INTERNATIONAL POPLAR COMMISSION

24th Session, Dehradun, India, 30 October-2 November 2012

IMPROVING LIVES WITH POPLARS AND WILLOWS

Synthesis of Country Progress Reports
- Activities Related to Poplar and Willow Cultivation and Utilization-
2008 through 2011

October 2012

Forest Assessment, Management and
Conservation Division
Forestry Department

Working Paper IPC/12E
FAO, Rome, Italy

Disclaimer

Twenty member countries of the IPC, and the Russian Federation, a non-member country, have provided national progress reports to the 24th Session of the International Poplar Commission. A synthesis has been made by the Food and Agriculture Organization of the United Nations that summarizes issues, highlights status and identifies trends affecting the 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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http://www.fao.org/forestry/ipc2012/en/

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 http://www.fao.org/forestry/ipc.
Highlights of the 24th Session of the International Poplar Commission, 2012, can be viewed on http://www.fao.org/forestry/ipc2012.

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ACKNOWLEDGEMENTS

This synthesis of Country Progress Reports is the product of National Poplar Commission personnel, FAO Consultants and staff. The 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 many IPC-member countries and the Russian Federation.

It is with appreciation that the efforts of the National Poplar Commission personnel are recognized for submitting Country Progress Reports in compliance with the general textual and statistical guidelines, which facilitated preparation of the global synthesis. Ms. Michèle Millanès and Ms. Lucia Cherubini, FAO consultants, provided professional services in editing and statistical compilation. The communication with the National Poplar Commissions was efficiently coordinated by Mr. Alberto del Lungo and Ms. Graciela Andrade from the IPC-Secretariat.

To all persons who contributed to this publication, the International Poplar Commission and its members, we express our sincere gratitude.

FOREWORD

Poplars and willows have become significant resources in agriculture and forestry, which are ideally suited for supporting rural livelihoods, enhancing food security, alleviating poverty and contributing to sustainable development. They provide raw material supplies for industrial processing (pulp, paper, engineered wood products, plywood, veneer and other boards, sawn timber, packing crates, pallets, furniture and increasingly bioenergy) and valuable non-wood products (e.g. livestock fodder, medicinal extracts, food products). Poplars and willows are highly valued for the 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. As fast growing species, they are effective at sequestering carbon and as carbon sinks, thus contributing to the adaptation to and mitigation of the effects of climate change.

Twenty member countries of the International Poplar Commission (IPC), as well as one non-member country, which grow poplars and willows in indigenous or planted forests, agroforestry production systems and as distinctive landscape components for protective and productive purposes, have submitted country reports in 2012[1]. Most reports provided detailed information on topical issues, statistics, innovations and trends in poplar and willow culture and use.

The total area of **natural poplars** reported to the International Poplar Commission is over 75 million ha, of which 96% occur in Canada, the Russian Federation and the United States. Canada has the world's largest area of native poplar at 30.3 million ha. The total area of **planted poplar** reported in 2012 is 8.6 million ha, of which 5.9 million ha (68 %) were planted primarily for wood production (industrial roundwood, fuelwood, biomass) and 2 million ha (23%) for environmental protection ; the balance of 0.7 million ha could not be assigned to any particular function. The Peoples' Republic of China accounts for 87.5% of the world's planted poplar resources (7.57 million ha). The area of **willows** is substantially smaller. Of the total reported area of 7.4 million ha of willows, 92% were natural (6.8 million ha) and 8% (0.6 million ha) are classified as planted forests.

This synthesis report was compiled from the available country progress reports and highlights status, innovations, issues and trends in regards to cultivation, management and utilization of poplars and willows. Another purpose is to draw the attention of policy makers, scientists, and producers to the rich diversity of expertise, knowledge and leadership documented in the various country reports. The synthesis report is complemented by a comprehensive listing of reference documents released during 2008 – 2011 by member countries (Working Paper IPC/13), encompassing more than 1000 technical publications. The synthesis report and list of publications are also available on the FAO website: www.fao.org/forestry/ipc.

Walter Kollert
Secretary
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[1] Argentina, Belgium, Canada, Chile, China*, Croatia, Egypt, Finland, Germany, India, Iran*, Italy, Republic of Korea, Russian Federation*, Switzerland, New Zealand, Romania, Serbia, Spain, Sweden, Turkey (*countries that provided only statistical information).

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SUMMARY of HIGHLIGHTS and ISSUES

The synthesis of country progress reports offers information on status, research advancements and issues concerning poplar and willow cultivation and use during the period 2008 to 2011, as reported more extensively by member countries of the International Poplar Commission for the 24th Session of the IPC. In total, 20 member countries of the IPC reported for this period and the Russian Federation, a non-member country.

Policy and legal framework

- In many reporting countries, poplar and willow cultivation and uses are well established in the national economy; government support programmes in some developing countries continue to promote investments in the establishment of planted forests and forest enterprises. In some European countries the area covered by poplars and willows is decreasing due to competition with other more profitable agricultural crops.
- In the European Union poplar and willow plantations outside forests are classified as agricultural crops eligible for subsidies under the Common Agricultural Policy. Afforestation permits are not required for the establishment of short rotation plantations outside forests. This policy is meant to facilitate the creation of short-rotation plantations outside forests.
- Short rotation poplar and willow plantations have been generally acknowledged as a viable land-use option to produce renewable energy. European countries are strictly implementing strategies for greenhouse gas emission objectives, including ambitious targets for renewable energy, for which biomass production with poplars and willows will play a key role.
- Technical guidelines for the sustainable management of poplar plantations have been developed in Italy to facilitate the application of forest certification schemes for poplar cultivation.

Identification, registration and varietal control

- Legislation on forest reproductive material has been amended in many countries including the establishment and maintenance of national clone registers for the registration and identification of poplar and willow clones of different origins.
- Programmes concerning the genetic modification of poplars and willows continue to be actively pursued, both in developed and developing countries. They report significant progress in genetic characterization and manipulation to enhance resistance against pests, diseases and other stresses, namely drought or flooding, improve technical properties as well as growth and yield, particularly with the objective of biomass production.

Production systems and cultivation

- The vast majority of poplars planted on forest and agricultural land are hybrids, predominantly cultivated in short rotations for the production of biomass.
- The use of clones or mixes of clones is usually avoided for the restoration of riverbanks and degraded sites, or the enrichment of natural environments; for this purpose plants with a greater genetic diversity from natural forests are used instead as sources of reproductive material.
- The gene flow from cultivated poplar plantations may have profound effects on wild populations including the risk of extinction of the wild poplar species. Cultivated poplars may become invasive thereby replacing the populations of the wild species through genetic assimilation. However, information about hybridization between cultivated tree species and their wild relatives is limited.
- Biomass growth turned out to be significantly dependent on soil fertility, silvicultural management and water supply.
- The global efforts to mitigate climate change and reduce greenhouse gases including the strategic energy objectives of the European Union have prompted a process towards the development of a number of distinct management models (e.g. varying planting densities), each of which will be

specific to a certain product (e.g. biomass) or environmental service (e.g. phytoremediation, landscape restoration).

- The competitiveness of biomass production in short-rotation poplar and willow plantations will depend to a large extent on the price of conventional energy. If the prices of mineral oil remain at their present high level for a longer time, woody biomass is likely to become competitive as a source of bioenergy, particularly if a rationalisation of seedling production, harvesting and transport can be accomplished.
- Agroforestry production systems using intercropping were found to be more productive than separate cultures of crops and trees. In addition, trees in the agroforestry system contributed to carbon sequestration and the reduction of nitrogen loss through soil leaching.

Genetics, conservation and improvement

- Most countries reported on their efforts to preserve the genetic resources of poplars and willows and to optimize breeding and selection of fast growing plantations. Work focused mainly on improving the attributes of planting material in terms of productivity, wood density, higher resilience to climatic conditions and diseases, phytoremediation and biodiversity conservation.
- In some European countries the drive for producing renewable energy had raised the demand for good quality seedlings to an extent, which could not be met by local nurseries, so that they had to be imported from other countries.

Forest protection

- The most frequent pests and diseases in poplar plantations, which have caused severe economic damages in some countries, are reported to be the leaf-rust (*Melampsora* spp.), stem cankers (*Septoria musiva),* brown leaf blight (*Marssonina brunnea*), and the poplar and willow borer (*Cryptorhynchus lapathi).* The "willow sawfly" (*Nematus oligospilus*) is the major plague in willow plantations causing serious defoliation that reduces timber production by up to 60%.
- The risk of pest outbreaks was reported to be considerabley higher in monoclonic or oligoclonic plantations as compared to more diverse populations. The spread of damaging pathogens has remarkably increased due to the increase in the use of monoclonic hybrid poplars.
- Various research projects are underway to better understand the life cycles and infestation patterns of damaging pathogens, and to determine the most effective treatments.
- In the reporting period the extreme climatic conditions greatly influenced the phytosanitary situation of poplar and willow plantations. The major poplar planting areas in many countries were subject to high water stress through an alternation of frequent floods and pronounced dry-spells resulting in high mortality rates, noticeably in young plantations.

Harvesting and utilization

- Pulp, paper and plywood are the major products from commercial poplar plantations, but there has been a growing interest in the use of poplar wood for higher-value products such as fibre boards, particle boards, oriented-strand boards (OSB) and furniture.
- The renewable energy policies pursued by many countries had opened a new dimension in the development of the *Salicaceae* species and prompted an enormous interest in the utilization of poplars and willows for the production of bioenergy in the form of woodfuel or liquid fuel (ethanol). To this end, a high number of research projects were implemented in many countries focusing on the development of technological innovations to enhance harvest mechanization, improve storage logistics and the collection and transport of biomass to conversion plants.
- Willow wood was found to be anatomically comparable to poplar wood. The principal difference is a higher share of tension wood in willows (15 to 50 %) as compared to poplars (5 to 10%), which usually depreciates the quality of the finished products. Nevertheless, willow wood, once air-dried is perfectly suitable for sawing, joinery, packaging, pallets, match making and veneer and plywood. It can also be used as raw material for pulp and paper, fibreboard and particleboard.

Environmental applications

- Poplars and willows have been extensively used in many countries to establish shelterbelts and windbreaks to protect agricultural and horticulture fields and fruit orchards, to preserve coastal and riparian buffer zones, and to control erosion, sediment transport and desertification. Poplars and willows are uniquely qualified for the establishment, restoration, and enhancement of these protective zones as they are quick growing, offer rapid biomass accumulation of nutrients from the soil, have been shown to break down certain pesticides and denitrify nitrogen, and can quickly stabilize soil.
- Forest carbon is becoming an increasingly significant component of climate action. Many countries have made commitments to reduce their greenhouse gas emissions through various initiatives, including reductions through afforestation, avoided deforestation and reforestation projects. To quantify the amount of carbon that can be attributed to forestry-related activities a few countries have developed an approved quantification protocol, that is required to obtain carbon credits.
- European black poplar (*Populus nigra* L.) and white poplar (*Populus alba* L.) were once dominant trees in riparian zones of many European countries. They became rare and even endangered, especially in the case of European black poplar. Their habitats were used for the establishment of plantations of more productive poplars, as well as for other purposes like agriculture, urbanization, and flood control. The protection of habitats and the reforestation of these species are considered of crucial importance in the restoration of riparian zones.
- Agricultural crops and poplar plantations have been compared and evaluated as carbon sinks according to the guidelines of the Intergovernmental Panel on Climate Change (IPCC). It was found among others, that the above-ground biomass and root biomass of poplar plantations and the soil organic carbon in agriculture make the highest contribution as carbon sinks. It appears that the planting of poplars, as an alternative to the cultivation of agricultural crops, has a clear advantage in storing excess atmospheric CO_2.
- The use of poplar and willow trees in environmental phytoremediation applications continues to be studied and explored in a number of research projects. However it still faces some obstacles, and although the technology has been successfully tested in many countries, full-scale applications are still limited.

National poplar commissions and international cooperation

- Most of the reporting countries indicated that their national poplar commissions continued to function and to hold or support the organization of meetings, plan and implement technical research and workshops, and field tours. Some of them maintain an active website.
- Many member countries reported that they had increased strategic cooperation with other countries, international organisations and professional networks. Cooperation focuses in particular on the transfer of knowledge and technology, on the planning and implementation of joint research programs and on the exchange of germplasm for breeding programmes.

I. INTRODUCTION

The main aim 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 purpose is to draw the attention of IPC members and individuals to the rich diversity of experience documented in the national reports, which are available on the IPC website: http://www.fao.org/forestry/ipc2012/78596/en/

In total, 20 member countries of the IPC reported for the 2008-2011 period (24 in 2000, 21 in 2004, 19 in 2008), and the Russian Federation, a non-member country.

The synthesis follows the structure of the National Reporting Guidelines. It will be presented to the 24th IPC-Session in plenary on 2 November 2012, and will also be posted on the IPC website. The list of publications and references in each national report has been extracted and published separately as Working Paper IPC/13.

II. POLICY AND LEGAL FRAMEWORK

The national legislation of **Argentina** continues to promote investments in planted forests and forest enterprises (National Law 25.080). Investors may receive a non-refundable financial subsidy per hectare forested area, which varies according to species, the size of the area and the implemented silvicultural measures. Since the law's adoption in 2008 until the end of 2011, 301,600 ha had been planted with various species, among them poplars and willows. Further, propagation material for poplars and willows was provided under this law to 200 farmers and foresters for the establishment of small forest plots and windbreaks.

Belgium reported that grants for poplar planting are available in the context of afforesting agricultural land under the Flemish Rural Development Programme. Public as well as private owners, and even tenants - on the condition that they have a written permission of the landowner - can apply for subsidies for afforestation of agricultural land on the conditions that the land has been used for agriculture at least 5 years before the application, that the minimum area to be planted is 0.5 ha, that the afforestation is in line with the environmental development plan and does not cause any harm to the habitats and species to be protected under the regulations of Natura 2000. It is further stipulated that the plantation can only be harvested from the age of 15 onwards. In 2011, the Flemish government approved an act for supporting agro-forestry systems in the context of the Flemish Rural Development programme 2007-2013. Farmers or owners of agricultural land are entitled to obtain a subsidy of 70 % of the eligible costs for the purchase, planting and protection of trees.
In the Walloon region forest owners and managers tend not to replant poplar stands after harvesting them. The risk of rust infection is often given as the reason for this, however the arguments raises doubts, as rust has not been affecting many commercial varieties during the last decade.

Provinces in **Canada** have full jurisdiction over forest management and agriculture regulations, thus taxation on property and various forest and agriculture regulations are strictly a provincial affair. Federal income tax rules apply nationwide and are administered by the Canada Revenue Agency (CRA). Two provinces, British Columbia (BC) and Alberta, have regulations and standards that govern the deployment of (hybrid) clonal material and/or genetically improved material on crown lands (land usually owned and managed by the respective provinces). The only province with a specific property tax policy and supporting regulations pertaining to *Populus* and *Salix* management is BC, where intensively-managed *Populus* or *Salix* crops can be recognized as primary agricultural production. The incentives and regulations in BC apply to private land. Besides the policy for intensively-managed *Populus* and *Salix* on private land, BC also has property tax regulations that apply to privately-held managed forests and/or woodlots, as do Ontario and Quebec. The three Prairie Provinces, Alberta, Saskatchewan and Manitoba do not have specific tax policies for privately-held managed forestland or woodlots.

Chile maintained a relative stability regarding the cultivation of poplars and willows, partly due to the state subsidies granted for the establishment of forest plantations. With a minimum density of 278 plants or cuttings per hectare a subsidy of USD 842/ha is granted, while a minimum density of 400 plants per hectare entitles for a subsidy of USD 1,000/ha.

The Republic of **Croatia** had applied for EU membership in 2003 and is currently undergoing a process of harmonizing its legislation with the European Union. The Nature Conservation Act and the Act on Agricultural Land was amended in 2008 and became in 2009 the Water Act and the Act on Forest Reproductive Material. These transitional processes have had an important impact on the forestry sector, coupled with the improvement of the quality and level of training of forestry employees to overcome insufficient organizational and technical experience at all levels of forestry management.

In **Egypt** poplars and willows are important resources for the protection and shading of agricultural drainage and irrigation chanels, the stabilization of sand dunes in dry desert environments and for the establishment of wind-breaks in newly reclaimed land. Government support programmes have been launched to promote research for the cultivation of poplars and willows, and the establishment and management of high-intensity plantations for biomass production.

Germany reported, that the Federal Forestry Act dated 31 July 2010 has been amended, so that short-rotation plantations and agroforestry systems are no longer considered forests. This implies, that no afforestation permit is required for the establishment of short rotation plantations outside forest land. Such areas can also be reconverted to agriculture at any time without clearing and conversion permit. This policy is meant to facilitate the creation of short-rotation plantations outside forests. Additionally, short-rotation plantations and agroforestry systems with poplar, willow, black locust, birch, alder and ash have been classified as permanent crops eligible for subsidies under the common agricultural policy of the European Union.
The establishment of poplar and willow plantations in short rotations has been generally acknowledged as a viable land-use option to produce renewable energy, which combines high CO_2 fixation rates with low CO_2 avoidance costs. Further, it can make use of marginal agricultural land and is not necessarily in direct competition with food production. Consequently, the cultivation of poplars and willows in short-rotation coppices has increasingly developed into a well-organized industry for biofuel production.
Efforts to preserve the remaining natural population of black poplar have been intensified as natural stands are predominantly relics of over-mature trees. Several black poplar stands have been selected for harvesting generative reproductive material for conservation purposes in accordance with the Act on Forest Reproductive Material. Additionally, the gene banks of several federal states have black poplars seeds of certified purity and origin on stock for restoration purposes. Some seed samples from gene conservation units have been made available to North American poplar breeders.
The cultivation of poplars, willows and black locust in short-rotation plantations alternating with agricultural crops are being studied as a new form of land cultivation in the scope of various research projects promoting agroforestry production systems. The anticipated effects on the interaction between woodland and arable crops are very promising.

India indicated that the supply of industrial roundwood from natural forests had been dwindling. Trees outside forests (TOF) have become the major source of raw material for the Indian wood-based industries, many of which, such as the plywood, pulp and paper industry, are largely dependent on wood grown on farms. Further, huge volumes of logs, sawn timber, pulp and newsprint are being imported to meet the growing domestic demand. Substantial improvements in the productivity of forest resources and the large scale expansion of agroforestry plantations will be critically important to meet the demand for wood and to achieve the national goal of 33% effective forest and tree cover.

The Government of Himachal Pradesh, in consultation with the State Forestry Department has promoted a liberalization of trade to enable the farmers to take forest produce out of the state after obtaining transit permits, thus facilitating marketing, transportation and trading of poplars outside the state. This move contributed towards increasing biomass production, especially of poplars.
India also acknowledges, that there is a need for the conservation and management of willow diversity and genetic resource as well as for indigenous poplars, since their significance has not been fully recognized vis-à-vis exotic poplars.

Italy indicated that poplar plantations are rather considered an agricultural crop than a forest, and their cultivation is not regulated by any specific national policy, apart from few regulations promoted by the National Poplar Commission of Italy and by some interested provinces (e.g. Regione Lombardia). The reason that poplar and willow cultivation is traditionally more related to agriculture than to forestry is the existence of a strict forest legislation that prohibits the conversion of land covered by forest into agriculture. The definition of "forest" as stipulated in Decree 227/2001 is currently under revision.
The area covered by traditional poplar cultivation is continuously decreasing due to competition with other more profitable agricultural crops and with competitive poplar products imported from other countries. As a reaction to this development, the Italian poplar sector has launched a number of research programs to develop innovative uses for poplars and to create new clones with higher resilience to salinity, drought and pests. In general, it is noted, that the interest in the use of poplars and other fast growing species (such as elms) is increasing, as they combine the goals of bioenergy production and phytoremediation of polluted waters and soils. Poplar wood is going to be used in a large-scale biorefinery to produce cellulosic ethanol. OSB boards from poplar will be produced in a new factory in due time.

In **New Zealand**, there have been no major policy developments that have affected poplar cultivation or utilization. Improved funding for poplar and willow breeding and research has been provided through a special Hill Country Erosion Fund prompted by major erosion events in the period 2004–2007. This support enabled sufficient funds to develop new initiatives in the breeding program. An associated program in soil science has provided funding for field-based research on effectiveness of erosion control of poplar and willow plantings on pastoral hill slopes. An Emission Trading Scheme (ETS) has been enacted by the New Zealand Government through the Ministry of Agriculture and Forestry which has enabled poplar and willow trees planted for soil conservation to qualify for carbon credits. Landowners with established plantings have been able to receive financial benefit from the ETS, and many landowners have renewed interest in poplar and willow planting because of this added benefit.

The poplar sector in the **Republic of Korea** is reported to be on the decline. Earlier, the main use of poplar wood was the manufacture of chopsticks, which nowadays are imported at almost 100% from China. Consequently, no poplar plantations have been established during the period from 2008 to 2011. However, the Korea Forest Research Institute has recently carried out experiments on phytoremediation using poplar, especially the hybrid poplar, P. alba x P. glandulosa. So far the experiments have concentrated on treating livestock waste water, especially from pig farms. The experiments showed good results, but they are not yet fully developed for operational use. Further, the Korean Forest Service launched a new policy of establishing poplar plantation as a means of wood industry promotion. During the period from 2012 to 2016, the country plans to annually plant on average 1,000 ha poplars on idle land along the riverbanks resulting from the Four River Restoration Program completed in 2011.

Romania informed that, during the reporting period, some new regulations related to poplars and willows had been adopted, or existing ones had been amended. The new Forest Law (46/2008) establishes that all forest areas, which are part of the national forest estate, will continue to be managed on the basis of forest management plans. This also applies to natural and planted poplar and willow forests. Reforestation of the harvested forest areas must be executed in the first two vegetation seasons following harvesting. For the development of Romania's national forest estate, the law

proposes that an area of 2 million ha of degraded agricultural land should be forested. Law 100/2010 creates a legal framework needed for the forestation of degraded land, regardless of ownership.
White and black poplar and hybrids thereof are among the most important species in Romanian forestry. In the reporting period Romania had at its disposal funds granted by the National Program for Rural Development (PNDR) for the afforestation of private agricultural land .

In the **Republic of Serbia**, a new Law on forests was adopted in May 2010 where, for the first time, short-rotation plantations were explicitly mentioned and defined, this being very significant for the development and increase of areas under poplar and willows. Approximately 60,000 hectares are available, where poplars and willows will be planted mainly for protective purposes (windbreaks, crop protection, stabilization of riverbanks). These plantings will at the same time provide wood for industrial purposes and woodfuel.

In **Spain**, activities for the cultivation and utilization of poplars and willows are subject to the rules and regulations of the European Union, in application of the Common Agricultural Policy (CAP) and to the national legislation. During the period concerned, a new decree was published, regulating the commercialization of forest products for reproductive material (Royal Decree 1220/2011 of 5 September 2011). The regulation decrees that, in order to ensure the proper identification of reproductive material from clones and clonal mixtures, the responsible ministry will establish a collection of reference material that will be recorded in the National Catalogue as base material.
In recent years, there has been a shift in the policy on water management with regards to poplar plantations. The water management authorities have addressed with great success the large-scale restoration of riverbanks, however, some of them have issued restrictive instructions on tree crops that negatively affect water supply, among them poplar plantations.
From the point of view of biodiversity conservation, two native species of Populus (P. tremula, P. x canescens) have been formally protected in the Province of Valencia. The new Renewable Energy Plan (2011-2020) promotes the establishment, extraction and processing of energy crops and the development of modern technologies for bioenergy production.

Sweden reported that its major interest for poplars and willows lies in developing new cultivars, their cultivation and utilization, and the ensuing environmental effects on cultivation. Europe and Sweden are implementing strategies for greenhouse gas emission objectives, including ambitious targets for renewable energy. In Sweden, biomass production with willows, aspens and poplars on agricultural land will play a key role in this development. During recent years, Sweden had been rather successful in introducing biomass as fuel for heat and electricity production, and in 2011 bio-energy became the single largest energy source in the country, representing 32 % of energy consumption. To date this source was dominated by black liquors and biofuels from forest residues, but new sources like aspens, poplars and willows were increasing. The success of bioenergy was initially the result of a combination of exogenous success factors such as high levels of available forestry resources, a strong forest products industry, and the existence of an established network of district heating systems. However, even in this context, strong policy instruments, in particular regulations on energy-related taxes, were required to support and guide the development of biomass as an energy source for heat and electricity.

Switzerland indicated that the interest of producers for poplar is on the decline and, as a consequence, poplar cultivation has been basically abandoned in the country. At the moment there are no intentions to establish new plantations.

Turkey informed that industrial plantations with fast growing species are of high priority to tackle the shortage of wood supply in the country. In order to increase wood production from poplars, particularly in the private sector, a regulation has been adopted to secure the clonal control and quality of poplar plants produced in private and state nurseries. According to this regulation, free planting material (cuttings) and some financial support would be given to producers growing quality plants under standardized techniques stipulated by the forestry authorities. Likewise, industrial quality standards for poplar saplings, poplar veneer and safety matches had been effective in regulating the poplar market. However, it is noted, that the existing national reforestation fund was utilized to a lesser extent for the reforestation with poplars as compared to the last reporting period.

III. TECHNICAL INFORMATION

1. *Identification, registration and varietal control*

Argentina informed that five poplar clones, mainly used in the Paraná Delta, had been incorporated by the National Institute of Agricultural Technology (INTA) in the National Clone Register of the National seed Institute (INASE); another eight clones had been registered following a study carried out by the Faculty of Agrarian Sciences of the National University of Cuyo. Furthermore, in 2011-2012 the five most utilized willow clones in the country had been documented for the first time in the official register in order to better control their propagation and production in nurseries. At the beginning of 2012, the description of four recently selected new willow clones had been finalized within the framework of the INTA tree improvement program, which will be registered soon. In southern Argentine the long-term project to compile a documentation of the southernmost clones in the world has been continued with the measurement and documentation of 11 clones of the Salicaceae family.

Belgium indicated that the release of new varieties was foreseen within a short time. The selection within progenies of controlled crossings of *P. deltoides x P. maximowiczii* and *P. deltoides x (P. trichocarpa x P. maximowiczii*) had been finished, including the evaluation of their wood quality. It was further announced that first steps will be taken to protect commercial poplar varieties on a European level.

Canada has no national regulations for the identification, registration or control of *Populus* or *Salix* clones, although it has passed the 1990 *Plant Breeders' Rights Act* 66, that only applies to certain species. Neither *Populus* nor *Salix* are on this list. *Populus* and *Salix* clones can and are widely propagated vegetatively for various purposes without any legal protection of intellectual property rights for the breeder, unless specific contractual arrangements are in place. There is no regulatory mechanism to ensure the origin and clonal identities of *Populus* or *Salix* clones. However DNA fingerprinting is available to check clone identity and it has been used. Because of the lack of regulatory framework, nursery-produced clonal planting stock has been known to be contaminated with unknown clones. This continues to be a common occurrence, primarily stemming from a lack of quality control at the nursery level. Several provinces in Canada have regulations pertaining to deployment of exotic species, e.g. hybrid *Populus* clones on Crown land. Several government agencies have been actively involved in the collection and conservation of genotypes of *Populus trichocarpa* (black cottonwood), *Populus balsamifera* (balsam poplar) and *Populus deltoides* (var. *monilifera*, a.k.a. *P. deltoides* var. *occidentalis* or Plains cottonwood).
Since 2004 the Canadian Forest Service (CFS) has collected material of seven native willow species and has been studying the genetic variation between and within species populations. The objectives are mainly aimed at ecological uses of native willow species in riparian zone restoration and phytoremediation. One interesting use is in bee pollination in blueberry production as willows are largely insect-pollinated and provide an early food source for bees. Also of great interest are traits related to biomass production. The CFS is pursuing additional research objectives with willows and is very interested in cooperating with industry to advance the species as a source of biomass.

In **Croatia** sixteen poplar clones and eleven willow clones had been identified and officially documented for preservation. Clone tests of poplars and arborescent willows have been established for the purpose of selecting the genotypes that are best adapted to the given habitat. The tests of poplars include American black poplar (*Populus deltoides*), hybrids of American black poplar and European black poplar (*P.* x *euramericana*), and balsam poplar (*P.* x *interamericana),* as well as *P. trichocarpa* and *P. simonii*. The clone tests of the arborescent willows include the autochthonous clones of the white willow (*Salix alba),* as well as the interracial hybrids of white willow and the English 'cricket' willow (*S. alba var. calva*), the interspecies hybrids (*S. matsudana x S. alba*), as well as the multispecies hybrids of willows. The aim of these field experiments is to select the clones of maximum productivity and stem quality.

Egypt reported that *Populus euphratica, P. nigra, P. alba, Salix babylonica* L., *S. safsaf* Forssk and *S. tetrasperma* Roxb. had been established in plantations in the middle of the 20th century. As from 1990, there was a forestation plan for the conservation of poplar and willow genetic resources and the selection of mother trees. Recently, new clons and hybrids, either local or imported, were evaluated in different habitats. The best sites for poplar cultivation turned out to be the irrigated fertile soils in northern Egypt. As from 2004, some poplars and willows had been tested for their ability of phytoremediation.

In **Germany** reliable identification methods, including molecular methods, for all marketable poplar clones and varieties have been created and reference databases are in development. These methods allow for the reliable and increasingly cost-effective control of the breeders' marketing rights for varieties. Biochemical analysis methods are also used for the conservation of the European black poplar with the objective to ensure that only pure species material is conserved. Since the European black poplar crosses spontaneously with the widespread hybrid clones, genetic mixing of both cannot be excluded.
Since 2011, the Federal Agency for Agriculture and Food (BLE) in Bonn has established the register of clones, clonal mixtures and parental stock approved in Germany by the respective authorities. Approved poplar clones and clonal mixtures are entered into the Arboriculture Register that is maintained by the Regierungspräsidium Kassel, Steinweg 6, D-34117 Kassel.

India reported that guidelines had been prepared by the Indian Council of Forestry Research and Education (ICFRE) for testing and release of new clones and varieties. In future, any new clones and cultivars of poplars and willows would be tested and released, based on the procedure laid down in the guidelines entitled "Approved Guidelines for Testing and Releasing of Tree Varieties and Clones". Wimco Seedlings has sent five new clones, namely: WIMCO 62, WIMCO 81, WIMCO 83, WIMCO 108 and WIMCO 109 for registration to the International Poplar Commission. These clones, along with WIMCO 110, have also been released for field planting in the poplar growing region.

The National Poplar Commission of **Italy** provided a list of 17 poplar clones that had been permanently registered in the National Register of Forest Basic Materials (NRFBM) according to Articles 10 and 11 of the Legislative Decree n. 386/2003. These clones had been selected by the Poplar Research Institute in Casale Monferrato and by private companies. Nine clones obtained temporary (10 years) registration, and eleven other clones are still in the testing phase. Concerning *Salix* spp., recent releases specifically targeted for biomass production are the two varieties 'Drago' and 'Levante' from seedlings of an open pollinated *S. matsudana* female.

New Zealand informed that four new *Populus maximowiczii* × *P. nigra* clones and three new *Populus deltoides* × *ciliata* clones bred by Alan Wilkinson in 1993 and field-trialled from 1999 by Ian McIvor, Sarah Hurst and Lindsay Fung of HortResearch (New Zealand's plant and food research organisation) were released for commercial propagation in 2009, and announced to end-users in 2011. These clones would be used in a range of climates for pastoral hill slope erosion control.

In **Serbia** the identification and registration of poplar clones follows the Law on Forest Reproductive Material which had been revised in 2004 maintaining the former register of varieties and cultivars. During the reporting period, two new poplar clones - *Populus deltoides* Bartr. cl."Bora" and *Populus deltoides* Bartr. cl."Antonije" - had been selected for registration. In 2009, these clones obtained conditional registration with a 5-year confirmation period. Final registration of these clones is planned for 2013.

Romania provided a list of 12 registered poplar cultivars and clones as well as 10 registered willow clones, the use and distribution of which are managed by the Forestry Research and Management Planning Institute (ICAS). Three poplar cultivars had been registered by the International Poplar Commission, specifically *Populus x canadensis* ‘Oltenița’, ‘Argeş’, and ‘Celei’. During 2008–2011, there were no proposals for the registration of new cultivars.

Spain reported that the Department of Agricultural Production and Markets has amended the National Register of clones to include forest reproductive material of the genus Populus L. This amendment had been based on the analysis and evaluation of 26 clones registered for the production of reproductive material of poplar. The University of Valladolid, has developed protocols for the genetic characterization of poplar clones, in order to solve the problems of identification between different source materials and other identity issues that may arise. The National Forest Improvement Center (el Serranillo) has been designated as a center for maintaining a collection of reference clones accepted in the National Register, in order to ensure, when necessary, the identification of the reproductive material from clones or clonal mixtures.
Under the European normative framework for the commercialization of forest reproductive material, the regional governments have identified and approved a number of seed collection stands in natural poplar forests for the production of forest reproductive material.

Sweden informed that there were currently two *Populus* cultivars registered at the Swedish Forestry Agency. One consists of 15 clones of hybrid aspen (*P. tremula* x *P. tremuloides*; KB-002) and the other cultivar a mix of 12 poplar clones (KB-003). This mix of pure species and hybrids consists of species from the section *Tacamahaca* (balsam poplars) of *Populus*. Both cultivars have been tested by the Forestry Research Institute of Sweden. New tests for improved material, suitable for larger areas of the country, are in progress.
The breeding of *Salix* has been carried out since the 1980s and, since then, over twenty varieties had been developed. All of them have obtained Plant Breeder’s Rights and hence are protected throughout the European Union. The national report provided a list of the 22 Swedish varieties.

In Turkey the registration and identification of poplar and willow clones of different origins have continued in the experimental nurseries of the Poplar Research Institute, Izmit. Varietal control was accomplished in all state-owned nurseries, and supported through the distribution of improved and controlled material to private poplar nurseries. However, this is made difficult by the ever increasing number of private nurseries in the past two years. *P.x euramericana* “I-214”, *P.x euramericana* “45/51” and *P.deltoides* “Samsun” clones have been successfully planted in hybrid poplar plantations, which are composed of 75% “I-214” and “45/51” clones, and 25% “Samsun” clones, the latter being preferred in the Black Sea region due to its rapid growth.

2. Production systems and cultivation

Few major developments in nursery, propagation and cultivation technologies, techniques and management practices were highlighted for the 2008-2011 period. Nevertheless, some countries reported at length on experiments, trial applications and the increasing significance of bioenergy plantations.

a) Nursery practices and propagation techniques

In the Paraná Delta region of **Argentina**, the traditional planting material are stem cuttings (50 to 70 cm long) or 1 to 2 year old shoots, the latter being preferred in agroforestry sytems with cattle. Field trials have been carried out on stem cuttings of *Populus deltoides* ‘Australiano 106/60’ to study their capacity for shoot and biomass production and crown development. Willow plantations are mainly established with stem cuttings of 1.2 metres, or in some smaller areas with one-year old rooted cuttings.

Belgium reported that the sale of poplar plants suffered a drastic drop during de planting seasons 2008/2009 and 2009/2010, but showed a slight recovery during the last season. The drop in sales was in particular noted with clones of the group *P. trichocarpa* and *P. interamericana* hybrids due to their sensibility to rust. Since the planting season 2007/2008 the new Belgian euramericana clones took the largest part of the production in poplar nurseries, but still a high number of seedlings belonging to old poplar varieties were sold, such as ‘Robusta’ and ‘Marilandica’, the latter being especially used for landscaping purposes.

In **Canada**, *Populus* stock types vary depending on the region, the general availability of clones and the *Populus* species. For poplar (non-aspen), ease of rooting is one of the criteria that determine the choice of stock type for poplar. *P. deltoides* is usually a problematic rooter, whereas *P. trichocarpa* is a very prolific rooter. Many of the hybrid clones are reasonable rooters; however, ease of rooting does vary by clone.
In British Columbia, the stock type of choice is a 1-year old unrooted, dormant cutting or whip. Cuttings (approximately 30 to 90 cm long) are used when establishing short-rotation-intensive-culture (SRIC) hybrid poplar crops where site preparation and weed control can be optimized in a farm setting. For plantations that cannot be managed as intensively, e.g. forest plantations, unrooted whips (1.5 to 1.8 m long) are best when some height is needed to dominate the weed competition.
In the Prairie Provinces, a private company has embarked on a large-scale SRIC hybrid poplar crop operation, using an agronomic approach to poplar crop farming. The company relies on rooted stock, preferably dormant bareroot stock and container-grown rooted stock (in that order). Experience with unrooted cuttings has been poor due to low soil moisture conditions after planting in the spring and early summer; this stock type is no longer in use. All stock is produced by contracted private nurseries. In Québec, hybrid poplar nursery production and distribution is strictly controlled. Since the vast majority of planting in Québec takes place on forestland and there is a ‘no-herbicide’ policy in place, large stock is required to ensure survival. The preferred stock type is a steckling, which is essentially the same as a set or rooted whip and varies from 1.2 to 1.8 m in length. The trees are grown in bareroot nurseries for one year from small unrooted cuttings. In the fall the stock is lifted, processed and cold-stored for outplanting the following spring. During the processing the roots are trimmed back to resemble a rough ‘bottle brush’.
Salix species are generally planted in high density SRIC biomass crops and are established using unrooted dormant cuttings. For aspen the stock type has to be a rooted plant, either a bareroot or container plant. Aspen does not root from an unrooted stem cutting and this is a distinct disadvantage from a tree improvement and an operational perspective.

In **Croatia**, poplar and willow plants are produced in specialized nurseries, which are often located close to the planting site. Production makes full use of the autovegetative propagation capability of poplars and willows. Parent material are ligneous cuttings from one year old shoots or one year old rooted seedlings with the above-ground part being cut off. Since plants are produced in areas with little rainfall (below 700 mm) and in the presence of summer droughts, additional water supply is necessary. Early in the vegetation period NPK fertilizer is applied at around 350 kg per hectare.

Egypt indicated that nurseries of poplars and willows were established in fertile, deep and fairly friable clay soils. Stem cuttings were obtained from selected and conserved stool beds. Early pruning was conducted to avoid the development of low branches.

India reported that nursery stock raised through tissue culture had been sold in the past by some agencies to growers and farmers in anticipation of a higher growth rate. However field trials revealed after 8 years that diameter and height growth of traditionally propagated plants was higher as compared to plants raised from tissue culture. Since 2008, poplar plants were also raised in containers to facilitate planting during the monsoon period.

The reasons for low survival rates or failures in poplar nurseries and plantations in Bihar are reported to be shallow planting of cuttings, improper water management and delays in early weedings. For vegetative propagation it is recommended to place plants under wider spacing and apply a higher level of cut back in order to produce the maximum number of desired cuttings, rather than apply narrow spacing and a low level of cut back.

In **Italy** the Research Unit for Intensive Wood Production in Casale Monferrato had been working during the last four years on developing new silvicultural management models for the new clones recently registered in the National Register of Basic Forest Materials. In particular, pruning trials are in progress, which are conducted in the nursery at the beginning of the second year, to reduce the dimension of knots and the tapering shape of the poles. New planting densities have been tested in the stoolbed for the production of cuttings of the new clones, in order to reduce above all the dimensions of the whips and the number of elliptic branches after each coppicing. Technical advice has been provided to private nurseries on the introduction of drip irrigation as an alternative to sprinklers, in order to reduce water consumption.

New Zealand informed that there had been no change in current practices for stoolbed production of un-rooted poles and cuttings and plantation practices from what has been described in previous reports.

Romania reported that planting material of accepted varieties used in plantations is produced in nurseries from cuttings of mother plants. Seeds are collected from protected seed reserves of 49.5 ha for *Populus alba* and *P. x canescens*. The applied nursery techniques ensure that the seedlings comply with the national quality standards. The standard quality features of cuttings (diameter, length, number of buds) from *P. x canadensis, P. deltoides, P. alba, P. x canescens* are reported in detail in the national report.

Serbia stated that the continuous improvement of the vegetative propagation of superior poplar genotypes is a high priority in the Institute of Lowland Forestry and Environment in Novi Sad. A well-organized production of reproductive and plant material was an essential factor in the production of poplar and willow plantations. This refers to the applied nursery practices, the analysis of soil properties, the efficiency of herbicide applications and the effect of the cutting date on the ability to develop roots.

Spain reported that the main poplar clones used for the production of roundwood are: 'I-214' (50.2%), 'MC' (17.3%), 'Beaupré' (9.3%), 'Unal' (5.8%), 'Raspalje' (4.0%), 'Triple' (3.4%), 'Viriato' (3.3%), 'Guardi' (1.5%), 'A4A' (1.1%). Compared with the previous period (2004-2007) the production of ‘I-214’ and ‘Raspalje’ remained at the same level, while ‘MC’ was in sharp decline and ‘Beaupré’ and ‘Unal’ had increased. For the production of woody biomass, both registered poplar clones and imports of other clones are used. For the restoration of riverbanks and degraded sites, or the enrichment of natural environments, the use of clones or mixes of clones is avoided, instead plants with a greater genetic diversity from natural forests are used as sources of reproductive material. This is in particular the case for *Populus alba, P. tremula, P. nigra and P. x canescens.*

Turkey emphasized that the quality of the planting material is essential for the success of poplar plantations. They are generally established by using one or two-year old rootless or rooted saplings and stem cuttings, all of which have shown similar results on diameter and height increment. So far, poplar saplings are classified only by the diameter at 1 m height, but this standardization system is under review. Further, standard cultivation techniques for the *Populus deltoides* clone “*İzmit’’*, have been developed and will be proposed for international registration.

b) Planted forests

In **Argentina**, various initiatives have been undertaken in cooperation with universities and the private sector to investigate a number of topics related to the establishment and management of poplar and willow plantations. They comprise the production of good quality timber through silvicultural measures, the dynamics of soil properties and nutrients in willow plantations, growth and yield studies in poplar and willow plantings, the productivity of biomass plantations, the efficiency of irrigation in forestry plantations and the development of a methodology for the characterization of poplar plantations using high-resolution satellite data.

Belgium had observed that the applied research conducted since 2002 resulted in a diversification of the commercial varieties, which created some difficulties for the growers and owners to identify and select the varieties suitable for their particular purposes and site conditions. A technical report that analyses and describes the principal characteristics of the 14 varieties currently on the market, has remedied this situation.

In **Canada**, depending on the region, suitable clones for *Populus* stands – whether a dormant unrooted cutting, bareroot stock or container-grown stock – are planted in a systematic pattern on properly prepared farmland. In the Prairie region rooted stock is preferred due to dry soil conditions at planting time. Bareroot stock is preferred over container-grown stock due to lower costs and a higher proportion of coarse roots. In Québec the preferred stock type is a steckling, which is a rooted whip or set of 1.2 – 1.8 m in length. This stock type is particularly useful where weed control is not feasible, such as in forest plantations. Unrooted, dormant cuttings are typically 30 to 90 cm long and are used in British Columbia. The increase in cutting length to 90 cm is a fairly recent development and is particularly useful in situations where complete site preparation is not possible.
Short-rotation intensive culture (SRIC) hybrid poplar crops are almost exclusively grown on existing farmland or newly-cleared agricultural lands in private ownership, using agronomic methods. Most SRIC hybrid poplar crops in Canada are for the purpose of supplying pulp fibre or logs for engineered wood products, such as panel board or OSB.
The cultivation approach for SRIC willow does not differ much from the cultivation of an SRIC hybrid poplar crop, however most willow production is still in an experimental phase and the majority of applications fall under an environmental application.
The vast majority of poplars planted on forestland are hybrids. This planting is classed as a reforestation activity. The establishment of the main forest plantations with *Populus* species takes place in British Columbia and Québec.

In **Chile**, the establishment, management and harvesting of forest plantations are mainly carried out by the private sector. Planted poplars and willows cover an area of approximately 8,000 ha, of which 3,000 ha belong to the *Compañia Forestal El Álamo,* which utilizes the harvested timber for the manufacture of matches and other small objects for the domestic and international market.

In **Croatia** most plantations are established on state-owned land (ca. 80% of forest area) due to the lack of incentives made available to the private sector. Planting is rather restricted to the reforestation of existing plantations. There is a large potential for future plantation development on so called ‘marginal’ land, which is not suitable for agricultural production and is either privately or state owned. Poplar and willow plantations occur most frequently in combination with or in close vicinity of existing large forest tracts, thus forming economic entities with them. The plantation development program supports cultivation of poplars and willows on light alluvial soils (habitats of natural stands of broad-leaved species) along the rivers Drava and Danube. On heavy alluvial soils the polar plantations established in the sixties and eighties have been converted to oak stands due to unsatisfactory results. Poplar planting is carried out using a proven and tested set of technologies comprising the careful selection of planting material, soil preparation by disk harrowing, and mechanized planting. Sixteen clones of poplar and eleven clones of willows have been officially registered and are approved for planting.

In **Egypt** the establishment of poplar and willow plantations is carried out manually either in line plantings along irrigation channels or in blocks. Some owners of newly reclaimed lands have planted poplars in blocks for wood production using sewage water for irrigation. Usually pruning up to 4 m and weed control in the first 4 years are carried out. Along the waterways, poplar and willow line-plantatings are planned for up to 35,000 km.

Germany reported that poplar, aspen and willow were predominantly cultivated in short rotations in Hesse, Lower Saxony, Saxony, Bavaria and above all in Brandenburg. Balsam poplar hybrids as well as aspen and aspen hybrids (*P. tremula* × *P. tremuloides*) were particularly suitable for this purpose. Biomass growth turned out to be significantly dependent on water supply. An average water supply of 300 l/m² during the vegetation period and good water-holding soils can produce yields of 10 t of dry matter per hectare annually. With high precipitation or groundwater impact also guaranteeing a continuous growth in dry periods, the yields can even be 20 t and higher, whereas with poor water supply the annual production of dry matter can be 6 t or less. The investment costs for establishing plantations are high and vary depending on the tree species and the number of plants used. Total costs of EUR 1,800 – 5,500 per hectare comprising establishment, operating and harvesting costs were calculated for biomass production in short rotations with a large number of plants. Harvesting costs of EUR 45-82/t of dry matter have been estimated with special harvesting machines. In total, production costs of between 30 and 45 EUR/t of absolute dry woody biomass have been calculated in bioenergy plantations, an average yield of 10 t/ha and seven 3-4 year rotations. If the operating risks are not taken into account and revenues of EUR 50/t absolute dry woody biomass are calculated, annuities (at 3.5% interest) of between 125 and 250 EUR/ha can be anticipated. Under these circumstances, short rotation plantations cannot compete with agricultural food production. Hence, it seems reasonable to establish short-rotation plantations on agricultural marginal soils with water supplies that are too low or too high and on poor soils. However, if the prices of mineral oil remain at their present high level for a longer time, woody biomass could become competitive as a source of bioenergy, particularly if a rationalisation of seedling production, harvesting and transport could be accomplished.

India indicated that poplar was a very prominent taxonomic group of tree species in plantation forestry, which is dominated by *Populus deltoides*, an exotic species. The area coverage and productivity of this species is expected to increase further, due to research and development efforts aiming at its genetic improvement for increased yield. The State Forest Development Corporation has established planted forests of *P. deltoides* for the production of industrial roundwood in Haldwani region (Uttarakhand), using a clear felling system at 12 years rotation age. Planted forests of *P. gamblei* have been established in Northern Bengal. Bihar state has also launched a massive programme for poplar planting; plantations of 12 million ha have been established in this state during the last four years.

The area of traditional poplar cultivation in **Italy**, based on a ten-year rotation for the production of plywood, is decreasing. The planting density of poplar plantations continues to decrease from 280-330 plants per ha to 240 plants in order to produce logs of higher quality and to dispose of greater flexibility in determining the rotation cycle. Poplar cultivation is undergoing a process towards a number of distinct cultivation models, each of which will be specific to a group of products or environmental services (e.g. phytoremediation, landscape restoration). The demand for poplar wood by the pallet, paper and bioenergy industries is likely to increase further, however such demand will no longer be met by traditional poplar cultivation; as a consequence plantations with specific production targets, e.g for rural bioenergy production will become necessary. Within this framework, 60 experimental plantations of poplar, willow, and other fast growing species had been established all over the country applying different planting densities from 1100 plants up to 10,000 plants per ha. Site characteristics (soil fertility, climatic condition) and water availability (precipitation and irrigation) turned out to be the main limiting factors to productivity. The clones/provenances used in short-rotation-coppice trials have shown yields of up to 25 tons (oven dry) per ha and year. In commercial plantations, where fertilization and irrigation are rarely applied by farmers, yields are considerably lower ranging from 6 to12 tons (oven dry) per ha and year. The coppice cycle in trials with very high planting density is generally short (2-3 years) and the quality of the woody biomass is low owing to a high bark percentage (15-20%). This material is mainly used as chips for bio-energy power plants or for co-firing in thermo-electric plants and incinerators. Plantations with lower planting density have a 5 to 6 years coppicing cycle and produce yields from 8 to 20 tons (oven dry) per ha and year. The quality of the raw material is better, having a lower bark percentage, and it is preferably used for industrial products or pellet production. Woody bio-energy crops will apply in future a 5-6 years rotation model, coupled with improved cultivation techniques, and enlarge the choice of clones/species suitable for different site conditions, especially in the drier parts of the country.

New Zealand informed that planted forests continued to be an insignificant use of poplars or willows. Research had continued on root development in unpruned wide-spaced *P.× euramericana* 'Veronese' trees growing on erodible hillslopes. Several papers on this work have been published in international journals, and reports have been distributed to landowners.

Romania indicated that poplar and willow plantations were mainly established in three important ecological regions, namely the Danube floodplains, the Danube delta and the floodplains of the big in-land rivers. Criteria for selecting the land for plantations are the soil fertility, the risk of flooding, the level of underground water and the site specific characteristics of the used species/cultivars. The traditionally very intense and costly soil preparation methods will be replaced by low-intensity measures to save costs. Only seedlings or long cuttings of those species/cultivars, which are recorded in the national register, are used for planting. The planting material used, the planting densities and the silvicultural measures are explained in detail in the national report.
Willows (*Salix alba, S. fragilis*, hybrids) were usually planted in the Danube floodplains and Danube Delta, using seedlings or long cuttings in different planting schemes related to the site quality.

In **Serbia** extensive studies were carried out on black poplars (section *Aigeiros* Duby) growing in their natural habitat on hydromorphic soils along riverbanks. The analysis of the physical and chemical properties of three forms of fluvisols (sandy loam, loam and fossil soils) in the central Danube basin showed the dominant influence of the site conditions on the productivity of poplar. Results from further studies analysing the production and structural stand characteristics of registered black poplar clones (I-214, 618, 457, 55/65 and S6-36) after 20 and 30 years of stand development on alluvial soils near the Sava river, have been published and are summarized in the national report.

Spain indicated that the global efforts to mitigate climate change and reduce greenhouse gases including the strategic energy objectives of the European Union have prompted a number of extensive scientific studies to develop management models for the production of lignocellulosic biomass in plantations of poplars and poplar hybrids. In Zamora province, a traditional poplar growing region, a decline of growth rates was notable in successive poplar production cycles, if no fertilization was applied. This study re-established the well-known fact, that phosphorus is of prime importance for plant nutrition and has a distinct impact on growth. In general, it can be stated that the presence of chemical nutritional elements, except phosphorus, is positively correlated with the percentage of fine soil mineral matter, as in clay and silt, whereas it is negatively correlated with the dominance of sand and other coarse-grained mineral matter.

Historically, the cultivation of willows in **Sweden** was performed at rather small scale until recently, when the potential of willow as bio-energy crop came into focus. During the last 4-year period, a new handbook for growers of *Salix* had been published by the National Board of Agriculture, as well as recommendations for the fertilization of *Salix* plantations. The Forestry Institute and the Swedish University of Agricultural Sciences investigated the possibilities for a large-scale introduction of *Populus* plantations. The study confirmed a large potential, but also stressed the need for intensified breeding, development of cost-effective regeneration methods and cultivation systems, the development of decision making tools for maximizing environmental qualities, and the investigation of public attitudes and social aspects. A number of studies had been conducted for estimating the productivity of poplar and willows based on yield records and climatic data. Among others, a study on the nitrogen economy under drought found that N-uptake efficiency and leaf N efficiency are important traits to improve growth under drought. In Sweden *Populus* and *Salix* stands would most often be grown to produce biomass for energy purposes. However, other products are highly appreciated globally. A study on pruning of hybrid aspen indicated that the pruning of hybrids facilitates the opportunity to produce more valuable products for other markets.

Turkey reported that the selection of suitable soils and adapted clones, the fertilization with organic manure, an intensive mechanized soil preparation and the availability of sufficient water are success factors in the establishment and management of poplar plantations, especially in the central region of Turkey where long summer drought are prevailing. Irrigation is generally carried out through sprinkler systems, while drip irrigation is used in small-scale plantations.

c) Indigenous forests

In most countries, except for Canada, the Russian Federation, and the United States, indigenous poplar and willow stands are either uncommon or of relatively small size. Therefore only few countries reported on them.

Argentina does not have significant areas of indigenous forests of Salicaceae. The only native species is *Salix humboldtiana* Wild., which grows in single mixture along the riverbanks; it is hardly used as a wood product.

A serious concern in **Belgium** is, that the exotic gene flow from cultivated poplar plantations may have profound effects on wild populations. A potential consequence is the increased risk of the extinction of the wild poplar species. The cultivated poplars may become invasive thereby replacing the populations of the wild species through genetic assimilation. However, information about hybridization between cultivated tree species and their wild relatives is limited and the underlying mechanisms behind are poorly understood. The limited occurrence of native willows and the lack of commercial and conservation interests may result in some indifference towards their potential ecological value and their significance for biological diversity.

In **India**, indigenous forests mainly comprise natural stands of *Populus ciliata, P. alba, P. euphratica, P. gamblei, P. jacquemontii* var. *glauca, P. rotundifolia*. Indigenous poplars occur only in mountainous regions in Northern and North-Eastern India and are subject to deforestation due to anthropogenic pressure; hence *in situ* and *ex situ* conservation measures are required. For this reason scientific studies were conducted on *Populus euphratica* in the Trans-Himalayas of Ladakh, Jammu and Kashmir and on *Salix fragilis* in the cold desert of the Lahaul valley. S. fragilis was found to be a significant contributor of fuelwood and fodder for the entire region.

Italy reported that environmental assessments had been carried out in the northern plains of Italy to characterize sites suitable for conversion into semi-natural forests. An old poplar plantation and an old natural forest located in a floodplain were chosen as an experimental site. They were felled and a semi-natural plantation was established using *Populus nigra* and *P. alba* as pioneer species, besides *Quercus robur* and *Crataegus monogyna.* Poplar seedlings were provided by the nursery of the experimental farm in Casale Monferrato, where more than 170 genotypes collected from the northern regions of Italy are conserved for environmental purposes.

Romania indicated that white poplar, black poplar, gray poplar and natural willow forests occur mainly in the Danube flood plains, the Danube Delta, along tributaries of the Danube and along artificial channels. In the past natural forests were replaced on large-scale with hybrid poplar and willow plantations, only *Populus tremula* forests in hilly and mountainous areas did not suffer significant changes. In 2011, 30 stands of native Romanian poplar and willow species on an area of 113.9 ha, were identified, phenotypically evaluated and conserved *in situ*. Furthermore, mono-clonal poplar plantations on alluvial soils were replaced by mixed poplar and willow stands from natural regeneration. Natural poplar and willow forests were identified and protected for the Natura 2000 network.

Serbia reported that European black poplar (*Populus nigra* L.) and white poplar (*Populus alba* L.) were dominant trees among autochthonous biocenoses in riparian zones of the country. However, they became rare and even endangered, especially in the case of European black poplar. Their habitats were used for the establishment of plantations of more productive poplar species (e.g. poplar and eastern cottonwood), as well as for other purposes like agriculture, urbanization, and flood control. The protection of habitats and the reforestation of these species are considered of crucial importance in the restoration of riparian zones because of their ability to contribute to the preservation of biodiversity, flood control, control of underground water, and water quality. More than 60 genotypes of European black poplar and white poplar from 18 populations were collected throughout the country and propagated by means of micro-propagation. This genotype collection will form the base for the production of planting material for nurseries and reforestation measures, presumably in protected areas.

Spain informed that a number of activities related to the sustainable management and conservation of natural forests, including poplar and willow stands, had been realized or are being initiated in the provinces of Valencia, Aragon and Castilla y Leon. The results of this work will contribute to establishing criteria for the management of reproductive material and to designing specific conservation plans.

In **Turkey,** natural poplar stands cover about 7,000 ha in different regions of the country. They mainly consist of *Populus tremula; P. euphratica* occurs in some natural stands in South and South-east Anatolia.

d) Agroforestry and trees outside forests

Since 2006, **Argentina** has established a technical working group to establish a scientific basis for the design and management of agroforestry production systems in temperate-humid areas using *Salix* plantations. The group investigates and evaluates in particular silvicultural management options (planting densities, pruning and thinning) and the impact of grazing on the productivity and the structure of the herbaceous vegetation.

In **Belgium,** an agroforestry production system was compared with conventional crops and a forest plantation in terms of yield. Crop yields and wood production were simulated for a 20-year period in a computer model. The result of the study was condensed into the Land Equivalence Ratio (LER), which quantifies the area of land that a conventional system needs, to be as productive as a corresponding agroforestry system. The agroforestry system consisted of *Populus* trees (83 trees per ha) and maize, winter corn, winter barley, peas, and spinach. The crops covered 85% of a standard crop monoculture field and the trees were pruned up to 6m bole height. The simulated potential crop yields indicated that tree shade started to affect the crops after 5 years. Competition for water in the agroforestry system was smaller during the first 10 years and larger afterwards, compared to an agricultural field with similar crop rotation. Management measures such as pruning the trees and irrigating the crops strongly affected the crop yield. The overall Land Equivalence Ratio (LER) for the simulated 20-year rotation was 1.36, and the yearly LER decreased from 1.47 in year 1 towards 0.78 in year 20, which indicated that, except for the final years, the agroforestry system was more productive and thus required less land than separate cultures of crops and trees. In addition, the trees in the agroforestry system contributed to carbon sequestration and the reduction of nitrogen loss through soil leaching.

India reported that *Populus deltoides* was the only species extensively planted in agroforestry fields and in areas outside forests, constituting the backbone of agroforestry in the irrigated plains of Northern India. It has been estimated, that an area equivalent to over 300,000 hectares has been planted in agroforestry production sytems. Uttar Pradesh leads in poplar culture followed by Punjab, Uttrakhand and Haryana states. In Haryana, three clones, G48, WSL 22, and Udai, were the leading clones accounting for 95% of the planting stock. *P. nigra* was established along the roads in Kashmir valley, but it does not contribute significantly to wood supply. The preferred agroforestry production was intercropping poplars with agricultural crops such as wheat, maize, mustard, turmeric and aromatic crops in order to provide scope for essential food production. India also describes various benefits with regards to the productivity of poplars, if they are associated with agricultural crops.

Poplars and willows are typical features of the rural landscape in Northern **Italy** (Po Valley) growing in forest plantations, tree rows, riparian strips and agroforestry systems, where poplars (*Populus nigra, P. alba, P. x canadensis* and *Salix spp;* 200-333 trees/ha) grow in combination with corn, soy, wheat, barley, horticultural and fodder crops during the first 2-3 years of a 10 year rotation. Agroforestry systems and trees outside forests cover an estimated area of around 30,000 ha and were found to play an important role in absorbing nitrate and in reducing the contamination of groundwater by nitrate leaching. The identity of the Po Valley landscape is tightly linked to the tree rows of poplars and willows and to the traditional use of these species as a support for vineyard cultivation. As such, the rows of poplars and willows in the lowlands are one of the few remaining elements of the traditional agricultural landscape in Italy.

In **Romania**, the lines of hybrid poplars established along roads, ditches, channels and dams constitute woodlands outside the forest area. In the past four years, no new line plantings have been established and the mature ones have been felled. The legal framework for promoting the establishment of new shelterbelts for agricultural land has been adopted, but actual planting has not started yet. Poplars will be important elements in the composition of these shelterbelts. A new trend has been noted that more private investors are interested in establishing forest plantations with poplars and willow clones for biomass production.

In **Spain** local initiatives are being developed to support the management and conservation of old, unused plantations of poplar (predominatly *Populus nigra*), which grow along rivers, dispose of high ecological value and confer an important element of identity in otherwise treeless landscapes. These initiatives comprise the implementation of forest inventories, awareness workshops and technical training for the rural population.

3. Genetics, Conservation and Improvement

Genetics, conservation and tree improvement have been central for many years to most country's strategies around poplar and willow cultivation. Most IPC members reported on their efforts to preserve the genetic resources of poplars and willows and their work to improve the attributes of planting materials in terms of productivity, mainly for biomass, and resistance to damaging pests, while considering biodiversity and biosafety issues.

In **Argentina**, research in relation to genetic selection and tree improvement has been strengthened and new clone trials have been initiated.

In **Belgium** the breeding population of the Research Institute of Nature and Forest (INBO) is composed of *P.deltoides, P.trichocarpa, P.nigra* and to a minor extend *P.maximowiczii*. During the period 2008-2011, several hundreds of new hybrids were selected based on traits measured in nursery tests. A collection of 20 highly selected clones are under observation. By producing next generation hybrids through backcrossings and three species crossings, the researchers were able to select hybrids with good general resistance to leaf-rust (*Melampsora larici-populina)*. The Laboratory of Wood Technology of Ghent University acquired an X-ray tomograph, a combined DSC-TGA device and an NIR spectroscope to analyse and evaluate the wood quality of selected clones. Valuable details of the work on tree improvement are given in the national report and related publications.

In **Canada**, the poplar breeding and nursery community have high hopes that advances in *Populus* genomics will eventually lead to opportunities to develop techniques to assist in the selection and breeding of *Populus* clones with desirable traits. The researchers aimed to use genomics to optimize breeding and selection of fast growing poplars to improve their potential as a biofuel resource. From an operational viewpoint, the main emphasis of *Populus* tree selection and breeding is to create useful clones that realize significant heterosis (hybrid vigour), are very resistant or tolerant to diseases and pests, and are able to successfully withstand the rigours of the Canadian climate. Also considered in the clonal selection and testing are characteristics like fast growth, adaptability and potential for reforestation and reclamation in the energy sector. Other potentially important criteria, such as improved wood quality to meet specific demands for processing, are at this time still secondary considerations.

In **Chile**, the private company *GreenWood Resources* started its activities in 2006**,** introduced new genetic material in the country and established trials for testing the development of this material under different climatic conditions, with the objective to develop in cooperation with other private companies commercially viable management models that could be implemented on large-scale.

In **Germany** no breeding or selection was undertaken for conventional cultivation. Genetic resources of the black poplar (*P. nigra*) in the form of pollen and seed were provided for breeding work in the USA. However, the drive for producing renewable energies had raised the demand for seedlings in Germany to an extent, which could not be satisfied by local nurseries, so that poplar and aspen seedlings had to be imported from Austria, Hungary, Italy and France, and willow cuttings from Sweden. A number of poplar varieties were found to be particularly suitable for bioenergy production in agriculture. However, many varieties have not yet demonstrated their suitability on agricultural sites, which calls for further field tests. Old poplar tests, clone collections and neglected mother plantations have been examined and secured within the scope of new breeding activities. Many of the existing clones have been identified with the help of molecular markers. The clones are also tested for their suitability for biomass production in short-rotation plantations.

In **Italy**, the 'Research Unit for Intensive Wood Production' in Casale Monferrato implemented *Populus* and *Salix* domestication programmes in four programmatic areas: (a) conservation and evaluation of genetic resources; (b) controlled hybridization and development of varieties able to meet the requirements of the main industrial applications, including the production of woody biomass for energy and for phytoremediation; (c) production of genetically modified plants by the insertion of useful traits of agronomic and environmental interest; (d) clone identification and assisted selection within conventional breeding programmes using molecular markers (SSR, AFLP). Further, a number of programs of genetic mapping had been conducted on the genus *Populus* that have resulted in the realization of more than 20 genetic maps.

In **Serbia,** gene banks and stoolbeds were renewed for selecting new genotypes for conservation purposes. New stoolbeds containing more than 50 genotype candidates were planted for future selection. Research with poplar species was conducted in the field of genomics dealing mainly with genotyping and molecular taxonomy using various nuclear markers to determine the genetic relationships within genotypes, their genetic distance and fingerprinting profiles, and their resilience to *Melampsora* sp. in order to evaluate their genetic potentials for breeding programs. Research related to the selection of poplar clones for phytoremediation was continued.

In **Spain**, an arboretum with a large clonal collection is maintained, composed of 94 clones of *Populus deltoides* and 195 hybrid clones, mainly of *P. x euramericana* and *P. x interamericana.* This collection also houses a variety of clones of commercial value from different European research centres, clones from the Spanish National Register as well as 40 hybrid clones (*Populus deltoides x Populus nigra*) selected through a breeding program developed by the Center for Research and Food Technology (CITA) in the 1980's.

In **Sweden**, the investigation of the potential of *Populus* for intensified breeding is continued. Research on wood density and vitality in 280 clones of hybrid aspen and 120 clones of poplar found that most clones had satisfactory densities although it will be possible to improve selections for biomass production in the future. A scientific review on the integration of agricultural research with crop breeding was published and a major conclusion was that breeding programmes for future biomass crops would greatly benefit from integration of ecological information affecting long-term productivity. Research groups at the Umeå Plant Science Centre have continued working with *Populus* species on physiological and molecular biological topics resulting in a substantial amount of publications which are compiled in a separate report (working paper IPC/14). A new research project, coordinated by the Swedish Agricultural University (SLU) and including both academia and private companies had started in December 2011 with the aim to develop molecular markers for the use in practical breeding. Further, several studies investigated the relationship between mycorrhiza formation in *Salix* plantations and nearby natural/naturalized willow stands and its impact on foliar chemistry, resilience to leaf herbivores and biomass production.

In **Turkey,** breeding programmes focus on black poplars *(Populus nigra L.)* as one of the main poplar species in the country. A project named “Genetic Characterization of Turkish Black Poplar Genetic Resources and Development of a Molecular Black Poplar Breeding Programme” began in 2010 with the collaboration of the Poplar Research Institute, Izmit, and the Middle East Technical University in Ankara. The aim of the project is to determine the genetic diversity in black poplar genetic resources, to provide genetic identity information of clones held in clone banks, and to re-establish the Turkish black poplar breeding programme including the application of molecular techniques.

a) Aigeiros section (e.g. P. nigra, P. deltoides, P. canadensis)

In **Argentina**, the industrial sector has improved its productivity through the application of better technologies in order to produce a higher added-value and to reach internationally competitive levels. This trend, coupled with a recovery of the timber market has generated a high demand for good quality planting material. Although a number of successful clones from *Populus deltoides* and *P. x canadensis* had been created, which showed resilience to leaf-rust, changes in rainfall patterns and temperatures possibly resulting from global climate change, generated new stress conditions that led to the occurrence of secondary diseases and caused great damage mainly in the *P. deltoides* clone 'Stoneville 67', which is being dismissed as an option for planting. As a consequence of this experience a new breeding program has been developed in cooperation with a number of partners to increase the competitiveness, sustainability and quality of the selected clones through a higher genetic variability and higher resilience to climatic conditions and diseases. Other important parameters for the breeding program are the ability to develop roots, stem straightness, branching behavior, and wood density. The program works with a collection of approximately 600 clones from Populus deltoides, P. nigra, P. canescens, P. trichocarpa and hybrids of P. x canadensis from Italy, France, Spain, USA, New Zealand and Uruguay.

Croatia informed that the preservation of the genetic resources of European black poplar (*Populus nigra*) through the ‘*ex situ*’ method started with the selection and auto-vegetative propagation of adult trees including 74 clones. The hairy type of black poplar (*P. nigra* ssp. *caudina*) growing along the Neretva River (Bosnia and Herzegovina) differs considerably from the black poplar in the riparian populations along the rivers Danube, Drava and Sava in Croatia. This rare hairy type of *P. nigra,* considered to be a tertiary relict and a xeromorphic form in the sub-Mediterranean region, was compared to the typical European black poplar applying discriminant analysis. Additionally, research on the biomass production capacity of four *Populus deltoides* clones (‘457’, ‘710’, ‘S 1-8’ and ‘S 6-36’) and 4 P. x *euramericana* clones (‘I-214’, ‘Bl. Constanzo’, ‘M-1’ and ‘Pannonia’) was conducted.

Egypt indicated, that mother trees of *Populus nigra and P. nigra* var. *Italica,* were represented in all poplar plantations in the country. Some new colons of *P. euramericana* had been produced through open pollination. *P. deltoides* plantations of 12 to 15 years can be found in six locations only. Recently, some new clones had been produced from stem cuttings of female and male trees.

India reported a high number of interesting results on various field trials with poplar clones, particularly *Populus deltoides,* with the objective to investigate growth characteristics, growth and yield, wood quality and wood use. Valuable details are provided in the national report and related publications.

In **Romania,** which reported jointly on the sections 'Aigeiros' and 'Tacamahaca', the genetic selection and improvement programs focussed on the enlargement of the genetic diversity in poplar and willow plantations by increasing the number of admitted cultivars/clones. To this end, research trials had been established under different soil and climate conditions, in which clone varieties of *P. x canadensis*, *P. deltoides*, *P. x interamericana*, and *P. nigra*, were introduced to investigate the adaptation capacity to growth conditions in Romania, the resilience to adversities, the production capacity, and the resistance to flooding. The conclusions after the first two years of research were as follows: very good adaptation of Italian clones to Romanian soil/climate conditions; the Danube Delta and Danube floodplains offered optimal conditions for further development of the tested clones as compared with other locations; the highest growth potential and best resistance to adversities were recorded with the Italian clones Monviso and AF6.

In **Serbia** the differences within genotypes and their attribution to particular poplar sections were established through cluster and principal coordinate analysis. Furthermore, fingerprinting profiles were developed for certain clones. Molecular phytopathology markers indicated the existence of two *Melampsora* species in poplar genotypes. The first, *M. larici-populina,* was widespread in Serbia, while the other, according to literature and preliminary results, could be *M. medusae*. The results of these investigations were of significant importance for further poplar breeding programs. Work within the EUFORGEN –*Populus nigra* Network was continued in this project period *through ex situ* collection.

Spain has implemented a large ex-situ conservation program for *Populus nigra* in order to conserve and expand the genetic base of the species and to document its major geographic distribution. The Centre for Forestry Research had maintained a collection of 41 natural clones of *P. nigra*, which in 2010 was transferred to the National Centre for Forestry Improvement. The program includes the in-vivo conservation of clones in nurseries (1.5 ha) and in a populetum (7 ha). This collection contains in total 535 clones of *P. nigra*.

b) Leuce section (e.g. P. alba, P. davidiana, P. tremula)

Croatia is about to initiate a large ex-situ conservation program for *Populus alba*, a species that has high significance for the preservation of biological diversity in riparian reserves of Croatia and entire Europe. This program includes a series of experiments to revive selected clones of the autochthonous *P. alba*, which is implemented in cooperation with the 'Research Unit for Intensive Wood Production' in Casale Monferrato, Italy.

Egypt stated that *Populus alba* grew only in the northern part of the Nile delta, where a selection of mother trees is available as well as some plantations for the production of propagation material.

In Finland some low-key breeding with hybrid aspen (*P. tremula x P. tremuloides*) was conducted with the objective to ensure the conservation of the existing genetic resources.

In **India** the growth performance of cuttings of *Populus alba* from 26 provenances of Himachal Pradesh, Jammu and Kashmir had been studied and highly significant differences had been found regarding height, basal diameter, leaf area, internodal length, root fresh weight, root dry weight, shoot fresh weight and shoot dry weight.

In **Romania**, 9 stands of white poplar were selected and evaluated from a phenotypical point of view with the objective to establish a conservation network of valuable local species. This network will be extended to the entire area of the Danube floodplains to be managed as a genetic resource for conservation.

In **Serbia** (and Hungary) white poplar (*Populus alba*) and its natural hybrid, grey poplar (*P. x canescens*) form native stands, of which more than 70% can be found on calcareous sandy sites in the Danube–Tisa region, where they play a significant role in poplar management. One of the most pressing tasks the Serbian and Hungarian poplar growers are faced with is to improve the quality of poplar stands and plantations in terms of wood production by selecting more drought-tolerant clones and cultivars. The juvenile growth and morphological characteristics of five micro-propagated *Leuce* poplar clones have been evaluated on a marginal site in central Hungary.

In **Spain** the genetic structure of *Populus alba* and *Populus nigra* has been studied and analysed, and the effects of the sexual and asexual reproductive systems on this structure have been evaluated. Furthermore, the underlying mechanisms and the adaptive and demographic effects of hybridization between P. alba and P. tremula have been studied by means of backcrossing. In Aragón, a populetum is maintained that comprises a collection of 90 clones growing on natural sites in the different river basins of the province.

c) Tacamahaca section (e.g. P. trichocarpa, P. ciliata, P. ussuriensis, P. suaveolens)

In **Belgium**, the Research Institute of Nature and Forest (INBO) in Geraardsbergen started a targeted breeding program to realise an optimal synergy between biomass production, rust tolerance and phytoremediation with short rotation coppice. A broad collection of willow and poplar clones (100 INBO-clones) made part of these screening effort. After the first year a phenotypic selection was performed and 26 of the poplar clones and 56 of the willow clones were selected for further research. After 4 years of growth the most promising clones found were crossings of *P. trichocarpa x trichocarpa.* Several of these clones achieved a productivity of more than 10 tons dry matter per hectare and year. As for willows, the most promising clones were found in crossings based on *Salix alba*, with a productivity level of more than 10 tons per hectare and year. *S. viminalis* as well reached satisfactory productivity levels, but the hybrids *S. viminalis x viminalis* were performing weaker. In general, willows were found to be less productive than poplars.

In Serbia hybrids of *Populus nigra x P. maximowiczii* were included in phytoremediation experiments. The clones produced from this experiment have also been used for investigations of the genetic resistance to *Melampsora spp.*

d) Other sections

Egypt reported that *Populus euphratica* grew only in the Mediterranean area of the country. The species was subject to an investigation to assess growth and yield under different site conditions.

e) Willows

In **Argentina,** willows grow mainly in the floodplains of the Paraná delta, where they cover an area of ca. 65,000 ha. Since 2003, a genetic improvement programme for *Salix* spp. has been carried out with the objective to broaden the genetic base by intra-species and inter-species hybridization and to integrate new productive clones in the management system. After 5 years into the program, the most outstanding plants in terms of growth, health, bole shape and branch formation are crosses of *Salix matsudana x Salix nigra* and *Salix matsudana x Salix alba*, as well as open pollinated individuals involving *Salix amygdaloides, Salix matsudana* and *Salix nigra*. Another important willow species is the basket willow (*Salix spp.*), which allows for annual harvests of wood products and represents a significant economic opportunity for small forest producers to diversify their production and to earn additional income.

In **Croatia** a breeding program with arborescent willows had been carried out with the objective to produce pioneer species for easier reforestation of difficult sites with more valuable species (oak and ash), and to establish plantations for high biomass production in short rotations on marginal sites, where agricultural production had ceased. The Chinese willow (*Salix matsudana*) was used as partner for the inter-species hybridization with autochthonous white willow (Salix alba). No fertilization or measures for pest control have been carried out, and weeding only to a limited extent at an early stage. Despite this low-intensity management, the results have shown a high biomass production of the researched clones ranging from 9.3 tons/ha up to 19.8 tons/ha in a biennial rotation.

Provenance trials were conducted in **Egypt** on willows, to evaluate the growth rate and the fertilizer and water requirements.

From over 200 clones of different species and hybrids of *Salix* imported to **India** from twenty countries, the most promising 18 clones were subject to a comprehensive field trial. Based on their performance, five clones were found suitable for reforestation in the lower and mid-hills of Himachal Pradesh. Other studies had been carried out for the molecular profiling of 25 species/clones of willow, and two in *situ* conservation plots have been established to test, propagate and distribute suitable planting material to farmers and plantation companies.

New Zealand reported that serious defoliation by the willow sawfly *Nematus oligospilus* has become rare. However, breeding activities have continued to increase resilience against this particular insect pest and to expand the genetic base of available commercial tree willows. The magnitude of the breeding operation has been quite small but the intent was to increase the range of clones available to end-users; for present needs in hillslope and riverbank soil stabilization, shelter and stock fodder; for anticipated future needs in bioenergy and timber; and in response to pest and disease incursions and other potential effects of climate change.

In **Romania** a new forest strategy promoting the ecological restoration of floodplains and the use of indigenous species, prompted the identification and phenotypical evaluation of eight natural willow stands for their *in situ* conservation.

Serbia investigated the physiological and growth characteristics of white willow, both on healthy and contaminated soils, and implemented an inventory on the incidence of fungi and *Chrysomela populi* in *Salix* species.

4. Forest Protection

This chapter reports on the incidence and impact of damages in poplars and willows from biotic and abiotic factors and on the research activities to mitigate these damages. Although some commonalities exist, the damaging factors vary significantly in nature, scope and distribution between countries.

a) Biotic factors, including insects, diseases and other animal pests

In **Argentina, t**he most common diseases in poplar plantations are the leaf-rust (*Melampsora* spp.) and cankers caused by *Septoria musiva*. The ambrosia beetle (*Megaplatypus mutatus*) causes serious economic losses, as it attacks standing, vigorous trees and leads to a lower harvesting yield due to breakage of trees. Various research projects are underway to better understand its life cycle and infestation patterns, and to determine the most effective treatment. In spite of some progress in this respect, a lasting solution has still to be found. Other pests are caused by *Oiketicus moyanoi* and

Rhytidodus decimusquartus. The "willow sawfly" (*Nematus oligospilus*) is the major plague in willow plantations causing serious defoliation that reduces timber production by up to 60%. Repeated attacks can cause the dieback of the plantations. Research projects between universities and private companies are investigating the biology and behavior of the pest. Argentina also reported on the importance of weed control in poplar plantations, and the costs related to it.

Belgium kept up its former information service about the diseases observed on poplar varieties since 2002, as a reaction to the poplar grower's concern about *Melampsora* leaf-rust. The control plots included 26 varieties composed of seventeen commercialized *P. deltoides* x *P. nigra*, five *P. trichocarpa* x *P. deltoides* as control for maximun sensibility, one *P. trichocarpa*, two *P. trichocarpa* x *maximowiczii* and one backcross *P. deltoides* x *P.* x *interamericana*. The intensity of infection varied yearly and between plots. For the 2004-2006 period, the intensity of infection was significantly higher than for the years 2007, 2010-11. Another research project on poplar growth characteristics demonstrated, that the defence mechanisms and the capability to adapt to risks (e.g. phytophagous insects) in forest poplars, like *P. trichocarpa*, diverge fundamentally from the pioneer poplars like *P. nigra* or *P.deltoides*.

In **Canada,** 13.7 million ha of all forested land were affected by insect defoliation in 2008 and 0.8 million ha were lost due to forest fires in 2009. For the *Populus* stands the increasing use and expansion also comes with the effect that diseases and insects affecting those stands are expanding, if no counter measures are taken. This is especially apparent in intensive monocultures. One prominent example is *Septoria musiva* (stem canker), which causes leaf blight and, more importantly, necrotic lesions (cankers) that often result in stem breakage. *Septoria* has been steadily spreading across the Prairie region, due to an increase in the amount of established SRIC hybrid poplar crops (SRIC = short-rotation intensive culture). Also the northward shifting and changes in climate and eco-zones that are part of the climate change development, put additional pressure on *Populus* stands with challenges from insects and diseases that they previously where not exposed to, with devastating consequences. In light of these specific challenges, it is unfortunate that no systematic attempts have been made so far in Canada to use biological means to control agents of plant diseases. Besides breeding and selection for resistance, mostly traditional chemical-based approaches are used. Besides *Septoria musiva*, other major *Populus* and *Salix* diseases and pests are *Melampsora spp.* (leaf rust), *Marssonina spp.* (leaf spot fungus), and the insects *Cryptorhynchus lapathi* (poplar & willow borer), *Hamamelistes spinosus (w*itch hazel gall aphids), *Lygus lineolaris* (tarnished plant bug), *Popilla japonica* (Japanese beetle), *Caelifera* (grasshopper), *Nematus sp.* (sawfly) and *Aphid spp.* (plant lice). The Poplar Council of Canada (PCC) has established the Pesticide Working Group (PWG) with the objective of expanding the range of available pesticides and fungicide products for use in SRIC (hybrid) poplar crops, including aspens, poplars and their hybrids, and willow.

Croatia observed that poplar wood production in monoclonic or oligoclonic plantations represented one of the biggest risks for the outbreak of plant diseases and the attack of damaging pathogens. In the last four years the brown leaf blight (Marssonina brunnea) has been constantly present in nurseries and plantations of *Populus* x *euramericana* (e.g. 'I-214', 'Bl. Constanzo'). The rust disease (*Melampsora sp.)* appeared on poplar and willow leaves in the second half of the vegetation period, particularly in autumn, at a time when it represents no significant risk. Cancer of the poplar bark (*Dothichiza populea Sacc. Et Br*.) was a far spread disease in the Drava valley, and caused significant damage, whenever the plants weaken physiologically (e.g. during planting or in arid periods). In central Croatia, the bark disease *Glomerella miyabeana* had been confirmed on willow seedlings. This fungus is very dangerous as it can destroy the entire plantation within two weeks. Besides preventive sprinkling of the seedlings in nurseries, there are no other known protection measures. The infected seedlings must be cut and burnt. A high number of defoliators have been recorded each year in spring time during the foliation period. In years with severe late spring frosts, poplar trees were affected by distinctively secondary *Trypophloeus* species, which otherwise do not appear in large numbers. Some poplar plantations became unproductive due to changes in the habitat and the subsequent outbreak of thrips (*Lispothrips crasipes Jabl.).* The pest was successfully treated by a phenologically adjusted application of contact insecticides. However it became clear that the main reason for its outbreak has been of physiological nature – the physiological stress of young poplar trees caused by dry periods. Croatia observed as well that physical damages by red deer (Cervus elaphus L.) were frequent in newly planted poplar plantations, while hares (Lepus europus) barked the willow seedlings.

Egypt reported that the following insects were present in the plantations of poplars and willows: *Cossus henleyi, Mesites (Rhopalomesite) cunipes, Rhyncolus cylidricus* and *Macrotoma palmate*. In the northern part of the Nile delta *Zeuzera pyrina* could be found on *Populus nigra , P. alba* and *P. deltoides*, while leaf miners attacked *Populus alba* without causing serious damage.

In **Germany**, notable plagues on poplars and willows are not known. However, protective measures against browsing, against rodents and competing vegetation must be taken, particularly in the first year of planting. *Chrysomela (=Melasoma) populi* L. has caused some feeding damage, particularly to the newly flushing coppice shoots after harvesting. Feeding damage by *Chrysomela vigintipunctata* can reduce growth in individual cases. After several years, however, a balance seems to be established between the beetles and their natural enemies so that damages become tolerable and do not need protective measures. In years with extreme spring aridity, mortality in poplar plantations can be high, in parts even total. Supplementary irrigation, particularly during the young growth phase, is recommended to safeguard successful regeneration and to increase growth. Pure black poplar stands are frequently damaged by fungi and insects, in particular by the leaf-rust (*Melampsora larici-populina),* which may be due to the over-maturity of these stands. The genetic resources must therefore be protected and regeneration measures be introduced.

In **India,** poplars are prone to over 143 fungal, bacterial, and viral pathogens, which are capable of causing considerable damage to leaves, branches, boles and roots. One of the major threats to commercial poplar plantations is the stem borer, *Apriona cinerea*. Pathways for movement, phytosanitary risks and best control measures have been identified for this pest, however, a genetic variation in the resistance of poplar clones has not been observed so far. Damage by defoliators (e.g. *Clostera cupreata)* decreases the growth of poplar trees established in agroforestry production systems. The loss is significant, when more than half the foliage is lost in the growing season. The spread of *Clostera* is mainly due to the carriage of eggs, larvae and pupae to new sites from nurseries by the commercial trade of plantlets during the growing season. Aerial spraying using carbaryl has been resorted to in some cases, to suppress the outbreaks. Wildlife also causes serious damage to poplars both in field plantations and nurseries, such as blue bull, monkeys, rats, rabbits, crows, parrots etc. The major damage by these agents is caused during dry spells when they get attracted towards the greenery of poplar and agricultural crops grown therewith. Studies on common poplar diseases were conducted in recent years at the Forest Research Institute Dehradun to (1) evaluate the status of nursery and plantation diseases on commercially viable clones; (2) study the biology, diversity, succession of the most prevalent pathogen(s); and (3) screen the disease resistance of promising clones under natural and controlled conditions. These studies had also the objective to select resistant genotypes for breeding and clonal propagation and to investigate the genetics of the host-parasite relationship. It is interesting to note, that a wide range of biological control agents native to India have been recorded that effectively check the pest populations in the field. These include a Nuclear Polyhedrosis Virus (NPV) and a large number of egg, larval and pupal parasitoids (e.g. *Trichogramma sp.).* Further details about the damaging pathogens and the geographic distribution are listed in the national report.

The most important pest in **Italian** poplar cultivation is the poplar and willow borer *Cryptorhynchus lapathi* L. Each year about EUR 1 million (30 % of the total costs of poplar protection) are spent, in order to prevent damages in young plantations and nurseries. This pest is also highly damaging in short-rotation biomass stands, where chemical control is technically difficult and financially unsustainable. Other «key» poplar pests in Italy were the large poplar borer *Saperda carcharias* L. and the goat moth *Cossus cossus* L., which destroys 8 % of poplar trees with considerable economical losses, since damaged wood is not appreciated by the plywood industry. The recently introduced American pest *Megaplatypus mutatus* (Chapuis) is an important threat to poplar cultivation in Central Italy (Caserta Province). It is able to attack different broadleaf species (including walnut, apple, hazelnut) causing severe damage to the trunks. *M. mutatus* has not spread yet to other Italian regions, however investigations are ongoing to determine suitable control strategies. Buprestid beetles (*Agrilus suvorovi-populnaeus, Schaefer Melanophila picta)*, attacked young trees suffering from transplant stress or drought, causing weakening or stem breakage. The poplar clear-wing moth *Paranthrene tabaniformis* Rott. affected not only poplar nurseries, but also young poplar stands in the Central Po Valley. The Poplar twig borer *Gypsonoma aceriana* Duponchel was always present at high population levels and causes severe damage to young trees in nurseries. Among sap-sucking insect pests, the poplar woolly aphid (*Phloeomyzus passerinii* Signoret) was the most harmful, causing bark damage and the die-back of trees under heavy and prolonged attacks. Infestations were recurrently recorded, mainly in moist areas along the rivers of the Central Po Valley. The incidence of this pest is markedly enhanced by the extensive cultivation of highly susceptible clones in Italy. Intense attacks of the polyphagous leafhopper *Asimmetrasca decedens* Paoli were recorded in poplar and willow nurseries in Northern Italy, where *Salix alba* clones were heavily damaged. Additionally, some outbreaks of defoliators (*Byctiscus populi* L., *Chrysomela populi* L.) occurred causing damage in poplar stands. The incidence of *Discosporium populeum*, a cortical parasite in the Po area, able to cause the death of already weakened young plants, was very low, in contrast with the high levels recorded ten years ago. In the adult plantations stressed by water deficit, cortical necroses were observed with a relatively low spread, but with localized high severity. This physiological disorder, also known as "trunk brown spot", can considerably reduce the quality of wood. In 2009, possibly alarming isolations of *Fusarium avenaceum* were obtained from bark necroses in adult plantations of several clones. The incidence of the leaf spot blight caused by *Marssonina brunnea* was remarkably reduced during the last four years. In 2011, defoliation ocurred only at the end of September. This unusual trend may have been related to the prolonged drought occurring just at the beginning of sprouting. As regards leaf rusts by *Melampsora* spp. (i.e. *M. larici-populina* and, to a lesser extent, *M. allii-populina*), all the recognized groups of pathotypes, better known as physiological races have been observed in Italy – except for race E2. Rusts are still a limiting factor in nurseries rather than in plantations, since summer defoliations in nurseries cause an impaired sprouting of nursery stock after transplant and a stronger predisposition towards weakening parasites. The damage caused by rusts in short-rotation plantations must be seen more in terms of stump survival and coppice quality rather than in terms of quantitative losses of dry matter. Among all recurring diseases, rusts are the most challenging ones for clonal selection and thus represent a limiting factor of genetic renewal. The presence of the Poplar Mosaic Virus remains very low. Eradication in the nursery was the only method to prevent PMV epidemics.

Romania reported from a high number of root insects, wood larvae, leaf and shout larvae, defoliating bugs, sucking insects, leaf (and shoot-tip) parasites; stem, branch, twig and shoot parasites; and root collar parasites, which have significantly damaged poplar and willow nurseries. Valuable details are provided in the national report and related publications.

In **Serbia,** *Dothichiza populea, Marssonina brunnea* and *Melampsora* spp., have a significant economic impact on nurseries and plantations of poplars and willows among various other pathogens. Several attacks of *D. populea* were reported in new formed stoolbeds of poplars in several nurseries. The cortical tissue of cuttings and the newly formed shoots were infested by the fungus. The cultivated clones were infected to varying degrees (15-40% of plants), and only a small number of clones was resistant to fungal attack. In the period 2008-2011, the conditions for the emergence and spread of the fungus *Marssonina brunnea* were not favourable, particularly due to the sudden change of rainy and dry periods followed by high temperatures. Additionally, the damage caused by fungus attack in previous years was largely mitigated by selecting and breeding clones (e.g. of *P. deltoides)* with low susceptiblity to the pathogen. Amongst the insect pests that occur each year in Serbia, a special place belongs to the insects of the family *Chrysomelidae,* which cause damage in nurseries and young poplar plantations. However, suppression actions were promptly taken, and major consequences for the plants were not observed. The most important disease of willows in Serbia is the fungus *Glomerella miyabeana* (Fuk.) Arx., which causes die-back of young shoots, leaves and bark. The occurrence of this fungus was found in young planted willows in the Middle Danube region. A wide range of other pests were noted, and are detailed in the full report of the country.

Spain described the various pathogens observed in the country, such as *Leucoma salicis, Melasoma populi, Cerura iberica, Operophtera brummata,Polydrusus impressifrons, Endromis versicolara* and *Paranthrene tabaniformis* and others, including the treatments which have been applied to protect the affected plants. Furthermore, it was noted with concern that *Marssonina brunnea* caused a severe die-back to plantations of *Populus* x *euramericana and Populus nigra,* and natural stands of *Populus tremula,* as well as a decline in growth in some regions of the country. In addition to biotic and abiotic factors, Spain pointed to a vegetative weakness of numerous specimens of *Salix* along the river Turia near Valencia. The symptoms of this unknown affection consisted in a progressive reduction of the vitality of the trees concerned, resulting in dry leaves, loss of foliar density, and finally the death of the tree. So far, analytical investigations did not reveal any pathogens which could be held responsible for this phenomenon.

In **Sweden** it was found, that wastewater treatment of willows resulted in increased leaf rust occurrence, while mineral fertilization did not show any effect three years after treatment. By using the leaf beetle *Phratora vulgatissima,* it was demonstrated that the risk of insect pest outbreaks is higher in monocultures than in more diverse habitats. The interaction between the serious damaging 'blue willow beetle' and its natural enemy *Perilitus brevicollis* was studied resulting in the suggestion that *Perilitus* parasitoids and omnivorous beetle predators may provide complementary protection to *Salix*.

In **Turkey**, there was no major epidemic outbreak originating from insects or fungi in poplar nurseries and plantations. However, it was observed that entomological and pathological problems originated rather from physiological weakness of poplars. *Cytospora* and *Melampsora* fungi continued to damage some poplar plantations on small-scale as observed in previous years. Important insect pests generally observed in the nurseries were *Gypsonoma dealbana Froel, Sciapteron tabaniformis Rott, Bystiscus populi L., Melasoma populi L. and Nycteola asiatica Krul., Melolontha melolontha* Fabr. Some insects that caused damages in plantations were *Hyphantria cunea Drury., Leucoma salicis L., Sciapteron tabaniformis Rott., Melanophila picta Pall., Agrilus sp., Aegeria apiformis (Cleck), Lepidosaphes ulmi L.,* and *Chionapsis salisis L.*.

b) Abiotic factors, including storms, floods, droughts, pollution and others

Argentina reported, that the major poplar planting area in the Paraná Delta is subject to high water stress through an alternation of frequent floods and pronounced dry-spells. The response of various commercial and experimental clones to this climatic condition had only recently been investigated through morpho-physiological research studies. The results obtained so far show effects of decreased height and diameter growth, a reduction of the total leaf area and a decline in the formation of new leaves, as well as a decline of the stomatal conductance and photosynthetic activity. An applied research project investigates the use of Salicaceae for integrated fire management in forest plantations of the Paraná-Delta. The project is expected to improve the prevention and suppression of forest fires.

Croatia had observed in 2010, that dieback of newly planted poplars had occurred due to high and prolonged flooding in the valley of the Drava river.

In **India,** the most significant damage to indigenous poplars is caused by local people who lop the trees for fodder. This often prevents the regeneration of *P. euphratica* and *P. alba.* The year 2010 was a year with pronounced dry-spells and 2011 witnessed heavy floods. Both these events caused heavy damage to poplar nurseries and plantations throughout the poplar growing region.

In **Italy**, the climatic conditions greatly influenced the phytosanitary situation of the poplar plantations in the period 2008-2011. As in previous periods, conspicuous droughts occurred early prior to the vegetative season. The droughts were associated with a very irregular distribution of rainfall, far from the equinoctial pattern typical of the Po Valley. Consequently, particularly in 2009 and 2011, high mortality rates were noticeable in young plantations, and the dry summer conditions induced typical symptoms, such as a drastic thinning of the crown, reduction of annual growth, difficulty of lignification of the young shoots, and the decline of reserve substances for the period of dormancy.

Romania indicated that flooding had affected nurseries and poplar plantations in the Danube floodplains and on other large rivers. On several occasions during the last decade, the water level had almost reached its historical peak, in some cases rising above dams or destroying them. The largest flooded areas have been recorded in 2005-2006 and 2010. On the other hand, drought had as well caused regular damage in poplar and willow plantations. Poplar decline was observed especially after extreme dry seasons or in periods with frequent alternation of floods and droughts in the Danube floodplains and its large tributaries. Die-back usually affected young plantations (on alluvial sandy soils), which were regularly infected with bark diseases (bacterian cankers, ascomycetes infections). Willow decline was recorded on smaller areas, but the die-back was more rapid. The main factors were climate variability (extreme flooding/long droughts) as well as the pollarding of the trees.

Young plantations in **Serbia** were exposed to flooding from Sava river during winter and early spring of 2009. Low temperatures caused bark damages due to ice formation. Smaller injuries were coated with phytobalsam to facilitate faster healing of the wounds, while severely damaged trees were replaced with new plants. Similar damages were recorded in poplar plantations in the Lower Danube in 2010 and 2011. Flooding at the Danube repeatedly river pushed over young poplar plantations due to the water-soaked soil. Trees were stabilized with wooden poles and ropes.

In **Spain** frequent hailstorms of high intensity had caused serious damage to young poplar plantations. Pruning was carried out to correct the crown shape and fungicides applied to prevent the penetration of pathogens through the stem wounds inflicted by the hailstorms.

5. Harvesting and utilization

a) Harvesting of poplars and willows

In **Argentina**, harvesting of poplars and willows is traditionally carried out manually, with the exception of three private companies, which deploy harvesting crews equipped with harvesters.

In **Canada**, poplar stands are mainly harvested by clear-cutting using all-tree harvesters in plantations and specially constructed machinery for short-rotation biomass plantations.

In **Croatia**, harvesting of plantations is traditionally carried out in three stages: felling by chain-saws, hauling by tractors or forwarders and transportation by trucks and railway.

In **Germany**, poplars and willows grown in conventional rotations are exploited according to usual forestry practices. Poplar roundwood is graded according to the statutory provisions on roundwood grades. The woody biomass produced in short-rotation plantations is used in the form of wood chips mainly for energy production.

In **India,** *Populus deltoides* is usually harvested at a target diameter of 24 cm dbh. In plantations of high growth performance farmers tend to harvest at a younger age once the tree attains this diameter. A study on the effects of shorter and longer rotations on the economic viability and biomass production showed higher economic returns with longer rotations in intensively managed plantations. The reduced yield of intercrops and the lack of information about economic returns from *P. deltoides* trees in older plantations may be the major reason behind a too early felling of this species. The marketing of poplar wood across India has been promoted by an exemption from transit permits in many states. In addition, income from poplar cultivation, has been exempted from income tax as it is considered an agricultural income. These factors have considerably promoted large scale planting of poplars by individuals in the poplar-growing region.

In **Italy**, three levels of mechanization can be identified for poplar harvesting: traditional, advanced and fully-mechanized. The traditional method is characterized by the use of chainsaws for felling and of agricultural tractors for skidding. The advanced method works with equipment that can carry out several field operations, e.g. a feller-buncher for felling, bunching and for the alignment of the trees. The fully-mechanized method uses specialized, combined machinery that can perform all the operations necessary to produce the final timber grades, e.g. a fully-equipped harvester. Currently, the traditional method is the most frequently used, although the adoption of advanced and fully-mechanized methods has spread in recent years. The applicability of the more advanced methods depends on the availability of highly professional operators who can fully exploit the mechanization potential, and on the presence of a well-managed enterprise that is able to quickly adapt to market fluctuations.

In **Sweden,** a major concern with Salicaceae cultivation is the limited space available for these species, though the area of populous is increasing. The issue has been addressed in a number of studies and reports. The major reasons for the stagnation of *Salix* areas since the 90s were low biomass production, limited availability of land and, in turn, little commitment by commercial companies. As a matter of principle it was found, that a successful development of woody biomass production on agricultural land in northern Europe depended among others on the dissemination of research results, skilled growers, the existence of a suitable infrastructure and markets, as well as favourable policies.

b) Utilization of poplars and willows for various wood products

In **Argentina** a peeling plant had been established in Mendoza province, to produce ice-cream sticks and some new production lines had been installed to manufacture laminated construction timber with poplar. In the Paraná-Delta region, the domestic market of poplar and willow products has experienced a revival resulting in an increase in the number of operating sawmills.

Belgium reported that willow wood is anatomically comparable to poplar wood. The principal difference is a higher share of tension wood in willows (15 to 50 %) as compared to poplars (5 to 10%), which depreciates the quality of the finished products. Nevertheless, willow wood, once air-dried is perfectly suitable for sawing, joinery, packaging, pallets, match making and veneer and plywood. It can also be used as raw material for pulp and paper, fibreboard and particleboard industries. Currently the wood quality of willow trees is investigated in a selection of potential clones for future commercialization. Further, the durability of the thermo-modified poplar wood treated by the BMT® process was tested for resistance to basidiomycetes.

In **Canada,** the value of naturally growing native aspen (*P. tremuloides*) in pulp and paper manufacturing is well recognized. Currently, aspen is used by several large pulp mills in Alberta and Québec. Most pulp mills also accept a certain percentage of balsam poplar and cottonwood in their wood supply. Aspen pulp is manufactured using the Kraft (chemical) process; or CTMP101 process. Use of poplar species for pulping requires less bleaching chemicals in the Kraft process and less brightening chemicals in the CTMP process. The end products are many and include high quality paper, for use in photographic grades and high gloss magazines. The Pulp and Paper Research Institute of Canada has carried out research into the use of short-rotation hybrid poplar fibre in the manufacturing of pulp and paper. The results are very encouraging and the fibre offers similar advantages to that of naturally growing native aspen. There has been a growing interest in the use of naturally growing native aspen (*P. tremuloides*) for higher-value lumber products and several small entrepreneurs have been experimenting with lumber recovery, drying and manufacturing. Native aspen is also the preferred stock for the manufacture of Oriented Strand Board (OSB) and laminated strand lumber (LSL). OSB has largely displaced plywood as a building product used in sheeting in

North American construction; LSL is used for structural (indoor) use. As in the pulp and paper business, there has been increased interest in use of short-rotation hybrid poplar wood for composite wood products. Several products were manufactured from this material and the test results were very encouraging. Products made and tested include OSB, Laminated Veneer Lumber (LVL), Medium Density Fibreboard (MDF) and plywood. High quality aspen and poplar veneers can be covered with expensive veneers for cabinetry.

In **Chile** the major product from commercial poplar plantations are matches and small utensils mainly for the international market. Local small-scale enterprises focus the production on fruit boxes, lumber for house construction, furniture, panels and woodfuel. Willow-shoots are traditionally used for the production of wicker furniture which locally have a high economic importance for rural development.

The main use of poplar and willow wood in **Egypt** is for furniture, particle boards, ice-cream sticks and plywood. In some areas, willow shoots are used for producing baskets and umbrellas.

In **India** about 80% of the poplar wood (mainly *P. deltoides*) is consumed by the plywood industry. About 400 veneer and plywood plants are located in Haryana province alone. Of the remaining 20 %, the major part goes to the match industry. The supply of poplar wood to produce pulp, paper or charcoal is very limited. Poplar wood in India is sold by weight and any delay in marketing results in economic losses to the growers. Poplar veneers are not suitable for classification as Type A surface (top quality) and, hence are used only as core and cross band veneers. Face veneers are made of other species which are usually imported or procured from the north-eastern states of India. Big diameter logs are peeled for veneers, and the core material along with small diameter logs are sawn to small panels to be used as flush door/block board inserts. Poplar wood can be easily treated with preservatives.
The indigenous poplars *P. ciliata* and *P. gamblei* grow fast and have the potential to enhance wood supplies for packaging and raw material for industries. In Kashmir, it is used for construction purposes, plywood, hard boards and as a fuel. Its leaves serve as fodder for goats. The wood of *P. gamblei* is suitable for making plywood, matches and packing cases. *P. euphratica* and *P. alba* are used as fodder. The former grows in the cold desert region and is heavily lopped. Heavy lopping prevents seed setting and natural regeneration.

In **Italy** a large industrial group has recently decided to establish an OSB (Oriented Strand Board) production line, which will be the first of its kind in Italy and the first one to use only poplar wood. The production should start before the end of 2012. Some preliminary investigation was carried out to evaluate the possibility of producing a so-called “poplar-brick” to erect wooden walls. Further tests of its applicability are under way. Several new unregistered poplar clones (*Populus nigra* × *P. deltoides* hybrids), have been studied as to their physical properties and suitability for peeling. Plywood panels were produced from each clone and subjected to mechanical testing.

In **Romania** the use of poplar and willow wood for plywood production decreased due to a declining demand for construction material, as well as the competition of comparable products or substitutes from the Far East. This development prompted as well a reduction in the efforts to achieve improvements in technology and productivity. Likewise, the closure of important cellulose and paper producing companies resulted in a low demand for poplar and willow wood and an increase in its usage as firewood. Private investments in hardboard factories partially balanced the otherwise low demand for small dimension poplar and willow wood. Eventually, poplar and willow timber production remained rather stable with small technological improvements being registered in the private sector.

In **Spain** investigations are being carried out to characterize and evaluate the suitability of poplar wood for the rotary veneer industry. The studies include among others an assessment of the impact of pruning on the bole shape, the occurrence of ‘black heart’ in poplar logs, the determination of the optimum rotation period and the quality of the end product.

In **Sweden**, the opportunities for billet harvesting from *Salix* had been investigated and evaluated, with the result that there was a significant potential in the future. Billets are a fuel material that are longer than chips, but still short enough for easy handling. The applicability of conventional forest technology in large-diameter willow stands was tested and it was found that specialized *Salix* harvesting systems were superior, although forest machines will always function regardless of stem thickness. In a comparative analysis of Salicaceae species it was found that the wood of hybrid aspen and aspen show quite different wood properties, e.g. with regards to Young's modulus, tensile strength and wood density.

In **Turkey**, poplar wood production continues to increase on or close to agricultural land. The traditional techniques of black poplar and willow cultivation, exploitation and utilization, which have developed over the centuries provide economically viable results even today. More than 80% of black poplar wood is utilized as roundwood for rural construction purposes and for the daily needs of the rural people. Additionally, poplar wood industries have developed, producing fibre boards and chip boards, furniture, packing material, particle boards, plywood, and matches, mainly from hybrid poplars (*P.x euramericana*). These industries consume nearly the total amount of wood from hybrid poplars (2,170, 000 m^3). In terms of wood properties black poplar has been found to show higher strength than hybrid poplars. Consequently, black poplar wood can be used for construction purposes, which are not suitable for hybrid poplar.

c) Utilization of poplars and willows as a renewable source of energy

Argentina reported, that in 2006 experimental plantations of *Populus (e.g. P. x canadensis)* and *Salix* had been established in Mendoza province with the objective of producing bioenergy. The plots were established with at high density of 10,000 to 20,000 plants per hectare for a rotation period of 2 to 3 years. Data and information on the growth characteristics, productivity and wood properties are currently being analysed and evaluated.

Belgium provided detailed information on the experimental design of a short-rotation coppice (SRC) poplar plantation established in 1996 with the objective to investigate the growth potential for biomass production and phytoremediation.

Research in **Canada** is underway to develop new products and technologies to maximize the value derived from forest biomass along the entire forest industry value chain. As one of the fastest-growing species of trees, hybrid poplars (*Populus* spp.) are well suited for the production of bio-energy (e.g. heat, power and transportation fuels), fibre (e.g. pulp and paper) and other bio-based products (e.g. organic chemicals and adhesives). While Canada's largest source of biomass energy is waste from sawmills and pulp and paper mills, governments and industry are looking at the potential of fast growing plant crops such as poplars and willows to boost the availability of biomass-derived energy in Canada. In 2011, a project was announced to enhance the development of clean energy by using genomics to enhance breeding and selection of poplar trees to improve their potential as a bio-fuel resource. The current production of bio-fuels, which are almost exclusively derived from agricultural residues, is insufficient to produce the requisite volume. Researchers at the University of British Columbia are using genomics to study tree growth at the molecular level, as well as wood traits associated with bio-fuel suitability in *P. trichocarpa* and *P. balsamifera*. Their aim is to develop short-rotation, fast-growing trees that can grow in a variety of climates across Canada and produce wood that can be more readily converted to biofuel while minimizing the ecological footprint. The potential payoff from a new energy crop could include job creation and stability in rural communities. Beyond energy production, researchers are also studying how poplars might be turned into liquid fuel, or ethanol. The process for producing cellulosic ethanol involves extracting sugars from the cell walls of plant material. As most plants contain more biomass than grain, cellulose could potentially provide more ethanol than grain. With trees, the biomass volume is even larger than it is with most row crops. Poplar trees offer advantages over other species as a cellulosic ethanol feedstock. In particular, poplars can be vegetatively propagated and poplar trees are very efficient at photosynthesis.

Chile reported, that a number of public and private initiatives had developed to promote research on new energy sources in order to cope with the energy crisis in the country. The possibility of producing biomass on large-scale for generating energy from the cultivation of poplars was investigated, which opened a new dimension in the development of the Salicaceae species in the country. One of the most successful experimental plantation of 5 poplar clones, which had been established at a density of 5500 plants/ha in central Chile and had been fertilized and irrigated, demonstrated a yield of $67m^3$/ha/yr or close to 27 tons of dry matter per ha and year at the end of the 2^{nd} rotation period.

Croatia indicated, that in recent years the wood waste remaining after logging on the forest roads was grinded and sold as forest biomass for energy production.

In **Germany** the biomass produced in short-rotation plantations is used as solid fuel, which is mainly burnt as wood chips in adapted boiler systems. If the supply of woody biomass will increase further, it can be anticipated that pellet production will gain in significance. The methods for the gasification of woody biomass (pyrolysis) or the liquefaction of fuels (Fischer-Tropsch process) have not yet been developed to the point of practical application.

Experiments in **India** suggest the high potential of short-rotation poplar plantations to produce biomass. A yield of 32.07 t/ha/yr air-dry biomass was observed in the second rotation of a *Populus deltoides* clone (S7C8), which had been planted at a density of 10,000 plants/ha and managed in a three-years cutting cycle. Other clones produced 23.89 and 22.23 t/ha/yr air-dry biomass, respectively. Poplar contributes as well to the production of firewood in rural locations. It is estimated that around 4.5 million tons firewood are available from poplar plantations and as wood waste from factories, which are used for bioenergy in rural India.

In **Italy,** research focused on the development of technological innovations to enhance harvest mechanization, improve storage logistics and the collection and transport of biomass to conversion plants. It was found that harvesting may take up to 50% of the production costs of biomass plantations. The quality and the storage of the produced chips were essential for the energy output, the most suitable power plant technology and the market price. The achievement of pre-defined dimensions and low moisture content in wood chips were the key parameters for the proper combustion in suitable boilers. Once the biomass has been harvested, one of the main problems is to adequately match supply and the demand of bio-energy plants through an appropriate storage strategy. To this end, several experiments were conducted aimed at identifying suitable conditions for natural storage in open air, in order to define the parameters of efficiency, economy and functionality ensuring the supply of biofuel to farms in a continuous manner and with the proper moisture content. The third pillar of the bioenergy chain concerns the logistics of biomass supply to conversion plants, a link connecting the agricultural production to the processing industry. Here, mechanization plays an important role as well, from both an economic and an environmental point of view.

In **Serbia** the existing national strategies, legislation and European directives were taken into account to develop and promote the use of biomass for energy production. The technically feasible energy potential from renewable energy sources in Serbia is estimated at over 4.3 million tons oil equivalent (toe) per year, of which 2.7 million toe are expected to be covered by biomass. The growth potential and estimated energy production of poplar plantations (max. planting density 16,667 plants/ha) have been evaluated for several clones of *Populus deltoides* and *P. x euramericana*. The estimated average energy yield for all clones in the second year (260,741 GJ/ha) was found to be significantly higher than in the first year (64,883 GJ/ha). The produced biomass varied in a wide range from about 3 t/ha to over 20 t/ha, depending primarily on the plant's age and the planting density, and only secondarily on the poplar clone. Differences in the calorific values among the tested clones were found to be relatively minor, except for the clone I-214, which has a significantly lower wood density than other clones, that affects the yield of oven-dry biomass. The highest productivity was achieved in a series of stand trials established with *P. x euramericana (*I-214) with annual rotations and a total production process of 9 years. Since the establishment, maintenance, clear-felling, transport and primary processing were simpler and cheaper as compared to biomass from other sources, it can be concluded that this form of poplar stand was the most profitable for biomass production for energy. In nine production cycles of one year, the produced biomass amounted to 485m^3/ha, or on average 53,9m^3/ha annually.

Spain indicated that the political framework stipulated by the national government and the European Union had raised high expectations and prompted an enormous interest in the utilization of poplars and willows for the production of bioenergy. However, the concerned farmers appeared to be very cautious in view of a possible land-use change, at the same time hoping, that the new power generation plants would be put in place and take a role as buyers of the produced woody biomass. The energy producing companies on their part requested that the establishment of forest plantations be subsidized, in order to be able to count on the security of supply. Currently, Spain has cultivated an estimated 3,500 ha crops designated for energy purposes, the majority of which are poplars. Willows are used only on trial basis. It is further noteworthy, that the establishment of high-density poplar plantations for the intensive production of woody biomass under the climatic conditions in Spain, requires the addition of water by way of drip-irrigation.

In **Sweden**, aspen wood was tested for future ethanol production with the result that the technology was well known and that the technical risk should be low. Steam pre-treatment prior to enzymatic hydrolysis of *Salix* wood for sugar and ethanol extraction resulted in a theoretical ethanol yield of 79 %.

6. Environmental applications

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.

a) Site protection, landscape improvement and carbon storage

Argentina indicated that, poplars are the main species for the establishment of windbreaks to protect horticulture fields and fruit orchards. In the Paraná-Delta *Salix babylonica* var. S*acramenta* is used for coastal protection because of its extensive root development. In Southern Patagonia, windbreaks had been evaluated for their impact on erosion control, sediment transport and desertification, and their significance for agricultural production. In the province of Buenos Aires, shelterbelts have been established around open-air garbage deposits, industrial parks, and along waterways and channels.

Belgium reported that, in the typically agrarian environment of Wallonia, where poplars are cultivated, the agronomic use of land competes with the expansion of rural infrastructures, leading to a rise of land values. In this context, the productive function of poplar cultivation often becomes essential for its owners. Additionally, poplar cultivation on agricultural land supports the re-colonisation of local forest species in the understory of poplar plantations because of the wide initial spacing between the plants. The landscape functions, among them the protection of hydrological resources and biodiversity, must be acknowledged by the local authorities to keep the balance between the commercial and non-commercial functions of the land.

In **Canada** hybrid poplars are being studied for their ability to protect water resources in **riparian buffer zones**, which play a vital role in healthy landscape ecology. The trees and shrubs provide soil stability, and keep potential pollutants from entering water sources. Riparian buffer areas offer a microclimatic zone, where shade and lower temperatures attract diverse wildlife, and help keep healthy algae levels in the water, things which are important to maintaining water quality levels and providing fish habitats. Hybrid poplars are uniquely qualified for the creation, restoration, and enhancement of riparian buffer zones as they are quick growing, offer rapid biomass accumulations of

nutrients from the soil, have been shown to be able to break down certain pesticides and denitrify nitrogen, and can quickly stabilize soil. When used in buffer strips poplar roots, stems and leaves are effective nutrient sinks. They are also a flood tolerant species, and are able to efficiently absorb water from the soil, offering further defences in maintaining water source nutrient levels. These characteristics of hybrid poplars qualifies them to be preferred in riparian areas adjacent to agricultural lands in order to both improve these environments and also to provide biomass for energy production as an additional revenue crop. Riparian buffer zones keep non-source pollutants specific to agricultural lands, such as pesticides, fertilizer, and manure, from travelling out of the soil and into the aquatic environment. Poplars offer the additional possibility of being used as a source of biomass for energy production because they can be harvested after 5-10 years compared to 15-20 years for lumber. This can be a mitigating factor in the potential prohibitive costs of creating riparian zones on agricultural lands. In addition these buffers have the potential to offer both water quality and carbon sequestration objectives to the agricultural industry in general.
Shelterbelts at the edge of pastures, near feedlots, and near dairy, hog and poultry facilities provide a variety of significant benefits to the farming industry and in the area of environmental protection while at the same time representing important eco-system habitats for many species. When planted as shelterbelts, trees can reduce wind velocity, greatly diminishing the effect of cold temperatures on livestock. This can significantly lower stress on animals and, consequently, reduce energy requirements for feeding. The benefits to livestock producers and ranchers include better animal health, lower feed costs, and greater financial gain. During the summer months, trees can reduce livestock stress by providing cool shade and protection from hot winds. The benefits to the landowner will last throughout the life of the shelterbelt. Crop yield increases in fields adjacent to shelterbelts have been reported in many studies. These increases occur because of reduced wind erosion of topsoil and wind damage to crops, improved microclimates and better snow (moisture) retention. Trees filter dust from tillage operations or roads, and buffer traffic or machinery noise. Shelterbelts also provide essential habitat for wildlife. Many species of birds and animals will benefit from the added protection trees provide. By planting a variety of tree and fruit-bearing shrubs, a diversity of wildlife will be attracted to the farm or ranch. By far the most important and prominent shelterbelt program in Canada is the Prairie Shelterbelt Program that is administered out of the Agroforestry Development Centre at Indian Head, Saskatchewan. The program has been on-going since 1901 and produces trees and shrubs that are provided at no cost for agroforestry plantings on agricultural land in Alberta, Saskatchewan, Manitoba and in the Peace River region of British Columbia. While a great variety of tree and shrub species is desirable in shelterbelts for environmental reasons, single tree species plantings are easier to establish and to maintain. Hybrid poplar feature prominently among the tree species utilised for shelterbelts in the Prairie Shelterbelt Program.
Given Canada's wealth of forestry resources, **forest carbon** is becoming an increasingly significant component of climate action. In the absence of a national strategy to deal with climate change, many provinces have made commitments to reduce their greenhouse gas emissions through various initiatives, including reductions through afforestation, avoided deforestation and reforestation projects. To quantify the amount of carbon that can be attributed to forestry-related activities and that would therefore be eligible to receive credits, the use of an approved quantification protocol is required. Both British Columbia *(Protocol for the Creation of Forest Carbon Offsets)* and Alberta have introduced forestry-related protocols to facilitate the creation of carbon offset credits. In addition, non-for-profit organizations are starting to recognize the need for high quality forest carbon offsets. For example, Tree Canada has developed its own offset protocol for forestry projects (*Tree Canada Afforestation, Reforestation and Urban Tree Planting Projects)*to be able to provide greater assurance to individuals and organizations of the GHG impact of its plantings.

In **Croatia** the strategy for the environmental management of protected areas pursues the objective to completely replace allochthonous (exotic) species with autochthous (indigenous) species. The replacement of Canadian poplar clones with European black poplar is expected to take ca. 50 years.

In **India** it was observed, that physical and chemical soil attributes benefit from poplar cultivation (*Populus deltoides*), if compared with soils of barren land. Soils under poplar were found to be richer in organic carbon and nutrients. The porosity and maximum water holding capacity increased, while the bulk density decreased in comparison to barren land. Likewise the morphogical features of the soil profile indicated a favourable development, which was confirmed by a positive change of the productivity index on planted soils as compared to barren soils. *Populus deltoides* clones G-48 and D-121 have been found to be useful indicator plants for an early diagnosis of stress due to air pollution or as a marker for physiological damage to trees prior to the onset of visible injury symptoms (chlorosis and senescence).

Italy had undertaken a number of river restoration projects aiming at restoring riparian habitats by converting areas dedicated to conventional crops or intensive poplar cultivation into floodplain forests, and to recover degraded areas on the upper part of the Po River basin. The main purpose of these projects was to restore floodplain forests for recreational purposes and to actively contribute to the conservation of native poplar genetic resources, black poplar in particular, by creating a network of artificial *in-situ* gene conservation units to support a dynamic evolutionary process.

In **New Zealand**, renewed interest in the role of poplars and willows for soil stabilization in pastoral hill country has followed several severe erosion and flood events during 2004–2006. Central Government, through a Hill Country Erosion Fund (HCEF), has promoted the planting of poplars and willows on pastoral hill country for erosion control, and more recently carbon storage. Ever since, production and planting of both poplar and willow poles have increased, though exact numbers are difficult to confirm. In 2010–2011 demand has exceeded supply and new nurseries are being developed to cope with farmers' demand.

Serbia reported that the northern autonomous province of Vojvodina was one of the least forested regions in Europe with a forest coverage of only 6.51% due to the regulation of the water flow along the Danube river, which resulted in a decrease of natural forest sites and a pronounced fragmentation of the existing vegetation. A scientific study was carried out to survey the phyto-cenological characteristics of the protected floodplains and to investigate options of reforestation with poplars and other suitable species.

In **Spain**, a project on the 'evaluation of poplars as an option for land use change under the Kyoto Protocol' has been carried out in the province of Castilla y Léon, within the framework of the program on 'Land Use, Land Use Change and Forestry'(LULUCF). In this project, the function of agricultural crops (barley and corn) and poplar plantations (I-214) have been compared and evaluated as carbon sinks according to the guidelines of the Intergovernmental Panel on Climate Change (IPCC). It was found among others, that the above-ground biomass and root biomass of poplar plantations and the soil organic carbon in agriculture make the highest contribution as carbon sinks. The soils of forest plantations store less carbon than agricultural farms, however, over the years this trend may be reversed in favour of forest plantations. As a final conclusion it can be stated that the planting of poplars, as an alternative to the cultivation of agricultural crops, has a clear advantage in mitigating excess atmospheric CO_{2}., but requires an implicit return on investment superior to agriculture, in order to be realized.

In **Sweden** a report on plant diversity in Swedish and German willow and poplar plantations from stand to landscape level found, that these plantations can contribute to increase habitat and species diversity in rural landscapes, but do not add new species to the landscape. An evaluation of aspen abundance showed, that changes in land use practices are the main cause of changes in abundance in Sweden during the last 50 years. Fire and retaining aspen in pre-commercial thinnings are the most important management recommendations to secure regeneration of aspen. A study on cyanolichens on aspen concluded that the biological value cannot be assessed on the basis of habitat quality alone, but has to include a landscape perspective for sustainable management of specialist species. A positive relation between habitat patch size and richness of aspen-associated species has been demonstrated. An investigation of the potential of short rotation forests as carbon sinks concluded, that almost one tenth of the annual anthropogenic emissions of carbon in Sweden could be sequestered, if 400,000 ha of arable land were planted with willow and poplar. An important topic when introducing new fast-growing species was the attitude of growers, authorities and the public towards the plantations. In the popular science book *Bioenergy – for what and how much?* published by the Swedish Research Council, complimentary values to biomass production for *Salix* cultivation were discussed.

b) Phytoremediation of polluted soil and water

Argentina reported that some commercial plantations of *Populus* sp. had been established in Mendoza, which are irrigated with waste water from domestic use. They show good results in terms of growth and health.

In **Belgium**, phytoremediation is recognized as an eco-friendly remediation method that uses plants and their associated microorganisms to deal with polluted soil and groundwater. Although phytoremediation is considered a promising technology, it still faces some obstacles: the pollutants bio-availability is often too low, increased concentrations can cause phytotoxicity and volatile organic pollutants can evaporate. These obstacles can be overcome by exploiting the potential of plant-associated bacteria. Field experiments with willow plantations were carried out to optimally combine biomass production and remediation of contaminated soils. Large differences were found in biomass production ranging from 1.5 to 12 tons dry matter per ha and year, in 8 commercial clones after four years of growth. Harvesting the woody biomass resulted in the removal of 72 g Cd and 2.0 kg Zn per ha and year. Under normal conditions short-rotation coppice crops are harvested in winter. However, as the leaves contain a high amount of metals, it was concluded that the extraction potential could be increased by 40% if they are harvested with leaves. To answer the question whether phytoremediation offers a multifunctional and sustainable alternative for conventional remediation technologies an economic decision-making model was developed. It was found that phytoremediation was more cost-effective than conventional remediation, within limited contamination ranges. Conventional remediation could not compete with willows, unless the cost of conventional remediation decrease drastically, or the potential income after remediation increases substantially. Short rotation coppice crops of willow have the physical and economic potential to sustainably remedy moderately Cd-contaminated land within a period of 40 years. The national report describes further the significant role of bacteria associated with poplars and willow in phytoremediation.

In **Canada** the use of poplar and willow trees in environmental remediation applications continues to be studied and explored in a number of research projects, which are described in detail in the national report. Further, a selected list of phytoremediation service providers is given. Although phytoremediation has been successfully tested in many locations, full-scale applications are still limited in Canada.

In **Chile** some trial plantations of poplars had been established in cooperation with copper mining companies in order to investigate the possibility of cleaning the water used in mine exploitation through phytoremediation. On an experimental scale the investigation shows promising results.

Finland reported that phytoremediation was tested so far on a research-scale only, and that there were no practical applications yet.

In **India,** poplar is being increasingly planted along effluent drain channels as a means for phyto-remediation. Using sugarcane (*Saccharum officcinarum*), guar (*Cyamopsis tetragonoloba*), wheat (*Triticum aestivum*), and poplar (*Populus deltoides*) in greenhouse and field studies, it was found that low sulfate concentrations in Punjab soils allowed the plants to accumulate high concentrations of Selen (Se).

Italy indicated that phytoremediation was considered a clean-up technology suitable for a variety of organic and inorganic pollutants. Poplars and willows were the most important woody species utilized in phytoremediation and several experiments and field applications had demonstrated the effectiveness of these trees in the country. Poplars have been found to be able to take up several heavy metals including cadmium, copper, chromium and zinc. Poplars have been reported to perform bio-accumulation of cadmium almost double as fast as willows tested in the same experiment. However, cadmium appeared mostly confined to the root system. A comparative analysis of a total of 16 poplar and willow clones for their capacity of phytoremediation, through a hydroponic screening for cadmium tolerance, accumulation and translocation, found that *Populus alba* AL35 performed as the best clone, combining a high metal-accumulating capacity and a significantly higher concentration of free and conjugated putrescine. It was found further, that the interaction between microflora and plant roots constitutes an important element in phytoremediation, which suggests the targeted use of mycorrhiza to enhance its effect on polluted soils.

Korea reports that the Forest Research Institute has an on-going research program for treating waste water from pig farms, but it has not been completed yet.

In **Serbia**, research in the past focused on heavy metal pollution in river floodplains, the influence of heavy metals on rooting, photosynthesis, and water use efficiency. After flooding on the river Danube and Tisa, the remaining sediments (sand and loamy sand) were analysed for lead (Pb), cadmium (Cd), zinc (Zn) and nickel (Ni). The phytoremediation capacity of some poplar and willow clones were evaluated through a screening for Pb, Cd, Ni and diesel fuel tolerance. The results indicated that three poplar genotypes (among them *P. deltoides*) and one willow genotype were suitable tools for phytoremediation.

Spain reported the results of a doctoral thesis submitted to the Polytechnic University of Madrid, which evaluates the significance of poplars for phytoremediation and investigates the molecular basis of the poplars' response to the presence of polychlorinated biphenyls (PCBs) and other damaging substances.

Sweden continued to work on water effects and phytoremediation by fast-growing Salicaceae stands. The Salicaceae species have been compared with other species and with different loads of nutrients, and the economy of such systems have been evaluated. It was found, that poplar and willows were suitable for phytoremediation and had soil-ecological advantages as compared to former arable soils. The potential of *Salix* for growing in heavy metal polluted areas as well as for their ability of absorbing heavy metals had previously been demonstrated. New studies showed, that the availability of nicotinamide and nicotinic acid in *Salix viminalis* increase the defense mechanisms against heavy metals. In another study the effect of potassium on Cesium (Cs) uptake was investigated but no overall effect on potassium supply could be demonstrated. *Salix viminalis* was found to enhance the degradation of polyaromatic hybrocarbons (PAH), which is explained by increased microbiological activity in the presence of willows.

IV. 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 research and workshops, and field tours. Some of them have an active website.

In **Argentina** a new Committee was formed for the organization of the conferences on Salicaceae comprising the National Poplar Commission, as well as technical and scientific personnel from government departments, professional forest associations, universities and research institutes; businessmen from the forestry and timber sector and poplar growers interested in the development of

Salicaceae in the country. In 2009 the Committee had organised the Second International Salicaceae Conference in Mendoza with 250 participants, and in 2011 the Third International Salicaceae Conference in Neuquén, Patagonia, with 400 participants. The website of the National Poplar Commission is available at http://64.76.123.202/new/0-0/forestacion/salicaceas/index.php.

The National Poplar Commission of **Belgium** is composed of two regional poplar commissions, one for Flanders and one for the Walloon Region, both of which are independent in their activities and functioning, but co-operate to represent the Belgian National Poplar Commission. The President of the National Poplar Commission is the president of one of the regional commissions, alternating in periods of 4 years. The Flemish Regional Poplar Commission and the Walloon Regional Poplar Commission have met regularly in the past 4 years to discuss future strategies and directions in poplar and willow cultivation and research. The Walloon Regional Poplar Commission is also a member of the Walloon High Council for Forests and Wood Processing (CSWFFB). Recently, a joint meeting of the Walloon and Flemish Regional Commissions was organised to exchange information on each other's objectives, achievements and working difficulties, as well as to coordinate efforts in producing the national report.

The Poplar Council of **Canada** (PCC) was established in 1978 and is an incorporated not-for-profit organization that functions as the National Poplar Commission of Canada. PCC is representing the Canadian perspective nationally and internationally in all matters dealing with growth, production and utilization of poplars and willows. PCC’s work is committed to the wise use, conservation and sustainable management of Canada's poplar resources. The PCC Secretariat is located in offices of the Canadian Forest Service in Edmonton, Alberta. The information and services provided by the PCC cover all aspects of the poplar and willow resource. The PCC undertakes studies and reviews of poplar resources, management and utilization. A newsletter is published twice a year with highlights from coast to coast, special research notes, fact sheets, a clone directory, member profiles, and general interest articles. Special publications, annual meeting proceedings, field tours, and workshops are among the activities arranged by the PCC and its members. Some of the publications are available on its website http://www.poplar.ca/. The PCC also assist in the process of research on poplar issues through contract administration, lobbying for funding, member contacts, and technological committees to evaluate projects and knowledge gaps. Although not a research agency, the PCC regularly publishes current information from research for its members. Through IPC, PCC has links with poplar and willow scientists throughout the world. Specific events that the PPC had organized or participated in are detailed in the full report.

Chile informed, that after the organisation of the 22nd Session of the IPC in 2004, together with Argentina, the activities of the National Poplar Commission had decreased due to various reasons, among them the reshaping of the poplar and willow sector for the production of biomass for energy production.

Croatia became an official member of the International Poplar Commission in 1992 after the 19th IPC-Session in Zaragoza (Spain). In 2011 the Minister for Regional Development, Forestry and Water Management appointed the members of the National Poplar Commission.

Finland reported that its National Poplar Commission had been inactive during the past four years.

In **Germany**, the National Poplar Commission is chaired by the head of Directorate-General 5 (Bio-Based Economy, Sustainable Agriculture and Forestry) at the Federal Ministry of Food, Agriculture and Consumer Protection, which also maintains the Secretariat of the National Poplar Commission.

In **India**, a meeting was conducted at the Indian Council of Forestry Research and Education (ICFRE), Dehradun, in December 2009 to discuss the draft constitution and related issues of the National Poplar Commission of India. The Executive Committee of National Poplar Commission has been constituted; it is chaired by the Director-General of ICFRE and comprises 18 members from public institutions, private companies and NGO’s.

The National Poplar Commission of **Italy** was established in 1962 and is based in the Ministry of Agriculture in Rome. Its Secretariat is traditionally hosted by the Italian State Forest Service (Corpo forestale dello Stato). The National Poplar Commission is a mixed body of public and private organisations and its composition is subject to a review every three years. The work of the NPC is presented on its website http://www.populus.it/CNP/, which is currently available only in Italian language. The main difficulty encountered by the Italian NPC was the lack of a permanent funding mechanism, resulting in a dependency on donations and voluntary or in-kind contributions from different institutions, private groups or foundations. A further risk is being cancelled altogether in the ongoing process of a simplification/reduction of government entities in Italy. Currently, the National Poplar Commission of Italy organizes one big national workshop per year for the stakeholders of the poplar sector.

The **Korean** National Poplar Commission in 2010 celebrated its 50th anniversary with a publication documenting its history. The Commission works closely with the Korea Forest Service, which jointly published a report on poplar as a suitable species for landfills, and decided to expand the mandate of the poplar commission to include *Liriodendron tulipifera,* a species that was introduced from the USA and grows as fast as poplars in Korea. The Korean Poplar Commission operates fully on donations without government support, which makes it difficult to run the Commission. Currently the Commission attempts to promote collaboration with government agencies on fast growing species, which may produce some funding.

The **New Zealand** National Poplar Commission is hosted by the New Zealand Institute for Plant & Food Research Limited, Private Bag 11600, Palmerston North 4442. While the New Zealand Poplar Commission had not met formally, technology transfer has happened through other formal and informal networks. Technical information is posted on the website www.poplarandwillow.org.nz.

The **Romanian** National Poplar Commission is integrated into the national forestry administration (ROMSILVA) and functions as a consultative body in the field of poplar and willow forestry. Its structure had changed in June 2009 and comprises now 30 members. The Commission organizes annual meetings for the commission members, scientists, researchers, poplar and willow growers and users. The major difficulties the commission is facing relate to the lack of a coherent medium to long-term strategic program and insufficient funds for equipment and hardware.

The National Poplar Commission of **Serbia** has not been formally established since the desintegration of Yugoslavia. The responsible authority for poplar and willow cultivation currently is the University of Novi Sad, Institute of Lowland Forestry and Environment.

Spain pointed out, that a structural reform of the ministerial departments at the end of 2011 also affected the composition of the National Poplar Commission. The NPC is now hosted by the Ministry of Agriculture, Nutrition and Environment and holds about 35 positions, mainly from national and regional government authorities. The Spanish National Poplar Commission met twice in Madrid during the reporting period. The major problems it is facing relate to the overall lack of statistical data on poplar cultivation and the scarcity of financial resources allocated to the Commission.

The National Poplar Commission of **Sweden** had been active during the period 2008–2011. It organised several annual meetings of the board as well as one annual meeting for the general public which offered excursions to different hosts of interest for *Salicaceae* issues. Efforts have been undertaken to obtain a more official status from the government with the result that the Swedish University of Agricultural Science was declared the official host of the National Commission in the beginning of 2012. The university now also takes on the responsibility for the international work of the commission.

The National Poplar Commission of **Turkey** located in Ankara, has conducted activities in accordance with the regulation adopted by the assembly of the Turkish government in 1964. Every year it organises 2-days meetings at locations within the poplar growing regions of Turkey. These technical meetings represent a very useful instrument for discussing the local and national issues and also serve as a useful means for encouraging improved poplar culture.

2. Relations with other countries

Argentina participated in the 2010 Executive Committee Meeting of the International Poplar Commission, and in the IUFRO International Poplar Symposium (IPS-V) both of which were held in Italy. These meetings supported networking with a number of other poplar experts from Italy, Belgium and Canada, and facilitated follow-up activities in these countries.

Belgium indicated that, since more than 50 years, national tree breeding programmes had been developed in many European countries and large collections of genotypes and networks of experimental trials have been established for most economically important tree species. In addition, original methodologies have been developed to test, evaluate, select and mass-produce forest tree species, which represents an unique infrastructure. However, reductions in manpower and funds resulted in a short-fall of the critical mass and in a decline in maintenance and/or follow-up of experiments. Moreover, sub-optimal collaboration between research teams inevitably lead to redundancies in research work and to the doubling of efforts. Belgium participated in TREEBREEDEX, a coordination action within the EU 6th Framework Programme comprising 28 partners from 19 countries. The programme Interreg IV Transpop 2 "Dynamisation of the trans-border Poplar wood chain" (*Dynamisation de la filière populicole transfrontalière*) focused on the development of the poplar wood chain, from the nursery (upstream) to the poplar wood industry (downstream).

Croatia cooperated internationally through the Seventh Framework Programme for Research and Development (FP7) funded by the European Commission, in the projects BEE (Biomass Energy Europe), and BENWOOD (Short Rotation Forestry as a sustainable and eco-efficient land use management system for fossil fuels substitution within CDM-projects). Further cooperation was established with Bioversity International (EUFORGEN), Italy; the Forestry Research Institute, Hungary; CRA-ISP, Italy; INRA (Institut National de la Recherche Agronomique) and Centre de Recherches d'Avignon, France; the Research Institute for Nature and Forest (INBO), Belgium; BFW, Austria, the University of Freiburg, Germany; the Institute for Forest Genetics and Forest Tree Breeding, Germany; and ALTERRA Green World Research, the Netherlands.

Egypt hopes to strengthen cooperation with Turkey, France, Spain and Italy in order to have Egyptian staff professionally trained in poplar and willow institutes on tree breeding, economics and wood utilization.

Finland informed that some exchange of hybrid aspen had been arranged with Sweden for research purposes.

Germany reported, that the University of Minnesota (USA) made available a collection of 58 clones of *P. deltoides* crossbreeds to the Institute of Forest Genetics of the von Thünen Institute in Germany and Poland. For phytosanitary reasons, the clones were transferred as tissue cultures in order to avoid the unintended introduction of harmful organisms. A total of six progenies of *P.tremula x P.tremuloides* crossbreeds were provided for field tests in Riga (Latvia) and Tartu (Estonia).

In **Italy,** the exchange of germplasm has been arranged with Austria, Belgium, France, Georgia, Germany, Poland, Serbia, Spain, and the USA in the period 2008-2011. The National Poplar Commission has increased its policy and strategic cooperation with other countries and international organisations at a number of events organized by the International Poplar Commission, FAO and IUFRO.

New Zealand indicated that there had been no exchange of material with breeding programmes in other countries. Regular correspondence had occurred with colleagues in Argentina, China, the Netherlands, Spain and the USA,. These relationships have been brought about by the involvement with the International Poplar Commission. New Zealand was represented at the 23rd IPC-Session 2008 in Beijing, China, and at the 44th Executive Committee Meeting and IUFRO-IPS-V, both of which were held in Orvieto in 2010.

Romania reported that its participation in the last IPC session in 2008 in China had offered opportunities of establishing new professional networks with poplar specialists from around the world. Following this conference, a lot of scientific material had been introduced in Romania, e.g. valuable information on short-coppice poplar and willow cultivation provided by Italian and Dutch colleagues. In 2008, Romania organized a workshop with the main objective of establishing a common database for short-rotation coppice for biomass production. Researchers from Austria, Belgium, Bulgaria, Croatia, Greece, Italia, Romania, Serbia, and Slovenia participated, which gave Romanian poplar specialists the chance to exchange experience with other poplar experts.

In **Serbia,** the Institute of Lowland Forestry coordinated the FP7-EU project entitled "STREPOW - Strengthening of research capacity for poplar and willow multipurpose plantation growing in Serbia". The objective of the STREPOW project was to strengthen the capacities of researchers to successfully participate in research activities at EU level, and to improve the research infrastructure of the Institute of Lowland Forestry and Environment, so that it could become the Center of Excellence in the region of Western Balkan Countries for growing of multipurpose poplar and willow plantations, aiming at the production of biomass for energy and the phytoremediation of contaminated sites. Further, a bilateral cooperation project between Serbia and Hungary had been realized for the exchange of poplar material and selection of clones adapted to climate change. Another bilateral cooperation agreement was concluded between Serbia and the national cultivar testing association of the Republic of Belarus for testing of poplar and willow material in Belarus. In 2011, the Institute of Lowland Forestry successfully applied for the EU-IPA cross border program in cooperation with the Biological Research Centre of the Hungarian Academy of Sciences.

Spain cooperated with Italy and the Czech Republic in evaluating greenhouse gas emissions from short-rotation poplar plantations in Europe. Further, some clones were exchanged with Italy, France and Belgium, in order to complete the evaluation of Italian base materials in the country.

In **Sweden,** new clone tests for hybrid aspen and poplar, established during 2010 and 2011, include material from other countries, i.e. Belgium, Finland, Germany, Italy, and Latvia, as a result of an organized exchange of planting material with these countries. With economic support from Nordic Energy Research, Sweden will also collaborate with Denmark, Finland and Norway on bioenergy supply, including management systems with hybrid aspen and poplar.

3. Certification of poplar plantations

Italy stated that the Poplar Research Institute in Casale Monferrato (CRA-PLF) in cooperation with a large stakeholder group had developed technical guidelines for the sustainable management of poplar plantations. These guidelines facilitated the application of two forest certification schemes for poplar cultivation: the FSC (www.fsc.org) scheme and the PEFC (www.pefc.org) scheme, both of which are based on internationally-recognized standards. The certification systems use an evaluation approach that takes place at the level of single companies or at the level of a group of private smallholders. Since 2007, about 4.600 ha of poplar plantations have been certified in northern Italy on about 150 farms, 95% of which belong to group certification schemes. The PEFC scheme was applied in 85 % of the cases, while FSC was applied in the remaining 15 %. In total however, less than 10 % of Italian poplar plantations are certified, whereas the demand for certified wood in the plywood industry reaches 15 % of the total poplar wood consumption in this industry.

4. Literature

Since the last session in 2008, 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/13E) on these publications by country has been prepared and will be available on the IPC website. **Belgium also** noted that a video and a leaflet had been produced to emphasize the environmental benefits of poplar plantations.

V. STATISTICS

Statistics related to poplar and willow cultivation and management are detailed in tables provided in Annex 1 (summary tables by country) and Annex 2 (country tables). These were drawn from the most current information provided by IPC member countries in their country progress reports. For those countries which were not able to produce an update or others that provided only partial data, data collected for the 2008 Synthesis Report were used to extract reasonable trends or to estimate world totals. The following tables are available:

Annex 1 **Summary tables by country**	**Annex 2** **Country tables**
1. Total area of poplars and willows 2. Total poplar area 3. Total willow area 4. Indigenous poplar area 5. Planted poplar area 6. Indigenous willow area 7. Planted willow area 8. Agroforestry area of poplars and willows 9. Area afforested and reforested with poplars and willows from 2008 to 2011 10. Poplar wood removals 11. Willow wood removals 12. Forest products from poplars 13. Forest products from willows	1. Argentina 2. Belgium 3. Canada 4. China 5. Croatia 6. Germany 7. India 8. Iran 9. Italy 10. Korea (Republic of) 11. New Zealand 12. Romania 13. Russian Federation 14. Serbia 15. Spain 16. Sweden 17. Turkey

1. Areas

The overall area of poplars and willows reported by 24 countries[2] is estimated at 95 million ha (94,987,686 ha). In 2004, 21 countries reported an area of 76.6 million ha and in 2008, 19 countries reported an area of 79.1 million ha.

The vast majority of the total (82.5 million ha = 86.8%) consists of **indigenous** poplar and willow formations, of which indigenous poplars take 75.6 million ha, indigenous willow stands cover 6.8 million ha and 46,319 ha represent mixed indigenous poplar and willow formations. **Planted** poplars and willows cover in total 9.2 million ha, of which 8.6 million ha (93.5%) are planted poplars and 572,282 ha are planted willows. Mixed plantations of poplars and willows cover 1,818 ha. Poplars in **agroforestry** systems or as trees outside forests cover 3.2 million ha. Fewer agroforestry projects or trees outside forests were reported with willow (37,324 ha) or a mix of poplars and willows (225,053 ha).

Indigenous poplar forests cover significant areas in Canada (30.3 million ha), the Russian Federation (24.8 million ha), the United States of America (17.7 million ha[3]) and China (2.5 million ha). In Canada and the Russian Federation the area of indigenous poplar forests appears to have increased as compared to the 2008 report. Natural willow forests are mainly found in the Russian Federation (6.6 million ha), India (108,000 ha), and France (66,600 ha[3]). Mixed stands of indigenous poplars and willows are reported mostly in Spain (30,300 ha).

[2] out of which 5 countries were added from the 2008 report
[3] figure reported in 2008

The major country for **poplar plantations** is China with an area of 7.6 million ha, which represents a remarkable increase since 2004. In 2004 China reported a planted poplar area of 3.9 million ha and in 2008 an area of 4.3 million ha. Other major countries for poplar plantations are France (236,000 ha[3]), Iran (150,000 ha), Turkey (125,000 ha), Spain (105,000 ha), and Italy (101,430 ha). China is also the country that reports the largest area for **willow plantations** at 437,600 ha, which represents a remarkable increase from the 43,200 ha reported in 2008 and the 79,000 ha reported in 2004. The other countries with major areas of willow plantations are Argentina (56,400 ha, increase from 39,000 ha in 2008), Italy (20,000 ha), Romania (19,505 ha) Sweden (11,100 ha) and Iran (10,000 ha). China as well accounts for the largest area of poplars and willows used in **agroforestry systems** and trees outside forests (2.8 million ha).

The total area that was afforested or reforested with poplars and willows from 2008 to 2011, as reported by 12 countries, adds up to 419,227 ha, of which 80% (334,857 ha) were planted with poplars and 20% with a mix of poplars and willows (64,556 ha) or willows only (19,814 ha ; see Annex 1, table 9). India reported the largest forestation area with 275,300 ha, of which 255,000 ha (93%) were planted with poplars in agroforestry. The second largest forestation area of 62,400 ha was reported by New Zealand, where a mix of poplars and willows was planted in agroforestry production systems, too. Italy, Iran, Serbia, Romania and Spain report remarkable forestation areas for poplar plantations ranging from 8, 000 ha to 20,000 ha.

2. Uses

Though not all poplar and willow areas could be assigned by the countries to a particular use, wood production (industrial roundwood, fuelwood, biomass) remains the main purpose for poplar and willow cultivation, with 23.0 million ha reported globally, of which 18.9 million ha are destined for the production of industrial roundwood and 4.1 million ha for fuelwood and biomass. Poplar wood, in particular from highly productive poplar plantations, is used for veneer/plywood, pulpwood, sawntimber, fuelwood/biomass and industrial roundwood. Other minor uses are poles, chips for OSB, baskets, matches, furniture and cricket bats. The wood from willow clones is mainly used for fuelwood/biomass and pulpwood.

Some 22 million ha of poplars and willows, almost the same area as for productive purposes, are reported as being used for various protective systems, of which the majority (80%) consists of indigenous poplars.

3. Growth performance and rotation age

In planted poplar forests, including highly productive poplar clones, growth rates are reported to range from 2.75 to 41 m^3/ha/yr mean annual increment, on average 17 m^3/ha/yr. Rotation periods are rather short and span in most cases 10 to 20 years for the production of industrial roundwood, and 2 to 30 years, on average 20 years, for the production of fuelwood and biomass.

Belgium reports from the Flemish region that the age of the poplar plantations is unequally distributed and may jeopardize the future supply of poplar wood as younger plantations are clearly underrepresented. Older poplar plantations had been rapidly exploited in the past, decreasing significantly the supply from Belgian poplar plantations.

4. Ownership

Indigenous poplar and willow forests cover large areas of public lands in many countries, as represented by Canada, China, India, Iran, Germany, Romania, the Russian Federation, Serbia and Turkey. They are largely used for protection purposes. In some countries indigenous poplar forests are owned by private corporations and smallholders as estimated for Belgium (80%) and Sweden (70%), Croatia (63%), Spain (50%) respectively.

Planted poplar and willow forests on the other hand are primarily owned by the private sector and are largely used for production purposes. Private corporations in Turkey and Argentina own 98% and 50% of the planted poplar forests respectively, while private smallholders hold a considerable proportion in Argentina (50%), Belgium (95%), Germany (100%), Italy (70%) and Iran (100%). In Canada planted poplar resources are fairly equally distributed among the public sector, private corporations and private smallholders.

Agroforestry production systems with poplars in India, Iran, Germany and Romania are owned to 100% by private smallholders, and in New Zealand to 75%. In the Russian Federation and Serbia this land-use form is only practiced on public lands (100%).

The ownership pattern found with poplars also applies by and large for **indigenous willows, planted willows and willows in agroforestry production systems** with few exceptions. In Belgium, e.g. all indigenous willow forests (100%) are owned by private smallholders. Planted willows in Croatia, India and Romania are primarily owned by public entities.

5. Wood removals

The removals of poplar wood reported by 13 countries (without China) add up to 20.3 million m^3, of which 17.4 million m^3 (85.7%) are estimated to come from planted forests and the balance of 2.9 million m^3 from indigenous forests. The top producers of poplar wood with reported removals of more than 1 million m^3 are India (5,100,000 m^3), Iran (3,750,100 m^3), Turkey (3,500,000 m^3), Belgium (3,200,000 m^3), Canada (2,844,255 m^3), and Argentina (1,670,000 m^3). The vast majority of the poplar wood is used for industrial roundwood (18.6 million m^3), while removals for use as fuelwood and biomass amount to 873,000 m^3 only. The major producers of fuelwood and biomass are Italy with 326,200 m^3 followed by India with 300,000 m^3.

China did not report on poplar wood removals, however it reported the consumption of 50 million m^3 of logs to produce plywood and wood pulp. Assuming that exports and imports of poplar roundwood are negligible, as all roundwood is processed locally into forest products, it is estimated that poplar wood removals in China exceed 50 million m^3, as wood consumption to produce particleboard and fibreboard was not reported.

Removals from willow forests are comparatively small. The removals from six reporting countries add up to 613,466 m^3, of which 559,313 m^3 (91%) are estimated to come from planted forests and the balance of 54,153 m^3 from indigenous forests. The major producers of willow wood are Argentina (410,000 m^3) followed by Romania with 105,704 m^3.

6. Forest products

Fifteen countries reported on the main products derived from poplars, and nine countries on willows. The total volume of forest products from poplars, measured in roundwood equivalents, was estimated at 70.4 million m^3 (r), the major producers being China with 50 million m^3 (r), followed by India (5.3 million m^3 (r)), Canada (4.6 million m^3 (r)), Turkey (3.5 million m^3 (r)) and Argentina (1.6 million m^3 (r)). Plywood and veneer still represent the largest portion of poplar products with 44 million m^3 (r) (62,7 % of the total production). The remaining products are wood pulp (16.6 million m^3 (r) or 23.6%), industrial roundwood (3.4 million m^3 (r) or 4.8%), and reconstituted wood panels (2.2 million m^3 (r) or 3.1%). Fuelwood and chips for energy still represent a small portion of 1.7 million m^3 (r) or 2.4%, which represents a slight increase from 0.9% reported in 2008.

The total volume of forest products from willows, measured in roundwood equivalents, was estimated at 763, 000 m^3 (r), the major producers being Argentina with 407,000 m^3 (r), and Iran with 120,000 m^3 (r).

7. Imports and exports

In general, the reporting countries found it difficult to source, retrieve or estimate quantitative data on international trade with poplars and willows in the absence of reliable and accurate trade statistics at the genus or species level. Thus, only an incomplete and fragmentary picture can be reported on imports and exports of poplar and willow products.

Italy, Belgium, Spain and Serbia are major importers of poplar wood products originating mainly from France and Hungary. Italy is the main importer of poplar roundwood (335,000 m^3) followed by Belgium (224,000 m^3). Similar figures had been reported in the 2008 report, though imports to Italy from France appear to have declined by ca. 120,000 m^3. Italy imports as well 193,000 m^3 (r) of sawntimber from Hungary. China imports considerable amounts of chopsticks made of poplar wood from the Republic of Korea (57,000 m^3 (r)).

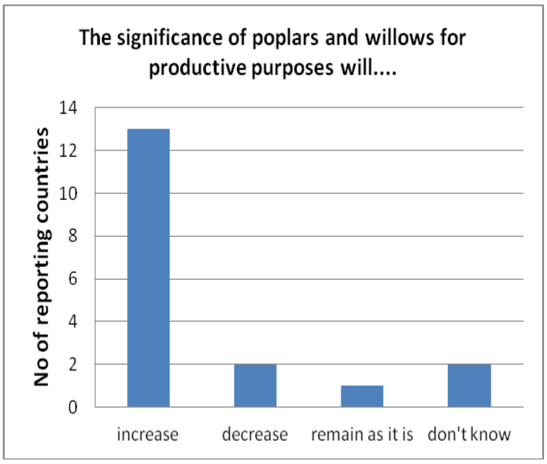
China, Belgium, Romania, Spain and Serbia[4] are major exporters of poplar wood. China exports 5.3 million m^3 (r) of plywood to the USA, Japan and the United Kingdom. Belgium exports 44,000 m^3 industrial roundwood to China, Morocco, France and Italy. It appears that Belgium's export volume of roundwood has considerably declined since 2008 from 209,000 m^3. Romania exports 43,000 m^3 (r) of particle and fibre boards to other EU countries and the Middle East. Romania in 2008 reported an export of 44,429 m^3 poplar roundwood, which ever since appears to have been processed locally into forest products. Iran exports ca. 6,000 m^3 (r) of sawntimber to Iraq and Turkey.

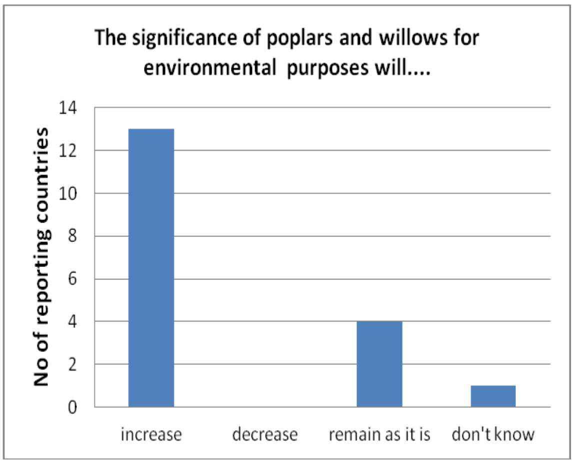
8. Trends and opinions

The IPC member countries had been requested to assess possible trends until 2020 in the development of poplars and willows in their respective countries. In total, 17 member countries and 1 non-member had reported for this assessment. Their opinions are presented in the following column diagrams for each of the 10 questions asked.

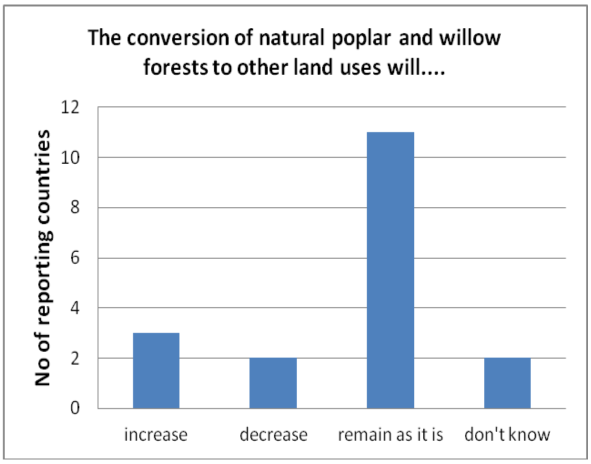
a) Future significance of poplars and willows

Most countries (13 out of 18) opine that the significance of poplars and willows for productive and environmental purposes will increase in the future. None of the reporting countries thinks, that the significance for environmental purposes could decrease. The conversion of natural poplar and willow forests to other land uses is assessed to remain as it is by most countries (11 out of 18), as most natural poplar and willow forests are guarded by some kind of formal regime of environmental protection.



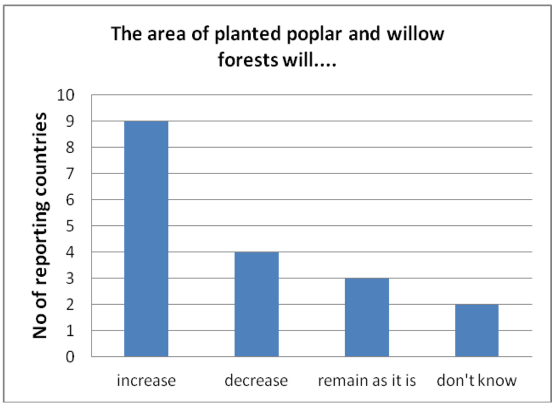


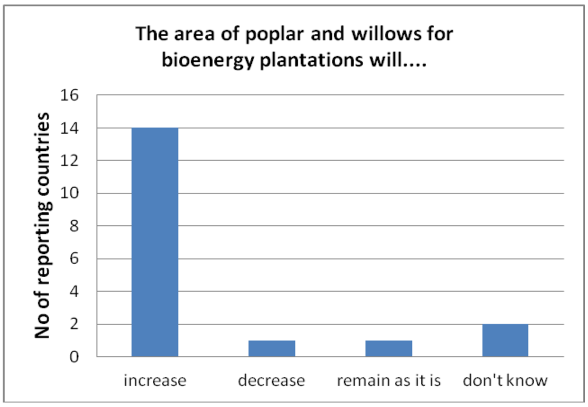
[4] No data are available from France and Hungary.



b) Area development

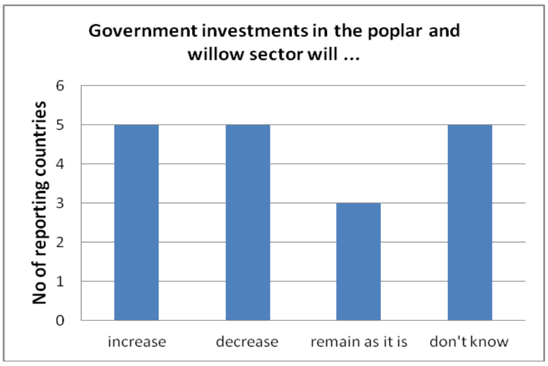
Most reporting countries concur that the area of planted poplar and willow forests will increase probably due to the afforestation of abandoned agricultural land. Possible decreases are reported only from Belgium (Walloon and Flanders), Romania and Turkey. The trend of increasing poplar and willow areas is even more pronounced with regards to the establishment of bioenergy plantations. Fourteen out of eighteen countries estimate that the area of bioenergy plantations will increase, though the markets and infrastructure for the use of biomass appears not to be fully developed yet in some countries.

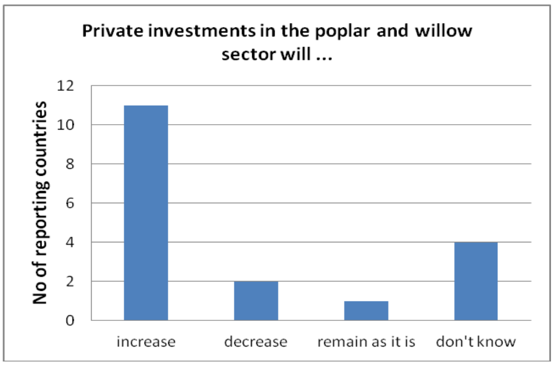


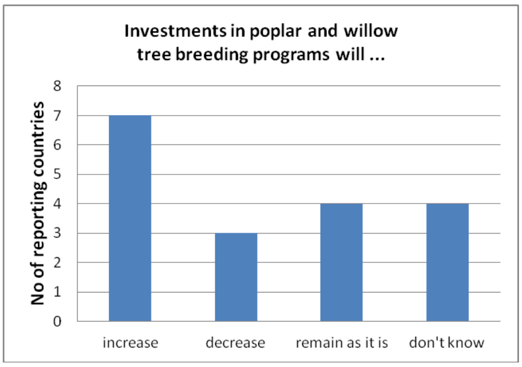


c) Future investments

The opinion of the reporting countries on government investments in the poplar and willow sector appear not to show a clear trend, though investments in tree breeding programmes are assessed by some countries to increase. However, a clear trend appears to be developing for private investments in the poplar and willow sector, which are anticipated to increase due to the growing interest in afforestation of agricutural lands and biomass production, especially in Canada, China, India, Iran, New Zealand, the Russian Federation, and many European countries (in total 13 out of 18).

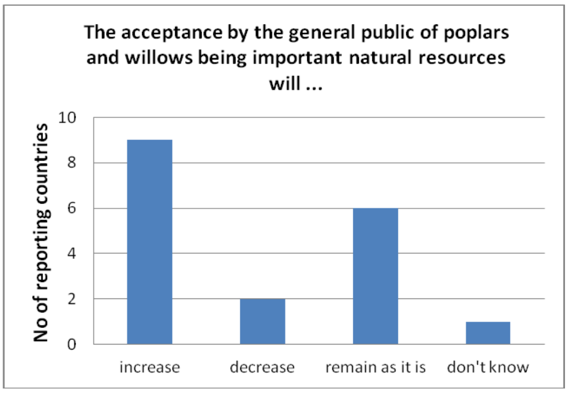


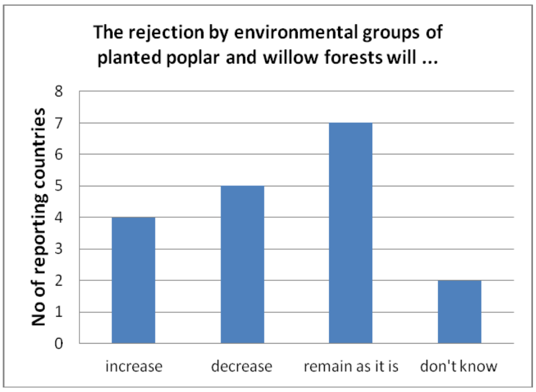




d) Public awareness on poplars and willows

The acceptance by the general public of poplars and willows being important natural resources is assessed predominantly positive, 9 countries opine that the acceptance will increase and 6 countries think that it will remain as it is. Only 2 countries predict that public acceptance will decrease. Accordingly, the rejection by environmental groups of planted poplar and willow forests is assessed to decrease (5 countries) or to remain as it is (7 countries) due to the increasing scope for environmental applications of poplars and willows in phytoremediation and agroforestry production sytems. Only 4 European countries believe that the opposition of environmental groups towards planted poplar and willow forests will increase.





ANNEX 1: SUMMARY TABLES BY COUNTRY 2011

1. Total Area of Poplars and Willows by Country 2011

Country	Total poplars and willows ha	Total Poplars ha	Total Willows ha	Mixed cultivation of poplars and willows ha
Africa				
Egypt	7,000	7,000		
Morocco*	*7,500*	*7,500*		
Asia				
China	13,337,600	12,900,000	437,600	
India	505,000	362,700	137,300	5,000
Iran	210,000	185,000	25,000	
Korea	1,749	1,749		
Turkey	132,963	132,963		
Europe				
Belgium	40,770	34,990	5,780	
Bulgaria*	*25,000*	*20,100*	*2,700*	*2,200*
Croatia	47,402	30,364	16,858	180
Finland				
France*	*342,400*	*275,800*	*66,600*	
Germany	15,500	13,250	2,000	250
Italy	179,653	143,655	35,998	
Romania	118,423	73,240	35,046	10,137
Serbia	48,808	34,402	14,406	
Spain	157,323	119,600	5,300	32,423
Sweden	60,475	49,375	11,100	
Switzerland	7,720	7,720		
United Kingdom*	*3,300*	*1,300*	*2,000*	
Russian Federation	31,325,000	24,757,000	6,568,000	
America & Oceania				
Argentina	117,400	61,000	56,400	
Canada	30,367,400	30,360,400	7,000	
Chile	8,000	5,000	3,000	
New Zealand	223,000			223,000
USA*	*17,698,300*	*17,698,000*	*300*	
Grand Total	**94,987,686**	**87,282,108**	**7,432,388**	**273,190**

Notes:

- * figures added from 2008 report as countries did not report for 2011

2. Total Poplar Area by Country 2011

Country	Total	Total poplar area by function			
	ha	Industr. roundw. ha	Fuelwood Biomass ha	Environm. Protection ha	Other ha
Africa					
Egypt	7,000				
Morocco*	*7,500*				
Asia					
China	12,900,000	5,382,000	897,000	5,976,000	645,000
India	362,700	334,430	9,435	18,835	
Iran	185,000	139,500	21,500	24,000	
Korea	1,749			1,399	350
Turkey	132,963	79,778		39,889	13,296
Europe					
Belgium	34,990	32,930		2,060	
Bulgaria*	*20,100*				
Croatia	30,364	27,682		2,682	
Finland					
France*	*275,800*				
Germany	13,250	10,000	3,000	250	
Italy	143,655	65,930	6,086	29,415	42,225[1)]
Romania	73,240	20,416	2,640	49,729	455
Serbia	34,402	31,475		2,927	
Spain	119,600	96,600	3,150	13,350	6,500[2)]
Sweden	49,375	47,375	2,000		
Switzerland	7,720				
United Kingdom*	*1,300*				
Russian Federation	24,757,000				
America & Oceania					
Argentina	61,000	50,750		10,250	
Canada	30,360,400	12,138,290	3,049,466	15,152,453	20,193[2)]
Chile	5,000				
New Zealand					
USA*	*17,698,000*				
Grand Total	**87,282,108**	**18,457,155**	**3,994,276**	**21,323,238**	**728,019**

Notes:

- * figures added from 2008 report as countries did not report for 2011
- [1)] indigenous poplar forests with no function assigned
- [2)] agroforestry area with no function assigned
- Total by functions does not tally with Grand Total as some countries could not assign functions

3. Total Willow Area by Country 2011

Country	Total	Total willow area by function			
	ha	Industr. roundw. ha	Fuelwood Biomass ha	Environm. Protection ha	Other ha
Africa					
Egypt					
Morocco*					
Asia					
China	437,600	328,200	43,760	52,512	13,128
India	137,300	23,375	54,920	24,680	34,325
Iran	25,000	7,000	10,500	7,500	
Korea					
Turkey					
Europe					
Belgium	5,780		20	5,760	
Bulgaria*	*2,700*				
Croatia	16,858	13,492		3,366	
Finland					
France*	*66,600*				
Germany	2,000		2,000		
Italy	35,998			20,000	15,998[1)]
Romania	35,046	3,787	1,614	29,462	183
Serbia	14,406	5,276		9,130	
Spain	5,300			4,600	700[2)]
Sweden	11,100		11,100		
Switzerland					
United Kingdom*	*2,000*				
Russian Fed.	6,568,000				
America & Oceania					
Argentina	56,400	39,480			16,920
Canada	7,000				
Chile	3,000				
New Zealand					
USA*	*300*				
Grand Total	**7,432,388**	**420,610**	**123,914**	**157,010**	**64,556**

Notes:

- * figures added from 2008 report as countries did not report for 2011
- 1) indigenous willow forests with no function assigned
- 2) planted willow forests with no function assigned
- Total by functions does not tally with Grand Total as some countries could not assign functions

4. Indigenous Poplar Area by Country 2011

Country	Total	Indigenous poplar area by function			
	ha	Industr. roundw. ha	Fuelwood Biomass ha	Environm. Protection ha	Other ha
Africa					
Egypt					
Morocco*	*2,500*				
Asia					
China	2,530,000			2,403,500	126,500
India	47,000	18,800	9,400	18,800	
Iran	30,000		6,000	24,000	
Korea	1,749			1,399	350
Turkey	7,963	4,778		2,389	796
Europe					
Belgium	2,060			2,060	
Bulgaria*	*1,000*				
Croatia	17,308	15,318		1,990	
Finland					
France*	*39,800*				
Germany	250			250	
Italy	42,225				
Romania	24,595	8,239	2,017	14,290	49
Serbia	1,194			1,194	
Spain	8,100			8,100	
Sweden					
Switzerland	2,316				
United Kingdom*					
Russian Fed.	24,757,000				
America & Oceania					
Argentina					
Canada	30,296,079	12,118,432	3,029,608	15,148,040	
Chile					
New Zealand					
USA*	*17,653,000*				
Grand Total	**75,464,139**	**12,165,566**	**3,047,025**	**17,626,012**	**127,695**

Notes:

- * figures added from 2008 report as countries did not report for 2011
- Total by functions does not tally with Grand Total as some countries could not assign functions

5. Planted Poplar Area by Country 2011

Country	Total	Planted poplar area by function			
	ha	Industr. roundw. ha	Fuelwood Biomass ha	Environm. Protection ha	Other ha
Africa					
Egypt	7,000				
Morocco*	*4,300*				
Asia					
China	7,570,000	4,542,000	757,000	1,892,500	378,500
India	700	630	35	35	
Iran	150,000	135,000	15,000		
Korea					
Turkey	125,000	75,000		37,500	12,500
Europe					
Belgium	32,930	32,930			
Bulgaria*	*18,900*				
Croatia	13,056	12,364		692	
Finland					
France*	*236,000*				
Germany	10,000	10,000			
Italy	101,430	65,930	6,086	29,415	
Romania	47,942	12,033	623	35,189	97
Serbia	33,132	31,475.4		1,657	
Spain	105,000	96,600	3,150	5,250	
Sweden	49,375	47,375	2,000		
Switzerland	5,404				
United Kingdom*	*1,300*				
Russian Fed.					
America & Oceania					
Argentina	40,500	40,500			
Canada	44,128	19,857.6	19,857.6	4,412.8	
Chile	5,000				
New Zealand					
USA*	*45,000*				
Grand Total	**8,646,097**	**5,121,695**	**803,752**	**2,006,650**	**391,096**

Notes:

- * figures added from 2008 report as countries did not report for 2011
- Total by functions does not tally with Grand Total as some countries could not assign functions

6. Indigenous Willow Area by Country 2011

Country	Total	Indigenous willow area by function			
		Industr. roundw.	**Fuelwood Biomass**	**Environm. Protection**	**Other**
	ha	**ha**	**ha**	**ha**	**ha**
Africa					
Egypt					
Morocco*					
Asia					
China					
India	108,000	16,200	43,200	21,600	27,000
Iran	15,000		7,500	7,500	
Korea					
Turkey					
Europe					
Belgium	5,760			5,760	
Bulgaria*	*2,600*				
Croatia	13,243	10,224		3,019	
Finland					
France*	*66,600*				
Germany					
Italy	15,998				
Romania	15,517	2,281	853	12,259	124
Serbia	7,464			7,464	
Spain	4,600			4,600	
Sweden					
Switzerland					
United Kingdom*					
Russian Fed.	6,568,000				
America & Oceania					
Argentina					
Canada					
Chile					
New Zealand					
USA*					
Grand Total	**6,822,782**	**28,705**	**51,553**	**62,202**	**27,124**

Notes:

- * figures added from 2008 report as countries did not report for 2011
- Total by functions does not tally with Grand Total as some countries could not assign functions

7. Planted Willow Area by Country 2011

Country	Total	Planted willow area by function			
		Industr. roundw.	**Fuelwood Biomass**	**Environm. Protection**	**Other**
	ha	**ha**	**ha**	**ha**	**ha**
Africa					
Egypt					
Morocco*					
Asia					
China	437,600	328,200	43,760	52,512	13,128
India	1,000	100	400	250	250
Iran	10,000	7,000	3,000		
Korea					
Turkey					
Europe					
Belgium	20		20		
Bulgaria*	*100*				
Croatia	3,615	3,267.96		347.04	
Finland					
France*					
Germany					
Italy	20,000			20,000	
Romania	19,505	1,482	761	17,203	59
Serbia	6,942	5,276		1,666	
Spain	700				
Sweden	11,100		11,100		
Switzerland					
United Kingdom*	*2,000*				
Russian Fed.					
America & Oceania					
Argentina	56,400	39,480			16,920
Canada					
Chile	3,000				
New Zealand					
USA*	*300*				
Grand Total	**572,282**	**384,806**	**59,041**	**91,979**	**30,357**

Notes:

- * figures added from 2008 report as countries did not report for 2011
- Total by functions does not tally with Grand Total as some countries could not assign functions

8. Agroforestry Area of Poplars and Willows by Country 2011

Country	Total	Agroforestry area by function			
	ha	Industr. roundw. ha	Fuelwood Biomass ha	Environm. Protection ha	Other ha
Africa					
Egypt					
Morocco*	*700*				
Asia					
China	2,800,000	840,000	140,000	1,680,000	140,000
India	343,300	322,075	11,320	2,830	7,075
Iran	5,000	4,500	500		
Korea					
Turkey					
Europe					
Belgium					
Bulgaria*	*200*				
Croatia					
Finland					
France*					
Germany	5,000		5,000		
Italy					
Romania	780	219		250	311
Serbia	76			76	
Spain	8,500				
Sweden					
Switzerland					
United Kingdom*					
Russian Fed.					
America & Oceania					
Argentina	20,500	10,250		10,250	
Canada	27,193				
Chile					
New Zealand	223,000		2,230	220,770	
USA*					
Grand Total	**3,434,249**	**1,177,044**	**159,050**	**1,914,176**	**147,386**

Notes:

- * figures added from 2008 report as countries did not report for 2011
- Total by functions does not tally with Grand Total as some countries could not assign functions

9. Area afforested and reforested with poplars and willows from 2008 to 2011

Country	With Poplars ha	With Willows ha	With a mix of poplars and willows ha	Total ha
Africa				
Egypt	1,200			1,200
Morocco*				
Asia				
China				
India	259,500	13,800	2,000	275,300
Iran	16,500	1,000		17,500
Korea				
Turkey				
Europe				
Belgium	2			2
Bulgaria*				
Croatia	1,280	3		1,283
Finland				
France*				
Germany	2,350	1,200		3,550
Italy	20,000			20,000
Romania	8,110	1,811	33	9,954
Serbia	16,415			16,415
Spain	8,000		123	8,123
Sweden	1,500	2,000		3,500
Switzerland				
United Kingdom*				
Russian Fed.				
America & Oceania				
Argentina				
Canada				
Chile				
New Zealand			62,400	62,400
USA*				
Grand Total	**334,857**	**19,814**	**64,556**	**419,227**

10. Poplar Wood Removals by Country 2011

Country	Type of forest	Total removals m3	Removals by type		
			Industr. roundw. m3	Fuelwood Biomass m3	From env. prot. areas m3
Asia					
China	Indigenous				
	Planted				
India	Indigenous				
	Planted	5,100,000	4,800,000	300,000	
Iran	Indigenous	50,100		50,100	
	Planted	3,700,000	3,700,000		
Korea	Indigenous				
	Planted				
Turkey	Indigenous				
	Planted	3,500,000	3,500,000		
Europe					
Belgium	Indigenous				
	Planted	3,200,000	3,200,000		
Croatia	Indigenous	7,155	6,076	1,079	
	Planted	119,500	112,819	6,681	
Finland	Indigenous				
	Planted				
Germany	Indigenous				
	Planted	76,000	3,000	73,000	
Italy	Indigenous				
	Planted	983,000	656,800	326,200	
Romania	Indigenous	102,152	29,262	12,557	60,333
	Planted	423,887	60,564	8,529	354,794
Serbia	Indigenous				
	Planted	397,850	362,791	35,059	
Spain	Indigenous				
	Planted	587,000	587,000		
Sweden	Indigenous				
	Planted	460,000	400,000	60,000	
Switzerland	Indigenous				
	Planted				
Russian Fed.	Indigenous				
	Planted				
America & Oceania					
Argentina	Indigenous				
	Planted	1,670,000	1,210,000		460,000
Canada	Indigenous	2,801,205	2,801,205		
	Planted	43,050	43,050		
Chile	Indigenous				
	Planted				
New Zealand	Indigenous				
	Planted				
Total	Indigenous	**2,960,612**	**2,836,543**	**63,736**	**60,333**
	Planted	**17,380,287**	**15,756,024**	**809,469**	**814,794**
Grand Total		**20,340,899**	**18,592,567**	**873,205**	**875,127**

11. Willow Wood Removals by Country 2011

Country	Type of forest	Total removals m3	Removals by type		
			Industr. roundw. m3	Fuelwood Biomass m3	Environm. Protection m3
Europe					
Belgium	Indigenous				
	Planted				
Croatia	Indigenous	20,771	15,796	4,975	
	Planted	6,162	5,565	597	
Finland	Indigenous				
	Planted				
Germany	Indigenous				
	Planted	48,000		48,000	
Italy	Indigenous				
	Planted				
Romania	Indigenous	31,102	3,937	2,431	24,734
	Planted	74,602	20,777	4,848	48,977
Serbia	Indigenous				
	Planted	20,549	12,258	8,291	
Spain	Indigenous				
	Planted				
Sweden	Indigenous				
	Planted				
Switzerland	Indigenous				
	Planted				
Russian Fed.	Indigenous				
	Planted				
America & Oceania					
Argentina	Indigenous				
	Planted	410,000	410,000		
Canada	Indigenous	2,280		2,280	
	Planted				
Chile	Indigenous				
	Planted				
New Zealand	Indigenous				
	Planted				
Total	Indigenous	**54,153**	**19,733**	**9,686**	**24,734**
	Planted	**559,313**	**448,600**	**61,736**	**48,977**
Grand Total		**613,466**	**468,333**	**71,422**	**73,711**

12. Forest Products from Poplars by Country 2011

Country	Fuelwood chips	Indust. roundw. (logs, pulpw.)	Wood-pulp (mech. or chem.)	Particle/ Fibreb. (MDF, (hardb.)	Veneer sheets	Plywood	Sawn-timber	Total
	1000 m^3 (r)							
Africa								
Egypt								
Asia								
China			12,000			38,000		50,000
India	350		240	800		3,900		5,290
Iran	210	870					380	1,460
Korea								
Turkey	539	1,435	42	203	753		529	3,501
Europe								
Belgium		300			195	97	188	780
Croatia	13	96	26					135
Finland								
Germany	70	3						73
Italy	316	14		180		336	127	973
Romania	140.3	16.1		206.7		49.6	141.7	554.4
Serbia	35	299	24					358
Spain					214	436	25	675
Sweden	60	380					20	460
Switzerland								
Russian Fed.								
America & Oceania								
Argentina			444	200		100	895	1,639
Canada			3,850	600				4,450
Chile								
New Zealand	1	2					1	4
Grand Total	**1,734**	**3,415**	**16,626**	**2,190**	**1,162**	**42,919**	**2307**	**70,352**

13. Forest Products from Willows by Country 2011

Country	Fuelwood chips	Indust. roundw. (logs, pulpw.)	Wood-pulp (mech. or chem.)	Particle/ Fibreb. (MDF, (hardb.)	Veneer sheets	Plywood	Sawn-timber	Total
	1000 m^3 (r)							
Africa								
Egypt								
Asia								
China								
India								
Iran	70	50						120
Korea								
Turkey								
Europe								
Belgium								
Croatia	1	17						18
Finland								
Germany	48							48
Italy								
Romania	37.8	5.7		22.4			3.5	69.4
Serbia	8	8	1					17
Spain								
Sweden	10	50					20	80
Switzerland								
Russian Fed.								
America & Oceania								
Argentina			168	182			57	407
Canada	1.14							1.14
Chile								
New Zealand	2							2
Grand Total	**178**	**131**	**169**	**204**	**0**	**0**	**81**	**763**

ANNEX 2: COUNTRY TABLES 2011

ARGENTINA

1) Poplar and Willow Area		Total ha	Poplar & willow area by function: Industr. roundw. ha	Fuelwood Biomass ha	Environm. Protection ha	Other ha	Total by genus ha	Area planted 2008-2011 ha
Poplars	Indigenous						61,000	
	Planted	40,500	40,500					
	Agroforestry	20,500	10,250		10,250			
Willows	Indigenous						56,400	
	Planted	56,400	39,480			16,920		
	Agroforestry							
Mix of popl. & willows	Indigenous							
	Planted							
	Agroforestry							
Total		**117,400**	**90,230**		**10,250**	**16,920**	**117,400**	

2) Wood removals		Total removals m^3	Removals by type: Industrial roundwood m^3	Fuelwood Biomass m^3	from env. protect. areas m^3	Total removals by genus m^3
Poplars	Indigenous					1,670,000
	Planted	1,670,000	1,210,000		460,000	
Willows	Indigenous					410,000
	Planted	410,000	410,000			
Total		**2,080,000**	**1,620,000**		**460,000**	**2,080,000**

3) List of main cultivars/clones used in planted forests

Poplars: Cultivars/clones	%	End use	Willows: Cultivars/clones	%	End use
1) Conti 12	35	pulpwood, sawntimber	1) Soveny Americano	60	pulpwood
2) Guardi	24	pulpwood, sawntimber	2) Ragonese 131-25 INTA	18	pulpwood
3) Australiano 129-60	15	pulpwood, sawntimber	3) Ragonese 131-27 INTA	17	pulpwood
4) Australiano 106-60	15	pulpwood, sawntimber	4) Alonzo Nigra 4 INTA	4	pulpwood
5) Mississippi Slim	2	pulpwood, sawntimber	5) Barret 13-44 INTA	1	pulpwood
6) Delta Gold	2	pulpwood, sawntimber			
7) 208-68	2	pulpwood, sawntimber			
8) Harvard	2	pulpwood, sawntimber			
9) Catfish 2	2	pulpwood, sawntimber			
10) Carabelas INTA	1	pulpwood, sawntimber			

4) Tree ownership		Public ownership %	Private corporate ownership %	Private smallholder ownership %	
Poplars	**Indigenous**				
	Planted		50	50	100
	Agroforestry		50	50	100
Willows	**Indigenous**				
	Planted		50	50	100
	Agroforestry				

5) Forest products from poplars							
Fuelwood chips	**Indust. roundwood (logs, pulpwood)**	**Wood-pulp (mech. or chem.)**	**Particle/fibre-board (MDF, (hardboard)**	**Veneer sheets**	**Plywood**	**Sawn-timber**	**Total**
1000 m^3 (r)							
		444	200		100	895	**1639**

6) Forest products from willows							
Fuelwood chips	**Indust. roundwood (logs, pulpwood)**	**Wood-pulp (mech. or chem.)**	**Particle/fibre-board (MDF, (hardboard)**	**Veneer sheets**	**Plywood**	**Sawn-timber**	**Total**
1000 m^3 (r)							
		168	182			57	**407**

Grand Total forest products from poplars and willows (1000 m^3 (r)) 2046

BELGIUM

1) Poplar and Willow Area		Total ha	Poplar & willow area by function Industr. roundw. ha	Fuelwood Biomass ha	Environm. Protection ha	Other ha	Total by genus ha	Area planted 2008-2011 ha
Poplars	Indigenous	2,060			2,060		34,990	2
	Planted	32,930	32,930					
	Agroforestry							
Willows	Indigenous	5,760			5,760		5,780	
	Planted	20		20				
	Agroforestry							
Mix of popl. & willows	Indigenous							
	Planted							
	Agroforestry							
Total		**40,770**	**32,930**	**20**	**7,820**		**40,770**	**2**

2) Wood removals		Total removals m^3	Removals by type Industrial roundwood m^3	Fuelwood Biomass m^3	from env. protect. areas m^3	Total removals by genus m^3
Poplars	Indigenous					3,200,000
	Planted	3,200,000	3,200,000			
Willows	Indigenous					
	Planted					
Total		**3,200,000**	**3,200,000**			

3) List of main cultivars/clones used in planted forests

Poplars Cultivars/clones	%	End use	Willows Cultivars/clones	%	End use
1)Vesten	20-25	industrial roundwood			
2)Koster	20-25	industrial roundwood			
3)Grimminge	10	industrial roundwood			
4)Serotina blanc du Poitou	10	industrial roundwood			
5)Gaver	8-9	industrial roundwood			
6)A4A	5-6	industrial roundwood			
7)Oudenberg	5-6	industrial roundwood			
8)Trichobel	4	industrial roundwood			
9)Ogy	3-4	industrial roundwood			
10)others	<10	industrial roundwood			

4) **Tree ownership**		Public ownership %	Private corporate ownership %	Private smallholder ownership %	
Poplars	**Indigenous**	20	80		100
	Planted		5	95	100
	Agroforestry		100		100
Willows	**Indigenous**			100	100
	Planted				
	Agroforestry				

5) **Forest products from poplars**							
Fuelwood chips	**Indust. roundwood (logs, pulpwood)**	**Wood-pulp (mech. or chem.)**	**Particle/fibre-board (MDF, (hardboard)**	**Veneer sheets**	**Plywood**	**Sawn-timber**	**Total**
1000 m^3 (r)							
	300			195	97	188	**780**

6) **Forest products from willows**							
Fuelwood chips	**Indust. roundwood (logs, pulpwood)**	**Wood-pulp (mech. or chem.)**	**Particle/fibre-board (MDF, (hardboard)**	**Veneer sheets**	**Plywood**	**Sawn-timber**	**Total**
1000 m^3 (r)							

Grand Total forest products from poplars and willows (1000 m^3 (r)) **780**

CANADA

1) Poplar and Willow Area		Total by type ha	Poplar & willow area by function: Industrial roundwood ha	Fuelwood Biomass ha	Environm. Protection ha	Other ha	Total by genus ha	Area planted 2008-2011 ha
Poplars	Indigenous	30,296,079	12,118,432	3,029,608	15,148,040		30,360,400	
	Planted	44,128	19,857.6	19,857.6	4,412.8			
	Agroforestry	20,193						
Willows	Indigenous						7,000	
	Planted							
	Agroforestry	7,000						
Mix of popl. & willows	Indigenous							
	Planted							
	Agroforestry							
	Total	**30,367,400**	**12,138,289.6**	**3,049,465.6**	**15,152,452.8**		**30,367,400**	

2) Wood removals		Total removals m^3	Removals by type: Industrial roundwood m^3	Fuelwood Biomass m^3	From env. Protect areas m^3	Total removals by genus m^3
Poplars	Indigenous	2,801,205	2,801,205			2,844,255
	Planted	43,050	43,050			
Willows	Indigenous	2,280		2,280		2,280
	Planted					
	Total	**2,846,535**	**2,844,255**	**2,280**		**2,846,535**

3) List of main cultivars/clones used in planted forests					
Poplars			**Willows**		
Cultivars/clones	**%**	**End use**	**Cultivars/clones**	**%**	**End use**
Walker hybrid poplar		pulpwood	SX 67 S. Myabeana		fuelwood/biomass
Okanese hybrid poplar		pulpwood	SX 64 S. Myabeana		fuelwood/biomass
Northwest hybrid poplar		pulpwood	Owasco (S. viminalis x S. myabeana)		fuelwood/biomass
P38P38 hyprid poplar		pulpwood	SX 61 S. sachalinensis		fuelwood/biomass
Hybrid aspen (P.tremuloidesxP.tremula)		pulpwood	Tully Champion (S.viminalis x S. myabeana)		fuelwood/biomass
NM-6		pulpwood	Otisco (S. viminalis x S. myabeana)		fuelwood/biomass
DTAC 7		pulpwood	Fabius (S. viminalis x S. myabeana)		fuelwood/biomass
TD 52-226		pulpwood	Fishcreek/S. purpurea		fuelwood/biomass
TD 15-29		pulpwood	Sherburne (S. sachalinensis x S. myabeana)		fuelwood/biomass
D Tac 7		phytoremediation	S. acutifolia		agroforestry

List of main cultivars/clones continued

Poplars			Willows		
Cultivars/clones	**%**	**End use**	**Cultivars/clones**	**%**	**End use**
TXD 53 242		phytoremediation	S. alba sericea		agroforestry
NM6		phytoremediation	S. amygdaloides		agroforestry
Walker		agroforestry			
Assiniboine		agroforestry			
Okanese hybrid poplar		agroforestry			
Katepwa		agroforestry			
CanAm		agroforestry			
P. tremuloides		OSB			
P. balsamifera		OSB			

4) Tree ownership		Public ownership %	Private corporate ownership %	Private smallholder ownership %	
Poplars	**Indigenous**	100			100
	Planted	33	33	34	100
	Agroforestry		26	49	100
Willows	**Indigenous**				100
	Planted		100		100
	Agroforestry			100	100

5) Forest products from poplars

Fuelwood chips	Indust. roundwood (logs, pulpwood)	Wood-pulp (mech. or chem.)	Particle/fibre-board (MDF, (hardboard)	Veneer sheets	Plywood	Sawn-timber	Total
1000 m^3 (r)							
		3,850	600				**4,450**

6) Forest products from willows

Fuelwood chips	Indust. roundwood (logs, pulpwood)	Wood-pulp (mech. or chem.)	Particle/fibre-board (MDF, (hardboard)	Veneer sheets	Plywood	Sawn-timber	Total
1000 m^3 (r)							
1.14							**1.14**

Grand Total forest products from poplars and willows (1000 m^3 (r)) 4,451.14

CHINA

1) Poplar and Willow Area		Total ha	Poplar & willow area by function Industr. roundw. ha	Fuelwood Biomass ha	Environm. Protection ha	Other ha	Total by genus ha	Area planted 2008-2011 ha
Poplars	**Indigenous**	2,530,000			2,403,500	126,500	12,900,000	
	Planted	7,570,000	4,542,000	757,000	1,892,500	378,500		
	Agroforestry	2,800,000	840,000	140,000	1,680,000	140,000		
Willows	**Indigenous**						437,600	
	Planted	437,600	328,200	43,760	52,512	13,128		
	Agroforestry							
Mix of popl. & willows	**Indigenous**							
	Planted							
	Agroforestry							
Total		**13,337,600**	**5,710,200**	**940,760**	**6,028,512**	**658,128**	**13,337,600**	

2) Wood removals		Total removals m^3	Removals by type Industrial roundwood m^3	Fuelwood Biomass m^3	from env. protect. areas m^3	Total removals by genus m^3
Poplars	**Indigenous**					
	Planted					
Willows	**Indigenous**					
	Planted					
Total						

3) List of main cultivars/clones used in planted forests					
Poplars			**Willows**		
Cultivars/clones	**%**	**End use**	**Cultivars/clones**	**%**	**End use**
P. x canadensis			S. integra		
P.deltoides			S. suchowensis		
P. tomentosa			S. suchowensis x S. integra		
P. davidiana			s. integra x S. suchowensis		
P.alba, P.alba var. Bolleana			S. jiangsuensis		
P. simonii x P.nigra					
P. cathayana					
P. yuanensis					

4) Tree ownership		Public ownership %	Private corporate ownership %	Private smallholder ownership %	
Poplars	**Indigenous**	70	20	10	100
	Planted	70	23	7	100
	Agroforestry	50	25	25	100
Willows	**Indigenous**	75	10	15	100
	Planted				
	Agroforestry	15	55	30	100

5) Forest products from poplars							
Fuelwood chips	**Indust. roundwood (logs, pulpwood)**	**Wood-pulp (mech. or chem.)**	**Particle/fibre-board (MDF, (hardboard)**	**Veneer sheets**	**Plywood**	**Sawn-timber**	**Total**
1000 m^3 (r)							
		12,000			38,000		**50,000**

6) Forest products from willows							
Fuelwood chips	**Indust. roundwood (logs, pulpwood)**	**Wood-pulp (mech. or chem.)**	**Particle/fibre-board (MDF, (hardboard)**	**Veneer sheets**	**Plywood**	**Sawn-timber**	**Total**
1000 m^3 (r)							

Grand Total forest products from poplars and willows (1000 m^3 (r)) **50,000**

CROATIA

1) Poplar and Willow Area		Total ha	Poplar & willow area by function: Industrial roundwood ha	Fuelwood Biomass ha	Environm. Protection ha	Other ha	Total by genus ha	Area planted 2008-2011 ha
Poplars	**Indigenous**	17,308	15,318		1,990		**30,364**	1
	Planted	13,056	12,364		692			1,279
	Agroforestry							
Willows	**Indigenous**	13,243	10,224		3,019		**16,858**	
	Planted	3,615	3,268		347			3
	Agroforestry							
Mix of popl. & willows	**Indigenous**	123			123		**180**	
	Planted	57	57					
	Agroforestry							
Total		**47,402**	**41,230**		**6,171**		**47,402**	**1,283**

2) Wood removals		Total removals m^3	Removals by type: Industrial roundwood m^3	m^3	Environm. Protection	Total removals by genus m^3
Poplars	**Indigenous**	7,155	6,076	1,079		126,655
	Planted	119,500	112,819	6,681		
Willows	**Indigenous**	20,771	15,796	4,975		26,933
	Planted	6,162	5,565	597		
Total		**153,588**	**140,256**	**13,332**		**153,588**

3) List of main cultivars/clones used in planted forests

Poplars: Cultivars/clones	%	End use	Willows: Cultivars/clones	%	End use
1)M-1	35	industrial roundwood	1)378		pulpwood
2)Panonia	34	industrial roundwood	2)V 158		pulpwood
3)S1-8	29	industrial roundwood	3)V 160		pulpwood
4)710		industrial roundwood	4)B 44		pulpwood
5)S1-3		industrial roundwood	5)B 72		pulpwood
6)S1-5		industrial roundwood	6)B 84		pulpwood
7)56/3	2	industrial roundwood	7)107/65/1		pulpwood
8)B-173		industrial roundwood	8)V 99		pulpwood
9)Bl. Constanzo		industrial roundwood	9)V093		pulpwood
			10)V052		pulpwood

4) Tree ownership		Public ownership %	Private corporate ownership %	Private smallholder ownership %	
Poplars	**Indigenous**	37.2		62.8	100
	Planted	84.8		15.2	100
	Agroforestry				100
Willows	**Indigenous**	67.6		32.4	100
	Planted	100			100
	Agroforestry				100

5) Forest products from poplars

Fuelwood chips	**Indust. roundwood (logs, pulpwood)**	**Wood-pulp (mech. or chem.)**	**Particle/fibre-board (MDF, (hardboard)**	**Veneer sheets**	**Plywood**	**Sawn-timber**	**Total**
1000 m^3 (r)							
13	96	26					**135**

6) Forest products from willows

Fuelwood chips	**Indust. roundwood (logs, pulpwood)**	**Wood-pulp (mech. or chem.)**	**Particle/fibre-board (MDF, (hardboard)**	**Veneer sheets**	**Plywood**	**Sawn-timber**	**Total**
1000 m^3 (r)							
1	17						**18**

Grand Total forest products from poplars and willows (1000 m^3 (r)) 153

GERMANY

1) Poplar and Willow Area		Total by type ha	Poplar & willow area by function: Industr. roundw. ha	Fuelwood Biomass ha	Environm. Protection ha	Other ha	Total by genus ha	Area planted 2008-2011 ha
Poplars	**Indigenous**	250			250		13,250	50
	Planted	10000	10000					
	Agroforestry	3000		3000				2,300
Willows	**Indigenous**						2,000	
	Planted							
	Agroforestry	2000		2000				1,200
Mix of popl. & willows	**Indigenous**	250			250		250	
	Planted							
	Agroforestry							
	Total	**15,500**	**10,000**	**5,000**	**500**		**15,500**	**3,550**

2) Wood removals		Total removals m^3	Removals by type: Industrial roundwood m^3	Fuelwood Biomass m^3	from env. protect. areas m^3	Total removals by genus m^3
Poplars	**Indigenous**					76,000
	Planted	76,000	3,000	73,000		
Willows	**Indigenous**					48,000
	Planted	48,000		48,000		
	Total	**124,000**	**3,000**	**121,000**		**124,000**

3) List of main cultivars/clones used in planted forests

Poplars: Cultivars/clones	%	End use	Willows: Cultivars/clones	%	End use
1)Max	80	fuelwood/biomass	1)Tordis	35	fuelwood/biomass
2)H275 (OP42)	15	fuelwood/biomass	2)Inger	35	fuelwood/biomass
3)P. koreana, AF2	5	fuelwood/biomass	3)Tora	20	fuelwood/biomass
			4)Sven	5	fuelwood/biomass
			5)Klara	5	fuelwood/biomass

4) Tree ownership		Public ownership %	Private corporate ownership %	Private smallholder ownership %	
Poplars	**Indigenous**	100			100
	Planted			100	100
	Agroforestry			100	100
Willows	**Indigenous**	100			100
	Planted				
	Agroforestry			100	100

5) Forest products from poplars

Fuelwood chips	Indust. roundwood (logs, pulpwood)	Wood-pulp (mech. or chem.)	Particle/fibre-board (MDF, (hardboard)	Veneer sheets	Plywood	Sawn-timber	Total
1000 m^3 (r)							
70	3						**73**

6) Forest products from willows

Fuelwood chips	Indust. roundwood (logs, pulpwood)	Wood-pulp (mech. or chem.)	Particle/fibre-board (MDF, (hardboard)	Veneer sheets	Plywood	Sawn-timber	Total
1000 m^3 (r)							
48							**48**

Grand Total forest products from poplars and willows (1000 m^3 (r)) 121

INDIA

1) Poplar and Willow Area		Total ha	Poplar & willow area by function: Industrial roundwood ha	Fuelwood Biomass ha	Environm. Protection ha	Other ha	Total by genus ha	Area planted 2008-2011 ha
Poplars	Indigenous	47,000	18,800	9,400	18,800		362,700	4,000
	Planted	700	630	35	35			500
	Agroforestry	315,000	315,000					255,000
Willows	Indigenous	108,000	16,200	43,200	21,600	27,000	137,300	10,000
	Planted	1,000	100	400	250	250		1,000
	Agroforestry	28,300	7,075	11,320	2,830	7,075		2,800
Mix of popl. & willows	Indigenous	5,000						2,000
	Planted							
	Agroforestry							
	Total	**505,000**	**357,805**	**64,355**	**43,515**	**34,325**	**500,000**	**275,300**

2) Wood removals		Total removals m^3	Removals by type: Industrial roundwood m^3	Fuelwood Biomass m^3	From Env. Protect. Areas m^3	Total removals by genus m^3
Poplars	Indigenous					5,100,000
	Planted	5,100,000	4,800,000	300,000		
Willows	Indigenous					
	Planted					
	Total	**5,100,000**	**4,800,000**	**300,000**		**5,100,000**

3) List of main cultivars/clones used in planted forests

Poplars: Cultivars/clones	%	End use	Willows: Cultivars/clones	%	End use
1)G 48		veneer/plywood	1)S. alba ssp. coerulea		baskets, furniture, cricket bats
2)WSL 22		veneer/plywood	2)S. alba ssp. alba		baskets, furniture, cricket bats
3)Udai		veneer/plywood	3)S. tetrasperma		baskets, furniture, cricket bats
4)L34/82		veneer/plywood	4)S. acmophylla		baskets, furniture, cricket bats
5)S7C15		veneer/plywood	5)S. fragilis		baskets, furniture, cricket bats
6)S7C8		veneer/plywood	6)S. babylonica		baskets, furniture, cricket bats

4) Tree ownership		Public ownership %	Private corporate ownership %	Private smallholder ownership %	
Poplars	**Indigenous**	100			100
	Planted	100			100
	Agroforestry			100	100
Willows	**Indigenous**	100			100
	Planted	100			100
	Agroforestry	53	47		100

5) Forest products from poplars							
Fuelwood chips Matches	**Indust. roundwood (logs, pulpwood)**	**Wood-pulp (mech. or chem.)**	**Particle/fibre-board (MDF, (hardboard)**	**Veneer sheets**	**Plywood**	**Sawn-timber**	**Total**
1000 m^3 (r)							
350		240	800		3900		**5,290**

6) Forest products from willows							
Fuelwood chips	**Indust. roundwood (logs, pulpwood)**	**Wood-pulp (mech. or chem.)**	**Particle/fibre-board (MDF, (hardboard)**	**Veneer sheets**	**Plywood**	**Sawn-timber**	**Total**
1000 m^3 (r)							

Grand Total forest products from poplars and willows (1000 m^3 (r)) **5,290**

IRAN

1) Poplar and Willow Area		Total ha	Poplar & willow area by function Industr. roundw. ha	Fuelwood Biomass ha	Environm. Protection ha	Other ha	Total by genus ha	Area planted 2008-2011 ha
Poplars	**Indigenous**	30,000		6,000	24,000		185,000	
	Planted	150,000	135,000	15,000				15,000
	Agroforestry	5,000	4,500	500				1,500
Willows	**Indigenous**	15,000		7,500	7,500		25,000	
	Planted	10,000	7,000	3,000				1,000
	Agroforestry							
Mix of popl. & willows	**Indigenous**							
	Planted							
	Agroforestry							
	Total	**210,000**	**146,500**	**32,000**	**31,500**		**210,000**	**17,500**

2) Wood removals		Total removals m^3	Removals by type Industrial roundwood m^3	Fuelwood Biomass m^3	from env. protect. areas m^3	Total removals by genus m^3
Poplars	**Indigenous**	50,100		50,100		3,750,100
	Planted	3,700,000	3,700,000			
Willows	**Indigenous**					
	Planted					
	Total	**3,750,100**	**3,700,000**	**50,100**		**3,750,100**

3) List of main cultivars/clones used in planted forests

Poplars			Willows		
Cultivars/clones	**%**	**End use**	**Cultivars/clones**	**%**	**End use**
1)P. eura 561/41		Pulpwood, sawntimber, poles	1)S. alba		Pulpwood,
2)P.eura 214		Pulpwood, sawntimber,	2)S. fragilis		Pulpwood,
3)P.eura.triplo		Pulpwood, sawntimber,	3)S. excelsa		Pulpwood,
4)P. deltoides 77/51		Pulpwood, sawntimber,			
5)P. deltoides 69/55		Pulpwood, sawntimber,			
6)P.nigra var Italica cv. Karaj		Pulpwood, poles			
7)P.nigra var Italica 62/154		Pulpwood, poles			
8)P.nigra var Italica 56/72		Pulpwood, poles			
9)P. alba cv. Boumi		Pulpwood, poles			
10)P. alba cv. Shirazi		Pulpwood, poles			

4) Tree ownership		Public ownership %	Private corporate ownership %	Private smallholder ownership %	
Poplars	**Indigenous**	100			100
	Planted			100	100
	Agroforestry			100	100
Willows	**Indigenous**	100			100
	Planted			100	100
	Agroforestry				

5) Forest products from poplars

Fuelwood chips	**Indust. roundwood (logs, pulpwood)**	**Wood-pulp (mech. or chem.)**	**Particle/fibre-board (MDF, (hardboard)**	**Veneer sheets**	**Plywood**	**Sawn-timber**	**Total**
1000 m^3 (r)							
210	870					380	**1460**

6) Forest products from willows

Fuelwood chips	**Indust. roundwood (logs, pulpwood)**	**Wood-pulp (mech. or chem.)**	**Particle/fibre-board (MDF, (hardboard)**	**Veneer sheets**	**Plywood**	**Sawn-timber**	**Total**
1000 m^3 (r)							
70	50						**120**

Grand Total forest products from poplars and willows (1000 m^3 (r)) **1580**

ITALY

1) Poplar and Willow Area		Total ha	Poplar & willow area by function Industr. roundw. ha	 Fuelwood Biomass ha	 Environm. Protection ha	 Other ha	Total by genus ha	Area planted 2008-2011 ha
Poplars	**Indigenous**	42,225					143,655	
	Planted	101,430	65,930	6,086	29,415			20,000
	Agroforestry							
Willows	**Indigenous**	15,998					35,998	
	Planted	20,000			20,000			
	Agroforestry							
Mix of popl. & willows	**Indigenous**							
	Planted							
	Agroforestry							
Total		**179,653**	**65,930**	**6,086**	**49,415**		**179,653**	**20,000**

2) Wood removals		Total removals m^3	Removals by type Industrial roundwood m^3	 Fuelwood Biomass m^3	 from env. protect. areas m^3	Total removals by genus m^3
Poplars	**Indigenous**					983,000
	Planted	983,000	656,800	326,200		
Willows	**Indigenous**					
	Planted					
Total		983,000	656,800	326,200		983,000

3) List of main cultivars/clones used in planted forests

Poplars			Willows		
Cultivars/clones	**%**	**End use**	**Cultivars/clones**	**%**	**End use**
1) I 214	77	veneer			
2) Villafranca	3	biomass			
3) Monviso	2	biomass			
4) A4A	2	biomass			
5) BL Costanzo	2	veneer			
6) San Martino	2	veneer			
7) Adige	1	veneer			
8) Boccalari	1	veneer			
9)Other	10	--			

4) Tree ownership		Public ownership %	Private corporate ownership %	Private smallholder ownership %	
Poplars	**Indigenous**				
	Planted	10	20	70	100
	Agroforestry				
Willows	**Indigenous**				
	Planted				
	Agroforestry				

5) Forest products from poplars							
Fuelwood chips	**Indust. roundwood (logs, pulpwood)**	**Wood-pulp (mech. or chem.)**	**Particle/fibre-board (MDF, (hardboard)**	**Veneer sheets**	**Plywood**	**Sawn-timber**	**Total**
1000 m^3 (r)							
316	14		180		336	127	**973**

6) Forest products from willows							
Fuelwood chips	**Indust. roundwood (logs, pulpwood)**	**Wood-pulp (mech. or chem.)**	**Particle/fibre-board (MDF, (hardboard)**	**Veneer sheets**	**Plywood**	**Sawn-timber**	**Total**
1000 m^3 (r)							

Grand Total forest products from poplars and willows (1000 m^3 (r)) **973**

REPUBLIC OF KOREA

1) Poplar and Willow Area		Total	Poplar & willow area by function				Total by genus	Area planted 2008-2011
			Industr. roundw.	Fuelwood Biomass	Environm. Protection	Other		
		ha	ha	ha	ha	ha	ha	ha
Poplars	Indigenous	1,749			1,399	350	1,749	
	Planted							
	Agroforestry							
Willows	Indigenous							
	Planted							
	Agroforestry							
Mix of popl. & willows	Indigenous							
	Planted							
	Agroforestry							
	Total	**1,749**			**1,399**	**350**	**1,749**	

2) Wood removals		Total removals	Removals by type			Total removals by genus
			Industrial roundwood	Fuelwood Biomass	from env. protect. areas	
		m^3	m^3	m^3	m^3	m^3
Poplars	Indigenous					
	Planted					
Willows	Indigenous					
	Planted					
	Total					

3) List of main cultivars/clones used in planted forests					
Poplars			Willows		
Cultivars/clones	%	End use	Cultivars/clones	%	End use

4) Tree ownership		Public ownership %	Private corporate ownership %	Private smallholder ownership %	
Poplars	**Indigenous**	100			100
	Planted				
	Agroforestry				
Willows	**Indigenous**				
	Planted				
	Agroforestry				

5) Forest products from poplars							
Fuelwood chips	**Indust. roundwood (logs, pulpwood)**	**Wood-pulp (mech. or chem.)**	**Particle/fibre-board (MDF, (hardboard)**	**Veneer sheets**	**Plywood**	**Sawn-timber**	**Total**
1000 m^3 (r)							

6) Forest products from willows							
Fuelwood chips	**Indust. roundwood (logs, pulpwood)**	**Wood-pulp (mech. or chem.)**	**Particle/fibre-board (MDF, (hardboard)**	**Veneer sheets**	**Plywood**	**Sawn-timber**	**Total**
1000 m^3 (r)							

Grand Total forest products from poplars and willows (1000 m^3 (r))

NEW ZEALAND

1) Poplar and Willow Area		Total ha	Poplar & willow area by function Industrial roundwood ha	 Fuelwood Biomass ha	 Environm. Protection ha	 Other ha	Total by genus ha	Area planted 2008-2011 ha
Poplars	**Indigenous**							
	Planted							
	Agroforestry							
Willows	**Indigenous**							
	Planted							
	Agroforestry							
Mix of popl. & willows	**Indigenous**						223,000	
	Planted							
	Agroforestry	223,000		2,230	220,770			62,400
Total		**223,000**		**2,230**	**220,770**		**223,000**	**62,400**

2) Wood removals		Total removals m^3	Removals by type Industrial roundwood m^3	 Fuelwood Biomass m^3	 From env. Protect. Areas m^3	Total removals by genus m^3
Poplars	**Indigenous**					
	Planted					
Willows	**Indigenous**					
	Planted					
Total						

3) List of main cultivars/clones used in planted forests

Poplars			Willows		
Cultivars/clones	**%**	**End use**	**Cultivars/clones**	**%**	**End use**
P.x euramericana			S. matsudana	10	protection
Veronese	27	protection	*S. matsudana x alba*		
Fraser	12	protection	Tangoio	36	protection
weraiti	11	protection	Moutere	24	protection
Tasman	8	protection	S. alba var. vitellina	5	
P.x euramericana x yunnanensis			S. schwerinii Kinuyanagi	5	Protection, fodder
Toa	4	protection	S. viminalis Gigantea	8	protection
P. deltoides x yunnanensis			S. purpurea	12	protection
Kawa	17	protection			
P. yunnanensis	6				
P. x euramericana x nigra					
Crowsnest	15	protection			

4) Tree ownership		Public ownership %	Private corporate ownership %	Private smallholder ownership %	
Poplars	**Indigenous**				100
	Planted				100
	Agroforestry	15	10	75	100
Willows	**Indigenous**				100
	Planted				100
	Agroforestry	30		70	100

5) Forest products from poplars							
Fuelwood chips	**Indust. roundwood (logs, pulpwood)**	**Wood-pulp (mech. or chem.)**	**Particle/fibre-board (MDF, (hardboard)**	**Veneer sheets**	**Plywood**	**Sawn-timber**	**Total**
1000 m^3 (r)							
1	2					1	**4**

6) Forest products from willows							
Fuelwood chips	**Indust. roundwood (logs, pulpwood)**	**Wood-pulp (mech. or chem.)**	**Particle/fibre-board (MDF, (hardboard)**	**Veneer sheets**	**Plywood**	**Sawn-timber**	**Total**
1000 m^3 (r)							
2							**2**

Grand Total forest products from poplars and willows (1000 m^3 (r)) **6**

ROMANIA

1) Poplar and Willow Area		Total by type ha	Poplar & willow area by function				Total by genus ha	Area planted 2008-2011 ha
			Industrial roundwood ha	Fuelwood Biomass ha	Environm. Protection ha	Other ha		
Poplars	Indigenous	24,595	8,239	2,017	14,290	49	73,240	
	Planted	47,942	12,033	623	35,189	97		8,110
	Agroforestry	703	144		250	309		
Willows	Indigenous	15,517	2,281	853	12,259	124	35,046	
	Planted	19,505	1,482	761	17,203	59		1,811
	Agroforestry	24	24					
Mix of popl. & willows	Indigenous	8,846	2,751	221	5830	44	10,137	
	Planted	1,238	254	25	933	26		33
	Agroforestry	53	51			2		
Total		**118,423**	**27,260**	**4,500**	**85,954**	**709**	**118,423**	**9,954**

2) Wood removals		Total removals	Removals by type			Total removals by genus
		m^3	Industrial roundwood m^3	Fuelwood Biomass m^3	From Env. Protect. Areas m^3	m^3
Poplars	Indigenous	102,152	29,262	12,557	60,333	**526,039**
	Planted	423,887	60,564	8,529	354,794	
Willows	Indigenous	31,102	3,937	2,431	24,734	**105,704**
	Planted	74,602	20,777	4,848	48,977	
Total		**631,743**	**114,540**	**28,365**	**488,838**	**631,743**

3) List of main cultivars/clones used in planted forests					
Poplars			**Willows**		
Cultivars/clones	**%**	**End use**	**Cultivars/clones**	**%**	**End use**
I 214	45	sawntimber, veneer/plywood	S. alba RO-202	25	pulpwood
Sacrau 79	25	Sawntimber, veneer/plywood	S. alba RO-326	25	pulpwood
Turcoaia	16	sawntimber, veneer/plywood	S. alba RO-204	18	pulpwood
I 45/51	11	sawntimber, veneer/plywood	S. alba RO-334	14	pulpwood
Lux (I-69/55)	3	sawntimber, veneer/plywood	S. alba RO-201	14	pulpwood
			S. fragilis x matsudana RO-1077	4	pulpwood

4) Tree ownership		Public ownership %	Private corporate ownership %	Private smallholder ownership %	
Poplars	**Indigenous**	92.5		7.5	100
	Planted	94.4	1.3	4.4	100
	Agroforestry			100	100
Willows	**Indigenous**	96.1		3.9	100
	Planted	96.6	1.7	1.7	100
	Agroforestry	100			100

5) Forest products from poplars

Fuelwood chips	**Indust. roundwood (logs, pulpwood)**	**Wood-pulp (mech. or chem.)**	**Particle/fibre-board (MDF, (hardboard)**	**Veneer sheets**	**Plywood**	**Sawn-timber**	**Total**
1000 m^3 (r)							
140.3	16.1		206.7		49.6	141.7	**554.4**

6) Forest products from willows

Fuelwood chips	**Indust. roundwood (logs, pulpwood)**	**Wood-pulp (mech. or chem.)**	**Particle/fibre-board (MDF, (hardboard)**	**Veneer sheets**	**Plywood**	**Sawn-timber**	**Total**
1000 m^3 (r)							
37.8	5.7		22.4			3.5	**69.4**

Grand Total forest products from poplars and willows (1000 m^3 (r)) **623.8**

RUSSIAN FEDERATION

1) Poplar and Willow Area		Total ha	Poplar & willow area by function Industrial roundwood ha	Fuelwood Biomass ha	Environm. Protection ha	Other ha	Total by genus ha	Area planted 2008-2011 ha
Poplars	**Indigenous**	24,757,000						
	Planted							
	Agroforestry							
Willows	**Indigenous**	6,568,000						
	Planted							
	Agroforestry							
Mix of popl. & willows	**Indigenous**							
	Planted							
	Agroforestry							
	Total	**31,325,000**						

2) Wood removals		Total removals m^3	Removals by type Industrial roundwood m^3	Fuelwood Biomass m^3	From env. Protect. areas m^3	Total removals by genus m^3
Poplars	**Indigenous**					
	Planted					
Willows	**Indigenous**					
	Planted					
	Total					

3) List of main cultivars/clones used in planted forests

Poplars			Willows		
Cultivars/clones	**%**	**End use**	**Cultivars/clones**	**%**	**End use**
Robusta					
Regenerata					
Marilandica					
Voronezh Giant					
Soviet Pyramidalis					
Veduga					
Bolid					

4) Tree ownership		Public ownership %	Private corporate ownership %	Private smallholder ownership %	
Poplars	**Indigenous**	100			100
	Planted	100			100
	Agroforestry	100			100
Willows	**Indigenous**	100			100
	Planted				100
	Agroforestry				100

5) Forest products from poplars							
Fuelwood chips	**Indust. roundwood (logs, pulpwood)**	**Wood-pulp (mech. or chem.)**	**Particle/fibre-board (MDF, (hardboard)**	**Veneer sheets**	**Plywood**	**Sawn-timber**	**Total**
1000 m^3 (r)							

6) Forest products from willows							
Fuelwood chips	**Indust. roundwood (logs, pulpwood)**	**Wood-pulp (mech. or chem.)**	**Particle/fibre-board (MDF, (hardboard)**	**Veneer sheets**	**Plywood**	**Sawn-timber**	**Total**
1000 m^3 (r)							

Grand Total forest products from poplars and willows (1000 m^3 (r))

1) Poplar and Willow Area		Total by type ha	Poplar & willow area by function: Industrial roundwood ha	Fuelwood Biomass ha	Environm. Protection ha	Other ha	Total by genus ha	Area planted 2008-2011 ha
Poplars	Indigenous	1,194			1,194		**34,402**	
	Planted	33,132	31,475.4		1,656.6			16,415
	Agroforestry	76			76			
Willows	Indigenous	7,464			7,464		**14,406**	
	Planted	6,942	5,275.92		1,666.08			
	Agroforestry							
Mix of popl. & willows	Indigenous							
	Planted							
	Agroforestry							
Total		**48,808**	**36,751.32**		**12,056.68**		**48,808**	**16,415**

2) Wood removals		Total removals m^3	Removals: Industrial roundwood m^3	Fuelwood Biomass m^3	From Env. Protect. Areas m^3	Total removals by genus m^3
Poplars	Indigenous					**397,850**
	Planted	397,850	362,791	35,059		
Willows	Indigenous					**20,549**
	Planted	20,549	12,258	8,291		
Total		**418,399**	**375,049**	**43,350**		**418,399**

3) List of main cultivars/clones used in planted forests

Poplars: Cultivars/clones	%	End use	Willows: Cultivars/clones	%	End use
P. x euramericana, cl. Pannonia	48	Sawntimber, fuelwood/biomass	S. alba, cl. B-74		Sawntimber, fuelwood/biomass
P. x euramericana, cl. I-214	46	Sawntimber, fuelwood/biomass	S. alba, cl. B-72		Sawntimber, fuelwood/biomass
P. deltoides, cl. Dunav (S-1-8)	<1	Sawntimber, fuelwood/biomass	S. alba, cl. B-44		Sawntimber, fuelwood/biomass
P. deltoides, cl. Sava (S-6-36)	<1	Sawntimber, fuelwood/biomass	S. alba, cl. NS-107/6		Sawntimber, fuelwood/biomass
P. deltoides, cl. NS-1-3	<1	Sawntimber, fuelwood/biomass	S. alba, cl. NS-79/2		Sawntimber, fuelwood/biomass
P. x euramericana, cl. Ostia	1	Sawntimber, fuelwood/biomass	S. alba, cl. NS-73/6		Sawntimber, fuelwood/biomass
P. x euramericana, cv. Robusta	1	Sawntimber, fuelwood/biomass	S. alba, cl. NS-107/65/1		Sawntimber, fuelwood/biomass
P. x euramericana, var. Italica	<1	Sawntimber, fuelwood/biomass	S. alba, cl. NS-107/65/7		Sawntimber, fuelwood/biomass

List of main cultivars/clones continued

Poplars			Willows		
Cultivars/clones	**%**	**End use**	**Cultivars/clones**	**%**	**End use**
P. deltoides, cl. Bora	<1	Sawntimber, fuelwood/biomass			
P. deltoides, cl. B-81	<1	Sawntimber, fuelwood/biomass			
P. deltoides, cl. 181/81	<1	Sawntimber, fuelwood/biomass			
P. deltoides, cl. Antonije	<1	Sawntimber, fuelwood/biomass			
P. deltoides, cl. 129/81	<1	Sawntimber, fuelwood/biomass			
P. deltoides, cl. S 1-5	<1	Sawntimber, fuelwood/biomass			
P. deltoides, cl. 665	<1	Sawntimber, fuelwood/biomass			

4) Tree ownership		Public ownership %	Private corporate ownership %	Private smallholder ownership %	
Poplars	**Indigenous**	72.31		27.69	100
	Planted	95.1		4.9	100
	Agroforestry	100			100
Willows	**Indigenous**				100
	Planted				100
	Agroforestry				100

5) Forest products from poplars

Fuelwood chips	Indust. roundwood (logs, pulpwood)	Wood-pulp (mech. or chem.)	Particle/fibre-board (MDF, (hardboard)	Veneer sheets	Plywood	Sawn-timber	Total
1000 m^3 (r)							
35	299	24					**358**

6) Forest products from willows

Fuelwood chips	Indust. roundwood (logs, pulpwood)	Wood-pulp (mech. or chem.)	Particle/fibre-board (MDF, (hardboard)	Veneer sheets	Plywood	Sawn-timber	Total
1000 m^3 (r)							
8	8	1					**17**

Grand Total forest products from poplars and willows (1000 m^3 (r)) 375

SPAIN

1) Poplar and Willow Area		Total by type ha	Poplar & willow area by function: Industrial roundwood ha	Fuelwood Biomass ha	Environm. Protection ha	Other ha	Total by genus ha	Area planted 2008-2011 ha
Poplars	Indigenous	8,100			8,100		**119,600**	
	Planted	105,000	96,600	3,150	5,250			8,000
	Agroforestry	6,500						
Willows	Indigenous	4,600			4,600		**5,300**	
	Planted	700						
	Agroforestry							
Mix of popl. & willows	Indigenous	30,300			30,300		**32,423**	
	Planted	123						123
	Agroforestry	2,000						
Total		**157,323**	**96,600**	**3,150**	**48,250**		**157,323**	**8,123**

2) Wood removals		Total removals m^3	Removals: Industrial roundwood m^3	Fuelwood Biomass m^3	From env. Protect. Areas m^3	Total removals by genus
Poplars	Indigenous					587,000
	Planted	587,000	587,000			
Willows	Indigenous					
	Planted					
Total			**587,000**			**587,000**

3) List of main cultivars/clones used in planted forests

Poplars: Cultivars/clones	%	End use	Willows: Cultivars/clones	%	End use
I 214	50	veneer/plywood			
MC	17.7	veneer/plywood			
Beaupre	9.1	veneer/plywood			
Unal	5.5	veneer/plywood			
Raspalje	3.9	veneer/plywood			
Triplo	3.3	veneer/plywood			
Viriato	3.3	veneer/plywood			
Guardi	1.5	veneer/plywood			
A4A	1.1	veneer/plywood			
others	4.6	veneer/plywood			

4) Tree ownership		Public ownership %	Private corporate ownership %	Private smallholder ownership %	
Poplars	**Indigenous**	50		50	100
	Planted	34	33	33	100
	Agroforestry				100
Willows	**Indigenous**	50		50	100
	Planted				100
	Agroforestry				100

5) Forest products from poplars							
Fuelwood chips	**Indust. roundwood (logs, pulpwood)**	**Wood-pulp (mech. or chem.)**	**Particle/fibre-board (MDF, (hardboard)**	**Veneer sheets**	**Plywood**	**Sawn-timber**	**Total**
1000 m^3 (r)							
				214	436	25	**675**

6) Forest products from willows							
Fuelwood chips	**Indust. roundwood (logs, pulpwood)**	**Wood-pulp (mech. or chem.)**	**Particle/fibre-board (MDF, (hardboard)**	**Veneer sheets**	**Plywood**	**Sawn-timber**	**Total**
1000 m^3 (r)							

Grand Total forest products from poplars and willows (1000 m^3 (r)) **675**

SWEDEN

1) Poplar and Willow Area		Total By type ha	Poplar & willow area by function: Industrial roundwood ha	Fuelwood Biomass ha	Environm. Protection ha	Other ha	Total by genus ha	Area planted 2008-2011 ha
Poplars	Indigenous						49,375	
	Planted	49,375	47,375	2,000				1,500
	Agroforestry							
Willows	Indigenous						11,100	
	Planted	11,100		11,100				2,000
	Agroforestry							
Mix of popl. & wilows	Indigenous							
	Planted							
	Agroforestry							
	Total	**60,475**	**47,375**	**13,100**			**60,475**	**3,500**

2) Wood removals		Total removals m^3	Removals: Industrial roundwood m^3	m^3	From env. Protect. Areas m^3	Total removals by genus m^3
Poplars	Indigenous					460,000
	Planted	460,000	400,000	60,000		
Willows	Indigenous					
	Planted					
	Total	**460,000**	**400,000**	**60,000**		**460,000**

3) List of main cultivars/clones used in planted forests

Poplars: Cultivars/clones	%	End use	Willows: Cultivars/clones	%	End use
OP42	35	fuelwood/biomass	Gudrun	4	fuelwood/biomass
Hybrid Aspen Ekebo KB-002	60	Pulpwood, fuelwood/biomass	Inger	26	fuelwood/biomass
Poplar Ekebo KB-003	5	fuelwood/biomass	Klara	4	fuelwood/biomass
			Lisa	4	fuelwood/biomass
			Olof	4	fuelwood/biomass
			Stina	4	fuelwood/biomass
			Sven	4	fuelwood/biomass
			Tora	26	fuelwood/biomass
			Tordis	20	fuelwood/biomass
			Torhild	4	fuelwood/biomass

4) Tree ownership		Public ownership %	Private corporate ownership %	Private smallholder ownership %	
Poplars	**Indigenous**	12	18	70	100
	Planted				100
	Agroforestry				100
Willows	**Indigenous**				100
	Planted			100	100
	Agroforestry				100

5) Forest products from poplars

Fuelwood chips	**Indust. roundwood (logs, pulpwood)**	**Wood-pulp (mech. or chem.)**	**Particle/fibre-board (MDF, (hardboard)**	**Veneer sheets**	**Plywood**	**Sawn-timber**	**Total**
1000 m^3 (r)							
60	380					20	**460**

6) Forest products from willows

Fuelwood chips	**Indust. roundwood (logs, pulpwood)**	**Wood-pulp (mech. or chem.)**	**Particle/fibre-board (MDF, (hardboard)**	**Veneer sheets**	**Plywood**	**Sawn-timber**	**Total**
1000 m^3 (r)							
10	50					20	**80**

Grand Total forest products from poplars and willows (1000 m^3 (r)) 540

TURKEY

1) Poplar and Willow Area		Total ha	Poplar & willow area by function: Industr. roundw. ha	Fuelwood Biomass ha	Environm. Protection ha	Other ha	Total by genus ha	Area planted 2008-2011 ha
Poplars	Indigenous	7,963	4,778		2,389	796	132,963	
	Planted	125,000	75,000		37,500	12,500		
	Agroforestry							
Willows	Indigenous							
	Planted							
	Agroforestry							
Mix of popl. & willows	Indigenous							
	Planted							
	Agroforestry							
	Total	**132,963**	**79,778**		**39,889**	**13,296**	**132,963**	

2) Wood removals		Total removals m³	Removals by type: Industrial roundwood m^3	Fuelwood Biomass m^3	from env. protect. areas m^3	Total removals by genus m^3
Poplars	Indigenous					3,500,000
	Planted	3,500,000	3,500,000			
Willows	Indigenous					
	Planted					
	Total		**3,500,000**			

3) List of main cultivars/clones used in planted forests

Poplars: Cultivars/clones	%	End use	Willows: Cultivars/clones	%	End use
1) P. x euramericana			1)S. alba		
2)P. deltoides			2)S. excelsa		
3)P. nigra			3)S. acmophylla		

4) Tree ownership		Public ownership %	Private corporate ownership %	Private smallholder ownership %	
Poplars	**Indigenous**	100			100
	Planted	2	98		100
	Agroforestry				
Willows	**Indigenous**				
	Planted				
	Agroforestry				

5) Forest products from poplars

Fuelwood chips	Indust. roundwood (logs, pulpwood)	Wood-pulp (mech. or chem.)	Particle/fibre-board (MDF, (hardboard)	Veneer sheets	Plywood	Sawn-timber	Total
1000 m^3 (r)							
539	1435	42	203	753		529	**3501**

6) Forest products from willows

Fuelwood chips	Indust. roundwood (logs, pulpwood)	Wood-pulp (mech. or chem.)	Particle/fibre-board (MDF, (hardboard)	Veneer sheets	Plywood	Sawn-timber	Total
1000 m^3 (r)							

Grand Total forest products from poplars and willows (1000 m^3 (r)) 3501

LIST OF IPC PUBLICATIONS

IPC/1 (English only)	Abstracts of papers and posters presented at the 21st Session of the Commission, Portland, Oregon (USA) (24-28 September 2000)
IPC/2 (English only)	Abstracts of papers and posters presented at the 22nd Session of the Commission, Santiago (Chile) (29 November-2 December 2004)
IPC/3	Synthesis of Country Progress Reports – Activities related to poplar and willow cultivation and utilization, 2000 through 2003
IPC/4 (English only)	Publications Listed in Country Progress Reports, November 2004
IPC/5 (English only)	Abstracts of papers and posters presented at the 23rd Session of the Commission, Beijing (China) (27-30 October 2008)
IPC/6	Synthesis of Country Progress Reports – Activities related to poplar and willow cultivation and utilization, 2004 through 2007
IPC/7	Publications Listed in Country Progress Reports, October 2008
IPC/8 (English only)	Field Handbook – Poplar Harvesting, October 2008
IPC/9 (not yet published)	Poplars and Willows in the World
IPC/10 (English only)	International Workshop “Improve the contribution of poplars and willows in meeting sustainable livelihoods and land-use in selected Mediterranean and Central Asian countries”, Izmit (Turkey), 27-31 July 2009
IPC/11 (English only)	Abstracts of papers and posters presented at the 24th Session of the Commission, Dehradun (India) (30 October-2 November 2012)
IPC/12	Improving lives with poplars and willows. Synthesis of Country Progress Reports – Activities related to poplar and willow cultivation and utilization, 2008 through 2011, October 2012.
IPC/13 (English only)	Publications Listed in Country Progress Reports, October 2012