Briefly

What is Alpenergywood

Alpenergywood is a virtual European wood-energy circuit set up as part of the Interreg III B Alpine Space community programme for 2003-2006. It comprises a series of actions, measures, and information initiatives of a scientific and informative nature, aimed at promoting wood as a renewable energy resource in the Alpine areas in Austria, France, Germany, Italy, Switzerland, and Slovenia. Wood is promoted as the driving force behind sustainable development, where environment protection goes hand in hand with the competitiveness of the entire field.

“Providing a sector platform for Short Rotation Forestry cultivation and harvesting” perfectly fits into this framework. The proposal was drawn up by Regione Lombardia in collaboration with Agri-team, a special company that belongs to the Camera di Commercio di Milano, for the Agriculture, Territory, and Environment sectors, in collaboration with Cnr Ivalsa and Cner, Consorzio Nazionale Energie Rinnovabili.

This publication, in the form of cards, summarises the fundamental aspects and serves as a vademecum. This technical handbook is intended for entrepreneurs that wish to know more about the cultivation techniques and sites currently capable of enhancing the entire biomass production cycle, using annual, biennial, and five-year rotation periods.

Target

“Providing a sector platform for Short Rotation Forestry cultivation and harvesting” is specifically designed for agricultural companies.

But this study is not aimed solely at this primary sector, as it envisages a sector that begins with the agro-forestry sector and goes all the way to the production units that work and use wood, also for non-energy purposes.

Goals

The idea behind this “proposed platform” is to show that today, thanks to the experience gained in the short rotation biomass sector, production can be increased also from a quality standpoint, with interesting profitability prospects. In other words, it is now possible to take wood to the maximum levels of quantity and quality with specific investments covering the entire plant cultivation cycle from transplanting to harvesting. It is important, then, to know what knowledge is available in terms of agronomics and what progress has been made in terms of agricultural mechanisation.
The Alpenergywood Project

From planting the cuttings to their maturation, when the time comes for the machines to harvest: an all-round coverage of the enhancement of the entire short rotation biomass wood production process, using modern agronomic techniques and most up-to-date agricultural machinery.

This is the basis of the study summarised in the card publication “Providing a sector platform for Short Rotation Forestry cultivation and harvesting”. The “Alpenergywood” Project was promoted by the Direzione Generale Agricoltura of Regione Lombardia, as part of the Interreg III B Alpine Space community Programme, and involved Agriteam (a special company that belongs to the Camera di Commercio di Milano for the Agricultural, Territory, and Environmental sector), Cnr Ivalsa, and Cine (Consorzio Nazionale Energie Rinnovabili). The aim is to promote the entire production system revolving around wood biomasses.

One of the most advanced areas in Europe in terms of Short Rotation Forestry, Lombardy boasts 3000 hectares of tree planting over the past five-year period and it has reaped the harvest of its ten years of research and experimentation in setting up a “sector platform” to explain how it is now possible to obtain maximum quantity and quality in wood production within a given time and in relation to costs. From the transplanting phase to mechanical harvesting operations, where each module requires very specific cultivation techniques and machinery for maximum production.

In this sense, reference is made to a “sector platform” - building on agronomic and technological knowledge at the highest levels to further enhance the strengths of biomasses with one, two, and five-year rotation periods. Providing full support for a complex sector in which wood is obviously a source of energy, but it is also the raw material for the pellet, cellulose, and panel industry. That is, an alternative source of income for agro-forestry companies and new opportunities for growth in the woodworking industry, making it possible to re-use what is left over from normal production activities.

“Providing a sector platform for Short Rotation Forestry cultivation and harvesting” therefore satisfies a single imperative - to optimise unit output by plants, while at the same time slashing transplanting, cultivation, and harvesting costs, and keeping an eye on product quality and environment protection. This allows to promote SRF as a responsible, successful entrepreneurial option. The core meaning of short rotation biomasses.

Short rotation biomasses: Why choose them and over what period, what you need to know for successful transplanting and cultivation, and what to do to enhance productivity during felling and harvesting. Rather than strict rules, a series of valuable “ready-to-use” suggestions for operators that know the impact of agronomic and technological innovation on the profit margin of their plants. This publication is made up of a number of cards in a logical sequence, with a general introduction on the advantages of short rotation biomasses, followed by macro cards on annual, biennial, and five-year rotation cycles. Each card comes with an additional technical appendix and a specific report on each machine specifically tested in the field.
When talking about short rotation biomass, there’s a feature that is always valid - a simple equation that itself explains what Short Rotation Forestry means today in Italy, and in Lombardy in particular. Why investments are increasing in research, agronomics, and mechanics. And what contribution these can make to the new scenarios of economic and entrepreneurial development. Algebra would tell us - short rotation biomass equals production of a raw material that is quantitatively and qualitatively superior, obtained over a shorter time and at lower costs, where raw material does not only mean wood to be used for energy purposes, but also a useful procurement source for the pellet, cellulose, and panel industry. This, basically, means opting for short rotation biomass. Short Rotation Forestry makes the natural plant growth process more efficient, as the “renewability” of the raw material becomes a real production factor - because it is obtained at the highest rate per unit of time - and because it is valorised in terms of higher quality of the product.
WHY CHOOSE SHORT ROTATION BIOMASS

Ongoing progress in research and technical innovation is a key factor, as it has led to producing knowledge and solutions that are ever more advanced in terms of cultivation, felling, and harvesting. Direct benefits are provided to agricultural entrepreneurs involved on the biomass front, and, as a result, to all users of wood as a raw material. From the laboratory to the field, for excellent results in productivity and environmental terms. To everyone’s advantage. Lombardy has had the courage to invest in promoting short rotation biomass. Times were different, it was only the beginning. Today, 10 years later, we can proudly say that we have an authoritative voice on the national scene when it comes to Short Rotation Forestry - 3000 hectares have been dedicated to Short Rotation in Lombardy in the last five years, which is added to the 7000 hectares of traditional poplar plantations and another 300 hectares of wood arboriculture and natural forests. An extraordinary heritage of entrepreneurial experience in the very forefront and know-how second to none even in Europe make all the difference, and allow us to tackle new challenges in the quest for innovation. Put another way, research and experimentation are non-stop despite the brilliant results obtained in ten years of projects. On the contrary, we are working to attain ever more ambitious goals, towards ever higher targets. Knowing that when you get involved you can only learn, Lombardy’s entrepreneurs are checking the output and durability of mixed plants with poplar, shrubs, walnut, hazel, elm, cherry, and other prized trees, in the certainty that biodiversity is the way to go to optimise production and enhance the environment. Today, the development of this sector means that Short Rotation Forestry is able to produce 40 tonnes of wood biomass per hectare per year in Northern Italy, with a short-term forecast of 50 tonnes when the field is full. Research and experimentation are keeping pace with this growth, with a view to identifying species and clones that produce high output and that grow better in high density conditions, indicatively of between 1100 and 12000 plants per hectare. All of this is obviously done by applying the most careful cultivation techniques to land with the necessary fertility. And that’s not all. Producing more and better from a quality point of view, with minimum wastage of time and financial resources means harvesting at one, two, or five year intervals using machines that are able to reach excellent unit output in relation to cost. Significant savings are made in terms of labour during felling operations. This means that wood becomes a truly renewable raw material that is constantly available. This prime quality raw material is produced making use of the maximum potential of plantations, with significant financial returns for agricultural companies that choose the most cutting-edge, efficient machines. That’s why short rotation biomass should be chosen. That’s what makes Short Rotation Forestry great.
Biomass Poplar

**Annual rotation**

### Characteristics

- Annual rotation biomass plants are characterised by double rows
- Average spacing: 2.8 metres between double rows and 0.7 m between each of the rows making up a double row
- In this cultivation module, the centres along the double row are 0.5–0.6 metres

### Harvesting

- Focus on the Claas system, the most widely used technology in Lombardy to date
- The site uses a special nose piece fitted on the feller/loader, on the front mounting plate
- The poplars felled are then conveyed towards the machine’s cutting drum
Fertilising the land: this is done when the land is prepared, using organic material. Alternatively, it is possible to use organic fluid fertilisation (even during the covering phase), or chemical fertilisation.

Ploughing: to be done to a depth of 40/60 cm or by deep-ploughing at 80/90 cm, followed by surface ploughing. Afterwards the land must be smooted using a harrow.

Layout of planting: double rows are used with a gap of 280 cm between double rows and 75 cm between the two rows in each double row. The centres along the rows vary depending on the type of clone, on average 50-60 cm.

Density of the planting: up to 14,000 plants per hectare.

Transplanting: between January and March (vegetative rest period). Propagation is done using cuttings.

Chemical weed-killing: pre-emergency using wide range anti-seedling herbicides locally along the row or covering the entire field.

Weeding: to be done annually to the extent required to keep the weeds below a height of 30 cm. This operation is usually repeated 2-3 times per year.

Phytosanitary care: limited to the needs of the individual event, with particular attention given to the Poplar beetle. In any event, the treatments are only to be carried out when the damage threshold has been exceeded. It is best to always consult technical personnel before proceeding.

Irrigation: essential for land that is very depleted or sandy and optional when there is a fair amount of moisture. Where possible and economically advantageous, it enhances the plant’s productivity.

Harvesting: this must be planned for the end of each year, during the vegetative rest cycle, when the soil is best suited to withstand the passage if mechanical equipment. The stumps must be cut at the maximum height of 10 cm.

Post-harvest operations: the structure can be reinstated by means of a sub-soil operation followed by weeding between the rows and treating with a chemical weed-killer.

Explantation: this takes place at the end of the cycle and involves milling the logs with suitable forestry equipment. This, in fact, allows to restore the land’s original condition and makes it suitable for sowing herbaceous crops.

Comments: the annual rotation system can result in some limits in relation to the quality of the product due to the significant presence of bark. Repeated cutting can result in partial extermination of the stumps, which is compensated for to varying extents by offshoots.

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Biomass Poplar

Biennial rotation

Characteristics

- Biennial rotation systems are made up of single row planting patterns
- The maximum spacing between rows is 3 metres, while the centres within each row do not exceed 0.5-0.6 metres
- Due to their high productivity levels, normally selected hybrid poplar clones are used

Harvesting

- The first aspect to be considered for the harvesting phase is the size of the trunks
- Specific solutions have been identified, further developing the technology used for annual rotation
- Nowadays, suitable equipment is available, providing various solutions
THE AGRONOMIC ASPECT

Fertilising the land: to be done when the soil is prepared, using organic material. Organic fluid fertilisation can also be used during the covering phase. Alternatively, chemical fertilisers can be employed.

Ploughing: this is done to a depth of 40/50 cm, or subsoiling at 80/90 cm, and ploughing the surface afterwards. Then, the land must be broken up using a harrow.

Layout of plantation: the spacing varies depending on the clones used, but normally spacing of 300 cm between rows and 50–60 cm within the rows is used.

Density of the planting: up to 6,000 plants per hectare.

Transplanting: between January and March (vegetative rest period). Propagation is done using cuttings.

Chemical weed-killing: pre-emergency using wide range anti-seeding herbicides locally along the row or covering the entire field.

Weeding: during the first year at least three passes are needed with suitable equipment fitted with a ridger. During the first two-year period, regular weeding is necessary to keep weeds to a height below 30 cm.

Phytosanitary care: limited to the needs of the individual event, with particular attention given to the Poplar beetle. In any event, the treatments are only to be carried out when the damage threshold has been exceeded and after consulting the technician appointed.

Irrigation: essential if the soil is very depleted or sandy and optional when there is a fair amount of moisture. Where possible and economically advantageous, it enhances the plant’s productivity.

CULTIVATION

Harvesting: harvesting takes place at the end of each two-year period during the vegetative rest period, and it can be carried out when the soil is able to withstand the passage of mechanical equipment. The stumps must be cut at the maximum height of 10 cm.

Post-harvest operations: possible restoration of the structure by sub-soil operations, followed by weeding between the rows and treating using a chemical weed-killer.

Explantation: this takes place at the end of the cycle and involves milling the logs with suitable forestry equipment. This, in fact, allows to restore the land’s original condition and makes it suitable for sowing herbaceous crops.

Comments: a biennial rotation biomass poplar system offers the correct balance between quality and quantity of production. Initially it was little used due to outdated machinery, but now this system benefits from a specific, functional, and dedicated set up.
Biomass Poplar

Five-year rotation

**Characteristics**

- Five-year rotation involves a 3 x 2 metre planting pattern
- The duration of this rotation period makes it possible to exceed 22 cm diameters one metre above the ground
- Due to the size of this type of cultivation, forestry equipment is required

**Harvesting**

- Compared to the annual and biennial systems, this system ensures better product quality
- Harvesting can be postponed by one or more years, without having to change the whole equipment
- It is also possible to produce a mix of logs and chips

Agriteam
Agricolture Territorio Ambiente

CNR Ivalsa
Consiglio Nazionale delle Ricerche

Regione Lombardia

Agricoltura

Regione Lombardia CULTIVATING THE FUTURE
THE AGRONOMIC ASPECT

**Fertilising the land:** to be done using organic material when preparing the land or even during covering. Alternatively, fertilisation is carried out using chemical fertilisers.

**Ploughing:** to be done to a depth of 50/60 cm or by deep-ploughing at 80/90 cm, followed by surface ploughing. The ground is then smoothed using a harrow.

**Layout of plantation:** the rows are spaced 300 cm apart, with centres of 200 cm in the rows.

**Density of the planting:** sparse planting in poor, sandy soils (1,100 plants per hectare), more dense in fresh, rich soils (1,500 plants per hectare).

**Transplanting:** between January and March. A one year old Canadian thistle is used for propagation material, planted at depths of 60–80 cm.

**Chemical weed-killing:** to be done pre and post emergency, using equipment able to localise the weed-killer in bands along the rows. This is repeated every six months and when growth starts again the second year. If development takes place regularly, from the third to the fifth year no further weed-killing or weeding is necessary.

**Weeding using harrows:** to be done to limit weeds, improve the structure of the land and avoid excessive transpiration. It is essential that this is done sufficiently frequently to keep the weeds below a height of 30 cm.

**Phytosanitary care:** these treatments are only carried out once the damage threshold has been exceeded and not after the first two years.

**Irrigation:** this is only essential for soil that is depleted or sandy and is optional where there is a significant amount of moisture.

Harvesting: to be done during the vegetative rest period when the soil is able to withstand the passage of mechanical equipment and the plants have a diameter of at least 18-22 cm one metre above the ground. The stumps must be cut at the maximum height of 10 cm.

**Post-harvest operations:** when vegetative revival takes place in the sixth year it may be necessary to select the offshoots to find the best subject for relaunching the plantation.

**Explantation:** this takes place at the end of the cycle and involves milling the logs with suitable forestry equipment. This, in fact, allows to restore the land’s original condition and makes it suitable for sowing herbaceous crops.

**Comments:** this system has provided the best production performance to date, with an excellent balance between the quality and quantity of product, limited management costs, and significant environmental validity.
Biomass Poplar

Annual rotation

- THE FIRST MODULE TESTED IN ITALY

It can be considered as the pioneer in Short Rotation Forestry. In the mid 1990s the first annual plants made their debut in Italy, and short rotation biomass became a topic of interest. We’ve come a long way since then. We’ve now reached what researchers were striving for: increasing production in the long term, after 10-15 years of repeated cutting.

- CHALLENGES IN THE FIELD

The first module, paving the way for subsequent short rotation modules. Started in Sweden and imported into Italy approx ten years ago, it immediately aroused the interest of agriculturalists, due to the possibility of planting and harvesting every twelve months, just like farm labourers. The difference, of no little importance, was found on the end product, i.e. wood.

Basically, as the forerunner of any Short Rotation Forestry, the annual module’s main strength lies in the typically “agricultural” frequency for harvesting wood biomass, renewed at short, frequent intervals. This is what attracted farmers. And today it is also the starting point for research into new entrepreneurial prospects resulting from an even better ratio between quantities produced and costs. In practice, this now means understanding how to maximise production over time in annual systems subjected to 10 - 15 harvests in the future. For the time being, we have to wait for the current plantations to “age” sufficiently to reach a stage of 10/15 harvests, so that we can check what agronomic techniques or cultivation tricks should be applied in the field. This allows the quantity of sprouts to remain consistent in terms of profitability.

Another aspect to stress is the relationship between annual rotation and energy. Of course, no general statement can be made in this area. It is true that the percentage of bark is relatively higher compared to longer rotation forestry modules. In fact, it all depends on the type of plant in which it is used. For this reason, if we look at large biomass power stations or modern gas producing plants (even of small size), as in the case of the new ventures in the provinces of Cremona and Lodi, annual rotation may be interesting in Lombardy as well. The important thing is to implement it in contexts offering the necessary technology so as to guarantee good performance and good combustion. Last but not least, also from an environmental point of view.

- THE LAND: BETTER WHEN HIGHLY PERMEABLE

Fertile, deep, permeable, with good water characteristics, surface water-table, and a clear-clayey-silty texture. These features make the land particularly suitable for accommodating annual rotation forestry. Frequent cutting seasons mean that quality land should be chosen.

In case of a risk of pools of water forming, it is best to take agronomic steps to enhance the permeability of the land (breaking the hard pan) and the draining of water off the fields (grading and ditching).
- **TRANSPLANTING: WHEN AND HOW**

  **The calendar:** annual rotation means that planting operations take place during the vegetative rest period for the cuttings, before the end of April, taking care to act before the buds open.

  In order to avoid jeopardizing the success of the operation, it is best to avoid transplanting in the coldest months. It is also important to keep the time interval between delivery and planting of the material as short as possible.

  **The method:** where necessary specific refining operations are carried out by harrowing when the land is hard. The cuttings must be planted with the shoots facing upwards and must always be fully enwrapped in soil, from which they can stick out by a maximum of 3 cm.

  **Advice:** when transplanting, all precautions must be taken in order to guarantee that the cuttings are fully preserved, mainly checking for dehydration risks. For this reason, if this is done late in the season (April), it is best to keep the material in the shade and covered with a dampened light coloured cloth.

- **CHEMICAL WEED-KILLING: IMPORTANT FOR WEED CONTROL**

  Combating weeds is particularly important during the first year of the plantation, especially in the periods following planting. In subsequent years after each cutting season, this must be done before new offshoots are put out. In this sense, using chemical weed-killers is allowed, and these must be distributed locally along the rows or covering the entire field, with one specific provision - the quantity and dosages of all the active ingredients must be used according to the instructions given in the ministerial registration forms, and as indicated on the label. More specifically, during the post-transplant phase, oxadiazon, oxifluorfen, and pendimethalin anti-shooting active ingredients may be used, while at the start of each new cycle, after the cutting season and before new shoots are put out, glufosinate ammonium may be used.

- **HARVESTING: WHAT TO DO DURING AND AFTER**

  Annual rotation call for agronomic practices which are very similar to the techniques used for biennial rotation forestry. After harvesting, in order to revive vegetative rebirth in the best possible manner, the plantation must be allowed to put out new shoots more easily than the weeds and with sufficient nitrogen reserves. It is also possible to think about switching to biennial rotation in order to reduce the number of cutting seasons.
GOLDEN RULES FOR SHORT ROTATION FARMERS

This technical appendix offers an overview on the recommended agronomic choices for biennial rotation poplar biomasses. A complete guide on “what to do” from land preparation to harvesting, it has been drawn up taking into account the most advanced technical knowledge in the sector and experience gained in the field by agricultural entrepreneurs. Here is what you need to know, point by point.

- PREPARATION: PLOUGHING, WEEDING, REFINING
In this very first stage it is important to look at the type of land texture. In clayey-limey conditions unfavourable conditions may occur at the time of ploughing (and also possibly during harvesting), due to it being unusable or excessively compacted after adverse weather conditions. In land that tends to be clayey ploughing must take place before September of the previous year; then – in late autumn - work begins on moderately deep weeding (25 - 30 cm). As soon as the soil conditions permit, the land is refined using a towed or rotating harrow. Generally speaking, it is important to work under optimum dampness conditions and not to put off the last cultural practices until late January. Due to the winter chill, the land keeps the dampness it has acquired, and provides ideal conditions for successful planting.

Another aspect - chemical fertilising of the land is not essential for the first rotation (normally good spreading of manure before ploughing is sufficient), while for subsequent rotations the need for adding fertilisers must be assessed in each case.

- TRANSPLANTING: WHEN AND HOW
Avoid icy periods. The best time is between December and the end of March, but it is best to transplant as soon as possible in land worked to a depth of not less than 20 cm using transplanters offering maximum hourly productivity (by way of example: 3000 cuttings/hour for a daily coverage of 4-5 hectares). If the land is not particularly heavy you can put off the operation until late May, but in this case you need to use a refrigeration conservation technique to keep the rooting percentage for the plants high.

As to the planting set up, you should preferably use a density of 5000 - 6000 plants/ha. At higher densities the bark-wood ratio increases and the quality of the product worsens without necessarily increasing productivity. On the other hand, lower densities force you to increase the rotation so as not to jeopardise production, which results in difficult-to-collect pieces for even the most efficient sites.

Methods: where necessary specific refining operations are carried out by harrowing when the land is hard. The cuttings must be planted always fully enwrapped in soil, from which they can stick out by a maximum of 3 cm.

Advice: when transplanting, all precautions must be taken in order to guarantee that the cuttings are fully preserved, mainly checking for dehydration risks. If early weed growth occurs, add a drying ingredient to the pre-emergency weed-killer in order to avoid subsequent surface harrowing and resulting trampling of the soil.
- THE WEED-KILLING OPERATION: HOW TO DO IT AND WHY IT IS IMPORTANT
One all-encompassing piece of advice - chemical weed-killing, that is, the first fundamental anti-weed step on which the success of the plantation may depend, must be planned beforehand, before any other work is done in the field, from all points of view - in terms of financial investment, timing, and type of active ingredient to be used. Thus, it is best to begin as follows: first plan costs and operations, then take action in the field as quickly as possible. Chemical weed-killing should be carried out every two years, localised in the rows before vegetative rebirth. It must be repeated as soon as weed growth resumes (gramineae), before the financial damage threshold is reached.

The second operation to control weeds is usually carried out in mid May when the shoots have reached a height of 25 - 40 cm and it is possible to intervene with localised strimming around the rows. In this case the minimum width to be cleared must not be less than 50 cm either side, leaving a gap of 1.5 - 2 m between the rows that will be weeded using disc weeders at a later date. The aim is to aerate the land near the cuttings and destroy any weeds that have “escaped” the chemical weed-killer.

As to using pesticides, a word of caution is essential - first and foremost, the limits of the range of action must be taken into account, secondly you should also bear in mind that this measure may often prove totally ineffective.

- IRRIGATION: LOOK AT THE TEXTURE OF THE LAND
For medium compact land that tends to be limy-clayey, irrigation is only advisable in exceptional cases and, anyway, always during the first year of life of the plantation. This changes in case of coarse, depleted soil: here use of irrigation techniques, which should be carried out from June onwards, may make a marked difference to the quality and quantity produced.

- HARVESTING: NEW MACHINES, MORE PROFITABILITY
The first harvest takes place at the end of the second year, but it is only from the fourth year, when the plantation is well and truly underway, that the potential of biennial rotation forestry reaches its peak. Today entrepreneurs can choose between two specifically designed machines that are able to enhance the felling and harvesting phases, to produce maximum yield compared to costs. These are the Spapperi feller/loader and the Claas Jaguar 880 with a GBE 1 modified nosepiece. They both offer good productivity levels, yet one is suitable for typical company sites while the other is ideal for large size plantations and agro-mechanical companies. As for all cultivation, biennial short rotation forestry plantations are also cleared at the end of their cycle (10 - 15 years). It should be said that technological innovation is making huge strides. Here are the details: since after 10 - 15 years of repeated felling the stump will have reached a significant size, a forestry machine has been put into the field that grinds up all the remaining cultivation completely. In this way the land is immediately ready for the next cultivation cycle.

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PromoPavese
AN INCREASINGLY POPULAR CULTIVATION MODULE

Not only agronomy experts say that five-year rotation is one of the most interesting modules - today farmers are also beginning to appreciate it, opting for it rather than one or two year Short Rotation Forestry. The reasons? Easy cultivation, a product of higher quality and the possibility of using highly mechanised systems for felling, harvesting, and chipping in the field. And value for money that is worthy of close attention.

ALL THE ADVANTAGES OF “LONG ROTATION”

The five-year rotation module is already practised in other areas, especially in America, and is now beginning to spread on a large scale in Italy as well. And this is how:

- It optimises the production capacity of clones, concentrating everything in a single harvesting phase.
- It offers a high quality product, characterised by a very high percentage of wood and, on the other hand, very limited amounts of bark. This means that biomass coming from five-year rotation plantations is particularly suitable for producing thermal energy, even in small size systems, as it releases the least combustion residues. It is not by mere chance that pellet manufacturers see this cultivation module as an important provisioning source for the future. The same applies to the panel and cellulose industries, where it is equally important to have a raw material that is of good quality.
- It simplifies the planting and cultivation phases. Not only does it require non-specific intervention during the preparation phase, but the five-year method is the only type of rotation that can be used successfully in critical situations, such as perennial weeds, logs, roots, steep slopes, or lack of water. And that’s without taking into account that it can be planted in deep winter harrowing.

THE PLANTATION: THE CALENDAR AND OPTIMUM DENSITY

One year old saplings (between 1.5 and 4 metres high) are transplanted mechanically between December and mid April, although this operation can be put off until late May provided refrigerated material is used.

Optimum planting density is 1000 - 1500 plants per hectare with a margin that varies depending on the fertility of the soil and the quantity of material you intend harvesting at the end of the five year period. It is best not to go below a certain threshold in order to avoid prolonging the felling period excessively and, worse still, jeopardising the successful completion of the harvesting and chipping phases due to oversized crowns.
- **WEED-KILLING AND CULTIVATION CARE: AN UNDEMANDING MODULE**

After planting chemical weed-killing begins. This is localised on the rows using total action active ingredients (glufosinate ammonium) mixed with anti-germination residue products. This operation can be repeated as a “corrective” measure if the results are not fully satisfactory. As to cultivation care at least **three passes with a disc harrow are required in the first year**, and under optimum growth conditions this reduces each year until it is no longer necessary. In June you may opt to carry out a **quick shaping pruning** aimed at eliminating split ends, but this need not be done if you choose clones that are predominantly apex-oriented.

During the first year **irrigation** may be useful especially in the case of late plants, but it is not essential. Subsequently, this need only be considered for impoverished soils that provide poor water retention. **Pesticide treatments** can be limited as this form of cultivation provides greater resistance than traditional poplars. Be careful of the poplar beetle - capable of stripping all the leaves off an entire plant - and the cryptorrhynchus - if not watched closely from the first year, it can cause a high percentage of shortening of the trunks.

- **HARVESTING: MECHANISED SITES FOR MAXIMUM OUTPUT**

**Goal:** to maximise the quantity of product and minimise harvesting costs. As is known, making use of efficient equipment makes all the difference if you want to maximise the profitability of the entire process of growing and producing wood biomass.

**When to do it:** normally in the fifth year, but in the fourth year if the environmental conditions are particularly favourable for growth.

**The advantages offered by modern technology:** in order to get some idea simply take a quick look at the strengths of the 5 machines used in the Alpenenergywood project.

Briefly: the **Keto 150 HD** falls the plants and places them in piles, but it can also split trunks intended for use in the paper industry. The **Naarva Grip 1600-40** develops its maximum potential when working with large size trunks. This is a feller-buncher. The **Davco QC 1400** is preferable to other feller-bunchers when you are looking for a light, flexible machine that is easy to transport. The **Timberjack 762 C** guarantees very high productivity per hour due to its forestry-designed technology. The **Gandini Bio Harvester 500** can fell and chip in the field in a single operation, and can be operated by a single person.

It should be noted that the material can also be stockpiled off site. In this case chipping takes place at a later date (summer) to allow the timber to lose some of its moisture, which brings about enhanced quality and possible financial advantages.
GANDINI BIO HARVESTER 500 Prototype

Simply activate an electronic remote control - just one person and the Bio Harvester 500 cuts and chips large and small size plants (5 to 45 cm diameter, weight up to 0.6 tonnes) in a single pass, and then conveys the chipped wood into an agricultural dumper or truck, depending on the ground conditions. In practice, the entire cutting, feed, and chipping cycle is carried out in sequence in the field, with the operator mainly involved in a control and supervisory role. A brand new Gandini prototype, the Bio Harvester 500 applies the most advanced technological knowledge in the sector to Short Rotation Forestry harvesting to guarantee maximum hourly production, minimum labour costs, and performance at the highest level. It is made up of two parts: a system that cuts and conveys to the chipper - particularly suitable for five-year rotation plants, but also for smaller size poplars - and a chipping mechanism that comprises a set of toothed gears used to grip the material and move it into the toothed drums. Both fixed and mobile, the toothed drums can adjust to trunks of different weights and sizes.
Activated by a remote control, this machine is able to cut and chip in a single pass.

Suitable for large diameter plants, yet versatile, the Bio Harvester 500 is ideal for five-year rotation forestry.

**BIO HARVESTER 500**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Machine weight (kg)</td>
<td>3900</td>
</tr>
<tr>
<td>Tractor power required (kW)</td>
<td>132 - 190</td>
</tr>
<tr>
<td>Test tractor power (kW)</td>
<td>154</td>
</tr>
<tr>
<td>Cutting/felling tool</td>
<td>chain saw</td>
</tr>
<tr>
<td>Type of chipper</td>
<td>Disc</td>
</tr>
<tr>
<td>Hourly production (tonnes/hour)*</td>
<td>30 - 50</td>
</tr>
<tr>
<td>Area harvested (Ha/hour)*</td>
<td>1.5 - 2.5</td>
</tr>
<tr>
<td>Number of plants (min)</td>
<td>6 - 8</td>
</tr>
<tr>
<td>People involved (n°)</td>
<td>1</td>
</tr>
<tr>
<td>Adjustable chip size (mm)</td>
<td>10 - 50</td>
</tr>
<tr>
<td>Minimum plant diameter (mm)</td>
<td>50</td>
</tr>
<tr>
<td>Maximum plant diameter (mm)</td>
<td>450</td>
</tr>
<tr>
<td>Height of chip discharge (mm)</td>
<td>5000</td>
</tr>
<tr>
<td>Transport sizes (cm)</td>
<td>234 x 325 x 280</td>
</tr>
<tr>
<td>Radio control for all operations</td>
<td></td>
</tr>
</tbody>
</table>

* Since these are based on a prototype, more detailed productivity data will be available after further field testing for different densities and plant shifts.

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CULTIVATING THE FUTURE
Technically speaking, this feller/buncher is equipped with a hydraulically powered circular saw fitted on a chassis with a double buncher arm.

With the same design as larger North American cutting systems, the Davco QC 1400 is conveniently light-weight (only 700 kg) and can be fitted to the universal connection of any mini-loader that is sufficiently stable and powerful. The feller can easily be transported on a light truck. For the field tests the feller was fitted to a track Bobcat T300 mini-loader. Chipping was done in the field using a radio controlled chipping machine that was powered by a self-propelled OP 80 T hydraulic loader. The chipper was supported by two tractors with trailers, operated by a single driver. While the full trailer was brought to the dumpsite, the chipper filled the empty trailer left in the field.
Light-weight and very mobile. These are the strengths of a machine that weighs only 700 kg and develops 70 kW of power. It can be operated by a single operator and is similar to North American cutting systems.

<table>
<thead>
<tr>
<th>Name</th>
<th>Feller/Buncher</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight, including rotator (kg)</td>
<td>700</td>
</tr>
<tr>
<td>Power required for the drive (kW)</td>
<td>70</td>
</tr>
<tr>
<td>Drive unit used for the test</td>
<td>Track Bobcat T300 mini-loader</td>
</tr>
<tr>
<td>Felling diameter (mm)</td>
<td>350</td>
</tr>
<tr>
<td>Maximum working pressure (bar)</td>
<td>230</td>
</tr>
<tr>
<td>Cutting unit</td>
<td>Circular saw</td>
</tr>
<tr>
<td>Output (t.s.s./ha)</td>
<td>35,0</td>
</tr>
<tr>
<td>Productivity (t.s.s./ha) *</td>
<td>4,0</td>
</tr>
<tr>
<td>Working cost (€/t.s.s.) **</td>
<td>9,10</td>
</tr>
</tbody>
</table>

* Including non-productive time
** Field of white poplar seedlings, average diameter at 1,30 m of 12 cm

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The latest version of the new Claas nose piece, the HS-2 features a strong chassis with a V-shaped opening that holds two circular saws used to cut down the plants, and a pair of spoked conveyors that send them to the rollers that feed the shredding drum. On the inner sides of the central opening two Archimedean screws push the stalks towards the centre, within the range of the circular saws and the conveyors. Above the chassis a Y-shaped bar pushes the stalks forward, facilitating introduction into the machine’s feed opening. All the parts are driven by hydraulic motors, with adjustable chain transmissions. The nose piece can be replaced quickly with a conventional maize cropper, making it very versatile. Overall, the machine provides good hourly production rates and excellent downtime reduction. However, being a feller/shredder/loader, it works best when the crop’s characteristics are somewhat similar to those of maize, i.e. with numerous stalks about 6 cm in diameter.
The machine is type-approved for road travelling and doesn’t require flatbed trailers to be moved around.

Its impressive hourly production rate depends on the length of the rows and the density of cultivation.

---

**CLAAS JAGUAR 850 WITH HS-2 NOSE PIECE**

<table>
<thead>
<tr>
<th>Name</th>
<th>Feller/shredder/loader</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type</strong></td>
<td>Self-propelled</td>
</tr>
<tr>
<td><strong>Power (KW)</strong></td>
<td>286</td>
</tr>
<tr>
<td><strong>Plant falling direction</strong></td>
<td>Parallel</td>
</tr>
<tr>
<td><strong>Maximum diameter of the plants (mm)</strong></td>
<td>60</td>
</tr>
<tr>
<td><strong>Cutting unit</strong></td>
<td>Circular saws</td>
</tr>
<tr>
<td><strong>Cutting unit position</strong></td>
<td>Front</td>
</tr>
<tr>
<td><strong>Shredding unit</strong></td>
<td>Cutters on a drum</td>
</tr>
<tr>
<td><strong>Product</strong></td>
<td>Chips</td>
</tr>
<tr>
<td><strong>Output (t.s.s./ha)</strong></td>
<td>11-14</td>
</tr>
<tr>
<td><strong>Productivity (t.s.s./hour)</strong></td>
<td>14-17</td>
</tr>
<tr>
<td><strong>Working costs (€/t.s.s.)</strong></td>
<td>43,00</td>
</tr>
</tbody>
</table>

* Including downtime

** 5 ha fields with an output of 120 t.s.s/ha, using two tractors and a trailer for the handling the chips

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Claas JAGUAR 880 with GBE 1 modified nose piece

Gathers up to 16 tonnes per hour of dry product and can cut trunks of 10-12 cm diameter.

According to the first field tests, the Claas Jaguar 880 equipped with a GBE 1 modified nose piece seems to offer a good profit margin. The machine was put together at the end of 2005.

This brand new harvesting tool was given full credit in the positive comments of Cnr Ivvalsa technicians that ran preliminary tests on it during the last few months. Here are the results of the field tests: the new feller/shredder/loader nose piece showed a harvesting capacity of more than 32 tonnes of fresh product per hour, working with biennially rotated biomass poplars with an average diameter at their base of 8-10 cm. In this sense, the harvesting site’s goal was to resolve the problem of harvesting larger diameter trunks, using a machine specifically designed for felling Biennial Short Rotation trees, offering good productivity performance. Developed by the Cner (Consorzio Nazionale Energie Rinnovabili), this new nose piece was developed with the direct involvement and experience of entrepreneurs involved in biomass cultivation.
According to initial field tests, the new nose piece gathers an average of 16 tonnes of product per hour, excluding trailer waiting time.

The new site is designed to solve the problem of harvesting biennial rotation trunks of larger diameter.

### CLAAS JAGUAR 880 WITH GBE 1 MODIFIED NOSE PIECE

<table>
<thead>
<tr>
<th>Name</th>
<th>Feller/shredder/loader</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>Self-propelled</td>
</tr>
<tr>
<td>Power (KW)</td>
<td>340</td>
</tr>
<tr>
<td>Plant falling direction in relation to the direction of movement</td>
<td>Parallel</td>
</tr>
<tr>
<td>Maximum diameter of the plants (mm)</td>
<td>80</td>
</tr>
<tr>
<td>Cutting unit</td>
<td>Circular saws</td>
</tr>
<tr>
<td>Cutting unit position</td>
<td>Front</td>
</tr>
<tr>
<td>Shredding unit</td>
<td>Cutters on a drum</td>
</tr>
<tr>
<td>Product</td>
<td>Chips</td>
</tr>
<tr>
<td>Output (t.s.s./ha)</td>
<td>11,4</td>
</tr>
<tr>
<td>Productivity (t.s.s./ora) *</td>
<td>15,6</td>
</tr>
<tr>
<td>Working costs (€/t.s.s.)</td>
<td>n.d.</td>
</tr>
</tbody>
</table>

* Including downtime

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Con la collaborazione di:
For the field test a Keto 150 felling nose piece was used, fitted in a track-driven 17 tonne excavator. The machine provides complex functions aimed at adding value to the product. In fact the machine not only fells the plants and bunches them in tiers, but it can also size poles from the trunks it treats for use in paper mills/panelling factories. Therefore, it would not make sense to judge its output merely on the basis of hourly production, as the increased complexity of the work done inevitably affects the time and cost factors of the entire harvesting phase. In this sense, its “profitability” margin must be calculated in overall terms, taking into consideration the lower materials handling costs and the better price that can be obtained for the poles. During field tests, the combined fellers worked on a 5 row section and placed poles and toppings in separate parallel tiers. Subsequently the poles were loaded onto an articulated lorry in the field, while the toppings were chipped (also in the field) and transported to the company’s premises.
The site deals with the production of both poles and chipped toppings, which is carried out in the field.

The feller is made up of a Keto 150 nose piece fitted on a track-driven excavator. It is strong, powerful, and flexible.

**KETO 150 HD**

<table>
<thead>
<tr>
<th>Name</th>
<th>Combined harvester head</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight, including rotator (kg)</td>
<td>1040</td>
</tr>
<tr>
<td>Power required for the drive (kW)</td>
<td>100</td>
</tr>
<tr>
<td>Drive unit used for the test</td>
<td>Track-driven Daewo 160 excavator</td>
</tr>
<tr>
<td>Felling diameter (mm)</td>
<td>550</td>
</tr>
<tr>
<td>Branch removal diameter (mm)</td>
<td>450</td>
</tr>
<tr>
<td>Branch removal cutters (N°)</td>
<td>5</td>
</tr>
<tr>
<td>Maximum working pressure (bar)</td>
<td>210</td>
</tr>
<tr>
<td>Cutting unit</td>
<td>Chain saw</td>
</tr>
<tr>
<td>Output (t.s.s./ha)</td>
<td>61,4</td>
</tr>
<tr>
<td>Productivity (t.s.s./ora) *</td>
<td>4,4</td>
</tr>
<tr>
<td>Working cost (€/t.s.s.) **</td>
<td>17,60</td>
</tr>
</tbody>
</table>

* Including non-productive time

** Field of white poplar seedlings, average diameter at 1,30 m of 12 cm

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AN EASY-TO-USE, YET NON-VERSATILE MACHINE

The LWF sizer is made up of a massive mechanical cylinder with a continuous spiral blade coiled around its surface, with vertical cutters at regular centres in the clear spaces. The cylinder is positioned vertically with a circular saw at its base. The unit is housed inside a sturdy steel structure and is mounted on the front-end lifting unit on an agricultural tractor with a power rating of at least 100 kW. A power take-off allows the cylinder to rotate fast when in contact with the stalks, chopping them off at the foot. The plant is then dragged towards the fixed structure where it comes into contact with a cutter and is split by the spiral blade. The vertical cutters remove any oversized sections. The pieces produced are about 10 cm long and move on to a device that propels them towards a square section conveyor. A simple and economical machine, its performance is biased by the lack of an independent feeding system. The chopping unit moves the cut plants along, which results in significant savings in terms of weight and power, but this makes it impossible to adjust the introduction of material.
The machine conveniently cuts and gathers pieces in a single pass, but the feed cannot be regulated.

Roughly sized, the pieces produced are of a lower quality in terms of sizing than the chips, also requiring further refining at a later stage.

<table>
<thead>
<tr>
<th>LWF PROTOTYPE</th>
<th>Chopper</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>Chopper</td>
</tr>
<tr>
<td>Type</td>
<td>Carried</td>
</tr>
<tr>
<td>Plant falling direction in relation to the direction of movement</td>
<td>Parallel</td>
</tr>
<tr>
<td>Maximum diameter of the plants at the base (mm)</td>
<td>70</td>
</tr>
<tr>
<td>Cutting unit</td>
<td>Circular saws</td>
</tr>
<tr>
<td>Cutting unit position</td>
<td>Front</td>
</tr>
<tr>
<td>Shredding unit</td>
<td>Cutters on a spiral blade</td>
</tr>
<tr>
<td>Product</td>
<td>Chopped pieces</td>
</tr>
<tr>
<td>Power required for the drive (Kw)</td>
<td>100</td>
</tr>
<tr>
<td>Output (t.s.s./ha)</td>
<td>12,8</td>
</tr>
<tr>
<td>Productivity (t.s.s./ora) *</td>
<td>2</td>
</tr>
<tr>
<td>Working costs (€/t.s.s.) **</td>
<td>83,00</td>
</tr>
</tbody>
</table>

* Including downtime
** The Company moves the chips using two tractors and a trailer

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This is a multi-purpose piece of equipment (feller-buncher) that is made up of a Naarva Grip 1600-40 shear, which was fitted on a 90 kW rubber-tyred excavator for the test. It can easily cut and hold three trunks in a single rotation. Despite reaching an overall weight of 16 tonnes, the machine can be moved easily from one worksite to another, as it is type-approved for travelling on the road independently.

On the experimental test site, the feller cut a front of five rows and brought down the trunks in a single tier. Chipping was done in the field. Tests showed significant findings, especially valuable for poplars rotated on a five-year basis, i.e. the larger the plant, the lower the costs for harvesting and delivering the product.

In light of the new clones of fast growing poplars of larger size, the prospects for this machine appear to be interesting, even in terms of profitability.
Felling is carried out by a Naarva Grip 1600-40 shear/bundler fitted to a rubber-tyred excavator. This machine is perfectly capable of felling and gripping three large diameter trunks in a single rotation.

### NAARVA GRIP 1600-40

<table>
<thead>
<tr>
<th><strong>Name</strong></th>
<th><strong>Feller/Buncher</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight, including rotator (kg)</td>
<td>560</td>
</tr>
<tr>
<td>Power required for the drive (kW)</td>
<td>90</td>
</tr>
<tr>
<td>Drive unit used for the test</td>
<td>Rubber-tyred Caterpillar 315 excavator</td>
</tr>
<tr>
<td>Felling diameter (mm)</td>
<td>320</td>
</tr>
<tr>
<td>Maximum working pressure (bar)</td>
<td>200</td>
</tr>
<tr>
<td>Cutting tool</td>
<td>Shear</td>
</tr>
<tr>
<td>Output (t.s.s./ha)</td>
<td>33.7</td>
</tr>
<tr>
<td>Productivity (t.s.s./ha) *</td>
<td>3.3</td>
</tr>
<tr>
<td>Working cost (€/t.s.s.) **</td>
<td>12.30</td>
</tr>
</tbody>
</table>

* Including non-productive time

** Field of white poplar seedlings, average diameter at 1.30 m of 12 cm

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Con la collaborazione di:
Agricultural entrepreneurs tested the performance of this machine, with an initial series of field tests that already showed it to be one of the most interesting solutions for plantations with 1.5/4 m saplings. Nothing speaks as clearly as numbers: 500 plants planted in an hour (750 1-m high cuttings), at least 180 kW power rating required, a planting depth ranging between 40 and 90 cm, and excellent soil arrangement both at depth and on the surface. These, in a nutshell, are the strong points of the R-innova 500 P transplanting machine, as shown by the tests organised by Cner, the National Consortium for Agricultural Renewable Energy, and carried out with the direct involvement of the farmers. The already high productivity of this transplanting machine is maximised with 3 basic operators being assisted by a fourth that checks the planting operations and the material supplies. By fitting a kit to the front of the tractor, the machine, which is particularly sturdy, proves to be efficient even in critical situations, such as when working with large root residues, which typically occurs when an arboretum is felled.
By making use of its deep-ploughing system, the transplanting machine guarantees a good planting depth (40 - 90 cm)

The arrangement of the soil around the sapling (on the surface and at depth) is excellent due to a double tamping system

### R-innova 500 P

<table>
<thead>
<tr>
<th>Name</th>
<th>Transplanting machine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight (q)</td>
<td>16</td>
</tr>
<tr>
<td>Power required for the drive (Kw)</td>
<td>180</td>
</tr>
<tr>
<td>Travelling speed (Km/h)</td>
<td>2,5 - 3,5</td>
</tr>
<tr>
<td>Material</td>
<td>Saplings and long cuttings</td>
</tr>
<tr>
<td>Length of material (cm)</td>
<td>100 - 400</td>
</tr>
<tr>
<td>Test driving power used (Kw)</td>
<td>180</td>
</tr>
<tr>
<td>Planting depth (cm)</td>
<td>40 - 90</td>
</tr>
<tr>
<td>Hourly production (number of plants per hour)</td>
<td>500/750</td>
</tr>
</tbody>
</table>

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RegioneLombardia  CULTIVATING THE FUTURE
The Spapperi feller/loader is a derivation of a tried and tested disc chipper. It is made up of two circular saws in front of the feed opening. The circular saws rotate on the same axle of two toothed rollers that are used to carry the trunks felled into the chipping unit. The machine is powered by the rear power take-off on an agricultural tractor of at least 100 kW, preferable driven in reverse. The entire job is carried out by a single operator. Tests carried out in the field showed that the machine can achieve good hourly production rates without causing excessive non-productive times. It is also fairly reliable (stoppages take up less than 20% of total working time), due to its design allowing it to move forward generally smoothly. The chips produced are of good quality. This is due to the forestry equipment disc chipper, specifically designed to produce material of a preset size. This machine is well suited to the mechanisation needs of small and medium sized companies.
As for the other machines used for biennial rotation felling, it can only harvest one row at a time.

This solution is aimed at meeting the harvesting needs of small and medium sized agricultural companies.

### SPAPPERSI PROTOTYPE

<table>
<thead>
<tr>
<th>Name</th>
<th>Feller/Loader</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>Carried</td>
</tr>
<tr>
<td>Power required for the drive (Kw)</td>
<td>100</td>
</tr>
<tr>
<td>Plant falling direction in relation to the direction of movement</td>
<td>Parallel</td>
</tr>
<tr>
<td>Maximum diameter of the plants at the base (mm)</td>
<td>100</td>
</tr>
<tr>
<td>Cutting tool</td>
<td>Circular saws</td>
</tr>
<tr>
<td>Cutting unit position</td>
<td>Front</td>
</tr>
<tr>
<td>Shredding unit</td>
<td>Cutters on a disc</td>
</tr>
<tr>
<td>Product</td>
<td>Chips</td>
</tr>
<tr>
<td>Output (t.s.s./ha)</td>
<td>14,3</td>
</tr>
<tr>
<td>Productivity (t.s.s./ora) *</td>
<td>3,8</td>
</tr>
<tr>
<td>Working costs (€/t.s.s.) **</td>
<td>41,65</td>
</tr>
</tbody>
</table>

* Including downtime

** The Company moves the chips using two tractors and a trailer

FOR FURTHER INFORMATION:
Regione Lombardia - Direzione Generale Agricoltura
www.agricoltura.regione.lombardia.it
O.U. Action for companies and policy for diversifying production
innovazione@regione.lombardia.it
O.U. Programming and research for Agro-industrial sectors - Technological research and innovation section
agri_ricerca@regione.lombardia.it
Agriteam - Agricoltura Territorio Ambiente
Special Company of the Milan Chamber of Commerce, Industry, Crafts and Agriculture
www.agriteam.it
agriteam@mi.camcom.it

Con la collaborazione di:
The tests on the Spapperi transplanting machine lead to two conclusions. First: thanks to the hydraulic compacting system for planting, the rooting of cuttings is always excellent. Second: the quality and quantity produced are improved by introducing a semi-automatic mechanism for feeding the cuttings, produced by R-innov@. The experiments carried out by Cner, the National Consortium for Agricultural Renewable Energy, in close collaboration with the agricultural companies that ran the tests over more than 200 hectares confirmed that the Spapperi machine is ideal for planting cuttings 22 cm long. In addition to its particular planting system that ensures smooth compacting of the soil around the cutting, its strengths include an average planting rate of 2500-3000 plants per hour, with minimum time wastage for restocking and moving. Given the weight of the machine (1.35 tonnes) its performance in the field improves when powered by an 80-100 kW tractor, while with expert operators it can achieve an average travelling speed of 1.2-1.8 km/h.
The hydraulic compacting system for planting allows for a high percentage of successful rooting of cuttings. Its average productivity rate is 2500/3000 plants per hour. Time for restocking materials and moving is very limited.

### SPAPPERI TRANSPLANTING MACHINE

<table>
<thead>
<tr>
<th>Name</th>
<th>Transplanting machine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight (q)</td>
<td>13.50</td>
</tr>
<tr>
<td>Power required for the drive (Kw)</td>
<td>80 - 100</td>
</tr>
<tr>
<td>Travelling speed (Km/h)</td>
<td>1.2 - 1.8</td>
</tr>
<tr>
<td>Material</td>
<td>Cuttings</td>
</tr>
<tr>
<td>Length of material (cm)</td>
<td>22</td>
</tr>
<tr>
<td>Test driving power used (Kw)</td>
<td>80</td>
</tr>
<tr>
<td>Planting depth (cm)</td>
<td>22</td>
</tr>
<tr>
<td>Hourly production (number of plants per hour)</td>
<td>2500 - 3000</td>
</tr>
</tbody>
</table>

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Regione Lombardia
CULTIVATING THE FUTURE
TIMBERJACK 762 C

With a work rate of 9 tonnes of trunks per hour, this machine can guarantee the highest production during felling and harvesting of five-year rotation biomasses. Highly efficient, this forestry-based technology stems from the felling and harvesting systems perfected in North European Countries, especially Sweden and Finland.

During experimental testing the Timberjack 762 C felling head’s capacity was tested with the unit fitted on a special 1270 B forestry vehicle that can develop 160 kW. With a felling diameter of about 65 cm and an average branch removal diameter of 43 cm, the machine felled and harvested poplars, reaching an hourly output of 9.2 tonnes of product, including non-productive time. To date, this forestry feller continues to be the most productive and interesting machine for felling large diameters.

In addition, chipping can also take place separately, using a dedicated machine.
The Timberjack 762 C felling head is based on forestry felling and harvesting systems used in Northern Europe.

During field tests the machine achieved an hourly production rate of 9.2 tonnes of trunks.

### TIMBERJACK 762 C

<table>
<thead>
<tr>
<th>Name</th>
<th>Combined harvester head</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight, including rotator (kg)</td>
<td>1270</td>
</tr>
<tr>
<td>Power required for the drive (kW)</td>
<td>160</td>
</tr>
<tr>
<td>Drive unit used for the test</td>
<td>Specialist 1270 B forestry vehicle</td>
</tr>
<tr>
<td>Felling diameter (mm)</td>
<td>650</td>
</tr>
<tr>
<td>Branch removal diameter (mm)</td>
<td>430</td>
</tr>
<tr>
<td>Maximum working pressure</td>
<td>240</td>
</tr>
<tr>
<td>Cutting tool</td>
<td>Chain saw</td>
</tr>
<tr>
<td>Output (t.s.s./ha)</td>
<td>42.7</td>
</tr>
<tr>
<td>Productivity (t.s.s./ha) *</td>
<td>9.2</td>
</tr>
<tr>
<td>Working cost (€/t.s.s.) **</td>
<td>11.00</td>
</tr>
</tbody>
</table>

* Including non-productive time
** Field of white poplar seedlings, average diameter at 1.30 m of 12 cm

For further information:
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  www.agricoltura.regione.lombardia.it
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