy weight base paper, used for liquid packaging, that uses *P. deltoides*, *Eucalyptus* and bamboo.

Poplar plantations have also become one of the main raw materials for timber processing in **China**, particularly in the wood-based panel industry. Given this importance, the country's progress report provides a lot of information about completed and ongoing research. One topic is the analysis of anatomical properties, such as fibre length, thickness of fibre walls and proportion of duct organs, comparing poplars growing on bottomlands with poplars growing under normal site conditions. Other studies looked at physical and mechanical properties of *P. xcanadensis* and *P. deltoides*, the latter under fertilized and non-fertilized, flooded and non-flooded conditions. Another experiment showed that the chemical composition of *P. pseudo-simonii* × *P. nigra* was affected after being infested by pests and diseases. As in many other countries, research is also conducted on the correlation between growth and the genetic variation of the wood properties for various clones, particularly of *P. deltoides* and *P. xcanadensis*. Poplar's wood drying properties were investigated which included not only high temperature drying but also microwave. Chinese scientists have also looked at improving some disadvantages generally associated with poplars, such as low density, weak strength, unstable dimension, flammability and perishability, which have so far limited the application scope. Some successes have been achieved. For example, a dyeing technology has been developed to produce decorative panels with poplar. New progress was also reported in the production of poplar LVL and new products have been developed, including poplar plywood for concrete moulding board, structural and non-structural poplar LVL with high strength and wear-resistance. As far as the production of pulp and paper is concerned, the current capacity of poplar chemi-mechanical pulp production with fast-growing poplar as raw materials in China is currently at nearly 2 million tons/year and the progress report indicates that this could climb to 10 million tons/year in a few years. Given this perspective, much research is underway to look at the adaptability of fast-growing poplar, high-yield pulping techniques, bleaching processes and waste water treatment technologies. The progress report also mentions the abundant products made of willows in China, namely willow knitting, paper, fibre board, handlers for agricultural tools and mining poles. In north and northwest China, willows are mainly used as fuelwood, some of which for charcoal.

P. tremuloides is used extensively in the **United States of America** for pulp, lumber, hard board and insulation board manufacturing. Yet, pulp and paper remain the major products from poplar wood in the country, using all types of commercial pulping processes (mechanical, semi-mechanical, kraft, sulfite). Many mills use 100% poplar wood; hybrid poplars are gradually becoming a more important supply source as native poplar resources decline. Willows currently have only local use.

Romania provided some results from its ongoing research activities on the physical and mechanical characteristics of *P. xcanadensis* and *P. xgenerosa* hybrid cultivars, both from a technological and processing perspective. **Belgium** also described in details various research projects relating to drying quality of *P. xcanadensis* clones, the influence of elevated CO₂ on poplar wood properties, the production of poplar laminated beams and the physical and mechanical properties of three *P. trichocarpa* × *P. deltoides* hybrid clones. Regarding *Salix*, one experiment looked at the development of a tool for early assessment of willows based on wood properties. Information is also provided on the treatability of willow wood through a study on *S. alba* that looked at the retention and penetration of the preservative CCA.

Italy reported on a project that looked at the physical characteristics and rotary peeling performance with trees of six different poplar clones of *P. nigra* × *P. deltoides* and *P. xcanadensis* × *P. deltoides*, for plywood manufacturing.

Spain noted that new experiments have demonstrated the potential of buds, particularly from *P. nigra*, to produce natural antioxidants. Analyses also revealed that extracts from these same buds are effective natural insecticides; this opens new research perspectives for pest control associated with *Populus*.

P. euphratica is the main species used in **Morocco** to produce beams while the leaves and twigs are used as fodder and the branches, as fuelwood. The plantations and imported wood are used mostly for lumber

and peeling. No specific research projects were reported on. The **Republic of Korea** indicated that no new utilization for poplars or willows had been undertaken during the reporting period.

Argentina mentioned that, in the province of Mendoza, one peeling plant was established to produce poplar sticks and new lines have been installed to manufacture glulam. The number of sawmills using poplar and willow has also increased in the Delta del Paraná region. Another peeling facility was built for the production of packaging material. Studies are underway to look at the durability of poplar poles treated with CCA and copper sulphate.

Belgium reported that studies are underway to better understand the biosynthesis of lignin because there is increasing interest in transgenic poplar lines that would allow lignin to be more easily degraded during wood processing. The country's progress report also notes that willows could further contribute to the diversification of wood production in the country, which is currently essentially restricted to poplars, even though willows have proportionally more tension wood which has an effect on the quality of finished products. Experiments are underway to select willow clones for commercialization and to promote willow plantation.

5.3 Utilization – Bioenergy

The use of fast-growing plantations for energy purposes is obviously a key agenda item for many countries. Under such short rotation intensive management, the end product is generally woody biomass and as such, tree size and form can be of less importance. The success of such production depends largely on efficiency of the entire production systems, from planting to cultivation, to harvesting and transport.

One of the countries where the potential for willows as bioenergy crop has gained attention is **Sweden**. From a few hectares around 1970, willow cultivation represented more than 16,000 hectares by the end of the '90s. This evolution has been described in a 2008 scientific publication.

Serbia provided detailed results of experimental high density field plantations where biomass was measured and the potential energy obtained by the combustion of the total aboveground biomass was estimated. **Argentina** reported the establishment of experimental plantations in 2006, using both *Populus* and *Salix* in densities of 10,000 and 20,000 plants per hectare for 2-3 year rotations; productivity and wood properties will be examined in the perspective of bioenergy production.

Romania has also initiated a series of biomass production experiments for energy purposes, using hybrid poplars, focusing on non-forested lands. Some of these experiments were conducted in areas polluted by animal dejections, around farms for example, as a means to clean these areas.

In 2001, **Italy** started a research project which included the testing of woody species and cultivars, including poplars and willows, in different sites of the country for the production of energy biomass. Influencing factors and ways to cut costs at every phase of the production cycle are being examined. During the last five years, about 4,000 ha of short-rotation plantations have been established and a programme is providing financial support for the establishment and maintenance of such plantations. The country's progress report points out that further evaluation is needed, given the variety of species and environmental conditions, before short rotation forestry can be broadly implemented.

The **United States of America** also noted an increased interest in biomass fuels with projections of large-scale conversion of idle cropland and pasture to biofuel plantations. The country's progress report mentions that large quantities of poplar biomass are currently used for boiler fuel by the forest industry and some hog fuel is returned to the field as compost.

Belgium provided detailed information about a multi-faceted project associated with an experimental short rotation coppice poplar plantation established in 1996; this project is looking at various specificities including survival rates, number of living shoots produced per stool after coppicing, dynamics of biomass

production, below-ground root traits, variation in leaf area, anatomy and nitrogen concentration. Conclusions are drawn on different biomass production strategies over the course of three rotations.

A process for the production of BTL fuel (from biomass to liquid) has been further developed in **Germany**, using chips from different tree species. The progress report mentions that wood chips produced in short rotation poplar plantations would likely be used in particular. A larger plant is currently being built and it is estimated that the biomass produced in one year on one hectare will yield 4,000 litres of biofuel.

China reported on a research project to examine the feasibility and potential of cultivating willows for bio-energy purposes. The economic feasibility still appears uncertain. One region in **Spain** also reported that the use of branches and twigs from poplar harvesting operations were increasingly being used for energy purposes.

New Zealand reported that a private company is now moving to commercialize the growing of short rotation coppiced willow stands for bioenergy products.

6. Environmental Applications

Over the years, the increased environmental awareness has resulted in the extensive use of poplar and willow plantations for riparian buffers and windbreaks, wastewater treatment and reuse through phytoremediation, and increasingly carbon sequestration.

6.1 Carbon exchange and storage

Scientists from several nations are collaborating on the ASPEN FACE⁵ experiment which is a multi-disciplinary study assessing the effects of increasing tropospheric ozone and carbon dioxide on aspen forest ecosystems. Belgium also highlighted multinational collaborations through the EUROFACE⁶ project, which is the continuation of the POPFACE experiment and aimed to assess the contribution of bio-energy plantations to carbon mitigation and to quantify the direct vs. indirect effects of this type of land-use change on carbon sequestration. The research of EUROFACE also contributed to the Global Change and terrestrial Ecosystems Core Project of the International Geosphere-Biosphere Programme.

Experiments in **China** demonstrated that during flooding seasons from 2005 to 2007, poplars were performing as carbon sequesters in both years and that the net ecosystem carbon absorption was related to photosynthetic active radiation, soil temperature and precipitation. Research was also conducted on the carbon storage in a 10-year *P. deltoides* plantation, looking at the input or output from the stand, the wood, the undergrowth and the soil. Other work looked at the carbon storage in plantations with different stand density.

India estimated that poplar agroforestry plantations in the country lead to the long-term locking of 0.62 million tonnes of CO₂ in plywood every year. The progress report mentions that the country is looking to have some of the benefits accruing from carbon credit go directly to poplar growers, often farmers, which would further encourage poplar cultivation in China. One reported study looked specifically at carbon sequestration potential and cost effectiveness of tree growing operations on farm lands, poplar being one of the major species involved.

Belgium reported detailed results from a study done in collaboration with Italy that looked at the effects of CO₂ enrichment on a short rotation poplar plantation. This experiment looked at final biomass production after two rotations under elevated CO₂ and fertilization, growth dynamics, photosynthesis and

⁵ The ASPEN FACE Project is led by the Michigan Technological University and the USDA Forest Service from the United States of America. Canada, Estonia, Finland, Italy, Japan, Slovakia, and the United Kingdom are among the other participating countries.

⁶ The EUROFACE Project was financed from 2002-2006 within the EU 5th Framework Programme.

leaf characteristics, species differences and carbon budget in ambient and elevated CO₂ conditions. One general conclusion is that in a future elevated CO₂ world, large amounts of biomass can be gained from a poplar coppice system provided that the poplars are growing under optimal conditions.

Of special note are research studies, reported by **Italy**, on the potential of poplar plantations as carbon sinks which have concluded that tillage, and particularly soil loosening performed 2-3 times a year, have a negative impact on the ability of the poplar system to store carbon. Italy also reported that plantations of black poplar and white poplar together with other forest species are being established to capture carbon dioxide. The planting operations and the subsequent tending activities are monitored to estimate the energy balance.

6.2 Vegetation rehabilitation, shelterbelt development and landscape improvement

In recent years, poplars have been extensively used in vegetation rehabilitation in **China**. Experiments have been made in hilly and gully areas (poplar and poplar + caragana) and sandy lands. Even in arid and semi-arid zones, where moisture retention and drought resistant technologies were applied, the survival rate of poplar plants has increased. Poplars are also broadly used for the development of shelterbelt systems, for wind breaking, sand fixing, and soil and water conservation. In one case, a shelterbelt was successfully established to protect an oasis and provide the first defence line. In terms of species selection, the combination of poplars and *Tamarix chinensis* is regarded as an ideal solution for its protecting effect and the features of fast-growing and drought tolerance. In arid and semi-arid zones, large amounts of poplars were planted to establish farmland shelterbelts for the purpose of reducing the evaporation of soil, maintaining the moisture of farmland, improving the soil micro-environment, increasing the use rate of irrigated water and preventing secondary salinization of soil. Research has also demonstrated that poplar plantations could be used for snail control.

Italy indicated that poplars and willows are being used with other shrubs and tree species to recover degraded land such as gravel quarries along rivers. Artificial forests are also planted near towns to restore fluvial areas for recreation and tourism, using poplars and willows as pioneer species. The country's progress report notes that experiments along the Po River have shown that forests (natural and poplar stands) contribution to control soil erosion better than agricultural crops and that poplar stands are in fact superior to natural shrubs and very close to natural alluvial forests.

Spain noted that afforestation efforts are made, particularly along river banks, using indigenous *Populus* species. In Northern **Egypt**, *P. euphratica* is planted for stand stabilization projects in dry areas and *P. alba* is used for sites with a high water table and salinity in compacted soils. The country also indicated that all willow plantations are being used either for shade purposes or as protection for irrigation canals. The **United States of America** also reported that native poplars and willows are used extensively for bank stabilization along streams, rivers, lakes and reservoirs where erosion occurs. The advantages of these projects are deemed both environmental and economic as natural materials are low cost, provide habitat, minimize flooding and are self sustaining.

In addition to having row plantations as traditional practice along rivers, streams, fields and roads for centuries, **Turkey** also mentioned poplar's great potential for gallery plantations (i.e. one or two rows along river and stream banks), although special attention must be given, particularly during planting, to prevent mortality from changes of the water table. In **Morocco**, poplar plantations are recommended as shelterbelts, particularly to protect against hot summer winds.

In **Argentina**, poplars are the main species used for windbreaks to protect fruit and flower productions whereas *Salix babylonica* is used for coastal protection. **Serbia** is also looking at the establishment of windbreaks and shelterbelts to combat wind erosion and improve microclimate conditions in specific situations, while contributing to general national afforestation plan. Another objective mentioned in the country's progress report is the use of plantations to increase the utilization of gley soils which has so far been limited because of their physical, chemical and hydrological properties.

India reported on microclimate improvement research using *Populus*. Investigations were started in the '90s to study the atmospheric humidity and air temperature during active growth stages of wheat crops growing under poplar trees. Results now show that atmospheric humidity was directly related to poplar row spacing while air temperature showed the reverse relation.

Various water erosion issues were raised by **Bulgaria**. Plans are to afforest 10-20 meter strips along riversides with several densely planted dendriform willows. These plantations undergo managed pruning, i.e. when the trees reach a certain height, they are pollarded so that new shootings are generated. The country also mentioned the implementation of projects for the reclamation of agricultural lands as well as the establishment of shelterbelts.

New Zealand has also experienced severe hill erosion following major storm events in 2004, 2005 and 2006 which have refocused attention on erosion control. The country's progress report mentions that this may result in additional support for poplar and willow breeding and research.

Belgium also reported on a study that looked at the use of poplars for ecological restoration. Among the conclusions, it was noted that although poplar afforestations do not have similar ecological values as old forests, they can be used to enlarge and connect small forests and bring these habitats in a favourable state of conservation, particularly if the poplars are combined with other tree species. **Sweden** cited publications which conclude that apart from their great potential for biomass production, poplar and willow trees can enrich the coniferous forests of boreal regions and increase biodiversity in open agricultural landscapes of the boreal zone.

Croatia mentioned its plans to replace all foreign species with indigenous species in its protected areas. Foresters are looking at some 50 years for the replacement strategy of *P. × canadensis* with European *P. nigra*.

6.3 Phytoremediation of polluted soil and water

Willows can play an important role in restoring polluted soil and water and over the last few years, **China** has initiated research in this field. The reported work focuses on the absorption and accumulation of cadmium in willows and the suppression of willow growth by cadmium. Another experiment dealt with the ability of *S. babylonica* in absorption and metabolism of ferro cyanide; the conclusion was that willow trees could absorb and effectively transfer some cyanide without harm to themselves.

In 1997, poplars and willows were planted to identify suitable species and varieties for landfill reclamation in a specific site in the **Republic of Korea**. Ten clones of four poplar species and two clones of one willow species were monitored. Results until 2005 show that the survival rate of all clones was drastically reduced year after year, the highest survival rate and dominant growth being recorded with a *P. alba × P. glandulosa* hybrid. In the end, two *Salix* clones and three *Populus* hybrid clones were selected for the restoration of the site. Other experiments looked at the performance of various poplar clones in absorbing livestock wastewater. The *P. alba × P. glandulosa* hybrids showed the best growth performance whereas as the weakest were *P. koreana × P. nigra* and *P. nigra × P. maximowiczii*. The physiological characteristics and antioxidant activity of *P. × canadensis* and *P. alba × P. glandulosa* were also examined in a livestock waste leachate environment.

In **New Zealand**, willow was recently examined as an alternative land use activity to animal farming around Lake Taupo which is showing high levels of nitrogen thought to be from surface and subterranean runoff of animal urine and nitrogen fertilizer. This was the first field trial of short rotation coppice willow cultivation in the country since 1981. Data is still awaiting analysis but clones that best performed were *S. viminalis* and *S. schwerinii*.

Belgium stated that phytoremediation has become a new objective for its breeding programme over the last years. It reported that two large-scale experimental fields with *S. alba* and *S. viminalis* have been set

up since 2004 to evaluate the cultivation possibilities of non-food crops as an economic alternative for farmers active on historically contaminated soils. Attention was focused on energy crops with high metal accumulating capacities and much interest was put in short rotation coppice of willow and poplar. Conclusions so far are that large differences in biomass production and tree health can be observed depending on local soil characteristics.

Phytoremediation projects are reported to be numerous in the **United States of America**. Most applications are installed streamside buffers and vegetative filters, although *in situ* applications are increasing. The country's progress report mentions some recent publications regarding the use of transgenic materials with enhanced ability to sequester contaminants. Along the same line, **Germany** reported on an experiments which looked at the phytoremediation potential of transgenic poplars having elevated glutathione concentrations and different wild type poplar species (*P. deltoides* × *P. nigra*, *P. canescens*) on heavy metals and organic pollutants, namely the herbicides paraquat and atrazine.

Around 30 large-scale phytoremediation systems irrigated with different wastewaters have been established in **Sweden** and about 10,000 ha of short-rotation willow coppice are reported to be fertilized with sewage sludge. A series of research activities connected to phytoremediation applications using *Salix* species are also underway. For example, biomass allocation and wood fuel quality were studied in stands fertilized with sludge, ash and sludge-ash mixtures. In another project, irrigation with landfill leachate was shown to increase willow growth and to not result in excessive nutrient drainage. High retention ability for some critical substances (i.e. organic carbon, phenols and phosphorous) was also demonstrated when log-yard runoff was applied in *Salix* plantations. The country's progress report indicates that possible environmental hazards associated with wastewater treatments are monitored and results so far indicate minimum risks.

Research has been conducted in **Serbia** on the potential of various poplar and willow clones for nitrate phytoremediation. Positive results were obtained with both *P. × canadensis* and *P. deltoides*. Other work looked at heavy metals where differences were revealed between genotypes and also regarding the fate of contaminants in plants tissues. In one experiment which examined various species of poplar and willow, phytoextraction of cadmium was most efficient in stems, leaves showed highest translocation of nickel and lead was mostly accumulated in the roots of investigated plants. Phytoremediation studies are also underway on soils contaminated with crude oil. Preliminary results show a significant impact of willows and poplars in the development of microorganisms and the degradation of petroleum hydrocarbons.

Croatia reported that preliminary investigations have been started with small field plots of poplar clones to remediate soils contaminated with heavy and toxic metals. The **Republic of Korea** also noted the development of transgenic clones of *P. alba* × *P. tremula* var *glandulosa* that show tolerance to many toxic heavy metals, especially cadmium and lead. These are being multiplied for testing in polluted sites including abandoned mines.

Air pollution must also be considered in poplar and willow cultivation. **India** reported an experiment where the impact of vehicular pollution on four dominant tree species was examined. Data indicates that various physiological parameters (e.g. total chlorophyll, carotenoids, NPK contents and carbohydrate levels) of tree foliage suffered heavy reductions due to pollution stress.

6.4 Other environmental uses

India mentioned the contribution of poplars in soil amelioration. In one study, an increased total porosity and water holding capacity with increase in tree age and fineness of the soil were observed in a poplar plantation. Another reported study looked at the litter fall addition and nutrients return in a poplar plantation. The quantities of available nutrients and soil microbial count were also examined in a poplar + fodder crop combination in comparison with the crop alone. Other projects investigated the decomposition rates and nutrient dynamics of *P. deltoides* litter in a coppiced plantation, or the monthly variation of nutrient concentrations in leaf and twigs of a *P. deltoides* plantation.

India also made the point that the use of clonal farm forestry and agroforestry plantations can contribute to the protection of natural stands by avoiding the felling of these forests. Similarly, an increase in high-yield fast-growing species cultivation on non-forest areas could protect additional hectares of both natural forest and poplar plantations established in forested zones.

Bulgaria mentioned that poplars are being planted as part of urban and periurban afforestation projects.

V. GENERAL INFORMATION

1. Administration and Operation of the National Poplar Commission or Equivalent Organization

Most countries indicated that their National Poplar Commission continued to function and to hold or support the organization of meetings, technical workshops and field tours. Many have an active website.

A number of National Progress Reports identify the current (2008) chair as well as the various members of their respective commission. In some cases, notably **Argentina, Croatia, Italy, Germany, Romania**, it was noted that members are designated by the country's ministry or equivalent organization responsible for agriculture and/or forest policy. In 2005, **Spain** adopted new regulations governing its National Poplar Commission, notably to include a wider representation of stakeholders and to ensure increased continuity in its activities. **Belgium's** National Poplar Commission continues to hold two regional independent commissions that alternate for the presidency (since 2006, the chair is held by the Walloon Poplar Commission).

Most countries reported on regular or special meetings organized by their NPC – examples include **Belgium, Bulgaria, China, the Republic of Korea, Romania, Spain, Sweden and Turkey**. In September 2005, **Argentina** created a new Organizing Commission of Salicaceas's Days involving its National Poplar Commission as well as technical personnel, businessmen and producers.

A few countries reported that formal NPC activities were limited between 2004 and 2007, notably **New Zealand** and the **United States of America**, but that technology transfer and collaborations still occurred through other networks. **Morocco** mentioned a possible reorganization of its national commission that would include members from the private sector and increase networking with research institutes. **Romania** highlighted various difficulties related to funding as well as legal support and promotion for poplar and willow culture development and wood processing. **Spain** also reported funding issues for the development of specific poplar cultivation work. **Serbia** mentioned that they have not had a national commission since 1992, although there is an agency responsible for poplar and willow cultivation.

2. Literature

Since the last Session in 2004, a massive amount of literature related to poplars and willows has been published by IPC member countries as well as others. A separate Working Paper (IPC/7) of the publications reported for 2004-2007 by each country has been prepared and is available on the IPC website.

Special attention is drawn to a booklet produced by **New Zealand**, entitled "Growing Poplar and Willow Trees on Farms", which contains practical information gathered from research and farmer experience on growing poplars and willows for soil conservation, fodder, shelterbelts, timber and amenity purposes. The country also produced a handbook, entitled "Energy farming with willow in New Zealand", which draws on domestic and overseas experience. **Belgium** noted the production of a leaflet and video that focuses on the environmental benefits of poplar plantations.

Germany also reported the publication of a handbook with instructions for the initiation of flood plain forests using *P. nigra*.

International collaboration is ongoing to revise the document “Poplars and Willows in the World: Meeting the Needs of Society and the Environment” to take account of the major changes in technology, applications and uses of poplars and willows. Originally the “Poplars and Willows of the World” was published in 1958 and revised and reprinted in 1979 by FAO under the auspices of the IPC.

3. Relations with other countries

Nearly all national progress reports indicate strong relationships as well as frequent plant material exchanges that have been either initiated or maintained between IPC participating countries. Many joint meetings were held, this being a strong indication of the IPC’s key networking function. Although these collaborations are too numerous to be individually listed, a few are listed below, most of which were briefly described in the relevant sections of the present document.

These are the International *Populus* Genome Consortium Project, the ASPEN FACE experiment, the EUROFACE Project, the POPYOMICS Research Project, TREEBREEDDEX and the Transpop Project. Mention should also be made of the Salicaceas's Days organized by **Argentina** in September 2006 in which participated many other countries, notably **Chile, Brazil, Uruguay, Cuba, Italia, Spain, Austria** and **Russia**.

ANNEX 1: STATISTICAL TABLES

Table 1	Areas of Poplars and Willows by Forest Categories
Table 2	Main Poplar and Willow Cultivars Used
Table 3	Main Trends in Poplars and Willows Area
Table 4a	Poplar and Willow Area by Ownership: Public
Table 4b	Poplar and Willow Area by Ownership: Private
Table 4c	Poplar and Willow Area by Ownership: Small Holders
Table 4d	Poplar and Willow Area by Ownership: Others
Table 5	Poplar and Willow Forest Product Production
Table 6	Average Import/Export of Poplar and Willow Roundwood or Wood Chips

Table 1: Areas of Poplars and Willows by Forest Categories

Country	Genus	Category	2004				2007						
			Area	Productive	Protective	Other	Area	Productive	Protective	Other			
			000 ha				000ha						
	Populus												
China		Agroforestry & Trees outside forests	1,000.0	500.0	200.0	300.0	2,500.0	750.0	1,625.0	125.0			
India		Agroforestry & Trees outside forests	60.0	60.0	0.0	0.0	60.0	60.0	0.0	0.0			
Argentina		Agroforestry & Trees outside forests	23.9	23.9	0.0	0.0	20.5	10.3	10.3	0.0			
Canada		Agroforestry & Trees outside forests	9.0	9.0	0.0	0.0	14.0	14.0	0.0	0.0			
New Zealand		Agroforestry & Trees outside forests	11.0	0.3	10.5	0.2	11.0	0.2	10.7	0.1			
Russian Federation		Agroforestry & Trees outside forests	5.0	0.0	5.0	0.0	5.0	0.0	5.0	0.0			
Spain		Agroforestry & Trees outside forests	6.0	0.9	4.8	0.3	6.5	1.0	5.2	0.3			
Serbia		Agroforestry & Trees outside forests	3.2		3.2		3.2	0.0	3.2	0.0			
Morocco		Agroforestry & Trees outside forests	0.7	0.1	0.6	0.0	0.7	0.1	0.6	0.0			
Romania		Agroforestry & Trees outside forests	0.8	0.2	0.3	0.3	0.7	0.1	0.3	0.3			
Germany		Agroforestry & Trees outside forests	0.5	0.3	0.3	0.0	0.5	0.3	0.3	0.0			
Bulgaria		Agroforestry & Trees outside forests	0.3	0.2	0.2	0.0	0.2	0.2	0.0	0.0			
Subtotal			1,120.4	594.8	224.7	300.9	2,622.3	836.1	1,660.4	125.8			
	Mixed Populus & Salix												
New Zealand		Agroforestry & Trees outside forests	2.0	0.0	2.0	0.0	2.0	0.0	2.0	0.0			
Spain		Agroforestry & Trees outside forests	2.0	0.1	1.8	0.1	2.0	0.1	1.8	0.1			
Romania		Agroforestry & Trees outside forests	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Bulgaria		Agroforestry & Trees outside forests	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Subtotal			4.0	0.1	3.8	0.1	4.1	0.1	3.8	0.1			
	Salix												
New Zealand		Agroforestry & Trees outside forests	3.0	0.0	2.9	0.1	3.0	0.0	3.0	0.0			
Serbia		Agroforestry & Trees outside forests	0.7	0.0	0.7	0.0	0.7	0.0	0.7	0.0			
Germany		Agroforestry & Trees outside forests	0.5	0.3	0.3	0.0	0.5	0.3	0.3	0.0			
Romania		Agroforestry & Trees outside forests	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Bulgaria		Agroforestry & Trees outside forests	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Subtotal			4.2	0.3	3.9	0.1	4.2	0.3	3.9	0.0			
	Populus												
Canada		Indigenous	28,287.0	20,508.1	3,535.9	4,243.1	28,287.0	20,508.1	3,535.9	4,243.1			
Russian Federation		Indigenous	21,900.0	15,330.0	6,570.0	0.0	21,536.1	15,075.3	6,460.8	0.0			

Croatia		Planted		4.0	3.6	0.4	0.0	3.0	2.7	0.3	0.0
Spain		Planted		2.0	0.4	1.6	0.0	2.5	0.5	2.0	0.0
Germany		Planted		1.0	1.0	0.0	0.0	1.0	1.0	0.0	0.0
United Kingdom		Planted		2.0	2.0	0.0	0.0	2.0	2.0	0.0	0.0
United States of America		Planted		0.3	0.3	0.0	0.0	0.3	0.3	0.0	0.0
Bulgaria		Planted		0.1	0.0	0.0	0.0	0.1	0.1	0.0	0.0
Subtotal				175.4	95.9	70.3	9.2	133.4	106.5	25.6	1.4
Overall Total				76,625.3	51,419.4	20,130.7	5,075.1	79,103.1	53,000.6	21,348.5	4,753.9

Table 2: Main Poplar and Willow Cultivars Used

Country	Genus Populus	Main Cultivars
Croatia		710
Italy		A4A
Italy		Adige
Germany		Androscoggin
Canada		Balsamifera x Trichocarpa
France		Beaupre
Spain		Beaupre
Croatia		Bl. Constanzo
Italy		Bl. Constanzo
Italy		Boccalari
France		Boelare
Spain		Canada Blanco
Canada		Deltoides x Balsamifera
Canada		Deltoides x Maximowiczii
Canada		Deltoides x Nigra
Canada		(Deltoides, x Nigra) x Maximowiczii
France		Dorskamp
Sweden		Ekebo (hybrid aspen)
France		Flevo
India		G48
United Kingdom		Gaver
Belgium		Gaver
United Kingdom		Ghoy
France		Ghoy
Belgium		Ghoy
Belgium		Ghrimminge
United Kingdom		Gibecq
United Kingdom		Hazendans
Canada		Hill-Deltoides x (Laurifolia x Nigra)
France		I-45-51
France		Koster
India		L34/82
India		L49
Spain		Luisa Avanzo
Croatia		M-1
Russia		Marilandica
Germany		Max
Canada		Maximowiczii x (Deltoides x Trichocarpa)
Canada		Maximowiczii x Balsamifera
Spain		MC
Germany		Muhle Larson
Belgium		Muur
Canada		NM6 - Nigra x Maximowiczii
Korea, Rep. of		No. 4 (72-30, 72-31)
Canada		Northwest- Balsamifera x Deltoides
Sweden		OP42
Croatia		Pannonia
Argentina		Populus x canadensis "Guardi"
China		Populus alba var. Bolleana

Korea, Rep. of		Populus alba x P. glandulosa No. 3 "Clivus"
China		Populus beijingensis (P. nigra var Italica x P. cathayana)
China		Populus cathayana
Turkey		Populus deltoides
Argentina		Populus deltoides "208/68"
Argentina		Populus deltoides "Australiano 106/60"
Argentina		Populus deltoides "Australiano 129/60"
Argentina		Populus deltoides "Catfish 2"
Argentina		Populus deltoides "Delta Gold" ("Stoneville 66")
China		Populus deltoides "Harvard"
Argentina		Populus deltoides "Harvard"
China		Populus deltoides "Lux"
China		Populus deltoides "Lux" x P. deltoides, "Harvard"
Argentina		Populus deltoides "Mississippi Slim" ("Stoneville 67")
Serbia		Populus deltoides cl. "Dunav" (S-1-8)
Serbia		Populus deltoides cl. "Sava" (S-6-36)
Serbia		Populus deltoides cl. 665
Serbia		Populus deltoides cl. B-129/81
Serbia		Populus deltoides cl. B-181/81
Serbia		Populus deltoides cl. B-182/81
Serbia		Populus deltoides cl. B-229
Serbia		Populus deltoides cl. B-81
Serbia		Populus deltoides cl. NS-1-3
Serbia		Populus deltoides cl. S 1-5
New Zealand		Populus deltoides x yunnanensis "Kawa"
Romania		Populus deltoids "I-69/55" (sin. Lux)
Turkey		Populus euramericana
Korea, Rep. of		Populus euramericana "Eco 28"
China		Populus euramericana "San Maritino"
Korea, Rep. of		Populus koreana x P. nigra "Suwon"
Turkey		Populus nigra
China		Populus nigra var. thevestina
China		Populus simonii x P. nigra
China		Populus tomentosa
Romania		Populus x canadensis "Harsova RO-16"
Argentina		Populus x canadensis "Conti 12"
China		Populus x canadensis "Guariento"
Romania		Populus x canadensis "I-154"
France		Populus x canadensis "I-214"
Croatia		Populus x canadensis "I-214"
Italy		Populus x canadensis "I-214"
Spain		Populus x canadensis "I-214"
China		Populus x canadensis "I-214"
Romania		Populus x canadensis "I-214"
Romania		Populus x canadensis "I-45/51"
China		Populus x canadensis "NL895"
China		Populus x canadensis "Robuta"
Romania		Populus x canadensis "Sacrau 79"
China		Populus x canadensis "Neva"
New Zealand		Populus x euramericana "Fraser"
New Zealand		Populus x euramericana "Selwyn"
New Zealand		Populus x euramericana "Veronese"
New Zealand		Populus x euramericana "Weraiti"

Bulgaria		Populus x euramericana Agathe F.
Bulgaria		Populus x euramericana Bachelieri
Bulgaria		Populus x euramericana BL
Bulgaria		Populus x euramericana CB-7
Serbia		Populus x euramericana cl. "I-214"
Serbia		Populus x euramericana cl. "Ostia"
Serbia		Populus x euramericana cl. "Pannonia"
Serbia		Populus x euramericana cv. "Robusta"
Bulgaria		Populus x euramericana I-45/51
Bulgaria		Populus x euramericana R-16
Serbia		Populus x euramericana var. Italica
New Zealand		Populus x euramericana x nigra "Crowsnest"
New Zealand		Populus x euramericana x yunnanensis "Toa"
Bulgaria		Populus x euramericana Triplo (I-37/61)
Bulgaria		Populus x euramericana Vernirubens
China		Populus x xiaozhuanica " No 6"
Bulgaria		Populus x euramericana I-214
China		Populus yunnanensis
New Zealand		Populus yunnanensis
China		Populus canadensis "NL95"
China		Populus x simonii x P. nigra var " Italica"
United Kingdom		Ralpalje
France		Raspalje
Spain		Raspalje
Russia		Robusta
Belgium		Robusta
Germany		Robusta
Croatia		S-1-8
Croatia		S-6-20
Croatia		S-6-36
India		S7C15
India		S7C8
Italy		San Martino
Canada		Trichocarpa x Deltoides
Canada		Trichocarpa x Maximowiczii
United Kingdom		Tricobel
France		Triplo
Spain		Triplo
Spain		Unal
Belgium		Vesten
Italy		Villafranca
Russian Federation		Voronezhsky Giant
Canada		Walker-Deltoidesx(Laurifolia x Nigra)
India		WSL22
	Salix	
Croatia		107/65/6 (NS-2)
Croatia		B44
Germany		Bjorn
Sweden		Gudrun
Germany		Inger
Sweden		Jorr
Sweden		Loden

Croatia		Mad 40
Croatia		MB 368
United Kingdom		Olof
United Kingdom		Parfitt
Canada		S25
Canada		S301
Canada		S365
Canada		S546
Canada		S625
Turkey		Salix acmophylla
Spain		Salix alba
Turkey		Salix alba
Romania		Salix alba "Camenita RO-204"
Romania		Salix alba "Cernavoda RO-202"
Romania		Salix alba "Ostrovul Lat RO-201"
Romania		Salix alba "Rast RO-326"
Serbia		Salix alba cl. B-44
Serbia		Salix alba cl. B-72
Serbia		Salix alba cl. B-74
Serbia		Salix alba cl. NS-107/6
Serbia		Salix alba cl. NS-107/65/1
Serbia		Salix alba cl. NS-107/65/7
Serbia		Salix alba cl. NS-73/6
Serbia		Salix alba cl. NS-79/2
Bulgaria		Salix alba kl.BG-2/24
Bulgaria		Salix alba kl.R-202
Bulgaria		Salix alba kl.R-204
Bulgaria		Salix alba Si-2/61
India		Salix alba ssp. Alba
India		Salix alba ssp. Coerulea
Argentina		Salix alba var. calva
New Zealand		Salix alba var. vitellina
India		Salix babylonica
Argentina		Salix babylonica var. sacramenta ("sauce americano")
Argentina		Salix babylonica x S. alba "A 131-25"
Argentina		Salix babylonica x S. alba "A 131-27"
Spain		Salix caprea
Turkey		Salix excelsa
India		Salix fragilis
Spain		Salix fragilis
Romania		Salix fragilis x matsudana "RO-1077"
Romania		Salix fragilis x matsudana "RO-1082"
China		Salix integra
China		Salix integra x S. suchowensis "JW9-6"
New Zealand		Salix matsudana
New Zealand		Salix matsudana x alba "Moutere"
New Zealand		Salix matsudana x alba "Tangoio"
Argentina		Salix matsudana x S. alba "A 13-44"
Argentina		Salix nigra N.4
Spain		Salix purpurea
New Zealand		Salix purpurea "Booth"
New Zealand		Salix purpurea "Irette"
New Zealand		Salix purpurea "Pohangina"

New Zealand		Salix schwerinii "Kinuyanagi"
China		Salix suchowensis x S. integra "JW8-26"
China		Salix suzhouensis
India		Salix tetrasperma
New Zealand		Salix viminalis "Gigantea"
China		Salix x jiangsuensis "J172"
China		Salix x jiangsuensis "J795"
United Kingdom		Stott
Canada		SV1
United Kingdom		Sven
Germany		Sven
Canada		SVQ
Canada		SX61
Canada		SX64
Canada		SX67
Sweden		Tora
United Kingdom		Tora
Germany		Tora
Sweden		Tordis
Germany		Tordis
United Kingdom		Torhild
Croatia		V 161
Croatia		V052
Croatia		V093
Croatia		V158
Croatia		V160
Croatia		V240
Germany		Zieverich

Table 3: Main Trends in Poplars and Willows Area

Country	Genus	Category	Trend
	Populus		
Canada		Agroforestry & Trees outside of forests	Positive
China		Agroforestry & Trees outside of forests	Positive
Germany		Agroforestry & Trees outside of forests	Positive
India		Agroforestry & Trees outside of forests	Positive
Spain		Agroforestry & Trees outside of forests	Positive
Serbia		Agroforestry & Trees outside of forests	Positive
United States of America		Agroforestry & Trees outside of forests	Positive
	Salix		
Canada		Agroforestry & Trees outside of forests	Positive
China		Agroforestry & Trees outside of forests	Positive
Germany		Agroforestry & Trees outside of forests	Positive
Spain		Agroforestry & Trees outside of forests	Positive
United States of America		Agroforestry & Trees outside of forests	Positive
	Populus		
China		Indigenous	Positive
Romania		Indigenous	Positive
Spain		Indigenous	Positive
United States of America		Indigenous	Positive
Russian Federation		Indigenous	Positive
	Salix		
Belgium		Indigenous	Positive
Bulgaria		Indigenous	Positive
China		Indigenous	Positive
Spain		Indigenous	Positive
	Populus		
Bulgaria		Planted	Positive
Canada		Planted	Positive
China		Planted	Positive
Germany		Planted	Positive
Sweden		Planted	Positive
United States of America		Planted	Positive
United Kingdom		Planted	Positive
France		Planted	Positive
	Salix		
Belgium		Planted	Positive
Bulgaria		Planted	Positive
China		Planted	Positive
Sweden		Planted	Positive
United Kingdom		Planted	Positive
	Populus		
Romania		Agroforestry & Trees outside of forests	Stable
Sweden		Agroforestry & Trees outside of forests	Stable
Russian Federation		Agroforestry & Trees outside of forests	Stable

	Salix		
Bulgaria		Agroforestry & Trees outside of forests	Stable
India		Agroforestry & Trees outside of forests	Stable
Serbia		Agroforestry & Trees outside of forests	Stable
Sweden		Agroforestry & Trees outside of forests	Stable
Russian Federation		Agroforestry & Trees outside of forests	Stable
	Populus		
Belgium		Indigenous	Stable
Croatia		Indigenous	Stable
Canada		Indigenous	Stable
Germany		Indigenous	Stable
India		Indigenous	Stable
Korea, Rep. of		Indigenous	Stable
Sweden		Indigenous	Stable
Turkey		Indigenous	Stable
United Kingdom		Indigenous	Stable
	Salix		
Germany		Indigenous	Stable
India		Indigenous	Stable
Romania		Indigenous	Stable
Sweden		Indigenous	Stable
United States of America		Indigenous	Stable
United Kingdom		Indigenous	Stable
	Populus		
India		Planted	Stable
Italy		Planted	Stable
Morocco		Planted	Stable
Spain		Planted	Stable
Serbia		Planted	Stable
	Salix		
Germany		Planted	Stable
Serbia		Planted	Stable
United States of America		Planted	Stable
	Populus		
Belgium		Agroforestry & Trees outside of forests	Negative
Bulgaria		Agroforestry & Trees outside of forests	Negative
Morocco		Agroforestry & Trees outside of forests	Negative
Belgium	Salix	Agroforestry & Trees outside of forests	Negative
	Populus		
Bulgaria		Indigenous	Negative
Morocco		Indigenous	Negative
Serbia		Indigenous	Negative
	Salix		
Croatia		Indigenous	Negative
Serbia		Indigenous	Negative
Russian Federation		Indigenous	Negative

	Populus		
Belgium		Planted	Negative
Argentina		Planted	Negative
Croatia		Planted	Negative
Korea, Rep. of		Planted	Negative
Romania		Planted	Negative
Turkey		Planted	Negative
Russian Federation		Planted	Negative
	Salix		
Argentina		Planted	Negative
Croatia		Planted	Negative
Romania		Planted	Negative
Spain		Planted	Negative
Russian Federation		Planted	Negative

Table 4a: Poplar and Willow Area by Ownership: Public

Country	Genus	Category	2004			2007		
			Productive	Protective	Other	Productive	Protective	Other
	Populus							
China		Agroforestry & Trees outside forests	230.0	470.0	0.0	425.0	925.0	0.0
Canada		Agroforestry & Trees outside forests	0.0	0.0	0.0	0.0	0.0	0.0
Argentina		Agroforestry & Trees outside forests	0.0	0.0	0.0	0.0	0.0	0.0
Germany		Agroforestry & Trees outside forests	0.1	0.0	0.0	0.1	0.0	0.0
Romania		Agroforestry & Trees outside forests	0.0	0.0	0.2	0.0	0.0	0.2
India		Agroforestry & Trees outside forests	0.0	0.0	0.0	0.0	0.0	0.0
Spain		Agroforestry & Trees outside forests	0.0	0.0	0.0	0.0	0.0	0.0
New Zealand		Agroforestry & Trees outside forests	0.0	0.0	0.0	0.0	0.0	0.0
Bulgaria		Agroforestry & Trees outside forests	0.0	0.0	0.0	0.0	0.0	0.0
Serbia		Agroforestry & Trees outside forests	0.0	3.2	0.0	0.0	3.2	0.0
Russian Federation		Agroforestry & Trees outside forests	0.0	2.3	2.5	0.0	2.3	2.5
			230.1	475.5	2.7	425.1	930.5	2.7
	Salix							
Germany		Agroforestry & Trees outside forests	0.2	0.0	0.0	0.1	0.0	0.0
Bulgaria		Agroforestry & Trees outside forests	0.0	0.0	0.0	0.0	0.0	0.0
Romania		Agroforestry & Trees outside forests	0.0	0.0	0.0	0.0	0.0	0.0
Serbia		Agroforestry & Trees outside forests	0.0	0.7	0.0	0.0	0.7	0.0
			0.2	0.7	0.0	0.1	0.7	0.0
	Populus							
Canada		Indigenous	22,629.6	0.0	0.0	22,629.6	0.0	0.0
Russian Federation		Indigenous	6,935.0	6,570.0	7,227.0	6,819.8	6,460.8	7,106.9
United States of America		Indigenous	2,177.2	1,176.9	0.0	2,177.2	1,176.9	0.0
China		Indigenous	483.0	1,092.0	0.0	630.0	1,620.0	0.0
Romania		Indigenous	2.9	6.2	0.0	2.5	5.6	0.0
Croatia		Indigenous	2.7	0.8	0.0	3.5	1.0	0.0
Bulgaria		Indigenous	0.4	0.5	0.0	0.4	0.5	0.0
Germany		Indigenous	0.0	0.5	0.0	0.0	0.5	0.0
India		Indigenous	0.0	9.0	0.0	0.0	9.0	0.0
Korea, Rep. of		Indigenous	0.0	0.3	5.7	0.0	0.3	5.7

Spain	Indigenous		3.3	17.6	1.1	3.8	20.0	1.3
Serbia	Indigenous		0.0	0.9	0.0	0.0	0.9	0.0
France	Indigenous		0.0	1.2	0.0	0.0	1.2	0.0
			32,234.2	8,875.8	7,233.8	32,266.7	9,296.6	7,113.9
	Salix							
Romania	Indigenous		0.6	5.0	0.0	0.5	4.6	0.0
Croatia	Indigenous		2.3	1.2	0.0	3.3	1.7	0.0
China	Indigenous		7.8	39.0	0.0	7.8	39.0	0.0
Bulgaria	Indigenous		0.1	1.4	0.0	1.2	1.3	0.0
India	Indigenous		0.0	14.0	0.0	0.0	14.0	0.0
Spain	Indigenous		0.1	5.7	0.2	0.5	23.8	0.8
Serbia	Indigenous		0.0	5.4	0.0	0.0	5.4	0.0
France	Indigenous		0.0	1.3	0.0	0.0	1.3	0.0
			10.9	73.0	0.2	13.3	91.1	0.8
	Populus							
China	Planted		1,287.0	1,560.0	0.0	1,204.0	430.0	0.0
Turkey	Planted		0.0	2.5	0.0	0.0	2.5	0.0
France	Planted		2.4	0.0	0.0	2.4	0.0	0.0
Spain	Planted		23.5	18.8	4.7	16.4	13.1	1.6
Argentina	Planted		0.0	0.0	0.0	0.0	0.0	0.0
United States of America	Planted		0.0	0.0	0.0	0.0	0.0	0.0
Italy	Planted		13.1	0.0	0.0	14.2	0.0	0.0
Romania	Planted		5.0	14.9	0.0	4.6	13.8	0.0
Croatia	Planted		6.0	0.5	0.0	5.5	0.5	0.0
Canada	Planted		0.8	0.0	0.0	0.9	0.0	0.0
Serbia	Planted		15.8	16.6	0.0	15.8	16.6	0.0
Bulgaria	Planted		9.4	4.8	0.0	9.1	4.6	0.0
New Zealand	Planted		0.0	0.0	0.0	0.0	0.0	0.0
Belgium	Planted		5.3	0.0	0.0	4.9	0.0	0.0
United Kingdom	Planted		0.3	0.0	0.0	0.3	0.0	0.0
India	Planted		0.2	0.0	0.0	0.2	0.0	0.0
Korea, Rep. of	Planted		0.0	0.0	0.2	0.0	0.0	0.2
Sweden	Planted		0.0	0.0	0.0	0.0	0.0	0.0
Russian Federation	Planted		8.7	8.2	8.6	8.7	8.2	8.6
			1,377.2	1,626.3	13.4	1,286.9	489.4	10.4

	Salix												
Argentina	Planted	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
China	Planted	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Romania	Planted	1.4	5.6	0.0	0.0	1.4	5.4	1.2	0.0	0.0	0.0	0.0	0.0
Croatia	Planted	1.8	0.2	0.0	0.0	1.3	0.2	0.0	0.0	0.0	0.0	0.0	0.0
Serbia	Planted	3.3	3.5	0.0	0.0	3.3	3.5	0.0	0.0	0.0	0.0	0.0	0.0
United Kingdom	Planted	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sweden	Planted	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bulgaria	Planted	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
United States of America	Planted	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		6.5	9.3	0.0	0.0	6.0	9.1	1.2	0.0	0.0	0.0	0.0	0.0
Overall Total		33,859.0	11,060.6	7,250.1	33,998.0	10,817.3	7,128.9						

Table 4b: Poplar and Willow Area by Ownership: Private

Country	Genus	Category	2004			2007		
			Productive	Protective	Other	Productive	Protective	Other
	Populus							
China		Agroforestry & Trees outside forests	170.0	50.0	0.0	375.0	125.0	0.0
Canada		Agroforestry & Trees outside forests	7.7	0.0	0.0	11.9	0.0	0.0
Argentina		Agroforestry & Trees outside forests	12.0	0.0	0.0	10.3	0.0	0.0
Germany		Agroforestry & Trees outside forests	0.2	0.0	0.0	0.2	0.0	0.0
Romania		Agroforestry & Trees outside forests	0.1	0.1	0.1	0.1	0.1	0.0
India		Agroforestry & Trees outside forests	0.0	0.0	0.0	0.0	0.0	0.0
Spain		Agroforestry & Trees outside forests	0.0	0.0	0.0	0.0	0.0	0.0
New Zealand		Agroforestry & Trees outside forests	0.0	0.0	0.0	0.0	0.0	0.0
Bulgaria		Agroforestry & Trees outside forests	0.0	0.0	0.0	0.0	0.0	0.0
Serbia		Agroforestry & Trees outside forests	0.0	0.0	0.0	0.0	0.0	0.0
Russian Federation		Agroforestry & Trees outside forests	0.0	0.3	0.0	0.0	0.3	0.0
			189.9	50.4	0.1	397.4	125.4	0.1
	Salix							
Germany		Agroforestry & Trees outside forests	0.3	0.0	0.0	0.2	0.0	0.0
Bulgaria		Agroforestry & Trees outside forests	0.0	0.0	0.0	0.0	0.0	0.0
Romania		Agroforestry & Trees outside forests	0.0	0.0	0.0	0.0	0.0	0.0
Serbia		Agroforestry & Trees outside forests	0.0	0.0	0.0	0.0	0.0	0.0
			0.3	0.0	0.0	0.2	0.0	0.0
	Populus							
Canada		Indigenous	5,657.4	0.0	0.0	5,657.4	0.0	0.0
Russian Federation		Indigenous	365.0	730.0	73.0	358.9	717.9	71.8
United States of America		Indigenous	353.1	2,353.7	2,942.2	353.1	2,353.7	2,942.2
China		Indigenous	252.0	63.0	0.0	330.0	120.0	0.0
Romania		Indigenous	9.1	0.0	0.0	8.1	0.0	0.0
Croatia		Indigenous	0.0	0.0	0.0	4.5	0.0	0.0
Bulgaria		Indigenous	0.1	0.0	0.0	0.0	0.0	0.0
Germany		Indigenous	0.0	0.4	0.0	0.0	0.4	0.0
India		Indigenous	0.0	0.0	0.0	0.0	0.0	0.0
Korea, Rep. of		Indigenous	0.0	0.0	0.0	0.0	0.0	0.0
Spain		Indigenous	0.0	0.0	0.0	0.0	0.0	0.0

Serbia		Indigenous	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
France		Indigenous	0.0	19.3	0.0	0.0	0.0	19.3	0.0	0.0
			6,636.6	3,166.4	3,015.2	6,712.0	3,211.3	3,014.0		
		Salix								
Romania		Indigenous	5.6	0.0	0.0	5.1	0.0	0.0	0.0	0.0
Croatia		Indigenous	0.0	0.0	0.0	5.0	0.0	0.0	0.0	0.0
China		Indigenous	1.8	1.2	0.0	1.8	1.2	0.0	0.0	0.0
Bulgaria		Indigenous	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
India		Indigenous	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Spain		Indigenous	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Serbia		Indigenous	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
France		Indigenous	0.0	32.6	0.0	0.0	32.6	0.0	0.0	0.0
			7.4	33.8	0.0	11.9	33.8	0.0	0.0	0.0
		Populus								
China		Planted	780.0	39.0	0.0	1,720.0	344.0	0.0	0.0	0.0
Turkey		Planted	122.5	0.0	0.0	122.5	0.0	0.0	0.0	0.0
France		Planted	116.8	0.0	0.0	116.8	0.0	0.0	0.0	0.0
Spain		Planted	0.0	0.0	0.0	27.9	3.3	1.6	0.0	0.0
Argentina		Planted	20.8	0.0	0.0	20.3	0.0	0.0	0.0	0.0
United States of America		Planted	18.0	4.5	0.0	18.0	4.5	0.0	0.0	0.0
Italy		Planted	0.0	0.0	0.0	9.5	0.0	0.0	0.0	0.0
Romania		Planted	0.0	19.9	0.0	7.7	10.7	0.0	0.0	0.0
Croatia		Planted	0.0	0.0	0.0	6.0	0.0	0.0	0.0	0.0
Canada		Planted	2.5	0.0	0.0	3.0	0.0	0.0	0.0	0.0
Serbia		Planted	0.8	0.0	0.0	0.8	0.0	0.0	0.0	0.0
Bulgaria		Planted	0.2	0.0	0.0	0.4	0.1	0.0	0.0	0.0
New Zealand		Planted	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Belgium		Planted	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
United Kingdom		Planted	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
India		Planted	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Korea, Rep. of		Planted	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sweden		Planted	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Russian Federation		Planted	0.0	0.4	0.1	0.0	0.4	0.1	0.0	0.1
			1,061.6	63.8	0.1	2,052.9	363.0	1.7	363.0	1.7

	Salix												
Argentina		Planted		22.0	0.0	0.0	0.0	19.5	0.0	0.0			
China		Planted		0.0	0.0	0.0	0.0	7.6	0.0	0.0			
Romania		Planted		0.6	6.4	0.0	0.0	5.6	0.0	0.0			4.3
Croatia		Planted		0.0	0.0	0.0	0.0	1.5	0.0	0.0			0.0
Serbia		Planted		0.2	0.0	0.0	0.0	0.2	0.0	0.0			0.0
United Kingdom		Planted		0.1	0.0	0.0	0.0	0.1	0.0	0.0			0.0
Sweden		Planted		0.0	0.0	0.0	0.0	0.0	0.0	0.0			0.0
Bulgaria		Planted		0.0	0.0	0.0	0.0	0.0	0.0	0.0			0.0
United States of America		Planted		0.0	0.0	0.0	0.0	0.0	0.0	0.0			0.0
				22.9	6.4	0.0	0.0	34.4	0.0	0.0			4.3
Overall Total				7,918.7	3,320.8	3,015.3	9,208.9	3,733.4	3,020.0				

Table 4c: Poplar and Willow Area by Ownership: Small Holder

Country	Genus	Category	2004			2007		
			Productive	Protective	Other	Productive	Protective	Other
	Populus							
China		Agroforestry & Trees outside forests	50.0	30.0	0.0	400.0	250.0	0.0
Canada		Agroforestry & Trees outside forests	1.4	0.0	0.0	2.1	0.0	0.0
Argentina		Agroforestry & Trees outside forests	12.0	0.0	0.0	10.3	0.0	0.0
Germany		Agroforestry & Trees outside forests	0.2	0.0	0.0	0.3	0.0	0.0
Romania		Agroforestry & Trees outside forests	0.0	0.3	0.0	0.0	0.2	0.0
India		Agroforestry & Trees outside forests	60.0	0.0	0.0	60.0	0.0	0.0
Spain		Agroforestry & Trees outside forests	1.2	3.6	1.2	1.3	3.9	1.3
New Zealand		Agroforestry & Trees outside forests	1.1	9.9	0.0	0.6	10.5	0.0
Bulgaria		Agroforestry & Trees outside forests	0.0	0.0	0.0	0.0	0.0	0.0
Serbia		Agroforestry & Trees outside forests	0.0	0.0	0.0	0.0	0.0	0.0
Russian Federation		Agroforestry & Trees outside forests	0.0	0.0	0.0	0.0	0.0	0.0
			125.8	43.8	1.2	474.5	264.6	1.3
	Salix							
Germany		Agroforestry & Trees outside forests	0.1	0.0	0.0	0.3	0.0	0.0
Bulgaria		Agroforestry & Trees outside forests	0.0	0.0	0.0	0.0	0.0	0.0
Romania		Agroforestry & Trees outside forests	0.0	0.0	0.0	0.0	0.0	0.0
Serbia		Agroforestry & Trees outside forests	0.0	0.0	0.0	0.0	0.0	0.0
			0.1	0.0	0.0	0.3	0.0	0.0
	Populus							
Canada		Indigenous	0.0	0.0	0.0	0.0	0.0	0.0
Russian Federation		Indigenous	0.0	0.0	0.0	0.0	0.0	0.0
United States of America		Indigenous	3,354.1	2,353.7	2,942.2	3,354.1	2,353.7	2,942.2
China		Indigenous	168.0	42.0	0.0	240.0	60.0	0.0
Romania		Indigenous	4.1	5.0	0.0	3.0	5.1	0.0
Croatia		Indigenous	3.5	0.0	0.0	0.0	0.0	0.0
Bulgaria		Indigenous	0.1	0.0	0.0	0.0	0.0	0.0
Germany		Indigenous	0.0	0.2	0.0	0.0	0.2	0.0
India		Indigenous	0.0	0.0	0.0	0.0	0.0	0.0
Korea, Rep. of		Indigenous	0.0	0.0	0.0	0.0	0.0	5.4
Spain		Indigenous	0.0	0.0	0.0	0.0	0.0	0.0

Serbia		Indigenous	0.0	0.3	0.0	0.0	0.0	0.3	0.0	0.0
France		Indigenous	0.0	19.3	0.0	0.0	0.0	19.3	0.0	0.0
			3,529.8	2,420.6	2,942.2	3,597.1		2,438.7	2,947.6	
		Salix								
Romania		Indigenous	2.5	3.1	0.0	1.1	4.0	0.0	0.0	0.0
Croatia		Indigenous	3.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
China		Indigenous	6.0	4.2	0.0	6.0	4.2	0.0	0.0	0.0
Bulgaria		Indigenous	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
India		Indigenous	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Spain		Indigenous	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Serbia		Indigenous	0.0	2.1	0.0	0.0	2.1	0.0	0.0	0.0
France		Indigenous	0.0	32.6	0.0	0.0	32.6	0.0	0.0	0.0
			12.0	42.0	0.0	7.1	42.9	0.0	0.0	0.0
		Populus								
China		Planted	195.0	39.0	0.0	516.0	86.0	0.0	0.0	0.0
Turkey		Planted	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
France		Planted	116.8	0.0	0.0	116.8	0.0	0.0	0.0	0.0
Spain		Planted	47.0	0.0	0.0	32.8	0.0	0.0	0.0	0.0
Argentina		Planted	20.8	0.0	0.0	20.3	0.0	0.0	0.0	0.0
United States of America		Planted	4.5	18.0	0.0	4.5	18.0	0.0	0.0	0.0
Italy		Planted	105.6	0.0	0.0	94.8	0.0	0.0	0.0	0.0
Romania		Planted	8.9	10.9	0.0	5.2	13.3	0.0	0.0	0.0
Croatia		Planted	6.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Canada		Planted	1.8	0.0	0.0	2.1	0.0	0.0	0.0	0.0
Serbia		Planted	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bulgaria		Planted	1.5	0.2	0.0	1.5	0.2	0.1	0.1	0.1
New Zealand		Planted	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Belgium		Planted	29.8	0.0	0.0	27.6	0.0	0.0	0.0	0.0
United Kingdom		Planted	1.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0
India		Planted	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Korea, Rep. of		Planted	0.0	0.0	1.5	0.0	0.0	0.0	1.5	1.5
Sweden		Planted	0.2	0.0	0.0	0.0	0.3	0.0	0.0	0.0
Russian Federation		Planted	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			539.3	68.1	1.5	822.6	117.7	1.7	1.7	1.7

	Salix												
Argentina		Planted	22.0	0.0	0.0	19.5	0.0	0.0	0.0	0.0			
China		Planted	0.0	0.0	0.0	35.6	0.0	0.0	0.0	0.0			
Romania		Planted	5.3	1.7	0.0	2.5	0.0	0.0	0.0	0.0			
Croatia		Planted	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Serbia		Planted	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
United Kingdom		Planted	1.9	0.0	0.0	1.9	0.0	0.0	0.0	0.0			
Sweden		Planted	14.9	0.2	0.0	14.9	0.2	0.2	0.2	0.0			
Bulgaria		Planted	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
United States of America		Planted	0.0	0.3	0.0	0.0	0.0	0.0	0.3	0.0			
			46.1	2.1	0.0	74.4	0.0	0.4	0.4	0.0			
Overall Total			4,253.1	2,576.6	2,944.8	4,975.9	2,864.3	2,950.5					

Table 4d: Poplar and Willow Area by Ownership: Others

Country	Genus	Category	2004			2007		
			Productive	Protective	Other	Productive	Protective	Other
	Populus							
China		Agroforestry & Trees outside forests	0.0	0.0	0.0	0.0	0.0	0.0
Canada		Agroforestry & Trees outside forests	0.0	0.0	0.0	0.0	0.0	0.0
Argentina		Agroforestry & Trees outside forests	0.0	0.0	0.0	0.0	0.0	0.0
Germany		Agroforestry & Trees outside forests	0.0	0.0	0.0	0.0	0.0	0.0
Romania		Agroforestry & Trees outside forests	0.0	0.0	0.0	0.0	0.0	0.0
India		Agroforestry & Trees outside forests	0.0	0.0	0.0	0.0	0.0	0.0
Spain		Agroforestry & Trees outside forests	0.0	0.0	0.0	0.0	0.0	0.0
New Zealand		Agroforestry & Trees outside forests	0.0	0.0	0.0	0.0	0.0	0.0
Bulgaria		Agroforestry & Trees outside forests	0.0	0.0	0.3	0.0	0.0	0.2
Serbia		Agroforestry & Trees outside forests	0.0	0.0	0.0	0.0	0.0	0.0
Russian Federation		Agroforestry & Trees outside forests	0.0	0.0	0.0	0.0	0.0	0.0
			0.0	0.0	0.3	0.0	0.0	0.2
	Salix							
Germany		Agroforestry & Trees outside forests	0.0	0.0	0.0	0.0	0.0	0.0
Bulgaria		Agroforestry & Trees outside forests	0.0	0.0	0.0	0.0	0.0	0.0
Romania		Agroforestry & Trees outside forests	0.0	0.0	0.0	0.0	0.0	0.0
Serbia		Agroforestry & Trees outside forests	0.0	0.0	0.0	0.0	0.0	0.0
			0.0	0.0	0.0	0.0	0.0	0.0
	Populus							
Canada		Indigenous	0.0	0.0	0.0	0.0	0.0	0.0
Russian Federation		Indigenous	0.0	0.0	0.0	0.0	0.0	0.0
United States of America		Indigenous	0.0	0.0	0.0	0.0	0.0	0.0
China		Indigenous	0.0	0.0	0.0	0.0	0.0	0.0
Romania		Indigenous	0.0	0.0	0.0	0.0	0.0	0.0
Croatia		Indigenous	0.0	0.0	0.0	0.0	0.0	0.0
Bulgaria		Indigenous	0.1	0.0	0.0	0.1	0.0	0.0
Germany		Indigenous	0.0	0.0	0.0	0.0	0.0	0.0
India		Indigenous	0.0	0.0	0.0	0.0	0.0	0.0
Korea, Rep. of		Indigenous	0.0	0.0	0.0	0.0	0.0	0.0
Spain		Indigenous	0.0	0.0	0.0	0.0	0.0	0.0

Serbia		Indigenous	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
France		Indigenous	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			0.1	0.0	0.0	0.1			0.0	0.0
	Salix									
Romania		Indigenous	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Croatia		Indigenous	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
China		Indigenous	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bulgaria		Indigenous	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
India		Indigenous	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Spain		Indigenous	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Serbia		Indigenous	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
France		Indigenous	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
	Populus									
China		Planted	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Turkey		Planted	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
France		Planted	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Spain		Planted	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Argentina		Planted	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
United States of America		Planted	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Italy		Planted	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Romania		Planted	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Croatia		Planted	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Canada		Planted	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Serbia		Planted	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bulgaria		Planted	1.8	0.7	0.0	0.0	1.9	1.1	0.0	0.0
New Zealand		Planted	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Belgium		Planted	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
United Kingdom		Planted	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
India		Planted	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Korea, Rep.		Planted	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sweden		Planted	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Russian Federation		Planted	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			1.8	0.7	0.0	1.9	0.0	1.1	0.0	0.0

Table 5: Poplar and Willow Forest Product Production

Country	Genus	Category	Pulp, Paper, Cardboard	Reconstituted wood panels	Plywood and Veneer	Sawnwood	Fuelwood & Biomass for Bioenergy	Others	Total
	Populus								
Germany		Agroforestry & Trees outside of forests	0	0	0	0	13	0	13
India		Agroforestry & Trees outside of forests	0	0	1,023	0	0	100	1,123
New Zealand		Agroforestry & Trees outside of forests	2	0	6	0	0	0	7
Romania		Agroforestry & Trees outside of forests	0	0	0	0	1	0	2
Subtotal			2	0	1,029	0	14	100	1,144
Bulgaria		Indigenous	1	3	0	0	1	0	5
Croatia		Indigenous	20	0	18	38	0	0	75
Romania		Indigenous	29	5	2	30	56	0	121
Spain		Indigenous	0	10	0	20	0	0	30
Subtotal			50	17	19	87	57	0	231
Argentina		Planted	444	200	100	895	0	0	1,639
Belgium		Planted	250	50	78	202	44	0	624
Bulgaria		Planted	0	36	37	23	11	17	124
China		Planted	9,000	17,790	48,850	2,830	390	0	78,860
Croatia		Planted	20	0	18	38	0	0	75
Germany		Planted	50	75	50	50	25	0	250
India		Planted	0	0	2	0	0	0	2
Italy		Planted	0	208	470	127	33	30	868
New Zealand		Planted	5	0	2	0	0	0	7
Romania		Planted	57	4	1	286	104	2	454
Spain		Planted	0	100	560	110	0	0	770
Subtotal			9,826	18,463	50,166	4,562	607	49	83,673

Table 6: Average Import/Export of Poplar and Willow Roundwood or Wood Chips

Country	Category	m ³	tonnes	Countries of origin (in order of importance)
Bulgaria	Import wood-chips	0	516	Romania
Belgium	Import round-wood	228,000		The Netherlands, France, Germany
Bulgaria	Import round-wood	34,233	6,800	Romania, Serbia, Ukraine
Croatia	Import round-wood		18,701	Serbia, Hungary, United Kingdom, Macedonia, Bosnia and Herzegovina
Italy	Import round-wood	457,000		Hungary, France
Korea, Rep. of	Import round-wood	41,428		Russian Federation, China, USA, Finland, Croatia
Spain	Import round-wood	5,400		France, Portugal, Ukraine
France	Import round-wood		242,449	Italy, Spain, Morocco
Bulgaria	Import others	12,206	8,300	Romania
Spain	Import others	1,218		USA, Romania, Brazil, Ukraine
Belgium	Export round-wood	209,000		France, Italy, the Netherlands, North Africa
Croatia	Export round-wood		13,560	Italy, Slovenia, Bosnia and Herzegovina, Austria, Bulgaria
Italy	Export round-wood	1,500		Hungary, France
New Zealand	Export round-wood		605	China
Romania	Export round-wood	44,429		Bulgaria, Syria
Spain	Export round-wood	12,886		France, Portugal
Serbia	Export round-wood		106,013	Italy
France	Export round-wood		127,380	Belgium, Luxembourg, Spain, Germany
Spain	Export others	69		Portugal, Romania
Total		1,047,368	524,324	