



THE REPUBLIC OF CROATIA
MINISTRY OF AGRICULTURE
CROATIAN POPLAR COMMISSION
Planinska 2a, 10 000 Zagreb

Period: from 2016 to 2019

I. POLICY AND LEGAL FRAMEWORK

Transitional processes in Forestry in the Central European countries take place in the context of great economic importance of their forestry resources, good forest preservation and a long tradition of forestry management, but at the same time in the context of insufficient organizational and technical level of all aspects of forestry management. One of the important tasks in the transition is related to the increasing of overall results of the forestry management. The key condition for this is raising the quality and level of training of forestry employees. The Republic of Croatia is joining the European Union and in the last period harmonized its legislation with the European Union (Nature Conservation Act, Act on Agricultural Land, Water Act and the Act on Forest Reproductive Material). Act on Short Rotated Woody Forest Cultures (2018) and Air Protection Act as well as the Climate Change and Ozone Layer Protection Act (2019) have been adopted. Using species from genus *Alnus*, *Betula*, *Carpinus*, *Miscanthus*, *Populus*, *Salix* and *Paulownia* are allowed by Regulation Act (2019) which also incorporates basic terms and conditions for their cultivation in short rotated culture but only on forest and marginal or abandoned agricultural lands.

II. TECHNICAL INFORMATION

1. Taxonomy, Nomenclature and Registration

During the previous period no more new registration was made.

The multiclonal approach in poplar and willow plantations is being practiced in the Republic of Croatia. The clone arrangement is mosaic. For the purpose of the exact identification of single clones in the nursery reproduction, as well as in the planting on the ground, the plans are being kept. All the poplar and willow selected clones are entered into the live archives in order to preserve the selected material through the 'ex situ' method, and for the identification of particular clones.

On the territory of Croatia, on various types of hydromorphous soils, the clone tests of poplars and arborescent willows are established for the purpose of selecting the genotypes that are best adapted to the given habitat. The tests of poplars include different selections of American black poplar (*Populus deltoides*), hybrids of American black poplar and European black poplar (*P. x euramericana*), hybrids of American black poplar and balsam poplar (*P. x interamericana*), as well as the clone tests of *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 the autochthonous 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 the max. production potential with the stem quality, and those poplar and willow clones which will give the satisfactory production on the so called atypical habitats for poplar and willow silviculture (e.i. the oak and ash habitats) and which can come in useful for the establishment of pre-cultivation for the purpose of easier reforestation of common oak and narrow-leaved ash. There are relatively many atypical habitats for the cultivation of poplar and especially stemlike willow silviculture in the area of the Sava river.

In total there are fifteen poplar clones and eleven willow clones in the reproduction, which are acknowledged and recorded.

2. Domestication and Conservation of Genetic Resources

Poplar

***Aigeiros* section**

Autochthonous black poplar (*Populus nigra*)

The preserving of the genetic resources of European black poplar (*Populus nigra*) through the 'ex situ' method started with the selection and autovegetative propagation of adult trees. The selection is carried out and is being continued on the area of the Sava, Drava, Danube and Mura rivers. The selection of black poplar is also carried out in Bosnia and Herzegovina, and 74 clones being included in this kind of the conservation programme has successfully been multiplied.

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 with the discriminant analysis. The analysed species differ significantly in all five investigated morphological traits. The role of the hairy black poplar in the conservation of forest genetic resources and its effects on climatic changes were studied.

Clone archive was established in the Darda forest management area in spring 1998. For now, the second archive contains 63 European black poplar clones, and will successively include repair planting, taking into consideration the old trees selection and reproduction programme. In the nursery reproduction there are yet another 15 clones which will be included in the clone archives.

The preservation of European black poplar and natural poplar stands through the 'in situ' method is under the permanent protection either of the Nature Park (Kopački rit) or of the special reserve of forest vegetation (Vukovar Danubian islets).

Through the programme of European black and white poplar conservation we are included in the European programme EUFORGEN (Bioersivity International). The 'in situ' method in general represents the preservation of the genetic conservation units, taking into account their number and geographical distribution. As a result, the area of riparian forests along the river Drava (the Slatina Drava river basin

forests) was exempted from the regular management as a genetic conservation unit for the protection of the black and white poplar in the area of about 200 ha. This area represents the dynamic preservation of the poplar genetic fund in the Drava basin, and is included into the European network of genetic conservation units (EUFORGEN).

Restoration of this species population and their importance, especially in habitats where riparian areas and their ecosystems have disappeared, represent a great genetic potential and future populations for longer periods of time, while restored and preserved poplar populations represent an important contribution to the preservation of a complex ecosystem.

From the foresters' point of view, biomass as a source of energy can be produced from genetically improved fast-growing trees in short rotation cultures or plantations. In Croatia, research work connected with the issue started at the beginning of the 1990s and was focused on selected arborescent willow clones (mostly white willow).

Leuce section

With the kindness of CREA-PLF (Casale Monferrato, Italy) as a breeder of *Populus alba* clone 'Villafranca' may be freely propagated, commercialized and use on the territory of the Croatia. The public enterprise company Croatian Forests has expressed interest in using 'Villafranca' clone for reforestation purposes.

To preserve the genetic resources through the method 'ex situ' the selection of the white poplar trees (*Populus alba*) will begin. Regarding the whole state of the riparian forests in Europe, these areas are significant for preservation of biological diversity of the natural structures of Croatia. The researches refer to the management impacts in the floodable ecosystems and their influence on the dynamic processes in the populations of the black and white poplar and on the reforestation of the marshland forests as well as on the research of indicators to follow the evolution diversity in the marshland ecosystems.

Willows

The selection of the arborescent willows has been carried out in the natural populations on the area of Croatia. The plant breeding was done in the intra species hybridization. The inter-species hybridization was performed as an intrapopulation and interpopulation hybridization. The Chinese willow (*Salix matsudana*) was used as the partner to the inter-species hybridization of the autochthonous white willow. The selection of the arborescent willows was aimed to create clone collection which will be used:

to establish intensive plant cultivation on the optimal sites;

to establish plant pre-cultivated plants on the atypical willow sites for easier reforestation of more valuable species of deciduous species (common oak and narrow-leaved ash);

to establish special plantations for biomass production in short rotations.

Willows compared with other species are the most suitable for biomass production in short rotations because of their very abundant growth during the first years. Nowadays, in Croatia, a large number of selected and registered willow clones are available. The main objective of the research should be to find genotypes which, with minimum nutrients, will produce the maximum quantity of biomass.

Clonal test of the arborescent willows includes the autochthonous White Willow (*Salix alba*), interracial hybrids of the autochthonous White Willow and the English 'cricket' Willow (*S. alba* var. *calva*), interspecies hybrids (*S. matsudana* × *S. alba*), as well as multispecies hybrids of willows. Average production of dry biomass (DM ha⁻¹ a⁻¹) per hectare was estimated in regard to the clone, survival, spacing and the number of shoots per stump.

The highest biomass production as well as the best adaptedness and phenotypic stability on testing site was shown by clones ('V 374', 'V 461', 'V 578' from 15.2 – 25.0 t DM ha⁻¹ a⁻¹) originated from backcross hybrid *S. matsudana* × (*S. matsudana* × *S. alba*) and by one *S. alba* clone ('V 95', 23.1 – 25.7 t DM ha⁻¹ a⁻¹). These four clones underwent DUS testing in Poland and are now registered as new plant varieties. These results indicate significant potential for further breeding aimed at biomass production in short rotations.

Willow clones showed high biomass production on marginal sites and dry biomass could be considerably increased with the application of intensive silvicultural and agrotechnical measures. No nutrition or pest control measures were applied (a practice otherwise widely used in intensive cultivation system), while weed vegetation was regulated only at the earliest age.

In the past research, the arborescent willow clones have shown the highest potential for the biomass production in short rotations. For this reason, the testing of arborescent willow continued, with the aim of identifying the clones with the biggest potential for the biomass production, especially on the so-called marginal habitats, *i.e.* grounds on which the agricultural production stopped and /or which are not suitable for the cultivation of valuable forest trees.

3. Plant Health, Resilience to Threats and Climate Change

The poplar wood production in monoclonal or oligoclonal plantations with the large increment of the selected clones represents one of the biggest risks for the plant disease and the outburst of noxious insects and other injurious organisms. The survey is given for the period under review regarding the nurseries and plantations health conditions with the attention paid to the work of control and protection against pests.

a) Biotic Factors

Health Conditions

The rust disease on the poplar and willow leaf (*Melampsora sp.*) appears in the second half of the vegetation period and especially in the autumn and therefore represents no more significant danger.

Cancer of the poplar bark (*Dothichiza populea* Sacc. Et Br.) in the Drava valley is a very spread disease, and causes significant damage whenever the plants weaken physiologically (during planting, arid periods etc.) From 1999 the disease begins to occur in some clones which have been considered very insensitive (for instance clone 'S-1-8').

In the central Croatia the disease of bark *Glomerella miyabeana* on the willow seedlings was confirmed. It causes the red fire disease and arson of willow bark. The disease appears on one side of the plant and the wild fire and bark decay expand all over the seedling. The fungus is very dangerous since in two weeks it can destroy the complete plantation. Beside the preventive sprinkling of the seedlings in

the nurseries there are no other known protection measures. The infected seedlings should be cut and burnt.

The disease *Pollaccia saliciperda*, seasoning of willow sprouts, generally less known disease of willow is diagnosed in the same area.

The spring pest defoliators have been recorded each year in the foliation period. The significant damages are not noticed and the control is regular. The pests which are noticed are *Operothera brumata* L *Melasoma populi* L., *Phyllodecta vitelinae* L., *Phylobius* sp., *Polydrosus* sp., *Rhabdophaga salicis* Shrank., *Helicomyia saliciperda* Duf., *Phyllocnistis suffusella* Z., *Lithocoletis populifoliella* Fr. but they are in latency or under our control.

Dusky clearwing (*Paranthrene tabaniformis* Rott.) damages the plants of American black poplar (*Populus deltoides* March.). Preventive treatment is carried out as necessary. Before the swarming of the hornet moth, poplar stems are treated with contact insecticides. Occasionally in the old stands, a hornet moth (*Aegeria apiformis* Clerck) appears, against which no particular preventive treatments were carried out. In the years with severe late spring frosts, poplar trees which suffered under low temperatures, are affected by distinctively secondary Trypophloeus species, which otherwise do not appear in large numbers.

Some habitats become unproductive for poplar due to the change of habitat and the subsequent outbreak of thrips (*Lispthrips crasipes* Jabl.), which was in mid 1990s a subject of intensive study of experts from the Osijek branch of "Croatian Forests", and entomologists from the Faculty of Forestry in Zagreb. The pest was successfully treated by a phenologically adjusted application of contact insecticides, but the main reason for its appearance has always been of physiological nature – the problem of dry periods and stress through which the young poplar trees suffer in these areas.

Harmful Influence of Other Biotic factors

In the newly planted poplar plantations great damages are done by the red deer (*Cervus elaphus* L.) through breaking plants while the hare (*Lepus europus*) barks the willow seedlings.

The study of weed flora and weed killing is done every year adjusting the way and method to the weed species and new herbicides.

Pest and Disease Control

Regular diagnostic and prognostic service following the disease outbreak and pests is organized to give the instructions for the control and wiping out (Croatian Forest Research Institute, CFRI). The seedlings in the nurseries must be examined twice a year by the authorized state organization for phytosanitary examination (Institute for Plant Protection).

The brown leaf blight of poplars (*Marsonina brunea*) is wiped out when the number of acervules on the leaf is increased (3-5p./cm²) and preventively in nurseries. The study of the control possibility of *Melampsora* sp. showed that the best results are achieved by the device Impact (Propikonazol).

Fenitrotion or some other similar devices are used for the efficient control of Byctiscus as well as for the other pests; piretrods (Fastac or Decis) can be also used.

Weeds are under control through the mechanized killing and the rest of surface around the seedling itself is eliminated manually or by herbicides. The best results are achieved with 'parakvat' (600 gr/ha) and 'glifosat' (around 1-3 l/ha).

b) Abiotic Factors, Thunderstorms

In June 2016, Osijek region in Eastern Croatia was affected by thunderstorms which badly damaged some poplar cultures along Drava river on area 700 ha in total.

4. Sustainable Livelihoods, Land-use, Products and Bioenergy

a) Nursery

The production of poplar and willow plants is mainly connected with the specialized nurseries, often near the areas where the seedlings are used.

The poplar and the willow plant growing are based exclusively on the autovegetative propagation capability. The starting material are lignified cuttings being cut from one year sprouts, and one year root of one year plant rootling after the above ground part is cut off.

The cutting works and new cycle establishing are done in spring (March and April) of the current year.

Since poplar and willow seedlings productions are in their essence, as well as in the planting production organization similar, some common characteristics apply for both. Generally, the production is organized in the way that a part of the area is in the plant production function, and a part in the preparation process for the future production cycle. The ratio of the active surface and the one in the preparation process is approximately 2:1 (two-year production cycle). The seeding of the leguminous plants, as well as other herbaceous species, which result in a large biomass production, is done on the fallow land.

In the peak luxuriant growth phase, the green fertilisation is performed through ploughing in of the plant mass. Periodically the plan manuring with farmyard manure is also performed in order to enrich the soil with micro-elements and to improve microbiologic soil activities.

The spacing between the rows (140-165 cm) is adjusted to the smaller abarticulation tractors width and operating machines for inter-row cultivation. Every forth to eighth row is wider (240 cm) and serves for the larger tractors and trailing implements (atomizers and sprayers) to perform protective activities.

Since the production is carried out in the areas with little rainfall (600-700 mm for East Croatia) with the presence of summer droughts, the additional water supply is necessary. The watering is adjusted to the existing water sources (watercourses, wells) and the available equipment. The most frequent way is the artificial rain application.

Soil cultivation is performed several times, in an inter-row, by machines, and hilling by hand is performed twice or three times during the vegetation period.

In the first part of the vegetation period the nourishment with mineral manure of NPK compound is performed with about 350 kg per hectare. The tests with the foil nutrition are also performed.

Agricultural tractors with the attachable units are the mechanization used for soil preparation. In soil cultivation, smaller abarticulation tractors with attachments are used for soil loosening. The situation

is similar with the protective activities, but the attachments are adjusted to specific conditions (increased height application). The ploughs are present as the specialized machines for cuts skidding for planting the roots and for taking out the seedlings.

The smaller equipment being applied lately, it is worth mentioning the pneumatic secateurs, which are used in the root separation process and for making cuttings.

The general characteristic, though, still is a significant participation of the manual work (placing down the cuttings, hilling, elimination of redundant shoots, help in taking out the seedlings and treatment of the seedlings after taking out).

The production of rooted seedlings is practiced in the poplar planting production. This includes one-year 1/1 and 1/2 and two-year 2/2 and 2/3.

The reproduction material is mainly produced on special areas, so-called 'root swellings'. The production is annual, and the produced plant is called swelled root. Their production is about 70,000 pieces per hectare. Root-swellings can give 3-4 quality cuttings and a root. The cuttings serve as the starting material both for further reproduction (re-establishing of the 'root swelling') and establishing of the plants 1/1 and 2/2 production. The root is used for the production of the 1/2 and 2/3 seedlings. As the spacing is the same in the establishing process (140 cm x 60 cm), the final production of seedlings ready for planting (2/2 or 2/3) is about 8,500 pieces per hectare. In the lesser degree, in the western part of Croatia, the simultaneous production of reproduction material and seedlings for planting production is being practiced. The production of seedlings is based on the cuttings and in the arrangement (165 cm x 35 cm). After one year, the sprouts are cut and used for further production (cuttings), and the root stays in the same place and is used for the production of plants 1/2 or 2/2.

In the willow planting production, there are two ways of reproduction material and seedlings production.

The first way being practiced in the Eastern Croatia is based on the production of the root swelled plants 1/1, 1/2 and 2/2. The reproduction material is produced together with the seedlings production.

The production is based on the cuttings (140 cm x 24 cm). After the first year a part of annual shoots is cut in order to make the cuttings for the new production. After the second year, the 1/2 seedlings develop from the roots which remain in the same place. On the part from which the shoots are not taken for cuttings, the seedlings 2/2 develop.

In the western part of Croatia, the planting material is made in the stool bed which is used for several years for the production of the plants without root 1/0 and 2/0.

For storage of cuttings from the moment of creation until the time of planting in the eastern Croatian is used refrigerator for cutting material introduced in the production 2009. year.

The clone material used for the production of poplar seedlings is *Populus × euramericana*, *Populus deltoides*, and *Populus alba*: 'M-1' (30%), 'S-1-8' (36%), 'Pannonia' (33%), '710', '54/76-8', 'S-1-3', 'S-1-5', '56/3', 'V 609', '79/41', '155/81', '182/81', 'B 173', 'B 31', and 'Villafranca' (1%).

The clone material used for the willow plant production is 'V 158', 'V 160', 'B44', '107/65/7', 'V 093', 'V 052', '378', 'B72', 'B84', '107/65/1', 'V99' and others.

b) Planted Forests

Plantations

The plantation areas and the ones with the intensive poplar and willow cultivation are most frequently in combination or in close vicinity of the existing large forest tracts, thus forming economic entirities with them.

The development programme supports this aspect of production on light alluvial soil (habitats of natural stands of broad-leaved soft species) along the Drava and the Danube with two especially significant areas: the course of the Drava in the north at the mouth of the Mura river, and in the eastern Croatia the area at the mouth of the Drava river, and in the Croatian part of the Danubian area. The alluvium of the Sava river, due to heavy soils, as well as to poor results achieved on the plantations afforested between the sixties and eighties is not planned for further upkeep of this production. The conversion of the existing plantations of poplars into climatogenic units of common oak is almost completed in this area.

The important fact for this production is that 80% of the forest area in Croatia is owned by the state, and concerning poplar and willow plantations, this percentage is a little bit lower and amounts to 66%. The existence of the so called 'marginal' land, which is not suitable for agricultural production, either privately or state owned, presents the potential for further development and increase of the production, which is nowadays reduced mainly to reforestation of the new plantations.

It is important to point out that, contrary to some neighbouring countries, and due to the lack of stimulating measures of the state, plantation afforestation is still restricted mainly to the state-owned land.

Certain measures of state policy on the use of land, as well as the fiscal and incentive measures (tax exemption, credit, provision of plant material and technology support) could help poplar and willow cultivation on privately owned marginal land. These processes, to a lesser degree, are initially present, but on the local level.

Two technologies are being applied in the current practice with poplars and willows. The plantation technology is applied in the best habitats with the usage of agrotechnical measures, and the cultures technology without the usage of agrotechnical measures. What they have in common is the usage of selected plant material, mechanized planting, planting depth (depending on the sand layers and ground water level).

Regarding the selected clone material, there are 16 registered clones of poplar in Croatia and about 20 clones in the experimental planting production, which are partly present in the production tests in the projects and in clone archives. The clone production palette is corrected continuously, every year, in practice based on single clones sprouting and growing progress analyses, which are carried out over many years. Compared to the situation in the eighties, the portion of plants *P. x euramericana* is somewhat larger in relation to *P. deltoides*. A clone of white poplar (*P. alba*) is present in the experimental production.

There are 11 clones with the recognized right (registered) of use in willow production. In the experimental production, mainly in the nursery, but also in the established clone archives there are additional 240 clones. For the selected clone material, it is significant that it is the inter-species white

willow hybrids, which are obtained by the controlled hybridization, which is the material derived from the autochthonic natural stands.

Two-year seedlings (2/2, 2/3) are mainly used in the production of the poplar planting material. The use of the two-year seedlings is conditioned by the planting depth and the possibility of the protection from the game (individual protection). The one-year-old and two-year-old plants are used in willow production with root (1/2, 2/2) or without root (2/0). The growth arrangement is used during the planting, most frequently from 5 to 10 clones with a larger or smaller portion of the single clone. The arrangement is not completely accidental and is partly dependent on the arrival of the plants from the nursery (sequence of lifting). The clones are marked with the permanent mark (colour combination).

Deep planting is in predominant use in plantation afforestation in Croatia. It is conditioned by the climatic, pedologic and hydrologic habitat characteristics (little rainfall quantities, summer droughts, large portion of sand in the soil, groundwater level). The planting depth is frequently 2-3 m, planting pits are made by mechanization, by the use of contemporary hydraulic drilling machines.

The following particularities are present regarding the plantations: the soil preparation is done solely by heavy disk harrowing, as stump chipping is not practiced any more, and the new plantations are put up only on the new plots of land. The deep ploughing or trenching is not practiced, partly due to the lack of adequate equipment, and partly due to the sandy soil where this activity is not necessary. Plants are planted in the hexagon arrangement 6.5 x 5.63 m (273 pieces per hectare). The soil tending in the plantation is done with the heavy disk harrow in an inter-row way 2-3 times per year, for up to 5 years. The inter row seeding of the agricultural crops (row-crops) in the first two, three years is not largely used. In regular management there is neither irrigation nor dressing of the plantations. The pruning of the branches is performed three times: in the 2nd or 3rd year (double-top correction), between the 7th and 9th year. The aim of the activity is 8-10 m of the solid trunk. This work is done by the hand tools (saw, budding knife). To perform one operation 1 to 4 workers are needed per hectare. The rotation of poplar plantations is between 15 and 20 years. A little longer rotation is in the function of the quality roundwood production (logs for rotary cut).

On good sites, the production of the net mass can in the course of 20 years reach about 350 m³, 80% of logs (for rotary cut and sawing) and about 20% of thinner roundwood and pulpwood. Thinning is not done in the poplar plantation (except the sanitary ones).

It is important to point out the problems in poplar management that arise in the area of lower Drava, upstream of the town Osijek, in the area where the influence of the Danube flood waters is not felt. For some cultures and poplar plantations, which were planned for the logging, it has not been decided yet whether to cultivate poplar in the next generation or to substitute species. A project started, which includes a complex research in pedology, phytopathology, physiology and cultivation, as well as works in selection and improvement with the aim to examine the possibility of restoration of poplar plantations after a few rotations in a particular habitat. Indirectly, we will get data about the productivity of poplar, the nutrition status, watercourse regimen, pedological and phytocenological circumstances in the area along the river Drava.

Intensive cultivation plants

Intensive cultivation plants are planted after the clear cutting of previous plants or natural stands that were not naturally reforested.

During the preparation, the weed vegetation is eliminated with various mechanized flail shredders. The planting is in rows in the square arrangement. The spacing of poplars is mostly 6m x 6m, in a lesser degree (western part of Croatia) 5m x 4m. The frequent spacing regarding willows is 3m x 3m and 4m x 4m (shorter spacing on heavier and flooded soils).

Several years after the planting, the mechanized inter-row weed control is carried out and hoeing around the poplar plants in the first 2 years. These measures protect from low fires, which are frequent, especially in the spring months after dry winters without snow.

Branch pruning is done with the poplar and willow cultivation plants, but not in the same volume and with the same intensity as in plantations because of the presence of underwood layer (pax ash, ashleaf maple, white elm and others) which frees the poplar trees of branches.

Rotations of poplars and willows are from 25 to 30 years. In the course of the production cycle, the thinning is done only in the willow plantations.

The possibility to cultivate mixed white willows (*Salix alba*) and black alder (*Alnus glutinosa*) exists on the peat-gley soils in the central Drava basin (Đurđevac).

c) Naturally Regenerating Forests

Concerning forest stands, three basic managements form are distinguished. First, the natural stands derived from the seed. This form is present with the first generation of the stands which are formed in the riverbeds meandering process and the formation of new surfaces of alluvial deposits, or by filling the parts of the previous watercourse riverbed. These stands are managed according to the principles of managing the natural stands, with the regular tending and cleaning of the young stands and thinning of the full-grown stands. The rotation is up to 60 years.

The other form is made up of the coppice stands (sucker forests) which mostly appeared after cuttings and because of difficulties with the seed reforestation. The most efficient reforestations with the root suckers are in the white poplar cultivation (*P. alba*). The young seed stands can turn into coppice forests if they are used irrationally for a longer period of time, in order to obtain handy material for waterworks (fascine material). These stands are managed similarly to the natural stands, but the rotation is up to 40 years.

Fairly frequent and mixed stand form derived through the repair planting of the unreforested parts of natural stands after the clear cuttings by selected poplar and willow clones. These stands, depending on the species participation, are managed similarly to natural stands or crops. During autumn of 2019 in strictly protected area near the mouth of the Drava river 86 ha have been reforested by using one-year old seedlings of European black poplar.

Problems that arise in the management of poplar along the entire flow of the river Drava, upstream of the town Osijek are reflected in the stands intended for cutting which have a very limited number of trees, small volume and average diameter. In young stands there is also a high number of dried up trees, the stands stagnate in their development, and the desired effect is not achieved by replanting. In this case too, the condition of stands and the insight into the data of basic management signify the need for the substitution of species.

In natural forests, together with poplars and willows, there is also *Ulmus laevis*, and in fragments also succession advanced towards common oak stands, narrow-leaved ash (*Fraxinus angustifolia*) and

common oak (*Quercus robur*). In the western and central parts of Croatia the black alder (*Alnus glutinosa*) and white alder (*Alnus incana*) come up as well. The black alder makes independent coherent stand tracts in the central part of the Drava basin (surroundings of Đurđevac). In the intensive poplar cultivation period, other species were experimentally introduced in order to lessen the negative monocultural affect. In addition to the black alder, the ashleaved maple (*Acer negundo*) was also used and especially white ash (*Fraxinus americana*). In East Croatia these two allochthonous species have extraordinarily adapted to the habitat conditions and thanks to the natural reforestation they propagated on the large area. The black locust (*Robinia pseudoacacia*) and mulberry tree (*Morus* sp.) appear in some parts of these forests.

The research has shown possible cultivation of the selected clones of white willow in association with the black alder. On the peat-gley soils of the Drava basin these two species can be cultivated without any harmful consequences, but the longest period is up to the 8th year of plantation activity. After that it is necessary to cut the white willow if the black alder is to be favoured as the main species. This experiment proves as well that black alder beside its meliorative role has a great influence on the weed vegetation dynamics concerning the quantity and durability and connective nutrients.

d) Agroforestry and Trees Outside Forests

Row plantations

The management type of row plantation afforestation along the canals and roads is not very common. Mass application of agricultural aviation caused the elimination of the previous row plantations, which as a rule, are not reforested.

e) Harvesting and Utilization of Poplars and Willows and OFGS

Forest and intensive culture logging are carried out classically in three phases: cutting and working up, hauling and transportation. The cutting and working up is done by power-saws, individually, predominantly by assortment method and working up longer wood for chemical processing. The felling is done in the dominant wind direction on the plantations because of the shorter hauling time per product unit. In last period, productivity of logging has been quite improved by using harvesters. The hauling is done by the tractors, mainly specialized for forestry (forwarders), but also by the adjusted agricultural tractors. Transportation is mostly done by trucks and by railway, in case of longer distance.

In recent years, exploiting the wood waste that remains after logging and development so that it forward on the forest road where it is grinded and sell as forest biomass for energy production.

5. Environmental and Ecosystem Services

The strategy for genetic characteristics preservation of autochthonous poplar can be divided into three operational goals:

- Insure the optimum quality of natural restoration
- Prevent the loss of biodiversity in the next generations
- Define and preserve the local genetic basis

Plans for environmental management on protected areas insist on full replacement of allochthonous with autochthonous species. For the strategy of replacement of Canadian poplar clones with European black poplar, foresters propose the period of 50 years. During that period of restoration, it is necessary to plant only about 25% of selected allochthonous species.

III. GENERAL INFORMATION

1. Administration and Operation of Natural Poplar Commission or equivalent Organization

Republic of Croatia has been internationally recognized state since 15th January, 1992, and the first initiative for membership in the International Poplar Commission was sent on to FAO in Rome on 9th March 1992. By voting on 23rd September, 1992, at the 19th session in Zaragoza, Spain the Republic of Croatia became the member of International Poplar Commission. It was more than a year before the general membership in FAO. This certainly shows the interest of the Republic of Croatia in the work in I.P.C.

The minister of regional development, forestry and water management in 2011 appointed on period of two years the following members of the Croatian Poplar Commission: Sanja Perić, PhD (chair), Miljenko Županić, MSc., (secretary), Milan Oršanić, PhD, Davor Prnjak i Stanko Antunović.

2. Literature

- Kajba, D., Ballian, D., Idžojić, M., Poljak, I., Andrić, I., 2016: Morphological variability of hairy and typical European Black Poplar (*Populus nigra* L.). FAO/IPC 25th Session Berlin, Germany, 13-16 September 2016, Poplars and Other Fast-Growing Trees – Renewable Resources for Future Green Economics, 18p.
- Kajba, D., Andrić, I., 2016: Selection of White Willow (*Salix alba* L.) and Chinese Willow (*Salix matsudana* Koidz.) for biomass production. FAO/IPC 25th Session Berlin, Germany, 13-16 September 2016, Poplars and Other Fast-Growing Trees – Renewable Resources for Future Green Economics, 44p
- Vusić, D., Šafran, B., Švenda, M., Kajba, D., Zečić, Ž., 2016: Results from the first Croatian SRC poplar plantation. Proc. Natural resources, green technology & sustainable development 2, 5th-7th October 2016, Zagreb, Croatia, 101p. ISBN 978-953-6893-03-4
- Posavec, S., Kajba, D., Beljan, K., Borić, D., 2017: Economic analysis of short rotation coppice investment: Croatian case study. Austrian Journal of Forest Sciences 134: 163-176.
- Vusić, D., Kajba, D., Andrić, I., Gavran, I., Tomić, T., Plišo Vusić, I., Zečić, Ž., 2019: Biomass Yield and Fuel Properties of Different Poplar SRC Clones. Croat. J. for. Eng. 40 (2): 231-238.

3. Relations with other countries

On behalf of the Croatian Poplar Commission, the international collaboration was established by the Ministry of Regional Development, Forestry and Water management, as well as Faculty of Forestry in Zagreb, Croatian Forest Research Institute and Public Company "Croatian Forests", Ltd.

It is necessary to emphasize exceptional cooperation with: Bioversity International (EUFORGEN), Rome, Italy; Forestry Research Institute, Sárvár, Hungary, CRA-ISP Casale Monferrato, Italy.

IV. SUMMARY STATISTICS (Questionnaire)

Table 1. Area

| Land Use Category | Total Area 2019 (ha) | Total area by forest function in % | | | | Area planted from 2016 - 2019 (reforestation and afforestation) (ha) |
|-------------------------------|----------------------|------------------------------------|----------------------|----------------|-------------|--|
| | | Production | | Protection (%) | Other * (%) | |
| | | Industrial roundwood (%) | Fuelwood biomass (%) | | | |
| Naturally Regenerating Forest | | | | | | |
| Poplars | 12.858 | 24,3 | | 8,8 | 66,9 | |
| Willows | 11.629 | 29,0 | | 10,5 | 60,5 | |
| Mix of P&W | | | | | | |
| OFGS* | | | | | | |
| Planted Forest | | | | | | |
| Poplars | 43 | | | 2,6 | 97,4 | 91 |
| Willows | 4.667 | 47,8 | | 2,9 | 49,3 | 56 |
| Mix of P&W | | | | | | |
| OFGS* | | | | | | |
| <i>P.xeuramericana</i> | 11.266 | 33,7 | | 3,6 | 62,7 | 1095 |
| Other Land with Tree Cover | | | | | | |
| Agroforestry | | | | | | |
| Poplars | | | | | | |
| Willows | | | | | | |
| Mix of P&W | | | | | | |
| OFGS* | | | | | | |
| Trees in urban settings | | | | | | |
| Poplars | | | | | | |
| Willows | | | | | | |
| Mix of P&W | | | | | | |
| OFGS* | | | | | | |
| Grand Total | 40.463 | | | | | 1242 |

* Protected by Act of Nature Conservation

| | increase | decrease | remain as it is | no coment |
|--|----------|----------|-----------------|-----------|
| 1a. The conversion of naturally regenerating forests of poplar to other land uses will ... | | | x | |
| 1b. The conversion of naturally regenerating forests of willow to other land uses will ... | | | x | |
| 1c. The conversion of naturally regenerating forests of other fast growing species to other land use will ... | | | | x |
| 2a. The conversion of planted forests of poplar to other land uses will ... | | | x | |
| 2b. The conversion of planted forests of willow to other land uses will ... | | | x | |
| 2c. The conversion of planted forests of other fast growing species to other land uses will ... | | | | x |
| 3a. The area of poplars for bioenergy plantations will ... | | | | x |
| 3b. The area of willows for bioenergy plantations will ... | | | | x |
| 3c. The area of other fast growing trees for bioenergy plantations will ... | | | | x |
| 4a. Government investments in poplars will ... | | x | | |
| 4b. Government investments in willows will ... | | x | | |
| 4c. Government investments in other fast growing trees will ... | | | | x |
| 5a. Private sector investments in poplars will ... | | | x | |
| 5b. Private sector investments in willows will ... | | | x | |
| 5c. Private sector investments in other fast growing trees will ... | x | | | |
| 6a. The significance of poplars for productive purposes will ... | | | x | |
| 6b. The significance of willows for productive purposes will ... | | | x | |
| 6c. The significance of other fast growing trees for productive purposes will ... | | | | x |
| 7a. The significance of poplars for environmental protection purposes will ... | | | x | |
| 7b. The significance of willows for environmental protection purposes will ... | x | | | |
| 7c. The significance of other fast growing trees for environmental protection purposes will ... | | | | x |
| 8a. The rejection by environmental groups of poplars will ... | | | x | |
| 8b. The rejection by environmental groups of willows will ... | | x | | |
| 8c. The rejection by environmental groups of other fast growing trees will ... | x | | | |
| 9a. The acceptance by the general public of poplars as important natural resources will ... | | | x | |
| 9b. The acceptance by the general public of willows as important natural resources will ... | | | x | |
| 9c. The acceptance by the general public of other fast growing trees as important natural resources will ... | | | x | |