Sustainable Forest management and Eucalyptus

GRUPO EMPRESARIAL ENCE

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The aim of *Sustainable Forest Management and Eucalyptus* is to inform society of the reality of a tree which is often criticised but about which little is actually known in terms of its extraordinary function and characteristics, aspects which make it a unique resource in terms of generating wealth and environmental benefits.

Through mass fixing of carbon and the corresponding oxygen production, eucalyptus plantations create the renewable raw material which is used to produce pulp and energy: cultivated wood and the forest residue, which also have many other industrial and consumer-related applications.

Above all, however, eucalyptus is a tree with a great environmental value: efficient in the use of water, its sustainable growth is conducive to biodiversity, reduces the risk of forest fires, provides new natural spaces, recovers degraded or unusable soils and enriches the landscape. All of which is, of course, hugely beneficial to the environment and to society.

This well-managed asset becomes a driver of economic and social development, and also provides us with one of the best options for curbing the deforestation of natural woodland.

Sustainable forest management thus becomes an appropriate means of extracting the potential wealth and prosperity offered by cultivated woodland, while also providing us with an efficient means of fighting climate change.

Sustainable Forest Management and Eucalyptus follows the work *ENCE: Creating jobs and wealth*, which provides a summary of the social and economic value of woodland and the Group's production of pulp and renewable energy in 2008 in Spain: 6,150 direct and indirect jobs and 5,070 induced jobs, in addition to 630 million euros in industrial and forest purchases and investments, and 361 million in tax, Social Security contributions and salaries.

This new work focuses mainly on eucalyptus and the environmental and industrial benefits arising from sustainable forest management. Its content is based on the compiling of independent reports and studies prepared by prestigious scientists in research centres worldwide, whose results are guaranteed, and whose most important conclusions are gathered and presented here in a didactic and summarised form.

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- Forest plantations acts as the planet's reserve oxygen tanks
- Eucalyptus is efficient in water use
- It helps in replenishing aquifers
- It takes better advantage of water in fog
- It does not dry out soils
- It adapts its water consumption
- It promotes biodiversity
- It does not degrade soils, but improves them
- Protects natural woodland
- Reduces the risk of forest fires

As a major industrial asset

- Eucalyptus generates wealth in the rural medium
- Great growth and productivity as wood for pulp and energy
- It is a renewable energy source
- In paper production, eucalyptus means quality at a lower cost
- Large variety of uses and profitable and sustainable industrial applications

Scientific and reference bibliography

Sustainable forest management multiplies its value — 49-69

ENCE and sustainable forest management

- ENCE is a model for forest management
- Introduces and promotes forest certification in Spain
- R&D&i at the service of productivity and the environment
- Helps to fix carbon in Spain
- Helps to increase the forest surface area in Spain
- Model of conservation and biodiversity management
- Pioneer in Europe in the biological control of forest pests
- Forest management prevents the erosion of hillsides and recovers their value
- Sustainable forest management enables the multi-functionality of hillsides and main tains their productivity
- Forest management is an activity regulated by law

Appendix: Main activities in sustainable management of plantations

Origin of Eucalyptus

- Eucalyptus came into being in Australia, but the *Iberian Peninsula has particularly ideal conditions* in terms of climate and soil for the tree's natural productive development, especially in Galicia and in the Cantabrian area.

- There are approximately ***700 species of eucalyptus,*** all with great environmental value; 37 of these species are of interest for the forest industry while ***only 15 are used for commercial purpose.***

- Eucalyptus is currently ***present in over 90 countries*** and is spread over more than 22 million hectares worldwide, ***although only 13 million*** hectares ***have a productivity*** of interest from the industrial standpoint.

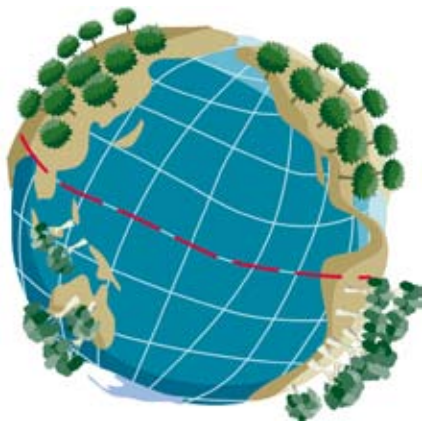
- ***In the south of the Peninsula***, through continued efforts to improve genetics and forest management, productive forest repopulations have been created which have ***adapted perfectly*** to less favourable climate and soil conditions.

- Eucalyptus plantations ***only account for 3% of the forest surface area*** in Spain, and thus offer a natural and sustainable social and economic ***development opportunity.***

Australia, the origin of the eucalyptus tree

The eucalyptus tree originally comes from Tasmania, Australia and other Indo-Malaysian islands.**There are approximately 700 species of eucalyptus,** all with great environmental value; 37 of these species are of interest for the forest industry while **only 15 are used for commercial purpose.**

The eucalyptus tree's natural distribution area is limited to the southern hemisphere and is symmetrical to the pine tree's distribution area.



Its natural distribution area is limited to the Southern Hemisphere, the only exception being *Eucalyptus deglupta,* which reaches latitude 11° N in Mindanao. In this regard, there is a curious parallel with the pine tree, which only has a natural distribution in the Northern Hemisphere, the only exception being *Pinus kesyii,* which reaches latitude 3° S, in the Philippines.

Both genera, **eucalyptus and pine, include the forest species most commonly used in plantations** with industrial purposes due to their great ecological breadth and ability to adapt.

The species *Eucalyptus globulus* or white eucalyptus was described by the French botanist Labillarolière in 1799. The name *Eucalyptus* is derived from the Greek *eu* (well) and *kalyptus* (covered), and refers to the protection afforded to the sexual organs by the operculum. The word *globulus* refers to the fact that its fruit are similar to certain buttons with that name which were fashionable in France at the time.

The eucalyptus was introduced in Europe over 200 years ago.
The first reference in the Iberia Peninsula - in Portugal - dates from 1829

The expansion of eucalyptus

Eucalyptus began to be used in plantations outside its natural distribution area over 200 years ago in Europe. **European botanists described the generus** and its main species. The first reference in the Iberia Peninsula dates from 1829 - in Portugal.

In the United States it was introduced in the mid-nineteenth century as a result of the migratory flow with New Zealand and Australia, which also prompted the introduction of the pine tree to Australia.

Eucalyptus has expanded all over the world due to its great degree of ecological breadth and its ability to adapt.

Eucalyptus reached South Africa and Brazil in the late nineteenth century and in the early twentieth century. In South Africa, this was prompted by the demand for wood, needed for mining activities; in Brazil to produce the coal used in the steel industry.

In other countries and areas of the world, eucalyptus was introduced through the British, French, Spanish, Portuguese and Dutch colonial powers, as well as by international governmental and non-governmental initiatives.

Through the British, French, Spanish, Portuguese and Dutch colonies, eucalyptus was able to reach other countries.

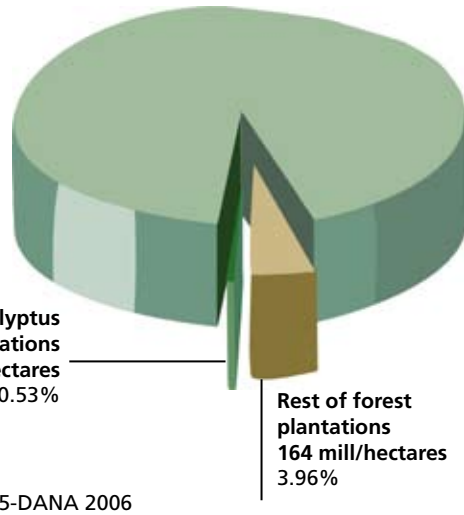
Eucalyptus is found in over 90 countries, but only accounts for 0.5% of the global forest surface area

Eucalyptus at present

At present, **eucalyptus is found in over 90 countries**, mostly in tropical and sub-tropical areas, although there are very productive plantations in temperate areas of New Zealand, Chile, Argentina, Brazil, Uruguay, South Africa, the Iberian Peninsula and the United States. The reason for this wide geographical distribution is the great number of species, and their tolerance to different ecological conditions.

Today eucalyptus is spread over more than 22 million hectares around the world (to which we would have to add over 11 million hectares of native eucalyptus woodland in Australia), which represent 12% of global forest plantations. However, it is estimated that **only 13 million hectares of these plantations are really of interest for industrial production.**

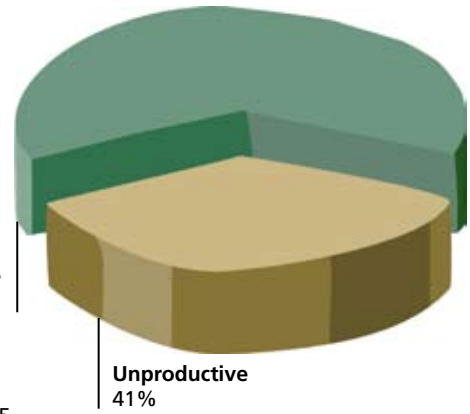
FOREST MASSES WORLDWIDE (IN MILLIONS OF HECTARES)



Forest Plantations worldwide only account for 4.5% of the forest surface area. Eucalyptus represents 0.53%.

Source: FAO 2005-DANA 2006

PRODUCTIVE EUCALYPTUS FORESTS



Eucalyptus plantations with industrial productivity account for 59% of eucalyptus forests

Source: FAO 2005

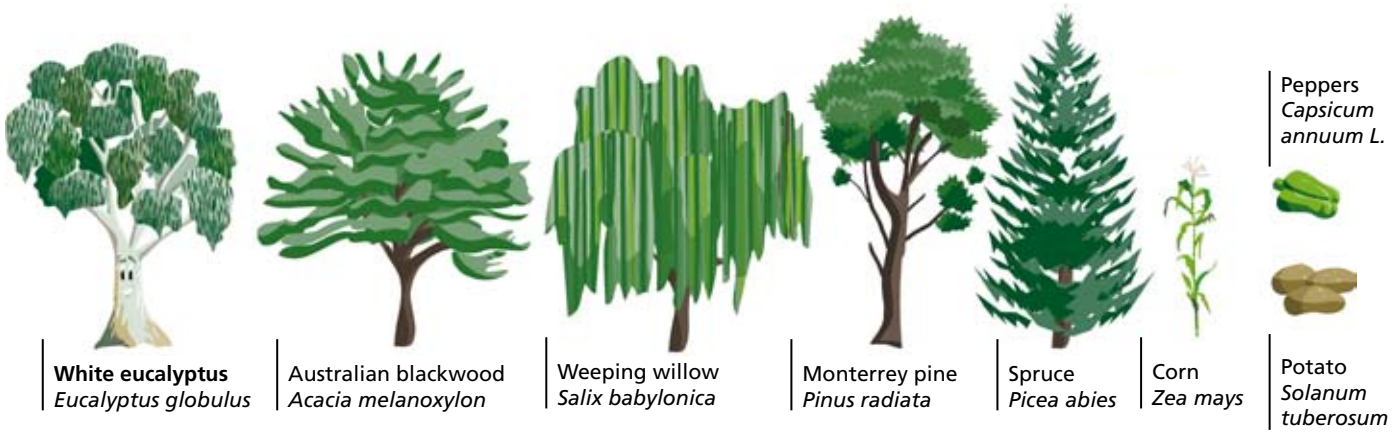
Eucalyptus, as with many other imported species, is perfectly adapted to the natural Spanish environment

Eucalyptus in Spain

White eucalyptus *Eucalyptus globulus* was introduced in northern Spain in the nineteenth century, as an ornamental plant. Due to the fact that it adapted so well to the environmental conditions on that territory, it became a highly successful and useful forest crop.

Eucalyptus is therefore an allochthonous species, such as is also the case with the Monterrey pine *Pinus radiata*, the weeping willow *Salyx babilonica* or Australian blackwood *Acacia melanoxylon* and many other agricultural crops such as potato, beetroot, corn, beans, peas, tomatoes and peppers.

EXAMPLES OF ALLOCHTHONOUS SPECIES INTRODUCED IN SPAIN



White eucalyptus *Eucalyptus globulus*

Australian blackwood *Acacia melanoxylon*

Weeping willow *Salix babylonica*

Monterrey pine *Pinus radiata*

Spruce *Picea abies*

Corn *Zea mays*

Peppers *Capsicum annuum L.*

Potato *Solanum tuberosum*

Plants, therefore, **are not good or bad because they come from one or another territory.** In fact, when an allochthonous or exotic plant adapts to its new medium and reproduces, it is said to be sub-spontaneous or that it has been naturalised.

Neither exotic nor autochthonous species *per se,* being the plants they are, give rise to irreversible deterioration in the environment which they need in order to exist; if the medium is inappropriate for the species, it will not be able to survive and will disappear. This is why white eucalyptus cannot live in high or cold areas.

Spain offers very appropriate climactic and soil conditions for the natural development of eucalyptus.

Species tend to reach a balance with the medium. Certain exotic species, if not managed appropriately, can displace other species or alter the dynamics of certain soils, but this is not the case with eucalyptus. In our country it is a species which is perfectly adapted to its environmental medium, especially in the north, and it is therefore naturalised.

Eucalyptus was born in Australia, but if it had been able to choose it would have chosen Galicia, whose climate and soil conditions are particularly ideal for its natural productive development. In terms of quality, the eucalyptus in this region may be likened to the famous Galician potatoes.

In the south of the Peninsula, by virtue of the continued efforts to improve genetics and forest management, **ENCE has created productive forest repopulations** of eucalyptus which are perfectly adapted to less favourable climate and soil conditions.

Eucalyptus, a sustainable development opportunity

The lack of autochthonous species with high productive capacity in Spain, and the difficulty faced by them in surviving in degraded or unused forest terrains, are reasons enough for the organised introduction of forest species such as eucalyptus, which because of its characteristics can live in very diverse climatic conditions.

Compared with agriculture, eucalyptus plantations:

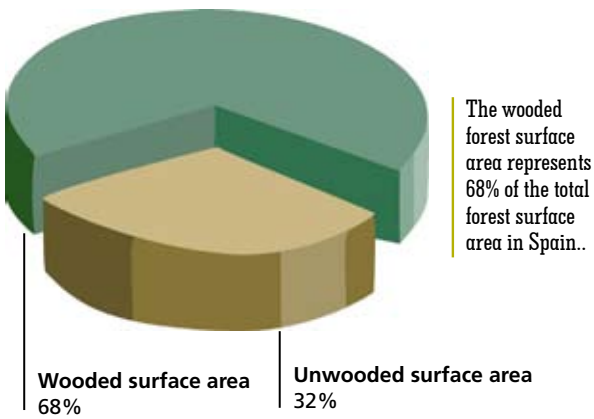
- Act as carbon deposits.
- Require less energy consumption.
- They have much lower rates of erosion.
- They are less management-intensive.
- They offer greater biodiversity.
- They enable a higher degree of multi-functionality.
- They improve the balance in the water cycle.

Compared with other forest species, eucalyptus plantations:

- Have a greater forest productivity, and thus require less surface area.
- Certain species are more efficient in their use of water.
- They offer a higher adaptation capacity and swift growth, multiplying their environmental and industrial potential and capacity for generating jobs and wealth.
- They offer a higher industrial return for pulp production.
- They offer a broad industrial versatility, standing out especially as a renewable energy source and an ideal raw material for manufacturing high quality products such as paper, honey, or essential oils.
- Its characteristics as a tree enable there to be a wider development of biodiversity.
- Reduced risk of forest fires.

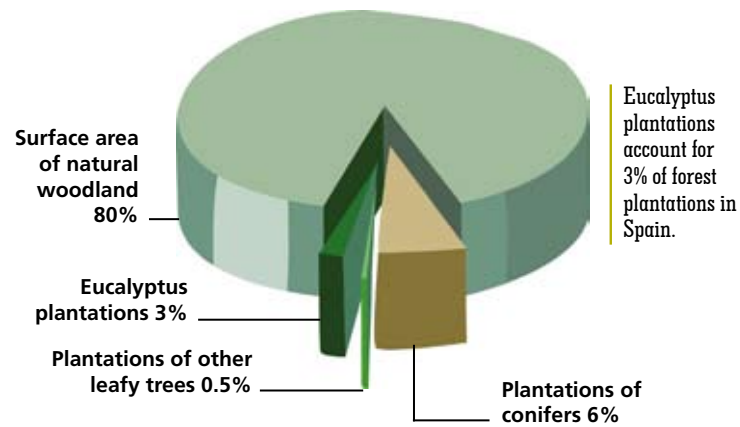
"It is important to recognise, highlight and promote the role played by forest plantations as sustainable and ecologically rational sources of renewable energy and raw material for the industry". II Earth Summit, Río de Janeiro, 1992

FOREST SURFACE AREA IN SPAIN



Source: Annual Forest Statistics (Anuario de Estadísticas Forestales) 2006

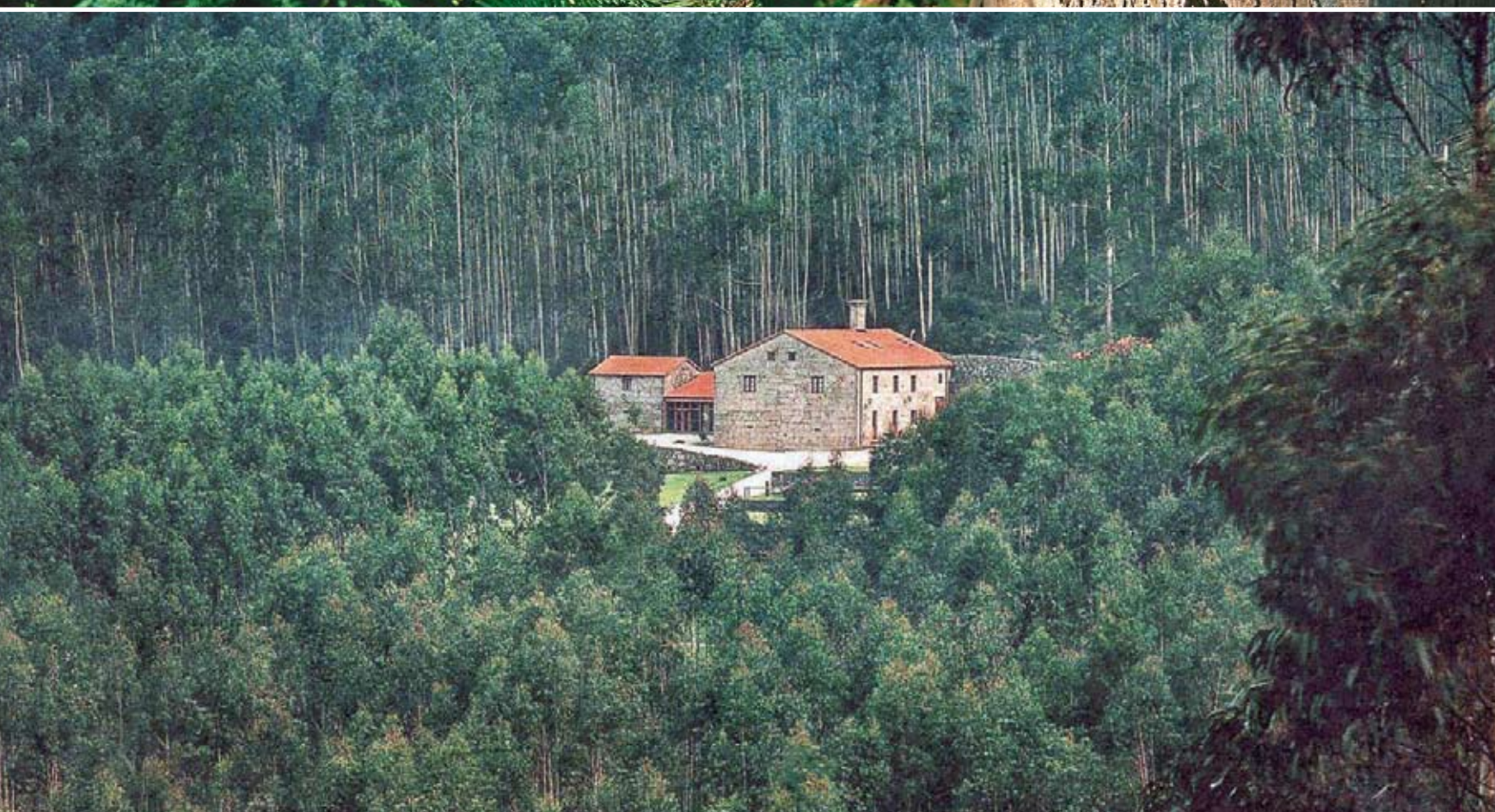
FOREST SURFACE AREA AND PLANTATIONS IN SPAIN

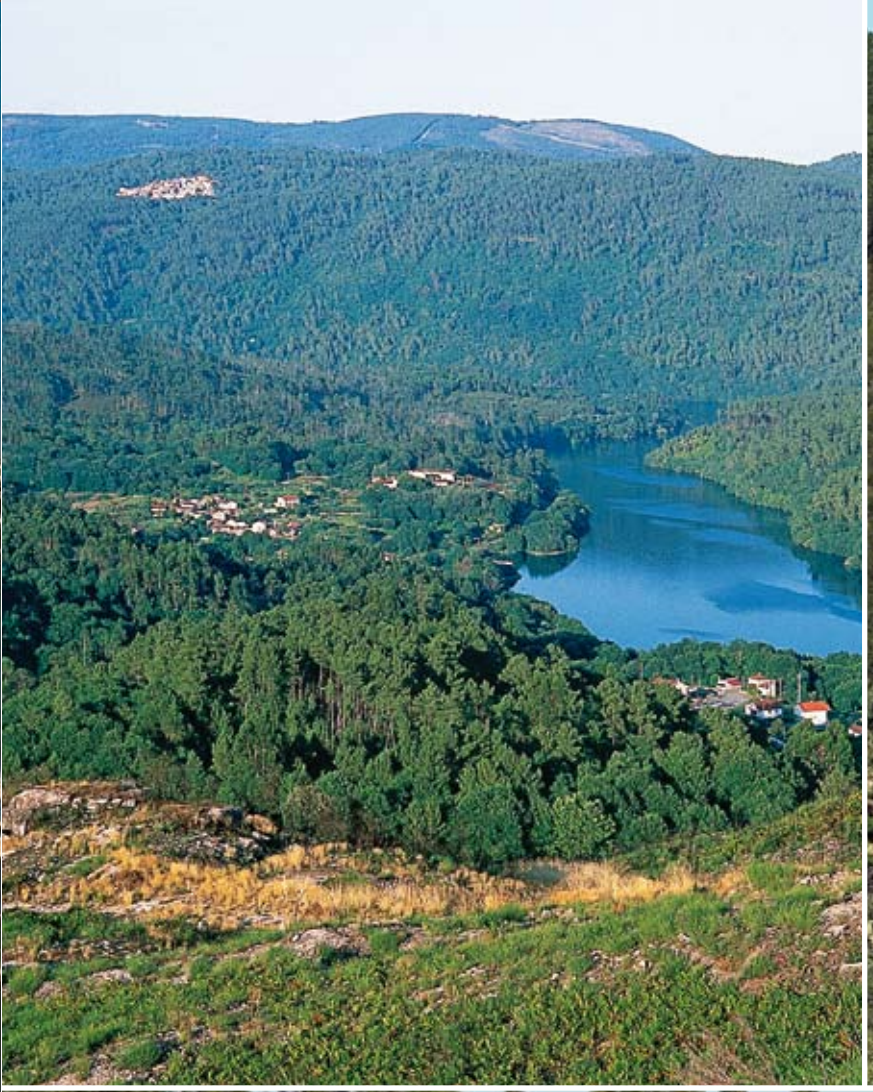


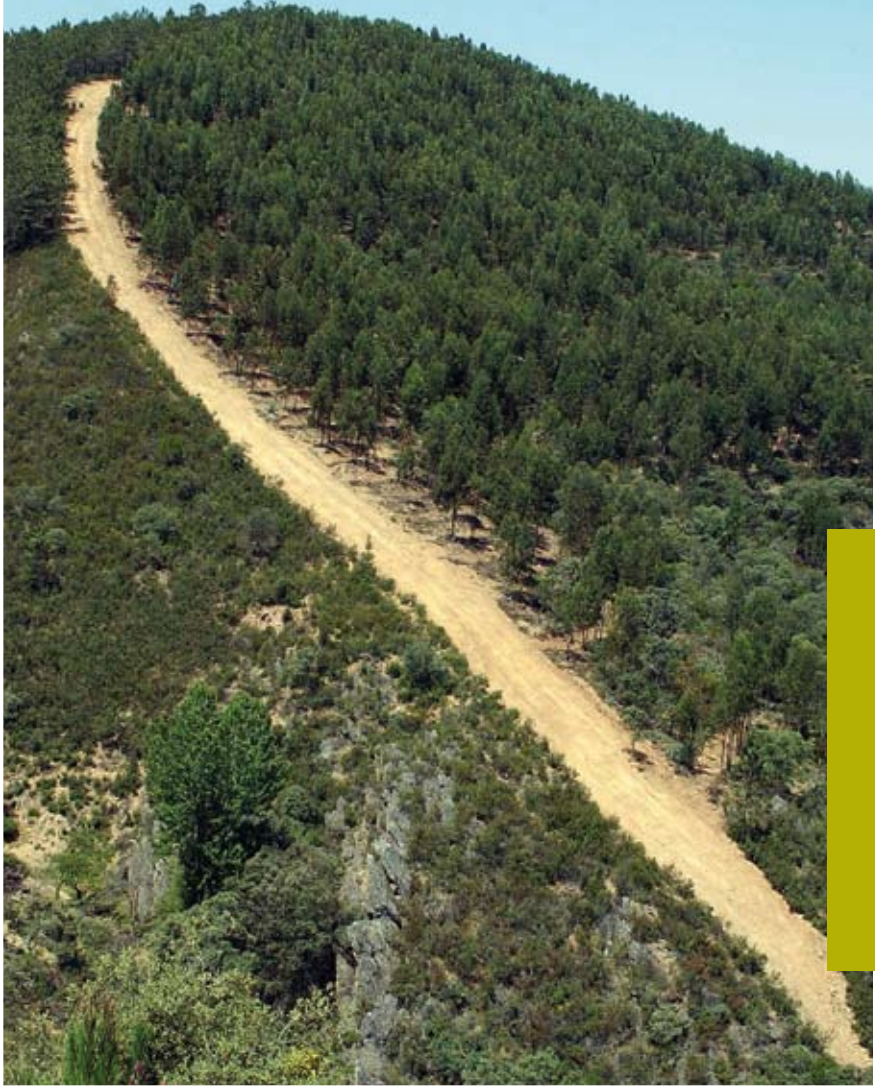
Sources: FAO/Annual Forest Statistics 2006


Eucalyptus
in Spain

A sustainable development opportunity







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Its advantages as a tree

Environmental benefits

- Due to its higher growth capacity and the density of its wood, eucalyptus is ***very efficient*** at ***capturing CO_2***, fixing carbon and generating oxygen.
- The mass effect means that ***forest plantations*** act as the planet's ***reserve oxygen tanks.***
- Its speedy growth and its renewal every 10 or 15 years mean that it fixes ***a greater amount of carbon.***
- Eucalyptus is more ***efficient in water use*** than other species
    - It helps in replenishing aquifers
    - It takes better advantage of water in fog
    - It does not dry out soils
    - It adapts its water consumption
- Eucalyptus ***promotes biodiversity*** and eucalyptus plantations create new natural spaces.
- A eucalyptus plantation is not a natural forest but because of its functions ***it acts in a similar way to a forest.***
- Eucalyptus does ***not degrade soils*** but improves them.
- Eucalyptus ***recovers degraded soils*** which are unused or unusable.
- Its ***leaves and branches*** act as nutrients and are not acidic for the soil.
- Eucalyptus ***protects natural woodland.*** A plantation can carry out the functions of a protective area to help fight pollution.
- Eucalyptus and its forest management ***reduce the risk of forest fires.***

Industrial benefits

- Eucalyptus plantations ***create employment and wealth*** in the rural medium. The land on which wood is grown is owned by families.
- Eucalyptus stands out because of its ***many industrial applications,*** which are profitable and sustainable.
- Its forest production and the ***wood yield*** make white eucalyptus the most appropriate tree for producing pulp and renewable energy.
- Eucalyptus implies ***quality at a lower cost*** in manufacturing printing, writing and tissue paper.
- Eucalyptus is also used for other ***many industrial and social uses,*** from manufacturing honey to essential oils, to hunting and livestock on its plantations, and leisure.
- The energy potential offered by ***eucalyptus biomass is an opportunity for economic and social development.***

Benefits of eucalyptus for nature and the environment

Eucalyptus has a twofold value:

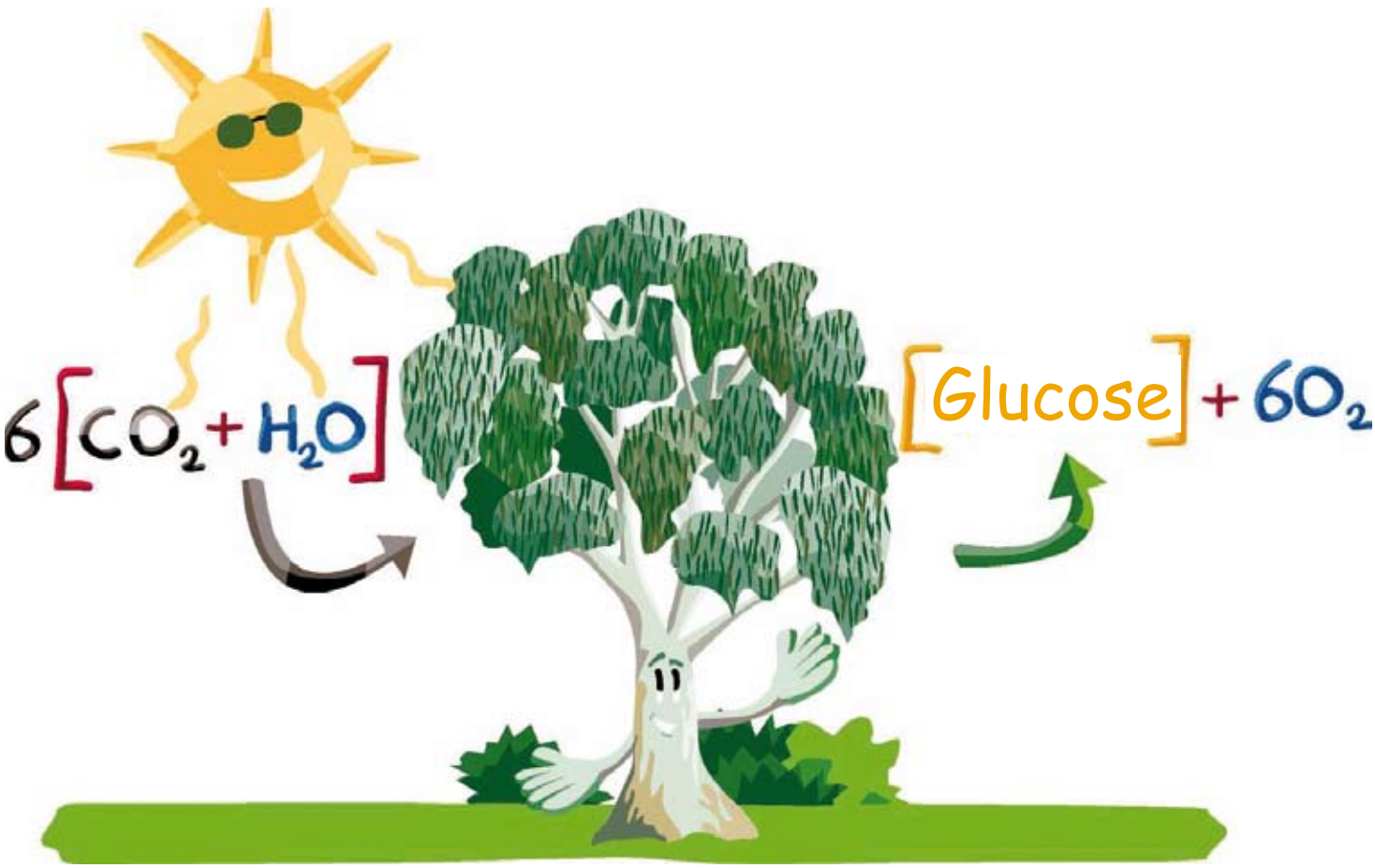
- It is a beneficial species for the environment.

- Its use as a renewable energy enables competitive industrial applications to be developed, with a high capacity for generating jobs and wealth.

Eucalyptus is beneficial to the environment and generates jobs and wealth.

Basic natural function: photosynthesis

Eucalyptus is a tree, and as such, it carries out a basic natural function for life: photosynthesis.



Eucalyptus captures large amounts of CO_2

Compared with other species, **eucalyptus is particularly efficient at capturing CO_2,** fixing carbon and generating oxygen. This is because it has a higher growth rate and the fact that its wood is denser - factors which enable it to accumulate more carbon per unit of volume.

The mass effect is favourable for species, and if these grow better, they fix more CO_2

FIXING OF CO_2 OF EUCALYPTUS COMPARED WITH OTHER FOREST SPECIES

Eucalyptus Eucalyptus spp.
0.1359 Tn CO2 / year/tree

Chestnut Castanea sativa
0.0681 Tn CO_2 / year/tree

Maritime pine Pinus pinaster
0.0366 Tn CO_2 / year/tree

Scots pine Pinus sylvestris
0.0291 Tn CO_2 / year/tree

Holm oak Quercus ilex
0.0254 Tn CO_2 / year/tree

Gregorio Montero, Ricardo Ruiz-Peinado, Marta Muñoz.
Monografías del INIA. Serie Forestal. Nº 13-2005. Ministerio de Medio Ambiente.
Average figure of annual fixings per foot.

Eucalyptus captures greater amounts of CO_2 than other species.

Forest plantations act as the planet's reserve oxygen tanks

This high individual potential is increased exponentially with the cultivation of forest masses, given that **all trees have a higher carbon fixing rate in their first years of life.**

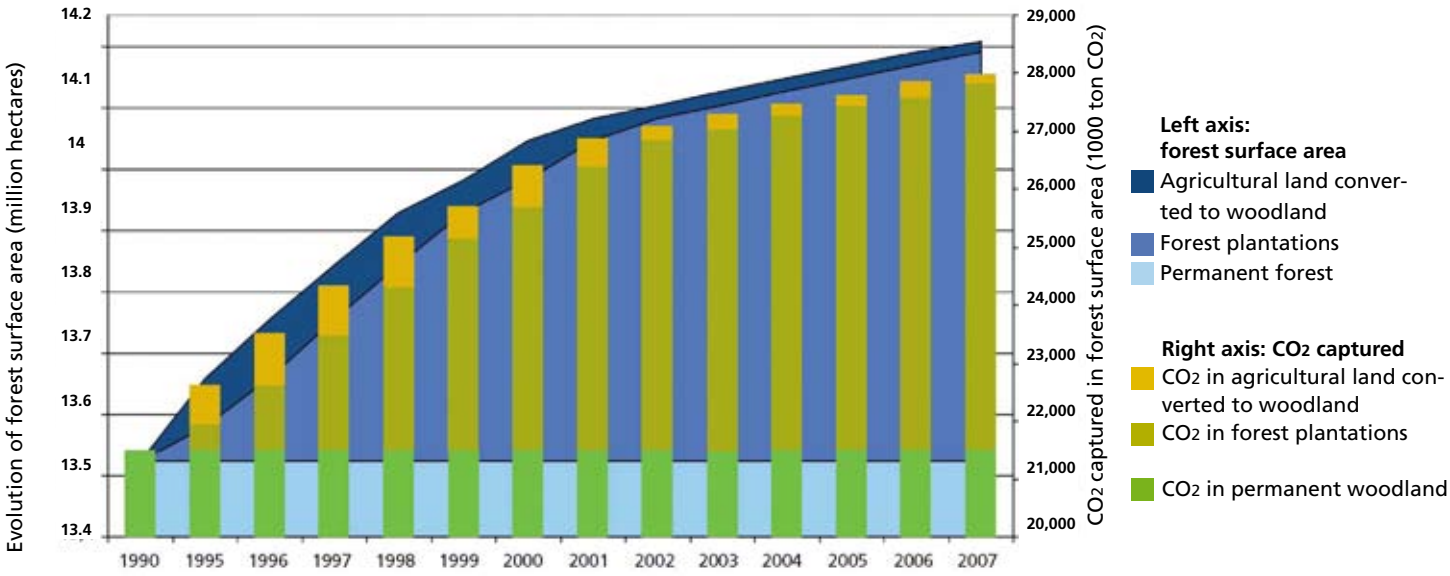
The mass effect is favourable for species (an isolated tree finds it more difficult to survive) **and if these grow better, they fix more carbon.** If a species is also induced to grow rapidly, it will grow more quickly and fix even more carbon.

In the case of eucalyptus, its speedy growth significantly **increases this capacity.** Furthermore, eucalyptus plantations rejuvenate each time they are felled, which takes place every 10 to 15 years approximately (depending on the species, example of tree, climate and soil), which implies having tree masses which are always young, with exuberant growth, and therefore fixing a lot of carbon. Australia, the origin of the eucalyptus tree.

In old trees the fixing rate decreases with age and they end up becoming net issuers of CO_2 due to the deterioration of their functions and their decomposition.

Trees in forest masses, therefore, not only capture more CO_2 and produce more oxygen than older trees in an over-mature forest, **but also mean it is possible to extract and renew again up to three times the higher potential** which a young tree offers in its natural function: carbon fixing.

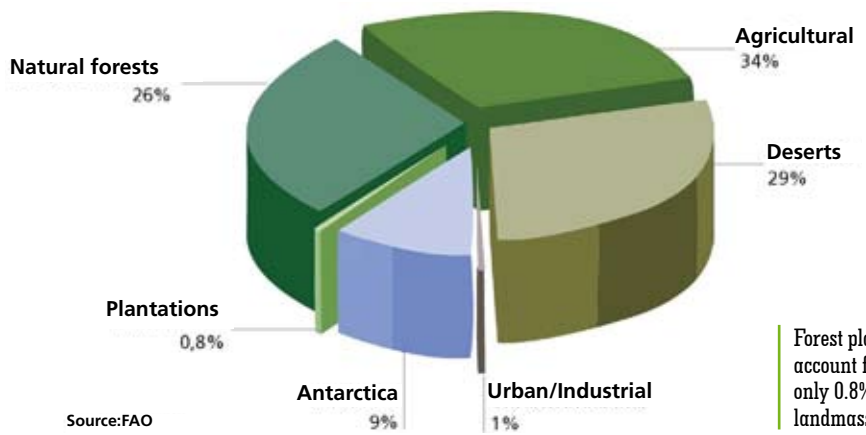
FOREST SURFACE AREA AND CARBON DEPOSITS IN SPAIN (1990-2007)



Source: Jaakko Pöyry – Ministerio de Medio Ambiente 2009.

Plantations are therefore **an efficient alternative solution in the fight against deforestation.** They can comply with the function of being the planet's "oxygen tank", but they only take up 0.8% of the soil compared with 34% in agriculture.

USES OF PLANET SOIL



Source:FAO

Forest plantations account for only 0.8% of the landmass.

Eucalyptus is efficient in water use

In general, **vegetation consumes a relatively small part of rainwater:** 30% is evaporated directly and the remaining water slides off the ground towards natural channels.

When a soil is soaked, part of the water is lost due to profound infiltration, and another part evaporates; it is only the remaining part which it used by trees and plants in their biological functions. Furthermore, part of this water is resent to the atmosphere through the leaves and is therefore not consumed. All vegetable species, with varying degrees of efficiency, take part in the same way in the water cycle.

Eucalyptus is a rapidly growing leafy tree, a group of trees which includes other species such as birch, poplar, plane tree, willow, mimosa and many other common trees in our country.

Any other rapidly growing and highly productive species, whether agricultural or forest, needs more water than others which grow more slowly or to a lesser degree.

Nevertheless, **eucalyptus is not a tree which stands out due to its high water consumption;** in fact, it has a better balance than that of the conifers and considerably better than that of any agricultural crop. In fact, **it is one of the most efficient species in water consumption for biomass production.**

Eucalyptus stands out because of its superior water balance, which is more efficient than that of other species.

WATER CONSUMPTION OF EUCALYPTUS COMPARED WITH OTHER SPECIES

Source: Jiménez, E.; Vega, J.A. et al (2007).

Eucalyptus
306 litres/kg of dry material

Oaks
400 litres/kg of dry material

Pines
303 litres/kg of dry material

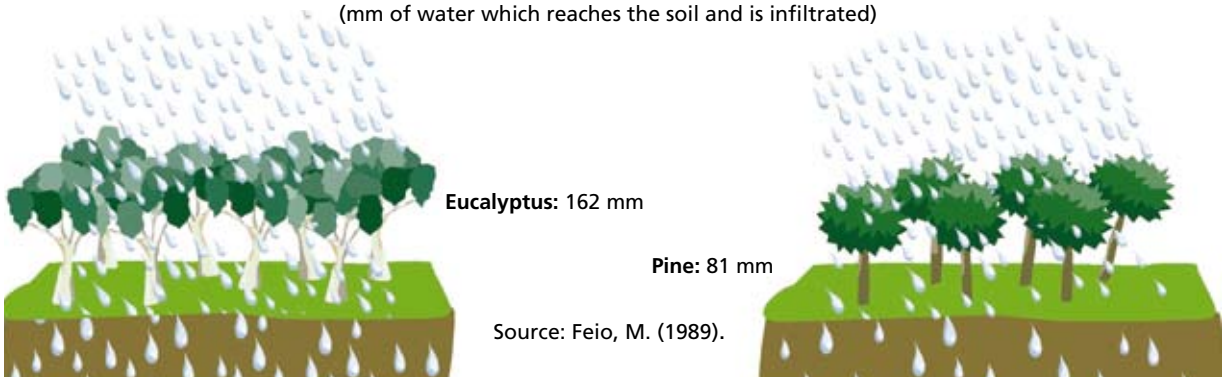
Corn
1,000 litres/kg of dry material

Sweet potato
2,000 litres/kg of dry material

Soya
2,000 litres/kg of dry material

WATER BALANCE OF A EUCALYPTUS COMPARED WITH A PINE

(mm of water which reaches the soil and is infiltrated)



Eucalyptus: 162 mm

Pine: 81 mm

Source: Feio, M. (1989).

Eucalyptus helps to replenish aquifers

Due to the characteristics of its crown, the arrangement of its branches and the form of its leaves, eucalyptus allows a greater amount of water to reach the soil than other species, thus helping to replenish aquifers and the circulation in the system overall.

INTERCEPTION OF RAINWATER IN DIFFERENT SPECIES

Eucalyptus	Maritime	Stone pine	Oak
Eucalyptus spp.	*Pinus pinaster*	*Pinus pinea*	*Quercus spp.*
6.5%	7.5%	22.8%	30%

Source: Gras, J.M., 1993; González et al, 1983.

Eucalyptus takes better advantage of water in fog

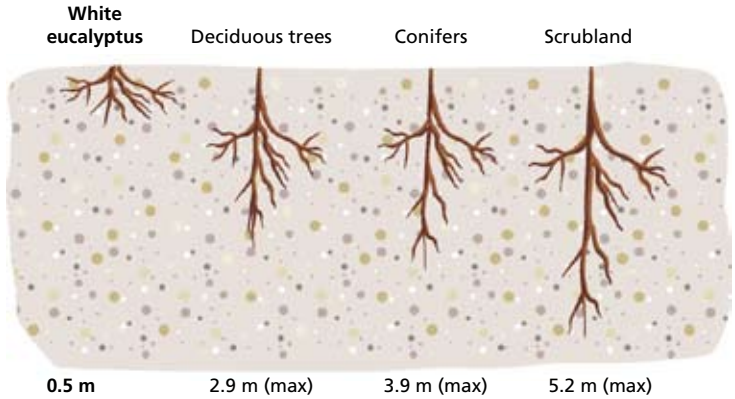
Eucalyptus is able to take better advantage of water from fog, which drips down on to the soil from the leaves. This process is helped by the vertical position of the leaves, the natural wax which covers them, and due to their channel-shaped form and pendular motion. The far ends of eucalyptus leaves are light and flexible and help this effect.

Eucalyptus does not dry out soils

Eucalyptus does not dry out deep aquifers because it is a plant with superficial roots, roots which are shorter than those of some of the autochthonous species in their environment.

80% of eucalyptus roots are found in the upper 60 cm of soil.

AVERAGE DEPTH OF ROOTS



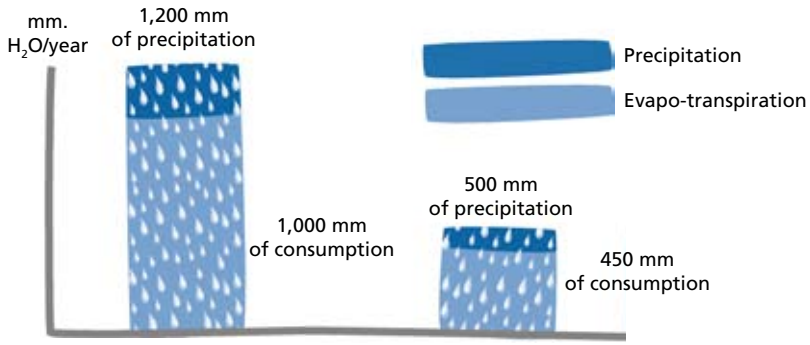
Source: FABIAO *et al,* 1994.

Eucalyptus adapts its water consumption

Eucalyptus adapts its water consumption to the availability of water. In scant water conditions, its efficiency is similar to that of autochthonous species such as pines or oaks.

Eucalyptus adapts its water consumption to the level of rain and the climate.

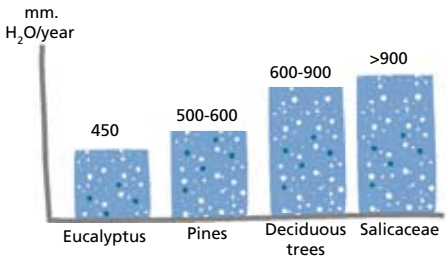
EUCALYPTUS: WATER CONSUMPTION ACCORDING TO PRECIPITATION LEVELS



The lower the availability of water, the lower their consumption (FAO, 1987, 1995).

Eucalyptus is more efficient in water use than other species.

WATER TRANSPIRATION IN DIFFERENT SPECIES



Lower transpiration of eucalyptus compared with other natural species (Gras, 93; Gozal et al 2006 and others).

A eucalyptus plantation is not a natural forest nor an agricultural crop; it is a forest crop

Eucalyptus promotes biodiversity

Eucalyptus does not eliminate other plants or trees, it is man's actions which destroy fauna and flora when the aforesaid activity is carried out without the proper care.

A eucalyptus plantation is not a natural forest nor is it an agricultural crop, it is a forest crop which through its functions acts in a similar way to a forest.

A eucalyptus plantation has a lower degree of animal and plant diversity than a natural forest, but the idea is not to reach this level, nor is it its main function, although it fulfils it in any case: **a plantation creates new natural spaces for the development of life.** For wild plants, birds and small mammals, reptiles or insects, it is an alternative natural refuge which affords them protection and which did not formerly exist, similar to the refuge which can be offered by a pine grove.

In northern Spain, the roe deer, an animal which is very selective when choosing its habitat, has surprisingly reproduced in the eucalyptus forests of Lugo and La Coruña. In the south-west of the Iberian Peninsula, open eucalyptus masses allow grazing areas to be implemented which feed large herbivores such as deer. Small game hunting, and of rabbits in particular, is a common practice in the eucalyptus forests of Huelva. Birds which are as demanding as the partridge or the arcea also use eucalyptus forests. And birds of prey use the height of eucalyptus trees to establish their nests and scan their territory.

A plantation creates new natural spaces for life to develop.

Eucalyptus does not degrade soils,it improves them

Eucalyptus does not put toxic substances into the soil; on the contrary: if the residue is crushed or incorporated into the soil (which is a natural biological process), or if most of it is extracted —branches, dry leaves, bark and peels — the remains which are left generate chemical components which act as nutrients and which for example have a much better relation of acids than the oak and the pine, which are autochthonous species.

Eucalyptus residues act as natural nutrients.

Extraction of nutrients from soil (kg/hectares/year)	Nitrogen	Phosphorus	Potassium
Eucalyptus *Eucalyptus globulus*	**4.8**	**1.3**	**6**
Poplar *Populus x euroamericana*	12.1	5.2	18.5
Willow Salix americana	51.6	9	21.6
Wheat *Triticum spp.*	110	22	50
Alfalfa hay	215	24	125
Potato *Solanum tuberosum*	94	15	131

Source: González Esparcia (1985).

In Huelva, as with other studies carried out in other areas, it has been proven that **the nutrients contributed by eucalyptus are more balanced in terms of acidity** than the cork oak or the holm oak, and in marked contrast to the minimum levels found in pine trees. Other studies show that the extraction of nutrients by the eucalyptus is lower than that of other species grown as forest or agricultural crops.

ACIDITY OF THE ORGANIC RESIDUE OF EUCALYPTUS COMPARED WITH OTHER SPECIES

Source: Domínguez de Juan (1986). These differences are confirmed by subsequent studies by the Universidad de Huelva.

Eucalyptus trees pH 6.32

Oaks-Holm oaks pH 5.28

Pines pH 4.74

Eucalyptus plantations on bare terrains improve their fertility in Mediterranean and sub-tropical areas, showing a better balance than pines and many tropical species.

Scientific studies show that **eucalyptus does not degrade the soil, nor does it reduce reserves or nutrients, nor destroy the microflora, nor cause impermeable strata to appear** (which would soak the soils and prevent them from being aerated), **nor damages to microscopic flora and fauna.**

Furthermore, as a plant layer, it protects soils from the erosion caused by rainwater and regulates the flow of water, helping to prevent rises in river levels and torrential river flows.

Scientific studies demonstrate that eucalyptus does not degrade the soil.

The eucalyptus forest, as a plant layer, protects soils from erosion by rainfall and regulates the flow of water.

Eucalyptus protects natural woodland

The main object of forest plantations is to obtain a high degree of productivity, in other words, to achieve the fastest possible growth in the tree and obtain the greatest amount of wood and biomass, while occupying the smallest possible space.

Plantations are carried out in forest areas, largely in soils without plant cover, or which are degraded or unused. Eucalyptus plantations do not therefore invade natural spaces, in fact they protect them.

The term "invasive" is derogatory. In the *Forest Dictionary (Diccionario Forestal)* of the Spanish Forest Science Society this term is not used.

Eucalyptus is a species which tends to expand, but it is not damaging to other species nor does it lead to an imbalance in the medium. It has a regrowth and germination capacity, just like many other species such as the poplar or pine, for example. It is a colonising plant, as it easily installs itself in an empty or free terrain.

A plantation can act as protective area to help fight pollution, damaging elements or forest fires.

Eucalyptus tends to self-reproduce, but it not damaging to other species nor does it lead to an imbalance in the medium

Eucalyptus recovers degraded parts of the countryside.

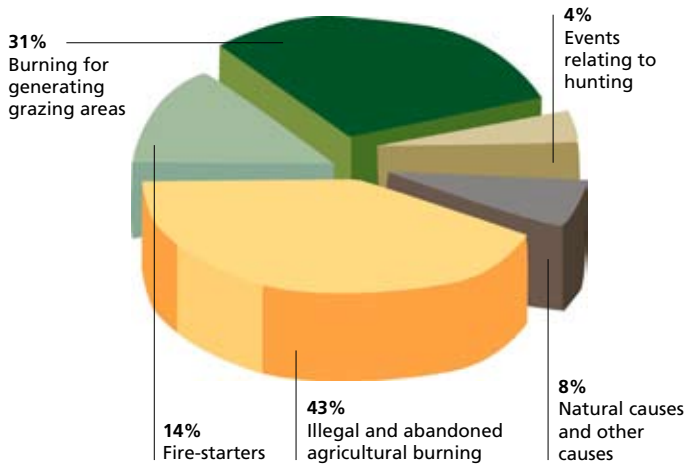
Eucalyptus can act as a protective area.

Eucalyptus reduces the risk of forest fires

Eucalyptus, like any other plant species, is combustible, in other words it burns easily, but eucalyptus is not the cause of forest fires, it suffers them.

"There is no relation between eucalyptus plantations and the danger of forest fires". FAO, 1981

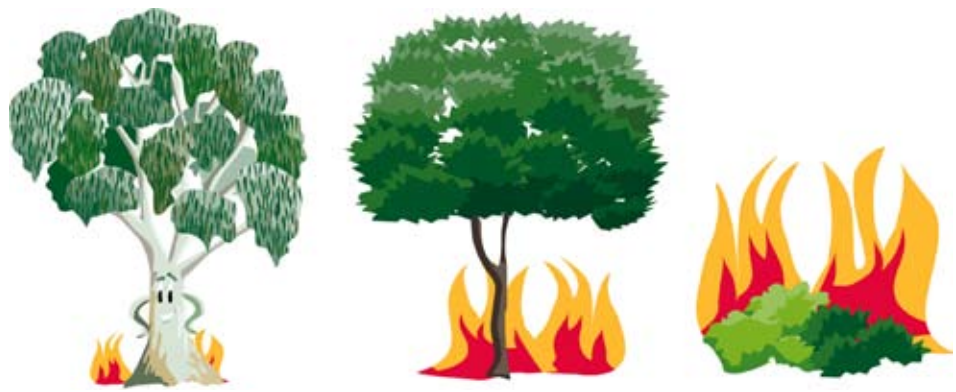
CAUSES OF FOREST FIRES IN SPAIN



Eucalyptus does not appear as a cause of forest fires. Source: Greenpeace 2007.

In the event of a forest fire, one of the distinguishing features of the eucalyptus tree is its lower propagation capacity when compared with other forest species such as the Aleppo, the maritime pine or the Monterrey pine, and also compared with low altitude bushes and scrub which are common in Spain.

Forest fuel models of Spain's Ministry of the Environment classify eucalyptus within the high tree category, **presenting the lowest fuel load parameter and the lowest flame height when compared to other types of tree,** and also shows important differences with regard to the other categories: grazing land, scrubland and forest waste.

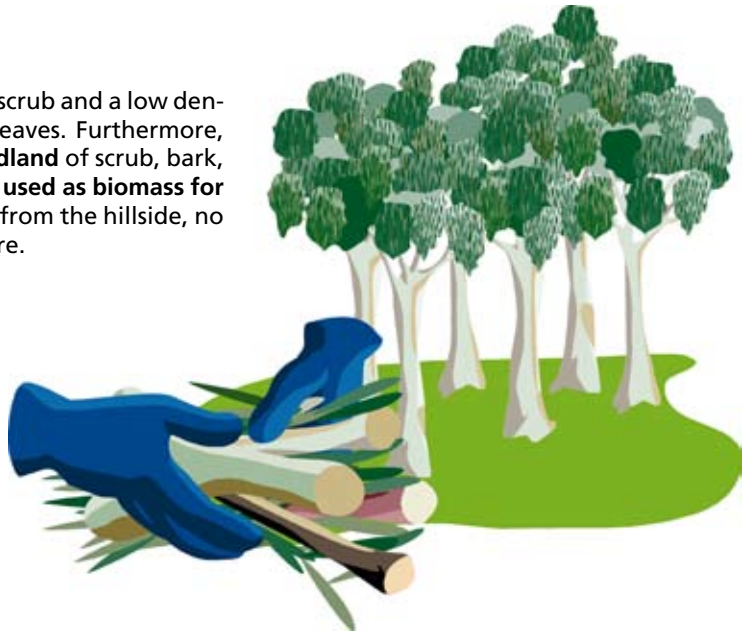


Eucalyptus has the lowest fuel load parameter and flame height. Source: MIMAM.

	Eucalyptus	Pine	Scrubland
Flame height (m)	**0.9**	1.4	5.3
Fuel load*	**0.88**	3.00	3.593
Advance speed (m/min)	**3**	3	22

* Expressed as kg/m²/area-volume σ (m^{-1})

Well-managed eucalyptus forest plantations have little scrub and a low density in their trees, in other words, few branches and leaves. Furthermore, **complete forest management regularly clears the woodland** of scrub, bark, branches and dry fruit peels, elements which are partly **used as biomass for generating energy** and which when they are extracted from the hillside, no longer act as a potential fuel in the event of a forest fire.

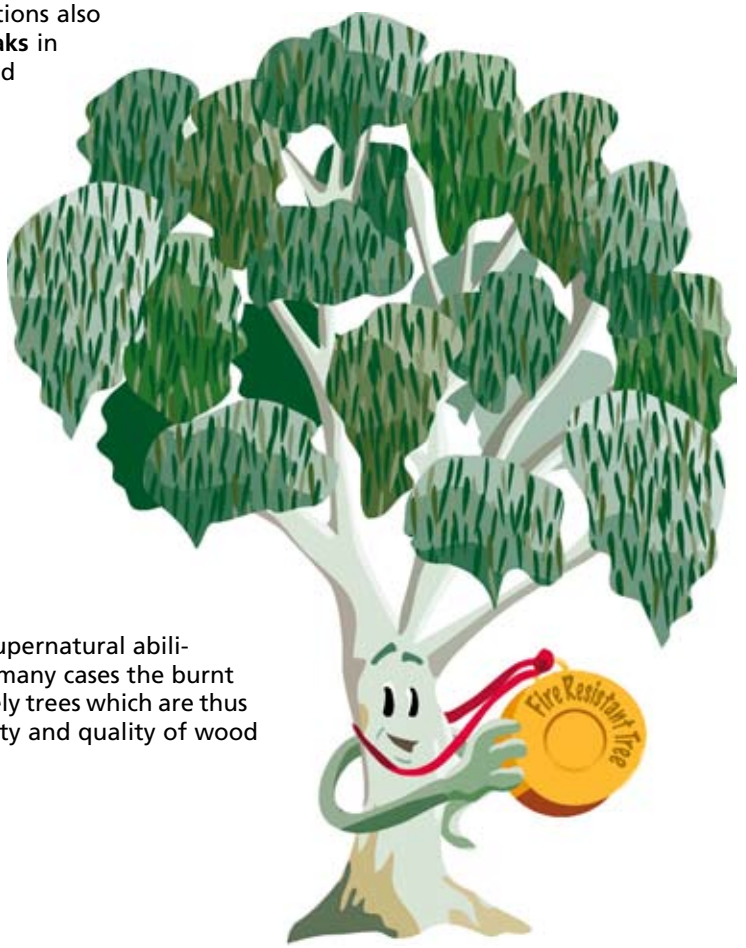


Eucalyptus management clears woodland of forest residue.

If a forest fire occurs at ground level in well-managed forests, cleared of scrub and other remains, the lower part of the eucalyptus bark is commonly burnt. But the tree continues to grow and within a few years a new bark displaces and replaces the bark which was burnt. Plantations also **have a greater number of paths and internal firebreaks** in order to allow the fire-fighting teams to act quickly and effectively and so stop the limit of the flames from spreading.

Because of these characteristics, well-managed eucalyptus trees **are extremely useful masses for the protection of our hillsides** against the risk of forest fires.

On the other hand, if the forest fire is particularly intense, due to a strong wind or due to the excessive fuel load, it reaches the tops of the trees and they are almost totally destroyed. **The damages to the wood caused by the fire are definitive** and mean it cannot be used for production. The pulp manufacturing process is particularly sensitive to these kinds of flaws (remains of coal or ash in the wood).



Although the great ability of eucalyptus - its almost supernatural ability - to cope with all kinds of situations means that in many cases the burnt trunks spring fresh shoots and rejuvenate, unfortunately trees which are thus affected can thereafter never produce enough quantity and quality of wood for it to be used in industry.

Eucalyptus as a major industrial asset

Eucalyptus has great industrial advantages which make it **a tree of extraordinary value** as a renewable raw material:

- It generates wealth in the rural medium.
- In terms of wood for pulp, its growth and productivity are higher than in other species.
- In paper production, eucalyptus means quality at a lower cost.
- It is a source of renewable energy as process biomass and as an energy crop.
- It allows a great variety of uses and profitable and sustainable applications.

Eucalyptus has great industrial advantages which make it a tree of extraordinary value as a renewable raw material

Eucalyptus plantations create wealth in the rural medium

In northern Spain, it is local families who are predominantly the owners of the wood. In Galicia, for example, there are 670,000 forest proprietors; most of them own small farms or a plot of land on hillsides with surface areas of no larger than two hectares, where they can grow small amounts of wood.

In the south of the Iberian Peninsula, eucalyptus has been used to recuperate former degraded agricultural soils and non-productive or unused terrains due largely to the warm dry climate of the region, which is very appealing from the standpoint of hunting, livestock farming and honey production.

Using techniques learnt from forest research, these terrains become very useful as surface areas for planting pulp wood, using varieties of trees selected genetically which adapt to climate and soil conditions, such as energy crops or as research plots. Great growth and productivity as wood for pulp and energy

Great growth and productivity as wood for pulp and energy

One of the most important applications of eucalyptus is the production of pulp - the basic raw material for **manufacturing paper and cardboard.** There are basically two kinds of trees used in pulp production: conifers, such as pines or firs, and leafy trees, such as eucalyptus, birch or acacia. Because of its long fibres, pulp from conifers is called long fiber, and that from leafy trees is called short fibre pulp.

As a forest species, **eucalyptus grows more quickly and is more productive per hectare** than other species of interest for pulp production.

With eucalyptus less wood is needed to manufacture a ton of pulp

YIELD OF SPECIES COMMONLY USED FOR PULP

Forest yield[1]	Eucalyptus	Birch	Pine	Spruce	Beech	Acacia[2]
m^3/hectare/year	15-30	3-8	2-10	4-10	2-9	15-25
shifts (years) of felling	9-14	25-45	75-110	60-80	100-140	6-12
Industrial yield	**E. globulus**	**E. grandis**	**Pine**	**Birch**	**Poplar**	**Acacia[2]**
m^3/adt	2.8-2.9	3.8-4.0	5.0	4.5	4.9	3.0

[1] Average data (depending on the species, climate and soil) for commercial wood (roll entry to factory measured without bark). Does not include marginal forest productions.
[2] Referring to estimates in Asia; acacia is used mainly in India and Indonesia.
adt: air dry tonne . m3: cubic metres of dry wood.

In addition to the higher degree of forest productivity offered by eucalyptus, **its specific yield is also higher** (lower amount of wood per ton of pulp produced). Specifically, the tree known as "Iberian" eucalyptus, white eucalyptus —Eucalyptus globulus globulus— is the world's most efficient tree for manufacturing pulp, which is an advantage for our industry, given that wood accounts for over half of the expenses of pulp manufacture. **Furthermore, renewable energy is generated in the process.**

With white eucalyptus 390 packages of 500 pages can be produced whereas with pine only 190 packages can be produced. With eucalyptus, 7,500 rolls of toilet paper can be produced, compared with only 3,700 for a pine.

Eucalyptus is a renewable energy source

Eucalyptus fibres are interconnected by lignin, a type of natural adhesive.

In the boiling phase of pulp production, this lignin is separated from the fibres and is then reused as fuel to produce electricity. This is what is known as black liquor or process biomass which is burnt in a recovery boiler. The heat produced gives off steam, which is directed to a turbine producing electricity. Forest residues and the bark separated from the tree go to another biomass boiler.

This energy is used to supply plant consumption. **ENCE's pulp mills are self-sufficient in energy and also produce an electrical surplus which is exported** to the national grid as renewable energy.

Because of these two advantages - forest productivity and industrial wood yield - eucalyptus is the most appropriate wood for manufacturing pulp and energy, products which are necessary and constantly in growing demand by society.

Biomass from the pulp process is reused to generate electricity

In paper production, eucalyptus means quality at a lower cost

The term "wood quality" needs to be accurately defined in terms of the wood's final use, given that the definition of quality can vary depending on its use.

In the case of bleached pulp and its subsequent application in the highest quality papers, cultivated **eucalyptus** is once again **the winning fibre.**

Paper is manufactured with pulp deriving from forest plantations and/or with paper recovered from which its fibres are recycled.

Most papers are composed of both long fibre and short fibre, in varying proportions depending on the types of paper. The morphology of the fibres differs in each tree and thus gives different characteristics.

The composition of fibres is adjusted according to cost criteria and the technical manufacturing requirements and the final use given to the paper. Certain types of paper are only made with long fibre, while others use only short fibre. Nonetheless, most papers are manufactured with a mixture of virgin fibres, recycled fibres and other additives.

BIOMETRIC PROPERTIES OF THE FIBRES

Characteristics	White eucalyptus	Birch	Beech	Acacia	Pine	Fir
No. of fibres per gram, million	19.1	8.0	7.0	16.7	2.6	1.5
Average length, mm	1.05	1.35	1.25	1.10	3.00	3.50
Average width, micras	19.6	18.1	23.2	27.0	38.0	40.0
Length/width ratio	53.6	76.1	55.0	40.7	79.0	87.5
Thickness of wall, micras	4.20	3.07	5.2	3.0	5.90	4.0
Proportion of wall	44.0	34.9	45.7	22.2	31.0	20.0
Width of lumen, micras	11.2	9.8	16.0	21.0	26.2	32.0
Flexibility index, %	57.1	57.0	61.0	77.8	68.9	80.0
Runkel Index	0.85	0.75	0.46	0.29	0.45	0.25
Fibre roughness, mg/100 m	8.6	13.1	13.1	8.9	20.9	13.0

Source: Fernando Sánchez Lafraya (2008). The Use of Eucalyptus Pulp in Paper Making.

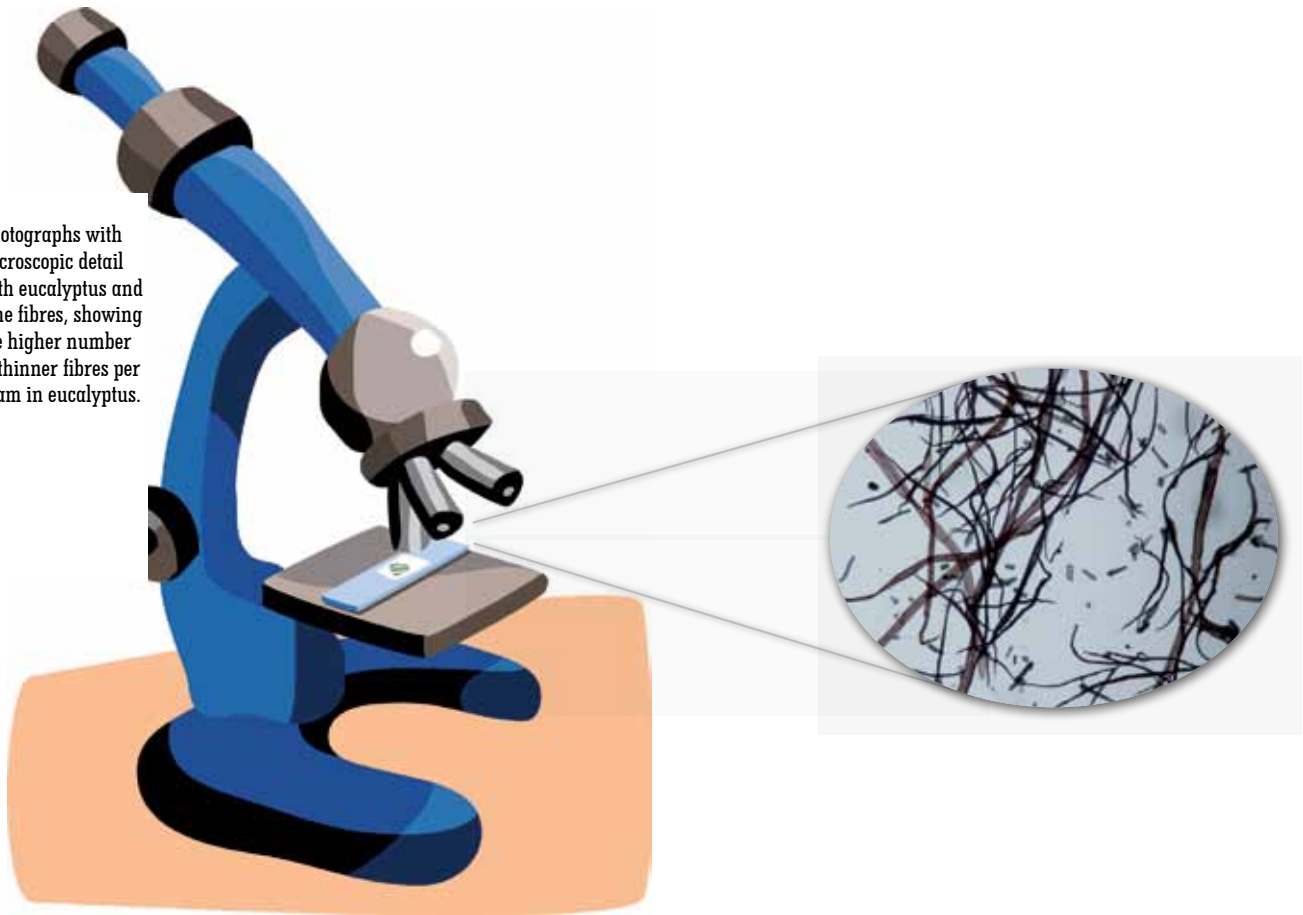
The longer fibre length in conifers is appreciated to achieve resistance and prevent breaks from occurring in the sheet of paper, both in its manufacture, where it is subjected to considerable traction, and in its final use - which requires a stronger and more resistant product, such as in paper bags, wrapping paper, boxes or very fine papers with little grammage.

Eucalyptus fibres, on the other hand, are shorter, but their proportion **improves the key quality parameters** in papers for quality printing and in tissue paper, while also guaranteeing the resistance they require.

This is because eucalyptus **has a lot more fibres - millions - per gram,** fibres which are interlinked and with a better relation of physical proportions than other fibres, which overall improves the formation of the sheet of paper.

Eucalyptus fibres provide rigidity and volume, they are thin and strong, and openly interlinked, giving them resistance and drying capacity, and this has an effect on aspects such as uniformity, smoothness and consistency in the formation. In other words, **they adapt better to the manufacturing process** of certain types of paper, in quality and in cost.

Eucalyptus fibres adapt better to the manufacturing process of certain types of paper, in quality and in cost



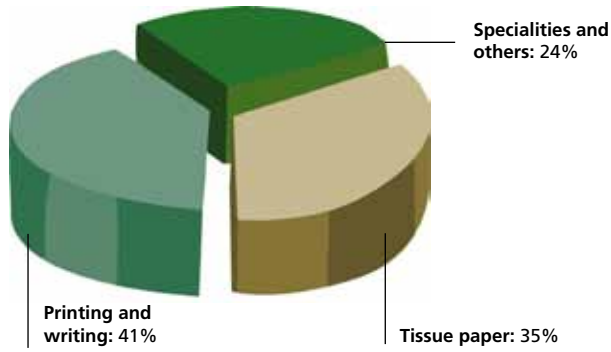
Photographs with microscopic detail with eucalyptus and pine fibres, showing the higher number of thinner fibres per gram in eucalyptus.

Eucalyptus fibres improve the key quality parameters in printing and writing paper and in tissue paper

Properly treated eucalyptus fibres provide energy savings and lower consumption in the paper manufacturing process. And short fibre pulp has a lower price than long fibre pulp, which is more scant and expensive to produce.

Eucalyptus is highly valued by printing and writing paper manufacturers (paper for printers and photocopy machines, coated and uncoated offset papers, top of the range papers for art books and catalogs) and other special applications.

DEMAND FOR EUCALYPTUS PULP BY PAPER TYPES



Source: Hawkins Wright

Eucalyptus is highly valued by manufacturers of printing and writing paper and special applications.

In addition, **smoothness is one of the qualities most valued by manufacturers of tissue paper** (toilet paper, paper handkerchiefs, napkins, kitchen roll) and eucalyptus fibres have a higher degree of smoothness and absorption capacity, properties which are essential in papers used for hygienic purposes.

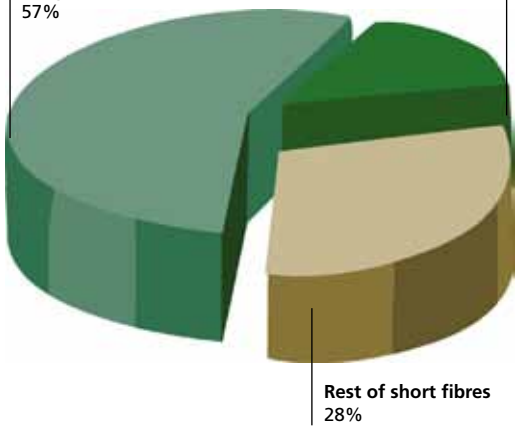
This threefold superiority —(i) productivity and specific yield, (ii) morphology and quality of fibres adjusted to the process of manufacturing the best papers (iii) and a lower cost of production as raw material — is transforming the pulp industry all over the world, **making eucalyptus the most strongly growing fibre in paper manufacturing.**

The superiority of eucalyptus is transforming pulp production all over the world

DEMAND FOR MARKET PULP BY FIBRE TYPE

Source: Hawkins Wright

1990



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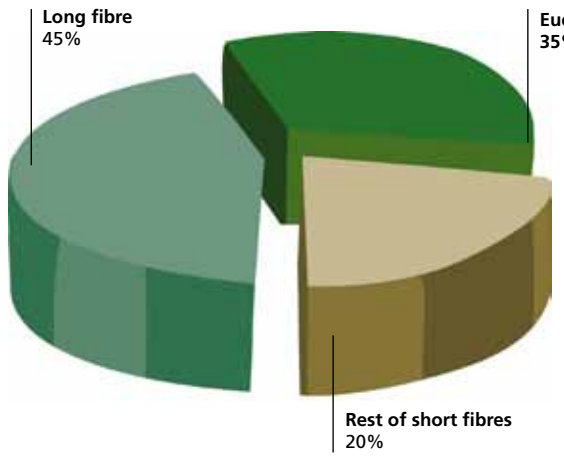


Eucalyptus now accounts for around 30% of market pulp consumed.

Society demands high production by necessity, low and competitive prices, quality smooth fibres, that the surface areas do not increase on plantations, and that the environment is protected. All these demands are met by eucalyptus plantations.

Large variety of uses and profitable and sustainable industrial applications

Eucalyptus wood, in addition to its use for pulp and energy, also stands out for its many applications; in fact, it is one of the most useful and versatile trees from the standpoint of its industrial exploitation.

"Eucalyptus is an excellent tree for producing quality short fibre, vegetable coal and non-forest products". FAO, 2002

Examples of use and paper applications of eucalyptus pulp

Pages, coloured cards, books, magazines, posters...

Toilet paper, paper handkerchiefs, kitchen roll, workshop rolls or industrial tissue paper...

Nappies, sanitary pads, medicine boxes...

Notes, bank cheques, football, cinema and theatre tickets, bottle labels, clothing/product labels, cigarette paper...

Toy boxes, jigsaw puzzles, computer or camera boxes, boxes containing products with printed packages...

Milk cartons, consumer product boxes, chocolate wrappers, boxes of biscuits...

Other uses and applications for eucalyptus

Vehicle filters, tea bags and other filters.

Textile, acetates, motherboards for computers, powder for explosives...

Medicinal uses, oils, sweets, soaps, essences...

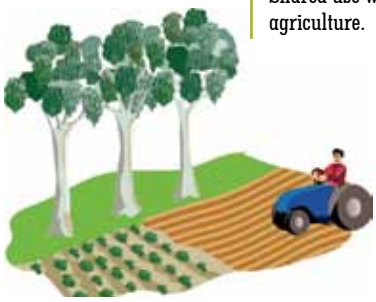
Wood for construction: boards, partitions, furniture...

Honey production, hunting...

Sanitary dressing, gauze and other dressings.

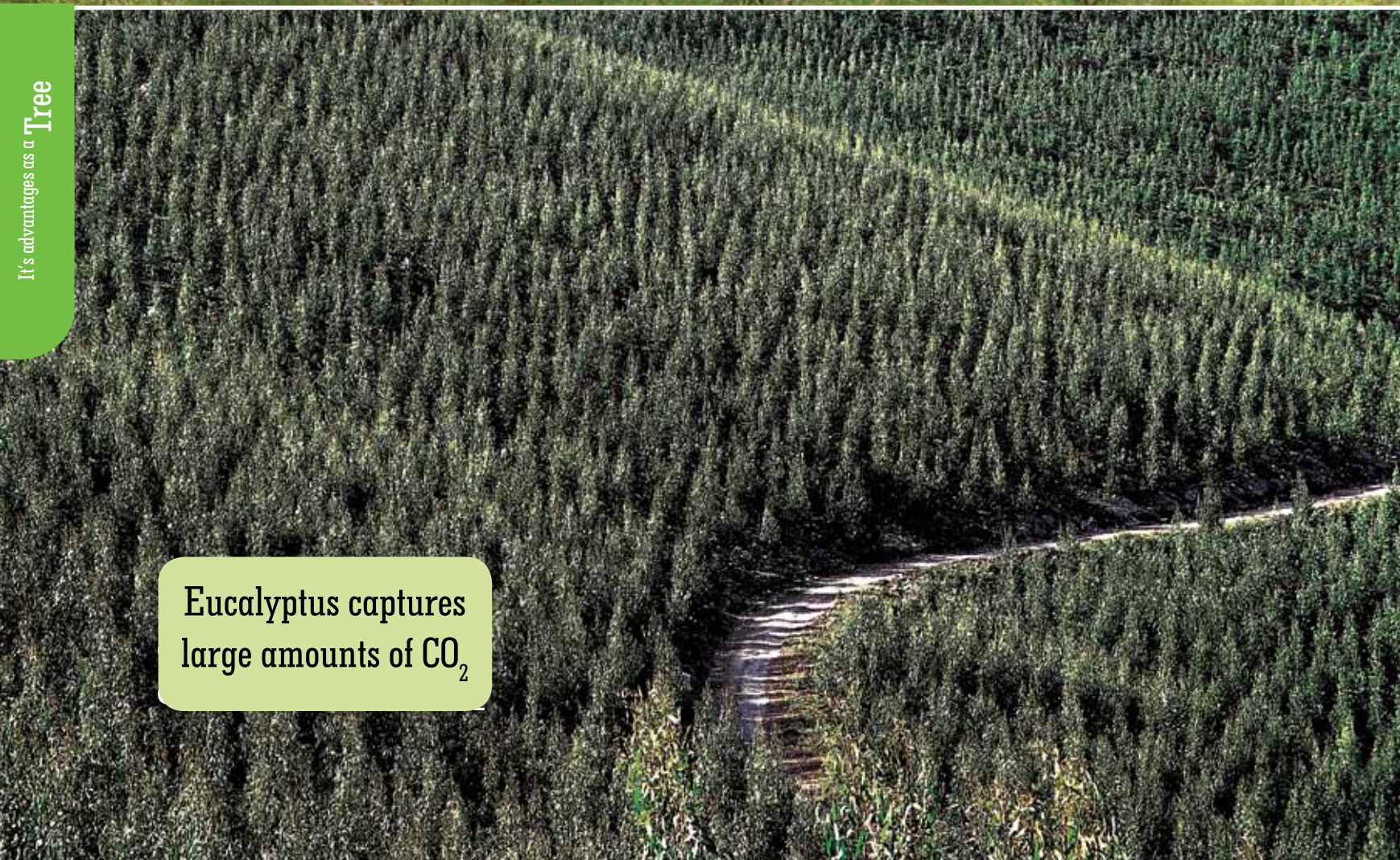
Ornamental tree in parks and gardens, golf courses, urban environment...

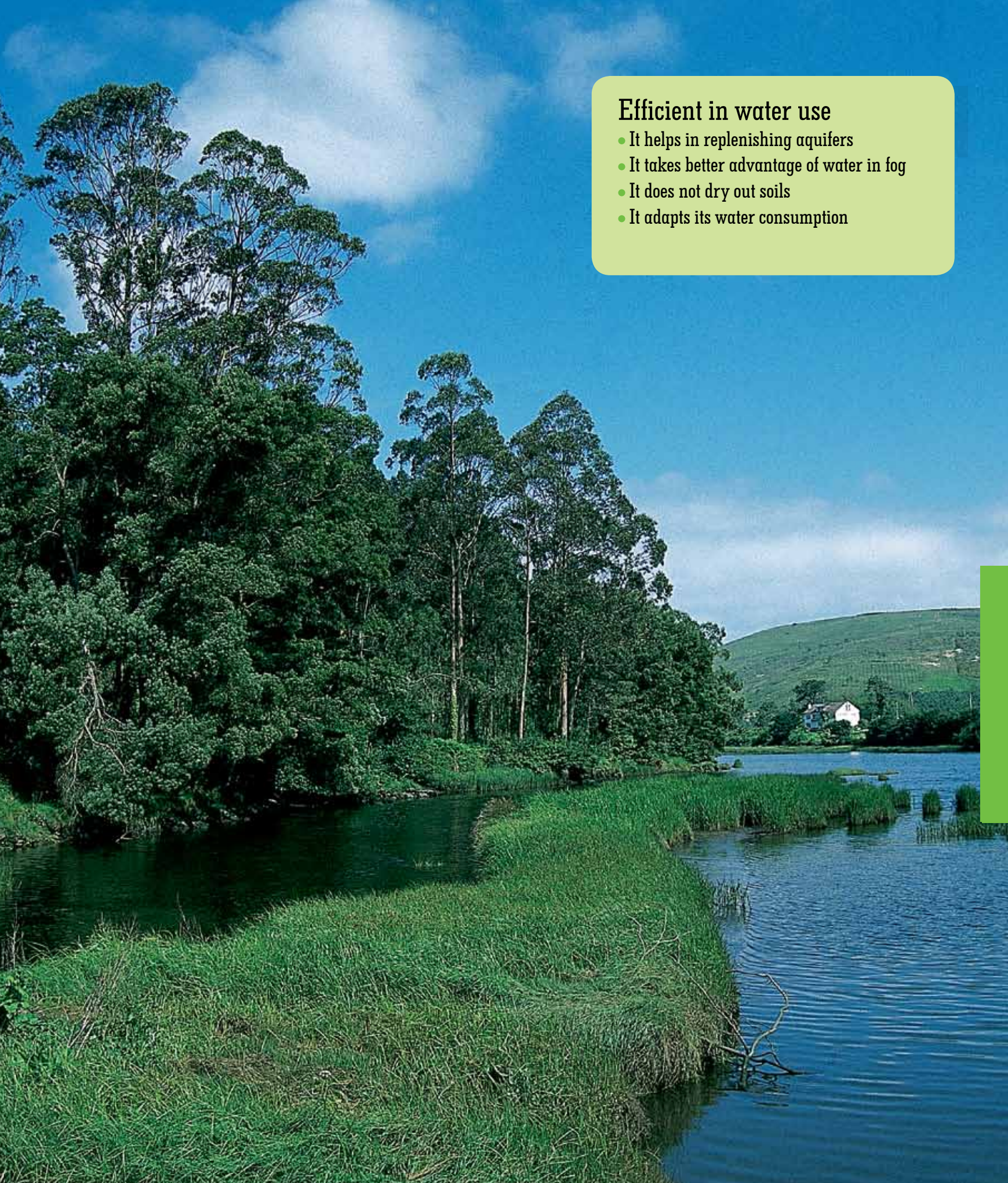
Shared use with agriculture.



Shared use with livestock, providing shade, food and refuge for animals.


Eucalyptus is good
for the environment


Eucalyptus captures
large amounts of CO_2



Efficient in water use

- It helps in replenishing aquifers
- It takes better advantage of water in fog
- It does not dry out soils
- It adapts its water consumption

It promotes biodiversity

Royal Owl Nest in
Mingallete (Huelva).

Roe deer in woodland (Galicia).

Eucalyptus flower.

It does not degrade soils, but improves them

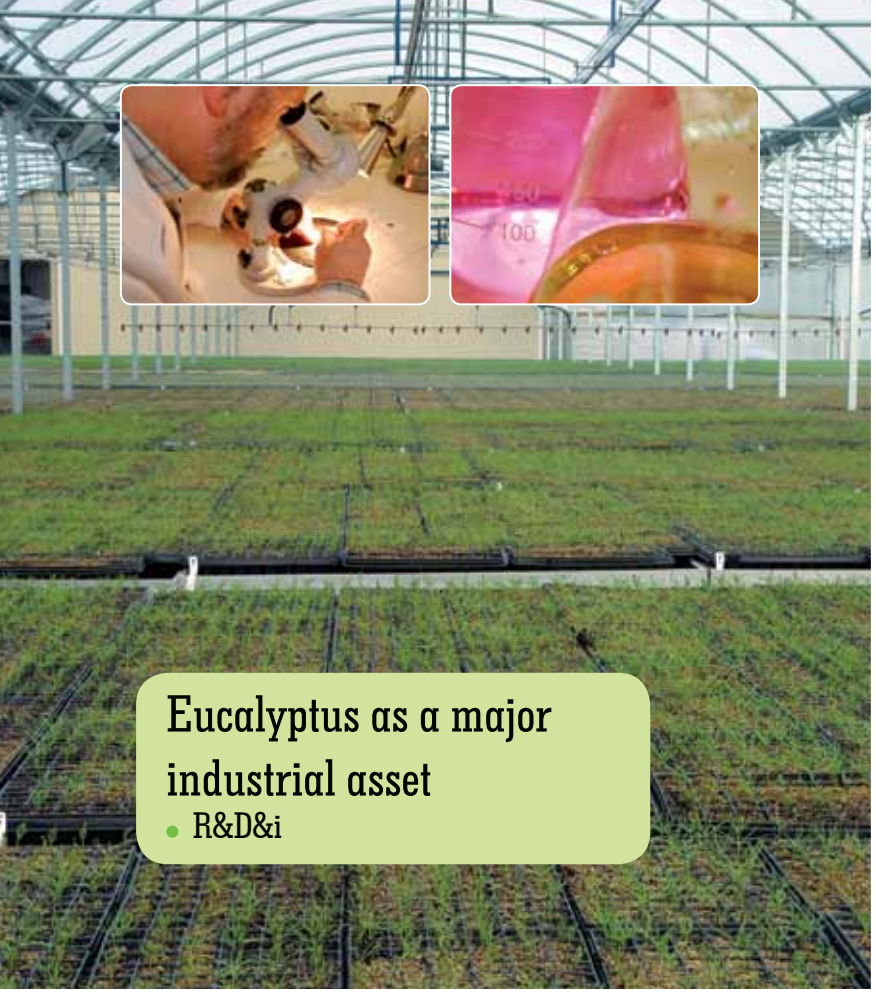
Evolution of land preparation showing the regeneration of the plant cover in Groba (Bayona, Pontevedra).

Protects natural woodland

Reduces the risk of forest fires

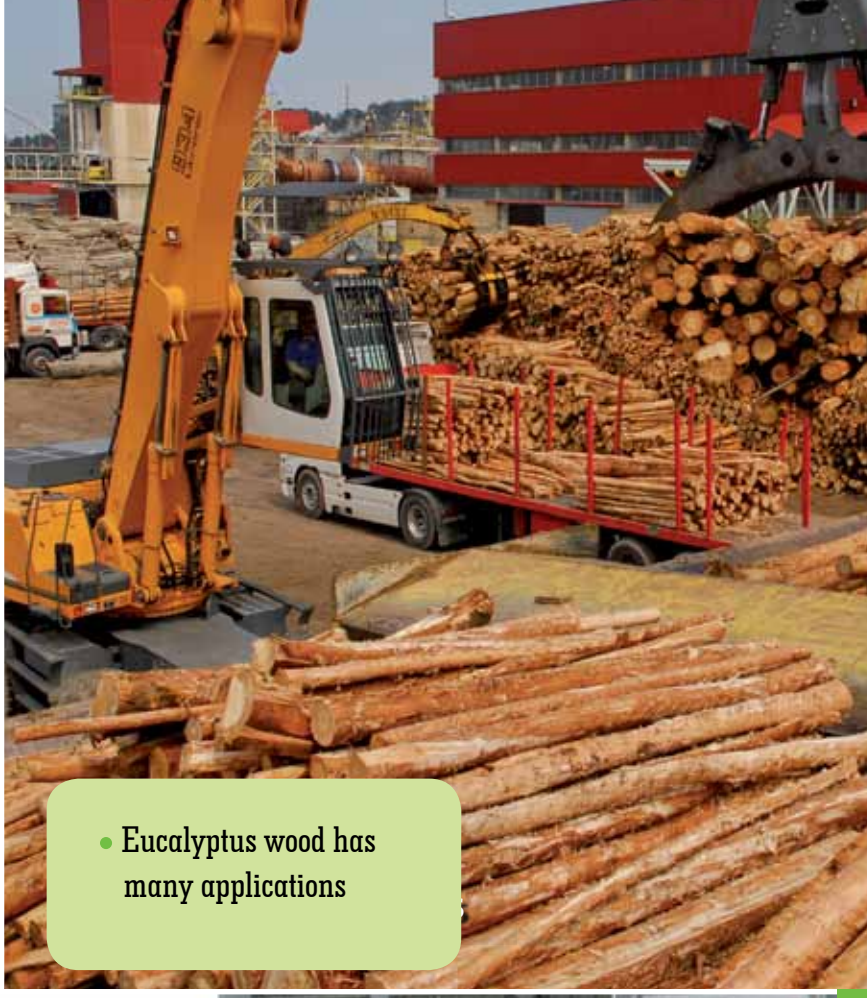
Forest fires in Monteroca (Pontevedra) in 2006, showing how eucalyptus stops the forest fire.

Forest fire on Mount Muimenta in Campolameiro (Pontevedra) in 2006. The path acts as a firebreak.



Eucalyptus as a major industrial asset

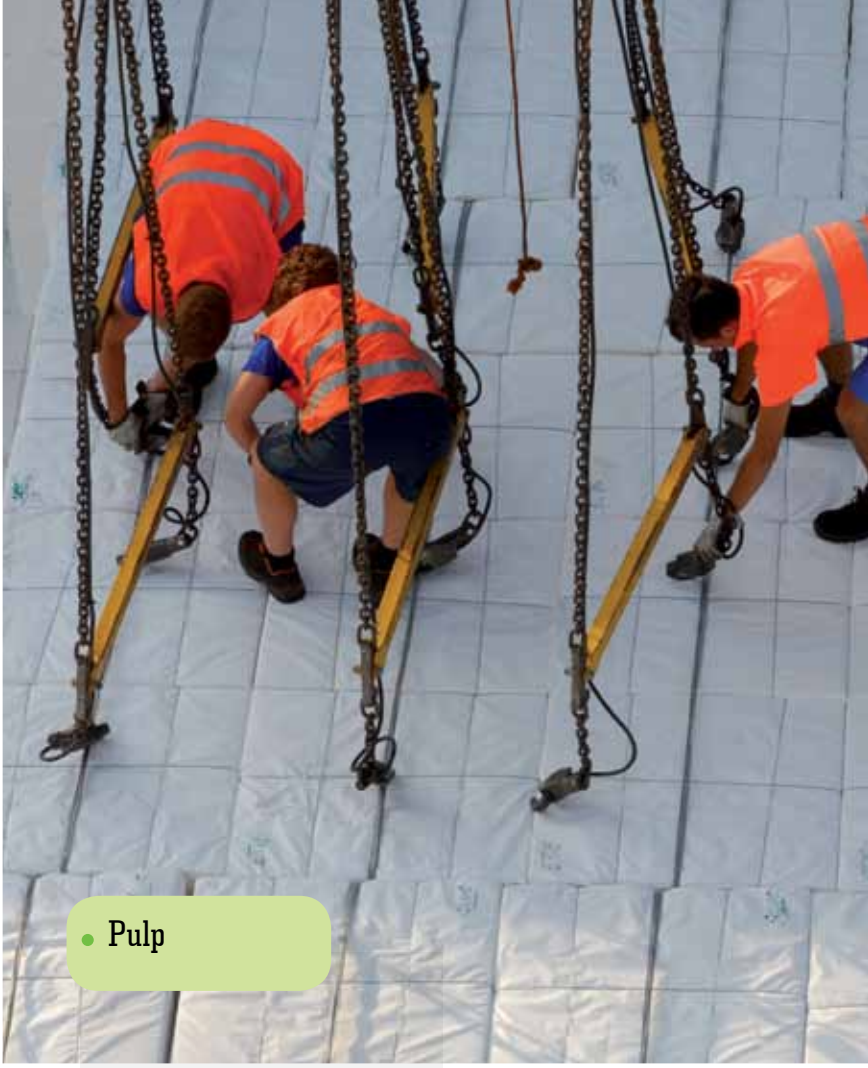
- R&D&i



- Eucalyptus wood has many applications

It creates employment and wealth

- Quality at lower cost



- Pulp

- Technology

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Sustainable forest management multiplies its value

ENCE is a model for sustainable forest management

- ENCE uses *advanced* forest management models *which protect nature* and the environment.
- Its forest activity generates over *4,000 jobs in the rural medium.*
- ENCE introduced *forest certification* in Spain.
- ENCE *manages over 83,000 hectares* in the Iberian Peninsula.
- *20% of the forest surface area* managed by ENCE are natural forest masses with a high conservation value.
- The ENCE Group has the most demanding *environmental and sustainable forest certifications* worldwide.
- ENCE is a company with *intense R&D&i activities,* with the aim of improving forest productivity and industrial yield.
- ENCE makes a massive contribution towards *carbon fixing in Spain.*
- ENCE's plantations fix *70 times more* carbon than Spanish forest ecosystems.
- The improvements carried out by ENCE promote the *increase in forest surface area in Spain.*
- ENCE is a point of *reference in Europe* in the biological control of forest pests.
- *Appendix.* Discover what ENCE does in woodland and how a forest management project is carried out.

ENCE and sustainable forest management

An activity is sustainable when it produces economic, social, and environmental benefits that contribute to the development of society and the well-being of future generations.

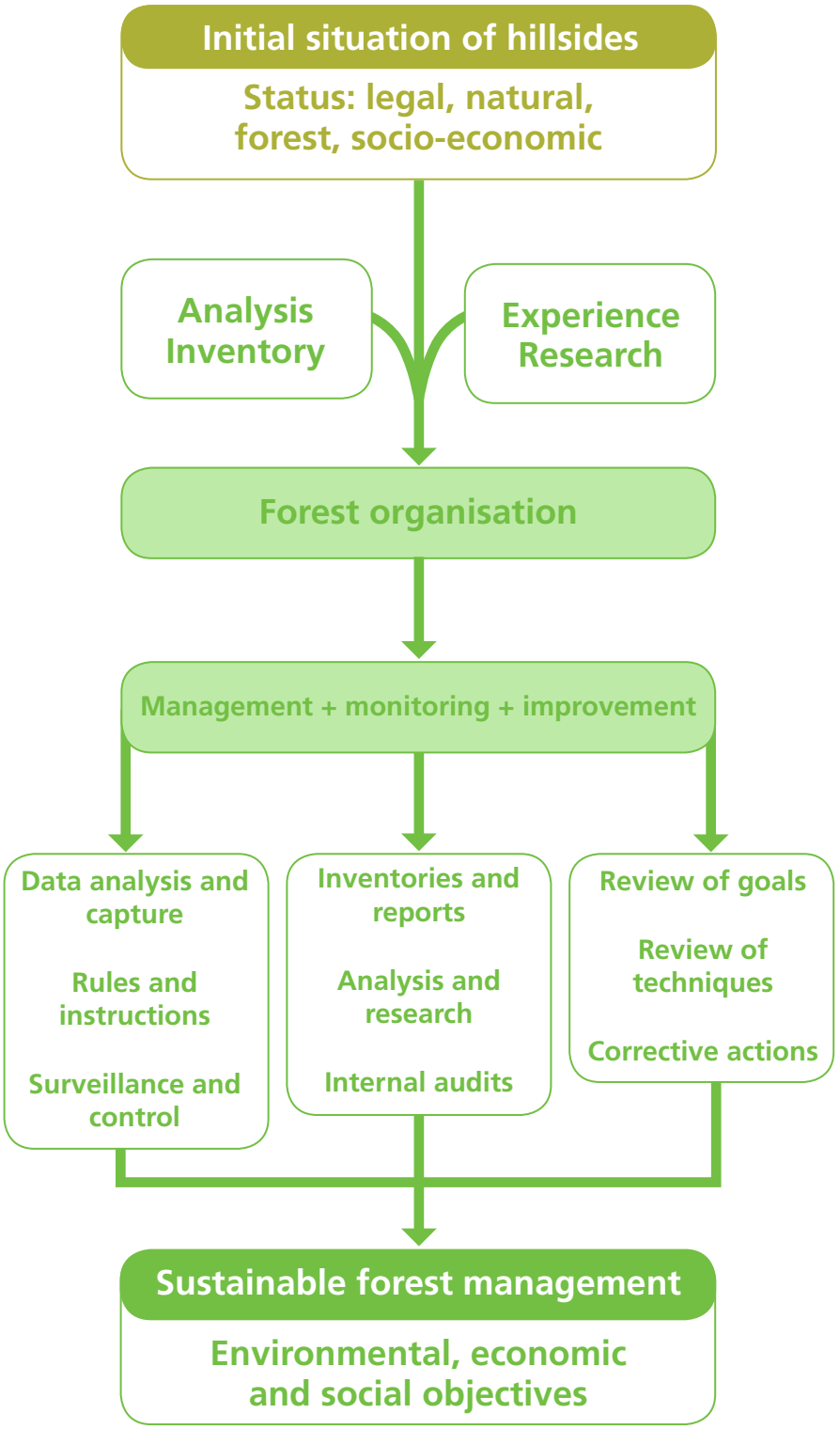
Beyond the environmental advantages of eucalyptus as a tree, set out in the preceding chapters, for over 60 years ENCE has been innovating in woodland and countryside management. Every year it creates thousands of hectares of woodland, develops new research techniques for genetic improvement focused on productivity of species, achieves the natural adaptation of the eucalyptus to very diverse conditions, and uses for that purpose advanced forest management models which serve to protect nature and the environment.

ENCE has been innovating in woodland and countryside management for over 60 years

ENCE's forest activity generates over 4,000 rural jobs which are stable and rooted in the environment.

Furthermore, not including its industrial activity, ENCE's forest activity generates over 4,000 jobs in the rural medium, jobs which are stable and rooted in the surrounding area, and a volume of wealth of over 300 million euros arising from tax, Social Security contributions and salaries, as well as forest acquisitions and leases to proprietors.

ENCE: forest management model



ENCE has a pioneering forest management model in Spain

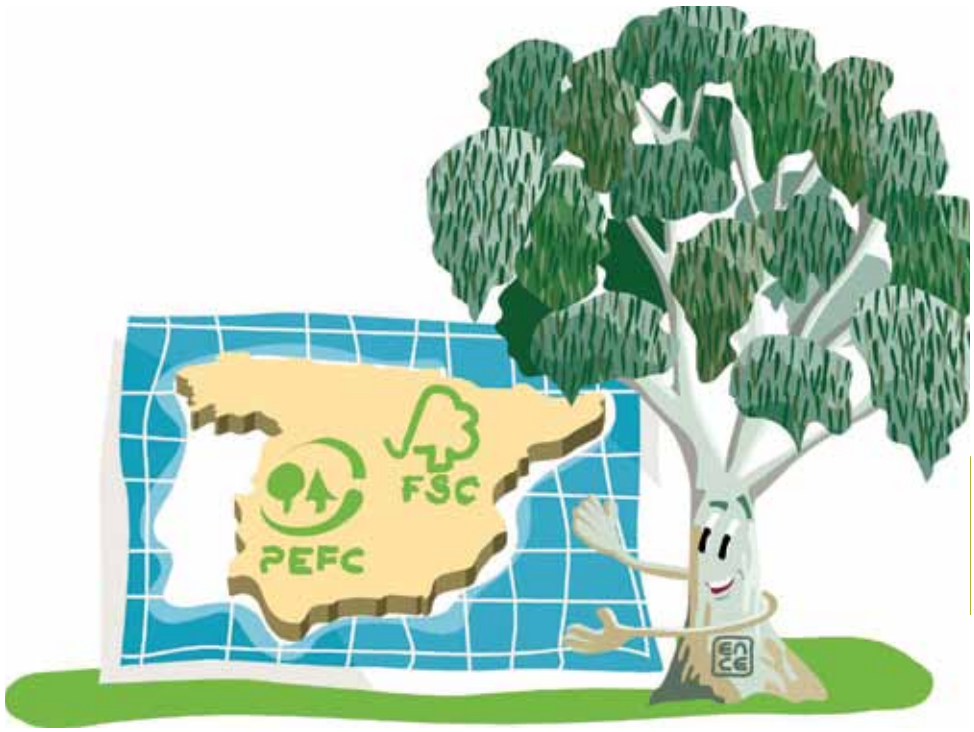
ENCE introduces and promotes forest certification in Spain

ENCE was the first Spanish company to introduce forest certification in Spain, between 2003 and 2004.

In Spain, there are currently over one million hectares certified by the PEFC system and around 120,000 by the FSC system.

In the Iberian Peninsula, ENCE manages forest assets of 83,000 hectares, over 15,494 of which are natural masses and forests with a high level of conservation, such as cork oak forests and Mediterranean woodland.

ENCE manages 15,494 hectares of natural masses and woodland with a high level of conservation



ENCE was the first Spanish company to introduce forest certification in Spain.

El patrimonio forestal del Grupo ENCE representa el 6,79% de la superficie certificada en España por el sistema PEFC.

The forest assets belonging to Grupo ENCE make up 6.79% of the surface area certified by the PEFC system in Spain.

Overall, the Group's proprietary woodland amounts to over 52,000 hectares in Spain and Portugal. The company also owns 30,000 hectares in Uruguay.

Since 2004, when ENCE obtained the PEFC and FSC certifications, the company has planted over 15,000 hectares of woodland in the Iberian Peninsula, for both pulp production and for energy crops.

R&D&i at the service of productivity and the environment

ENCE forestry management begins with research, development, and innovation activities. In this regard, Grupo ENCE boasts 25 years of specific R&D&i activity and has national and international cooperation agreements with 12 universities, seven research and development centres and five technological centres.

The company has the following centres in Spain:

- The Pulp Research Centre of Pontevedra, equipped with a pilot plant (firing/purification/bleaching), four laboratories, a samples store and technical library.
- The Huelva Forest Research Centre, with 11 hectares of greenhouses and clone nurseries, a forestry network of 200 hectares for genetic and forest management tests and a biological control laboratory.
- Two auxiliary pilot plants in Navia (Asturias), which simulate pulp firing, purification, and bleaching processes and refining and testing for paper applications and various industrial uses.
- A biotechnology centre in Navia.

The main object of research and development activity in ENCE is to improve forest productivity and industrial yield, with the aim of maximising the self-supply of wood and biomass.

The company carries out various forest research and applied industrial research programs. We may highlight the following main lines of forest research:

Wood for manufacturing pulp

- Programme for genetic enhancement through the selection of individual plants best adapted to the conditions of each area of terrain.
- Forest management improvement programme to improve the growth and productivity of the plantations.

Biomass and energy crops

- Energy crops program with ten selected species.
- Residual biomass programme.
- Assessment of forest waste as fuel.

Technical forestry assistance

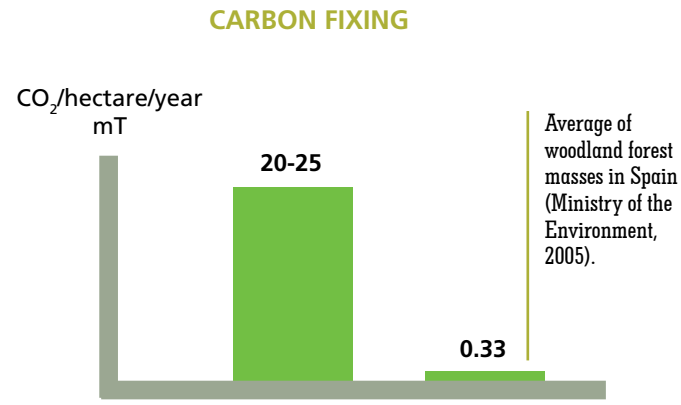
The selections of best individual plants are cultivated in technologically advanced greenhouses which simulate the most appropriate conditions. Cloning is performed using cuttings (branches of selected individual), which will subsequently be transferred and planted in their corresponding plots where they can be studied and monitored.

The selections of the best individual plants are cultivated in technology advanced nurseries, before being transferred to the plots in order to be studied and monitored.

On average, ENCE's eucalyptus plantations fix 70 times more carbon than the average for Spanish forest ecosystems.

ENCE makes a massive contribution towards carbon fixing in Spain

On average, ENCE's plantations fix 70 times more carbon than the average in Spanish forest ecosystems.



The average carbon fixing of 1 hectare of ENCE eucalyptus forest is equivalent to the average annual emission by 5.11 units of the biggest selling car in Spain in 2008.

Fixing by all ENCE eucalyptus surface area in one year is equivalent to the emissions of 306,531 cars in the same period.

Carbon fixing on hillsides is always positive. Even in marginal terrains; masses split into 16 year shifts fix around 112.58 mT/hectare, with annual increases of 7.04 tons of carbon/hectare/year.

Carbon fixing by ENCE's entire surface area of eucalyptus forest is equivalent to the emissions by 306,531 units of the biggest selling car in Spain in 2008.

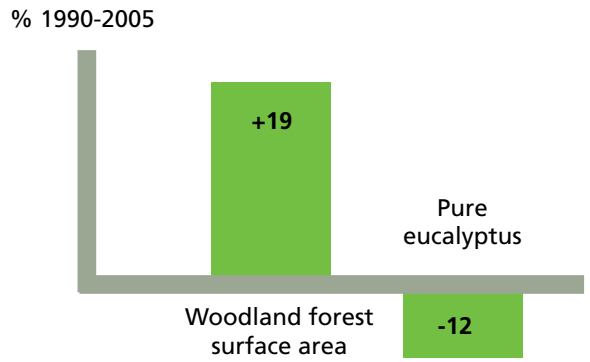
The improvements carried out by ENCE promote the increase in forest surface area in Spain

Genetic and forest management improvements enable ENCE to increase productivity on its plantations, thus helping to increase the total forest surface area, both natural - through converting plantations with low productivity levels - and plantation by yield.

Between 1996 and 2006 the forest surface area managed by ENCE fell by 18%. The new plantations managed by the Group are plantations which are already established or derive from barren land or withdrawn agricultural surface area.

In Huelva, ENCE has increased its average productivities per m3/hectare/year by percentages of over 400%

INCREASE IN FOREST SURFACE AREA IN SPAIN

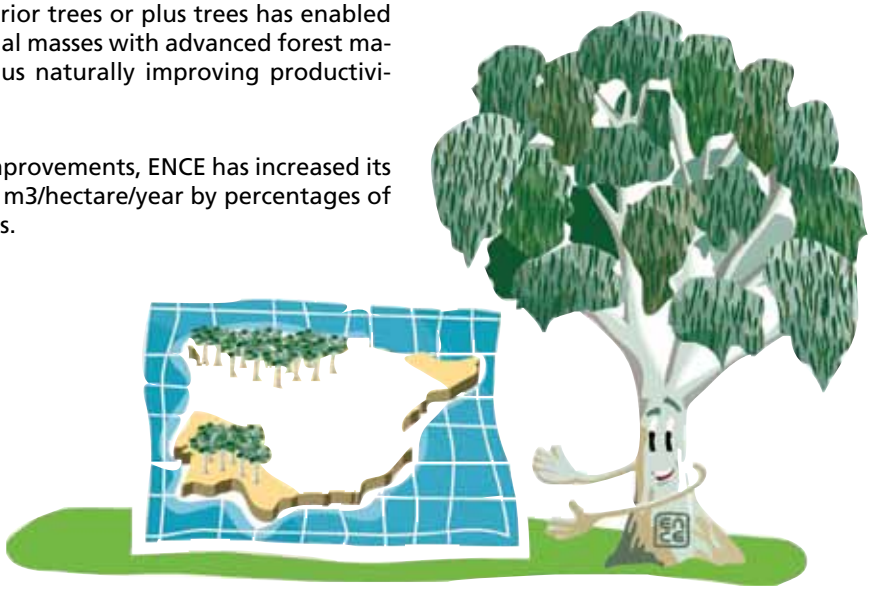


Source: 2nd and 3rd National Forest Inventory 1995-96/2005. Ministry of the Environment.

The fall in the surface area of eucalyptus is offset by a rise in productivity based on the forest management and genetic improvement programs, which guarantee sustainability.

The reproduction of superior trees or plus trees has enabled the company to form clonal masses with advanced forest management techniques, thus naturally improving productivity.

In Huelva, due to these improvements, ENCE has increased its average productivities by m3/hectare/year by percentages of over 400% since the 1980s.



Galicia and the north of the Iberian Peninsula have unique natural conditions for productive forest development.

19.5% of the surface area managed by the company is natural masses

Conservation and biodiversity management model

In Spain, ENCE is the pioneer in private forest management in the specific management of diversity, in accordance with FSC principles. The forest surface area managed by the Group addresses conservation on three fundamental fronts:

- **Managing woodland with high conservation value.** ENCE does not only manage eucalyptus plantations, it also maintains and strengthens selections of natural ecosystems which form part of the assets managed. ENCE manages a total of 15,494 hectares of natural masses, 19.5% of the forest surface area managed by the company.

- **Maintaining biodiversity.** Managing these masses enables biodiversity to be developed in the surroundings of the plantations. At the same time, the company is developing projects for the identification, characterisation and design of the management of particularities in collaboration with the Universities of Santiago de Compostela and Huelva.

ENCE maintains its own catalogue of particularities which includes 41 items of high environmental value.

The management of these forest masses permits the development of biodiversity in the surroundings of the plantations.

- **Landscape management.** In collaboration with the Universities of Huelva and Vigo, ENCE promotes pioneering landscape management projects in plantations. Planning and reforestation projects include landscape management measures to reduce temporary unsightly impacts.

The company promotes the diversification of the landscape into masses of larger than 10 hectares using different species and ages.

The plant biodiversity of the eucalyptus forest, in any event, **is greater than that existing in a pine grove,** beech or oak forest, given that the arrangement of the branches and the leafiness of the eucalyptus canopy allows a greater amount of light to enter, so favouring the growth of plant species such as mosses, ferns and other grasses.

The eucalyptus forest has a greater amount of plant biodiversity than that of pine grove, a beech or an oak forest.

Pioneer in Europe in the biological control of forest pests

The majority of specialists consider biological defence against forest plagues to be the safest, most efficient and most economical therapeutic system.

Pest management in ENCE promotes using non-chemical methods for their control. Biological action is based on three fronts:

- Increasing the vitality of the forest mass to make it less vulnerable to pests.
- Disposal of dead roots.
- Producing parasitoids to fight the causal agents: Gonipterus scutellatus and Phoracantha semipunctata, in the north and south of the Iberian Peninsula, respectively.

In Huelva levels of disease control of 85% have been reached.

Biological control, however, is a control **mechanism within an integrated control strategy** which includes other management measures.

The company promotes using non-chemical methods for pest management.

Any action in woodland includes a control of impacts before and after being executed.

Forest management prevents the erosion of hillsides and recovers their value

Any action in woodland includes a control of impacts before and after being executed

Preparing and clearing land does not permanently modify the soil structure. The effects are limited to adjusting the superficial section of the soil, enabling a small physical space for the roots to grow in and the infiltration of rainwater. This is a temporary effect given that with the passing of time the soil will become more compact again.

Soil management in ENCE woodland includes adapting the land, the gradient, the rock type and the run-off to prevent erosion.

Soil management in ENCE woodland includes adapting the land, the gradient, the rock type and the run-off to prevent erosion.

The development of efficient preparation techniques in high-gradient productive areas, together with appropriate means in the exploitation phase, enables the water properties of the land to be maintained and prevents the risk of erosion.

This activity has a visual impact due to the apparent elimination of the plant layer. However, after a few months this surface is turned into a green and leafy layer which improves the original landscape and the soil quality which, generally speaking, was formerly occupied by abandoned plantations, barren land or unused agricultural land.

Sustainable forest management enables the multi-functionality of hillsides and maintains their productivity

Sustainable forest management allows ENCE to produce non-wood materials from the eucalyptus forest.

Eucalyptus forest plantations are compatible with other uses, as described on page 39.

This versatility in terms of uses and non-wood applications makes eucalyptus a unique tree from the standpoint of its industrial use, its social sustainability and economic yield.

In ENCE's case, it is used for producing pulp and energy with biomass, while also supports uses unrelated to wood such as grazing, hunting and honey production.

The versatility of uses and non-wood applications make eucalyptus a unique tree

USES OF EUCALYPTUS BIOMASS IN ENCE

67% AIR

	Final use % of total
20% Branches	12% Energy
14% Bark	9% Energy
33% Lignin	23% Energy
33% Celulose	23% Pulp

33% ROOT

	Final use % of total
	33% Energy

Forest management is an activity regulated by law

Forest management is the set of activities which is carried out for the care of woodland and taking advantage of forest plantations. In virtually all countries, it is regulated by law.

In Spain's case there is a legal framework of application, such as the Hillside Act (Ley de Montes) of 2006, the Water Act of 2001, regulation on Environmental Impact of 2008 and the rules concerning the Organisation of Hillsides (Ordenación de Montes), both nationwide and at autonomous community level, as well as different local, environmental and labour regulations relating to the activities carried out in rural and forest environments.

Subject to this set of regulations it is necessary to develop forest management plans, which are submitted to public consultation and must be officially and regularly approved by the Official Hillside Association (Colegio Oficial de Montes) and the pertinent Public Authorities.

Forest activity is controlled at all times by authorities and the companies themselves.

A eucalyptus plantation is work of forest engineering, and as such it has to comply with laws in force and following the corresponding regulatory and administrative control procedures, in the phases of planning, environmental impact and design, and during field work.

The ENCE Group has the most demanding environmental and sustainable forest certifications.

In addition, there is a set of sustainable forest management practices and criteria internationally accepted and acknowledged by the FAO since 1981, which have been subsequently promoted since the Río de Janeiro Earth Summit of 1992. Over the years, they have been implemented and broadened on a regulatory and voluntary basis in successive international summits and by means of non-governmental initiatives.

The ISO 14001 quality and environmental management standards, as well as private initiatives regarding sustainable forest management, are signs of the **degree of demand** and control reached in accordance with standards and criteria whose compliance is regularly audited by independent entities.

The most common forest certification system worldwide is PEFC (Programme for the Endorsement of Forest Certification), with 223 million certified hectares. Furthermore, the FSC system (Forest Stewardship Council) has 112 million certified hectares.

The ENCE Group has the UNE-EN-ISO 14001-2004 environmental certification. Moreover, the Group's forest assets are certified in accordance with PEFC systems in Spain and FSC in Uruguay.

The group's forest assets are certified in accordance with PEFC and FSC systems.

APPENDIX

Main activities in sustainable management of plantations

Planning and forest engineering

The forest organisation project

Eucalyptus plantations are Forest Engineering works which have the purpose of creating stable tree masses which are able to comply with the objectives for which they were designed, either to produce renewable raw material, or for the conservation of natural resources.

In any work of engineering, correct planning is essential; in the case of eucalyptus plantations, the general rule is that the first two years are vital as far as the subsequent growth of the trees is concerned. What is more, good planning ensures the future mechanisation of the operations for maintaining and exploiting forest products, thus reducing the impact on the environment.

In the planning phase, the initial situation of the hillsides is studied and analysed from the legal, natural, forest and socio-economic standpoint, and this, together with experience and research, establish the bases for developing the forest organisation project.

The planning phase is also essential in order to properly design the infrastructures, which are mainly the network of paths and tracks for accessing and extracting the wood, firebreaks and water points.

The network of paths and access and extraction tracks will enable employees to carry out the tasks for implementing, maintaining and extracting the product at the end of the shift. The perimeter firebreaks and firebreaks based around the watershed, the water points, and the structure of the compartments ensure prevention and will facilitate fire-fighting tasks in the event of a forest fire.

In this preliminary phase, the possible impacts which could be caused by the forest engineering project are assessed. The company carries out a preliminary assessment of the appropriate demarcation of the repopulation zones, the size and form of the compartments, and the species used, in order to ensure that the effects of forest activities on the landscape are compatible with the environment.

On the basis of ENCE's forest experience and the scientific studies existing, there is no evidence of the eucalyptus forest having any negative effect on the soil - in fact, it is the other way around; its action is an improvement on the results of real alternatives such as meadows and scrubland. Its effect can be compared and even improved in many aspects to the effects of pine groves or oak forests. The breakdown of dry leaves prevents the acidification of the soil, and scientists have not found any incompatibilities with any tree species.

During the design phase and when carrying out the repopulation, measures are taken to improve the possible negative effects, which are of a temporary nature and are easily reversed: using visual screens, which through the age and height of the vegetation enable the perception of change in the landscape to be reduced, or energy dissipators which prevent the loss of soil due to run-off on the tracks; these measures are planned and executed, and their effectiveness is assessed.

Preparing land and plantation

In every situation, the preparation of land for a forest plantation has to be adapted to the gradient, the rock type and the potential run-off. The ultimate aim is to prevent erosion while also guaranteeing that the implementation and development of the plantation are successful.

It is essential to properly prepare the land in order to develop the roots which seek the sustenance and stability required for the plant, thus being a key factor in their growth. The object of the preparation is therefore to help root systems to develop successfully, correcting and repairing the main limitations in the soil at the initial soil site for the growth of roots: compact soil, lack of air, little depth…

Initial clearing

Before planting, it is sometimes necessary to clear the initial vegetation in order to prevent it from competing with new plants which are to be installed. This vegetation, which is normally thicket, grazing land or remains of other crops, could compete with the plantation and help to spread fungi and disease.

Sub-soiling and terraces

The next step is the sub-soiling, using a forest tractor which makes incisions of between 60 centimetres and one metre deep using an instrument which consists of one to three rippers.

This method does not permanently modify the soil structure nor alter horizons. The effects are limited to preparing the soil vertically, enabling physical space for the roots to grow in, increasing the depth and improving the infiltration of rainwater. Its effects and possible visual impacts are of a temporary nature given that after a short period, the soil becomes compact once again, the subsoil furrows close and the soil is covered once again with grasses and thickets. This process can only be carried out on gradients up to 35 or 40%.

If it is a mild gradient, then a crossed sub-soiling is carried out: this consists of carrying out two steps which are described as follows. First, in lines near the steepest gradient on the slope; and the second, following the curves of the level of the land. Proceeding in this way ensures the fewest possible impacts from erosion.

If it is a steeper gradient then a single pass is carried out in lines slightly off the steepest gradient, and regularly interrupting the subsoil furrows approximately every 20 metres. This measure is used to ensure that the run-off water energy is dissipated into the furrows thus reducing the risk of erosion.

Repairing terraces

Sometimes eucalyptus plantations are implemented on land that was formed into terraces in the past. The building of terraces for growing plants is a traditional technique used by man in the Mediterranean basin (200 BC) and which for many year was commonly used to carry out reforestations. Terraces were formerly used because of the limited machinery available to properly prepare the land. The objective sought might be to increase the soil's water retention capacity or, on the other hand, to improve the evacuation of the run-off on the hillside and reduce the risk of erosion.

Today, terraces are no longer built for carrying out eucalyptus plantations. If the terrain of a hillside is arranged into terraces, the terrace is restored during the preparation of the land, and then the platform of the terraces is sub-soiled.

The objective of preserving terraces by restoring their profile and longitudinal gradient is to maintain their hydrological benefits. Abandoning the terraces would cause the gradual loss of their water properties, thus increasing the risk of erosion, particularly after their exploitation.

Quality of plant and plantation

For the plantation it is essential to use a quality plant material. The plant of clonal origin is synonymous with genetic quality, while also ensuring a high degree of uniformity and stability in the field planted in the future. The clonal plant is the result of modern genetic improvement programs. This is through either selecting superior individual plants in plantations, or, even better, controlled crosses between the best progenitors. Clonal reproduction ensures that all the characteristics assessed are captured and reproduced: higher growth, better structure, greater strength, stronger resistance to pests and diseases…

The clonal masses are planted in rows 4.5 and 3.5 metres apart in order to ensure that all tasks can be carried out in mechanised form. Along these rows, the plants are separated between 2 and 3 metres apart, depending on the quality of the land. This gives rise to plantation densities of between 740 to 1,430 trees per hectare. The different clones used in the repopulation are not mixed one by one, but are arranged in mono-clone tesseras which are inserted in a mosaic form.

It is always necessary to review the state and quality of the plant deriving from the nursery. In this painstaking process - virtually a work of art - the most important points to be observed before being used in the field are as follows: proper packaging to prevent tangling of roots, absence of fungi, the base of the stem must be slightly lignified, and without a greenish colour.

Initial fertilisation

The new plants are fertilised as soon as they are planted to ensure that nutrients are available at this stage while guaranteeing the nutritional levels of the medium, given the high demand in the early months of growth. This fertilisation is known as initial or start-up fertilisation, and is carried out in localised form, putting the corresponding dose next to each plant. This enables a greater yield to be achieved while also optimising the amount of fertiliser applied. The fertiliser used is soluble mineral in all cases, and the balances and dosages are adjusted to the nature of the land the quality of the season.

After the plant is introduced, it has to cope with the most delicate period; after having developed in a container, in the more favourable conditions of a nursery, it has to develop on the hillside. It is at this point that problems and failures may occur in the plants. Given the rapid growth of this species and in order to prevent the new plants from being dominated by the rest, they must be replaced as quickly as possible.

Cultural treatments

Controlling thickets

In the first stages of life of a repopulation, the main task is to control competing vegetation, mainly from plants, by means of clearing.

The effectiveness of the clearings depends on the seasons of the year. The clearings are more effective in spring and autumn, and before the grasses go to seed.

Thickets and basically the grass which grows randomly about eucalyptus plants pose very strong competition for light and nutrients, particularly for nitrogen, while also causing severe water shortages.

This maintenance therefore has a threefold objective: in addition to eliminating the competition and reducing water consumption, there is less danger of forest fires. It is fine fuel at medium and low height such as thicket or grasses which causes the tallest flames and which advance most quickly in the event of a forest fire breaking out.

This vegetation is controlled using tractors with chain brushcutters or also applying a suspended tier. The soil should not be ploughed under any circumstances, given that recent studies have shown that this not only reduces tree growth but also it damages the soil structure, transferring more instability to erosion processes. By means of mechanical methods, it is possible to rationalise the use of herbicides combining the two control techniques.

The herbicides used in the chemical control of the vegetation are products which are subject to stringent environmental laws regulating the use and application of each one of them to certain cultivated species. In eucalyptus plantations, ENCE uses products registered for their use in forest plantations. These are systemic herbicides, in other words they do not act upon contact, and have a low persistency in the medium, i.e. they act in the medium for a short length of time. For these and other reasons, these products are permitted by the most demanding forest certification standards.

Maintenance fertilisation

Many studies have demonstrated that it is profitable and useful to carry out maintenance fertilisations during the growth phase of the repopulation. This not only improves the growth and vigour of the masses, but it also helps to close the canopy. By this means, the reduced intake of light is conducive to self-pruning, hinders the growth of scrub, and, most importantly, the recirculation of nutrients within the ecosystem.

With maintenance fertilisation, the fertiliser is located in the plantation lanes with the help of a centrifuge fertiliser device enabling the fertiliser to be dosed and distributed evenly throughout the plantation. This fertiliser re-establishes deficient nutrients in the system, ensuring the correct nutritional status of the plants while also increasing their vitality, and thus their resistance to pests and disease. The fertilisers are sometimes manufactured using an organic base, which helps to improve the levels of organic material in the soil. Occasionally, the balances of the main nutrients (nitrogen, phosphorus and potassium) are

complemented with other micronutrients such as boron, which are added in very small doses but which are also essential for the plants' correct growth.

Integrated pest prevention and control

Integrated control consists of using all the appropriate techniques and methods, combining their interaction to the utmost, in order to keep pests at levels which do not give rise to economic damages. In accordance with this definition, we can ensure that the control of pests in eucalyptus forests is managed using an integrated control model.

In this model, preventive treatments are particularly important; these treatments are forest management treatments and cultural practices which are used to achieve a higher degree of vitality and resistance in the plantation in order to cope with pests and illnesses.

Because of the nature of the main pests which affect eucalyptus forests in the Iberian Peninsula, biological control is used as the control method. By this means, the company permanently monitors the levels of parasitic activity of the insects causing a plague, proceeding to release beneficial insects or parasitoids when there are evidently imbalances between the two populations.

By combining the two aforementioned control methods, the company is able to control pests in most cases, while also reducing the need to use chemical control. Chemical methods are used when there is a specific need, and as said above, in a complementary form integrated with the other control methods.

The methods and treatments are defined for each particular situation, following a study of the environmental conditions and the dynamics of the pest and parasitoid populations.

Selection of shoots

Masses of Eucalyptus globulus are regenerated after the first felling through stump shoots, and from that moment on become coppice shoot masses. The proliferation of many shoots in each stump means that the nutrients are shared out, and thereby sharing out growth and thus giving rise to masses with smaller diameters. This is why a selection of shoots is carried out in order to concentrate growth in a few shoots for each stump.

Harvesting

Regeneration treatment

Forest management science defines the uses of eucalyptus using fellings as regeneration treatments. It is a good idea to fell a tree, in fact it is the first step towards ensuring its regeneration. Therefore, the fellings in each species must be adapted to their characteristics in order to ensure that they regenerate quickly and fully.

In the case of the eucalyptus, the type of cuts used to ensure its regeneration is the clear felling type. Using this method, several shoots will arise from each stump and will grow, thus renewing the plantation. The masses which have been initially planted known as saplings become masses of shoots or coppice shoots after being felled.

Time and height of harvesting

The felling season is planned taking into account the weather conditions which could affect both the buds arising from the stumps and the subsequent development of the shoots. Thus it is a good idea not to delay the cuts in order to prevent the young shoots from drying out, but it is not a good idea to fell in winter because the frost can destroy the buds which will later form the shoots.

Generally speaking, in the south of the Peninsula the best conditions are from September to June, though this period is reduced in particularly dry seasons. In the north of the Peninsula, with less harsh conditions, felling can take place all year, except from November to January if it is very rainy.

Another important factor when felling is the felling height as this will mark the height of the stumps left on the terrain. Although it does not have an influence on the regrowth capacity, if the stumps are excessively high this could compromise the movement of machinery on the hillside. It also means a loss of yield given the shorter length of the logs used.

Number of fellings or crop rotations

Given that the eucalyptus is a very vigorous species and with good regrowth capacity, it is possible to carry out successive fellings to regenerate the mass. The goal here is to obtain the highest number of fellings or rotations allowed by the particular location (place or context), without reducing the final production.

If a eucalyptus grove is felled several times, there is a loss of production due to the death of some of the stumps. At this point the plantation must be renewed and replaced with a new one. On average, the number of rotations varies between three fellings in the south and five in locations with good conditions in the north-west of the Peninsula.

Management and use of forest residue

The felling residues are branches, twigs, treetops, leaves, bark and other forest residue which are not used for the same purpose as the wood, which is the main use. Stumps are also considered to be forest residue when there is a change of variety. They have to be managed correctly in order to take advantage of their use given that operations with this material are costly. What is more, these remains can cause problems in the plantations and also cause diseases in certain circumstances. They must always be arranged in such a way that they do not cover the stumps, given that if they did so they would hinder the growth of the stumps or could give rise to mechanical damages in the future shoots.

Possibilities range from sealing off the remains in the lanes of the plantation or crushing them and adding these remains to the soil in order to recycle part of the nutrients. Management of felling residue has changed recently due to the possibility of using biomass for energy purposes.

This is very interesting as it diversifies production, and in some cases increases the yield of the plantations. It is also common to extract these remains in the form of bales or already chipped as biomass for energy production. This use as a source of clean energy reduces CO_2 emissions and other greenhouse gases, and also reduces the energy dependency on fossil fuels.

To the forest personnel of Grupo ENCE, made up of Engineers and Technicians of the various branches of Forest, Woodland, Industrial, Biology, Environment and other related technical and forest specialities, prestigious professionals in their fields of expertise, with decades of experience in forest management and field work, university teaching and applied research.

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