PAULOWNIA FOR BIOMASS PRODUCTION

INTRODUCTION

The first fuels used by humans were timber biomass and even nowadays it remains the main energy source for more than half of the world's population. The biomass in global aspect of energy consumption is evaluated between 11 and 14%. Climate changes and fossil fuel supply insecurity has led to increasing interest and realisation of sustainable biomass production systems.

PAULOWNIA AS A BIOMASS SOURCE

The calorific value of Paulownia biomass is little over 50% than the one of the coal (as with the rest of the wooden biomass species) but the lower content of pollutants such as sulfur and the fact that Paulownia is a renewable resource clearly points to its environmental benefit. Paulownia wood has the advantage of lightness and substantially reduces the transportation costs comparative to other woods – at normal conditions it will rapidly air dry to moisture content between 10 and 15%. Open air dried the wood density generally ranges between 260-330 kg/m^3.

By correct cultivation Paulownia is definitely one of the most rapidly growing plants. Paulownia uses highly efficient photosynthesis to include carbon inside its metabolic pathways. Within a Paulownia plantation soil carbon levels increase from the accumulation of organic matter at the time of defoliation and due to the large root system that has an important function as regards to the carbon reception. Paulownia could be cut from the same root system at least 4 - 5 times consistently improving the soil by its growth, and thus its turning it into a truly sustainable culture compared to other biomass systems.

REQUIREMENTS FOR GROWING PAULOWNIA

As regards to the the climatic conditions paulownia grow effectively in the range from temperate to tropical climate. Different Paulownia cultivars tolerate temperatures in the range from -20 to 47°C. The optimal temperature for growth of trunk diameter and height is around 27°C. Annual rainfall within the natural distribution of Paulownia ranges from 500mm to 3,000mm. To promote rapid growth for commercial scale production of timber in a warm climate at least 700mm of rain is required during the peak growing season (late spring to early autumn) or supplementary irrigation system should be installed. Paulownia will grow in a wide range of soil types but prefer deep, well-drained soil rich in nutrients or supported with fertiliser application.

Weed control should be close to total within at least a 1m around the trunk and the soil must be kept trenched. The weed in middle of the rows may be kept slashed.

Paulownias are trees with enormous growth potential under ideal conditions but will perform badly in poorly selected sites or if mismanaged. BIO TREE company could assist you through this process with a detailed consultation and information – from the terrain selection and planting scheme to the biomass yield.

PATTERN FOR PAULOWNIA TIMBER BIOMASS PRODUCTION

The most important supply for a Paulownia plantation is sunlight for photosynthesis. This means that even if there are optimal inputs of water and nutrients, growth will be reduced when the trees begin to crowd each other and excessively compete for light. At that time the reduction of timber accumulation will be reduced. Biomass could be obtained also from waste material after harvesting of Paulownia cultivated for fine timber, generally planted at a density of 550-600/ha or less and grown for a period of 10 years. However the annual yield tons of dry matter (TDM) per hectare will be low relative to that possible from dedicated Paulownia biomass plantations.

The development of one plantation should start with the question "What will be the biomass used for?" (Used for ethanol production or combustion), and based on our experience with paulownia planting schemes correlating to different stem size requirements and harvest age, plantation modeling can determine optimal production systems.

The following models describe a requirement for woody biomass from single or poly stem trees of reasonably uniform size with a diameter measured at 1.3m of height at harvest greater than 7cm and not more than 15cm. The possibilities of different planting schemes single and multi-stem coppice regeneration may be advantageous under different feedstock requirements. Plantation methodology is moderately flexible and open to modification with the experience or if requirements change. The most difficult parameter to increase is the Stem/ha density after the plantation is established establishment but may be decreased.

POLYSTEM GROWING - PLANTATION FOR BIOMASS WITH 3300 PLANTS PER HECTARE AND DISTANCE IN BETWEEN 1.5m AND 2m

First cut at age of	Rotation period	Expected stem diameter	Expected mean yield per tree		Expected mean yield per hectare		Expected dry biomass per hectare	
			stems	total	Stems	total	stems	total
3 years	2 years	7 cm	0.057 m^3	0.093 m^3	188 m^3	307 m^3	48.91 t	80.01 t

MONOSTEM GROWING PLANTATION FOR BIOMASS WITH 3000 PLANTS PER HECTARE AND DISTANCE IN BETWEEN 1m AND 3.3m

First cut at age of	Rotation period	Expected stem diameter	Expected mean yield per tree		Expected mean yield per hectare		Expected dry biomass per hectare	
			stems	total	Stems	total	stems	total
3 years	2-3 years	10 cm	0.035 m^3	0.045 m^3	105 m^3	136 m^3	27.3 t	35.36 t
3 years	2-3 years	12.5 cm	0.059 m^3	0.077 m^3	177 m^3	231 m^3	46.02 t	60.06 t
3 years	2-3 years	15 cm	0.089 m^3	0.116 m^3	267 m^3	348 m^3	69.42 t	90.48 t

Thicker plantations allowing many stem growing are appropriate for certain conditions and certain purposes which are having aspects for maximum possible output. The growing technology could be modified and applied up to each specific case by the accumulation of knowledge or the change of the circumstances. The use of young planting material from especially selected hybrid cultivars of *Paulownia elongata* and *Paulownia fortunei* is recommended. The land should be cultivated and as a necessity to improve drainage or topsoil depth the

planting rows shall be mounded at a distance depending on the planting scheme. The young planting material can be planted using mechanical or hand tool methods at 1-1.5m spacing in the row. The trees must be planted into moist soil and immediately watered in. Fertilisers and possible irrigation requirements should be determined based on soil analysis and observed plant growth. The first growing season should be regarded as a period of root establishment and any trees less than 3 meters tall (in mono-stem plantation) at the end of this season should be coppiced to promote a stronger trunk to regenerate. The first harvest is expected to be around 3 years after planting. Each subsequent regenerated crop is likely to take 2 years to reach harvest size. In areas with warm climate a stem diameter around 10-12 см is normal for the plant. Due to the statistical generalization of the results used for the tables it could be expected stem diameters less than 10 and more than 15cm for mono-stem paulownia plantation.

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