Forest management in *Eucalyptus* stands: the Spanish case

Guillermo Riesco Muñoz

Departamento de Ingeniería Agroforestal (Universidad de Santiago de Compostela)

Escuela Politécnica Superior. Campus Universitario s/n. 27002 Lugo (Spain)
Tel. +00-34-982-285900; Fax +00-34-982-285926;
e-mail: riescomu@lugo.usc.es

Abstract

The *Eucalyptus* forests in north-western Spain are well known by their high productivity. They contribute heavily to the national forest production although the area occupied by these sorts of plantations is very small comparing with the total area covered with forests in Spain. The importance of these plantations is rising due to the investments of private owners nearly in absence of public funds for the *Eucalyptus* forestations. Historically, the investments in forest management have been very scarce in north-western Spain because of the incidence of forest fires (affecting the risk of the investments) and because of the fragmentation of forest properties (affecting the profitability of the silviculture). Nowadays, the Government, the main forest industries and private owners are making some efforts to improve the management of high productivity forests. The possibilities and constraints of these new forest plans in Spain are reviewed.

Key words: forest management, *Eucalyptus*, Spain.

1. Introduction

The *Eucalyptus* plantations have been promoted in all countries whit natural conditions for that crop. The forecasts about the world forest development point out an increment in forest plantations, moving the timber productions from the cold regions to the temperate and tropical zones, where the site conditions are better for the growth of forest trees. Galicia is an exception to that trend to reduce the timber production in northern countries due to its very favourable conditions for the nurture of *Eucalyptus globulus* in many zones and due to its proximity to the European market (KELLISON, 1992). In fact, the north western of the Iberian Peninsula is the area with the highest production of *Eucalyptus globulus* in the world, with outstanding conditions for this species (in the best sites the productions reach 50 $m^3 ha^{-1} yr^{-1}$).

In Spain, there are 13 million hectares of forest lands without trees. In this surface, 2.5 million are in the Atlantic region, with altitudes up to 800 m, where high productivity species can be implanted. So, Spain is the country with the highest potential timber productivity in Europe (MOLINA, 1985). In addition, the high productivity plantations contribute to reduce the Spanish deficit in timber and contribute also to reduce the pressure over the lands covered with native hardwoods.

The forest lands in Galicia in 19^{th} century were bare lands and were used as

agricultural and livestock lands because since 18th century the increasing population forces to the use of land for food production. In fact, the systematic use of the forests for timber production is relatively recent (since 1940 approximately) because there was no high demand of wood products in Galicia due to the traditional use of stone in the construction (FERNÁNDEZ LEICEAGA, 1990).

In the 19th and 20th centuries the region begins to be forested with high productivity species as *Pinus pinaster* Aiton, *Pinus radiata* D. Don and *Eucalyptus globulus* Labill.). The earliest forestations with *Eucalyptus* were with gardening and landscape purposes but the forestations with industrial goals began in 1944. The result of that process is the present state of the forests in Galicia, where 70 % of the forest trees are exotic.

In the 20th century the plantations of *Eucalyptus* have heavily increased, first with firewood production objectives and afterwards with an objective of pulpwood production. Now, those uses of *Eucalyptus* wood are 85 % of the total *Eucalyptus* production in Galicia. Two pulping mills in North western Spain consume annually 1,000,000 m^3 of *Eucalyptus* timber (TOUZA, 1999). It is mainly coming from the region although there is importation of *Eucalyptus* timber from Portugal, roughly estimated in 300,000 m^3, and the unique company producing pulpwood in Galicia (ENCE) consumes round pulp timber from South America plantations.

The installation of a pulping mill in Galicia in the early 1960s, another one in Asturias in the early 1970s and some more in Portugal made increase heavily the forestations with the species *Eucalyptus globulus*, contributing to the strong spreading of this species the good site conditions in north western Spain for *Eucalyptus*. The goal of these plantations is offering pulpwood for the mills in the region, that only use *Eucalyptus* globulus as raw material (DÍAZ-MAROTO HIDALGO and VILA LAMEIRO, 2002).

The pulp and paper market has global scope and roughly 50 % of the sulphate pulp demand in the world comes from Europe, mainly Western Europe, and this demand is going to increase at the rhythm of the level of welfare, as many authors peer. The *Eucalyptus* pulp demand has the most sustained increment there. The pulp factories in Spain are not very large if the comparison is made with the Brazilian, Scandinavian, north American or Asian factories but Spain is a very important sulphate pulp exporter because of the strategic position of the industries near the European market, the Spanish main market, and because of the competitive advantage derived from the high quality of the produced pulp and the high ecological quality of the products and production systems.

In Galicia, the supply of *Eucalyptus* timber is increasing year by year while the offered softwood timber decreases continuously. In 1997, for the first time, the harvested volume of *Eucalyptus* surpassed the harvested softwood timber. In the next years the offered pine and *Eucalyptus* timber have been snaking but since 2000 the offer of *Eucalyptus* is clearly over the offer of pine. There is no doubt that the annual harvest of *Eucalyptus* timber is going to reach 3.5 million m^3. This is a consequence of the plantations in the 1980s, when many adult softwood stands (mainly *Pinus pinaster* stands) were replaced by new *Eucalyptus* plantations.

The pulping industry in Galicia is growing sharply but the harvested timber of *Eucalyptus* is increasing in a so noticeable way that some authors foresee timber surplus. So, it is necessary to look for new applications to this type of timber or to install a new pulping mill in the region because the plans about the increments of production are not enough to

consume the regional *Eucalyptus* production (DÍAZ-MAROTO HIDALGO and VILA LAMEIRO, 2002).

At the moment, most of the *Eucalyptus* timber produced in Galicia is bounded to pulpwood industries (only 5 % is used as saw logs). On the long term it is not sustainable the production of pulpwood, having low added value, with high production costs while many other regions in the world are able to produce this type of timber with lower costs. Because of that, it is necessary to find new more added value products derived from *Eucalyptus* as sawn wood, fibreboard, chipboard or plywood (TOUZA, 1999).

The earliest industrial plantations were used to produce firewood, charcoal and, later, pulp. However, the low prices of wood as fuel, the ordinary cyclic pulp market and the surplus of *Eucalyptus* timber (CIS MADERA, 2001) aimed one decade ago to look for new applications for the *Eucalyptus* timber. It is peered the use of this raw material as solid and veneer wood because it is a tropical-like wood, precisely growing in Europe, where there is an important deficit in tropical woods.

The growing stresses, very common in *Eucalyptus* stems and logs, produce fissures and warp in the saw mill. So, the *Eucalyptus* for sawing produce many waste and it is easy to buy it at low prices but the final manufactured product has a price close to that made with native hardwoods. To develop these new uses of *Eucalyptus* it is necessary to extend the rotations up to 25-30 years front of the current 10-20 years (TOUZA, 99).

The effective productions in Galician forestlands are significantly under the optimum. This phenomenon is attributable to several restrictions related with the site, the infrastructures, the structure of the forest property, the low population levels, the production systems, the absence of silviculture and the financial situation.

Related with the site, the forest lands are not all of them highly productive. There is summer draught in the south, winter frozen in inner lands, poor soils (acidic reaction, low fertility, high proportion of stones, scarce depth, poor drainage) and complex geography in the entire region.

Related with the infrastructures, there is an excessive fragmentation of the forest properties and low accessibility in some forests.

The structure of the property is characterised by very few public forests (3 % of the forest lands). In Galicia, 64 % of the forests are private and 33 % are private but collective properties (they are the so called forest owned by neighbourhood communities). The first type of private properties are very small (the average size of the property is 1.78 ha and over 80 % of the private forests are lands less of half hectare). They are mainly the most productive forests but their small size and their fragmentation reduce the profitability of those forest exploitations (ZUGASTI ENRIQUE, 1993). The private forests owned by neighbourhoods are characteristic of Galicia and also are present in other regions of North western Spain. The average extension of this type of property is 255 ha and there are more than 600,000 ha in Galicia. Only 25 % of them are covered with trees (mainly *Pinus* and *Eucalyptus*). Roughly half of these properties is managed by the Public Administration, and that creates an increasing inhibition of the owners about their forest property, leading to the abandon and degradation of the land if the public management is not intensive enough.

Related with the characteristics of the population, the farmers are aged, the population levels are low and there is lack of hand workers. The farmer is only part-time forester and the revenue coming from his forest exploitations is just remainder revenue. The land owner is the forest manager and he has absence of perspectives about the future of his farm and, anyway, the objectives of the small forest owner are not always the timber production. In such scenery, it is not easy to reach high forest productivities. The owner makes forestations in his crop lands with *Eucalyptus globulus, Eucalyptus nitens, Pseudotsuga menziesii, Quercus rubra* or *Castanea* if the site is fit, when the lands are left because of the retirement of the farmer.

Related with the production systems, there is lack of machinery in the farms and absence of systems for the common use of machinery.

Related with the absence of silviculture, there is too low densities in the stands, too short rotations and low quality of the harvested timber products.

Related with the financial situation, there is low liquidity in the farms, low investments in infrastructure and machinery (comparing with other agronomic domains) and deficient commercialisation routes. It affects the quality of the products and the high management costs.

In Portugal there are also many small forest properties, with big fragmentation of them. The silviculture is very poor, being also very present the forest fires and diseases.

The forest lands in Galicia are heavily influenced by the man. So, the intervention in the forest throw forest management techniques is necessary to achieve a stable equilibrium in woodlands. However, the forest management plans have been rarely formulated and they are not performed. Many started plans are usually left in successive revisions. The forest management plans affecting Galician forests being formulated in the 1970s (forests of the province of Pontevedra or forests in the councils of Entrimo and Caldas de Reyes) are lost by forest fires and by the changes in the Public Administration. The private foresters in Galicia do not consider the forest management plans as effective tools for the advantageous use of their forest properties and the Government left the management plans in the 1970s.

The forest management plans are nowadays improved due to the funds offered to the private forest owners by the Government. In addition, the recent modifications in the Spanish tax laws comprise the reduction in taxes in those incomes coming from forests being managed by forest plans (DANS DEL VALLE, 1999). More than 10 forest properties (roughly 6,000 ha) have been recently subject to forest management plans in the south of Galicia.

The regional laws in Galicia force the forest properties over 250 ha to be managed under a forest management plan, with clear and explicit objectives and technical procedures in the long, medium and short term. In addition, forest properties over 50 ha must be managed under a single forest management plan, with clear and explicit objectives and technical procedures in the long and medium term.

The scheduling of the forest activity relies on a document called forest management plan. In this plan, the necessary tasks to face in the forest to achieve some explicit objectives are detailed with indication of time and place. The plan takes into account the limitations imposed by the law, the site conditions and the technical and economic feasibility of the proposed tasks.

Whatever management plan has three main objectives to reach in the fully regulated forest to be:

- To guarantee the persistence of the forest stand by means of artificial or natural regeneration

- To achieve sustained yield, in physic terms of quantity of forest products, coming from the forest by means of the implementation of a suitable management method, also called sustainable crop (BANCO MUNDIAL, 1991)

- To obtain the maximum profit from the forest (a general postulate in economics). So, the forest management is close to other subjects related to the optimisation of the economic profit derived from the use of the land. In a strict sense, this objective is referred to the maxim timber production (both in quality and quantity) that can be achieved by means of suitable cutting criteria.

Arbitrary decisions might be derived in the public institutions around the formulation and approval of forest management plans for private forests because there are no established main lines or rules throw forest policies or territorial management plans (PITA ANDREU and VALERO MORENO, 1992).

The new rhythm about the formulation of new forest management plans is introducing more technical content and dynamism in the forest management: early detection of errors or irrational purposes before the starting-up of the activities in the site, motivation of the owners, focusing on the forest nurture, owners associations, evenness in the offered timber in the market (PITA ANDREU and VALERO MORENO, 1992; SAUSSAY, 1987).

The objectives in the use of forest lands are radically different depending on the type of owner. The objective of the small forest owners is the immediate revenue from the forest while big owners are able to face silviculture because the profit is more achievable with large properties (HUMMEL and HILMI, 1989). The small forest owners do not face easily the management of their properties because they give priority to the advance of the incomes front of the maximisation, against whatever technical criterion. What is more, the difficulty in the achievement of agreements in collective properties and the permanent presence of the risk of forest fires make weakly realistic a purpose of management in the long run as a management plan is.

The forest state managed by the important forest industries is not very large in Spain and it is not under control of management plans. The raw material supply coming from forests managed by these firms is just a small share of the total demand of raw material in their factories. Because of that, the fully regulation of those extensions would not be an advantage in the smoothing of the supply to the mills. The industries only plans the rhythm and frequency of the final cuttings, varying from year to year and limited more by the mill supply policy than by a cutting plan focused on the minimisation of the cutting out of the planned rotation, basic aspect in the optimisation of the productions. The brought about cutting schedules consist in a preliminary area control method where the rotation is extended or shortened as it is required by the mill. The largest forest in Galicia where this kind of management is carried out is Coto Muiño (Zas, La Coruña), with 650 ha covered with *Eucalyptus* and owned by NORFOR (ENCE group).

2. Results and discussion

The usual forestland subject to a management plan in Galicia is a property of one owner (one person, one firm, one neighbourhood community, the Government) because it is extremely hard the forest management of a property with several owners, where the objectives, financial position and wishes about their forest property are rarely coincident.

The typical forest property in Galicia exhibits mixed stands if the extension of the forestland is enough (about 100 ha and up). In those cases, the current forest management plans usually divide the forest in management units, according generally to the species covering the unit and the land uses in it. Each unit, called working circle, is going to be fastened with a specific management plan, relatively independent of the rest of the working circles in the same forest. The number of working circles being designed in the property is variable (from one to three or more). The plans can consider the forest areas covered with *Eucalyptus* as little management working circles (25 hectares and up).

The working circles in Galicia being covered with *Eucalyptus globulus* are currently managed by means of the area control method. This is one of the oldest and simplest rational methods. It is so easy to design that the sector agents (owners, timber buyers, manufacturers) believe that it is not actually a management method. However, the poor forest culture in our country, where the forest activity is very elemental (predominance of simplified even-aged pure stands, stand timber selling, no thinnings or only systematic thinnings, etc.), aims to use this type of single management methods to assure the success of it implementation.

The area control method is based on the fragmentation of the working circle in several parts called blocks, all with the same extension. Each year one complete block is harvested; so, the block is the annual cutting area. The working circle is divided into T blocks, where T is the fixed rotation age to put on the trees in the working circle. Therefore, the time one needs to reap the whole working circle is T years. If the harvest is followed every year by natural or artificial regeneration, in year T+1 and successive years the harvested timber will come from trees with the rotation age and then we will have a fully regulated working circle.

The usual rotation of the crop in *Eucalyptus globulus* ranges from 15 to 20 years in high forest and ranges from 10 to 15 years in coppice forest.

In a fully regulated working circle, each year it is harvested a fixed number of hectares with T year trees and presumably with the same stand density. So, the timber revenue is constant every year and the goal of the sustained yield is achieved, with the logical variations attributable to not controlled perturbations (draughts, floods, diseases, fires, etc). That conclusion of constant revenue is not always true because in large working circles the site index is not usually homogeneous and the year one harvests in a high productivity block the amount of timber is bigger than in a less productive block. To avoid this problem in the future fully regulated working circle it is necessary to size the blocks inversely proportional to their site indexes, to attain blocks of different surface but with the same potential production.

The block design starts with the sizing of the annual clearcutting areas. In the case of a working circle with a unique site index inside, the area of the block is:

$$St = \frac{S}{T}$$

where St = surface of the block
S = surface of the working circle
T = rotation (years).

It is not convenient the design of very large and continuous blocks because of the magnitude of the scenic impact of clearcuttings on extent areas. On the other hand, it is convenient the design of blocks big enough to incur in logging and harvesting cost reduction per hectare. What is more, the financial aids from the Government to face the future silviculture in harvested blocks it is only feasible on areas of at least 3 hectares in one piece. (The magnitude of the public financial aids makes them just useful in profitable forest exploitations or in exploitations close to the threshold of profitability). In addition, in larger blocks the expected amount of timber to be harvested is likely more interesting for the timber buyers and, perhaps, the timber price can become higher for the forest owner.

Taking into account the above reasons, in small working circles with long rotations it must be avoided the use of small blocks. In these cases, the clearcutting must be performed every h years, and not annually, and the harvesting would affect a group of h blocks together. The surface to be harvested is then computed with the next formula (regarding the site index is the same in the whole working circle):

$$St = h \cdot \frac{S}{T}$$

where St = surface of the block
S = surface of the working circle
T = rotation (years)
h = intermittence between clearcuttings (years).

If the working circle is so managed whit clearcuttings every h years, the fully regulated working circle will yield constant revenue every h years.

The composition of each block must be clearly defined in the forest management plan. The block to be harvested in the current year or in the next years must comprise the bare lands, low density stands, damaged stands, aged stands and those stands where the regeneration of the trees is a priority. In successive blocks to be harvested in successive years the rest of stands of the working circle are included, beginning with the oldest ones and finishing with the youngest stands, avoiding or reducing the advancement or delay in the clearcutting respect to the rotation age.

One unavoidable condition to achieve the success in the implementation of the method is the immediate regeneration after the harvesting. This condition is accomplished in Galicia by means of natural regeneration (vigorous shoots of the *Eucalyptus* stumps after harvesting) or artificial regeneration (in bare lands or if the natural regeneration is not vigorous enough after several rotations).

The type of harvesting is clearcutting, brought about every year or every h years, as it was pointed out before.

The annual calculated cut in the working circle is computed as the number of hectares to harvest in a year. It can be obtained, more precisely, as harvested volume. For example, the

amount of timber *P* to reap a specific year is calculated by means of the inventory data of the block to be harvested that year. The block, which is going to be harvest by means of a final clearcutting *n* years later, exhibits a current stock of *V* m^3 and a current growth of *CC* m^3 yr^{-1}. So, the estimation of the annual cut is $P = V + CC \cdot n$ m^3. In this single calculation it is assumed that current growth is going to remain constant at least *n* years. This hypothesis is only realistic at short sight because the growth rhythm in *Eucalyptus* changes markedly with age. In order to roughly foresee the annual cut in the long run it is better to use suitable yield tables to obtain estimations of *V* and *CC*, modifying the tabulated values with coefficients depending on the inventoried basal area.

In the working circle, the annual cut coming from intermediate harvests is negligible due to the scarce silviculture applied in *Eucalyptus* stands. In fact, the small private owner considers that a big effort in the *Eucalyptus* reforestation tasks (fertilising, appropriate plantation time, suitable plantation density, use of high productivity reproductive material for planting) is a good investment in the profitability of the land. However, the subsequent silvicultural tasks to nurture the plantation are nearly inexistent because the owners consider that intermediate harvestings are not profitable in small properties producing pulpwood. There is only silviculture to defend the stand against fires or biotic damages and shoot selection in the butts of coppice stands, two years after the clearcutting of the previous stand, keeping two or three shoots on each stump for the rotation (BENITO PARDO, 1995).

Many times, the forest fires make necessary to carry out the extraordinary harvests over the scheduled volume in the plans (VEGA, 1996).

A frequent point of view among foresters and technicians is to believe that forest regulating, planned management or forest management are tools for slow growth species but not for high productivity plantations. So, the forests where a scheduled management is feasible would be those in the provinces of Orense and Lugo (inner east of Galicia), where the slow growth species mostly appear.

In spite of that, the area control method is used in *Eucalyptus* stands because the method is useful with short rotation species, constituting pure stands (many times *Eucalyptus* does), if the species in the working circle can face clearcuttings (regeneration without crown coverage) and if the implementation of clearcuttings is not going to promote severe damages on the site and trees. The area control method is used in high forest of *Eucalyptus* in conversion to coppice forest.

It is also an advisable method in small properties with homogeneous soils, very common in Galicia, where other type of management method is not feasible maintaining the objectives of sustained yield.

The advantages of the method is the single management, the low cost of the exploitation due to the concentration of the harvesting in time and space and the possibility of selecting the reproductive material to use in forestations. The timber from plantations is more appreciated in the industries, because it is more homogenous in quality and dimension while the wood from natural regeneration is less uniform and it means an increment in the harvesting and manufacturing cost. On the other hand, the very short rotations reduce the fertility of the soils, the scenic impact of the clearcuttings is not easy to smoothen, the new forested plants have not protection from adult trees and the instability of the stands increases front of fires, climate damages or diseases due to the simplicity of the forest system (pure

stands, even-aged stands, genetically homogeneous stands).

3. Conclusions

Eucalyptus globulus Labill. is a widely spread species in North-western Iberian Peninsula and the presence of this important forest resource is strongly increasing. The capacity of the regional pulping mills to transform this raw material into pulpwood is nearly in the top. So, it is necessary to develop new uses for this type of timber in the solid wood and the wood-based panels industries. Some effort is now being performed from the Public Administration to develop forest management plans in private forests, many of them covered with *Eucalyptus globulus*, to enhance the quantity and quality of the yielded timber products. A single management method is proposed for these types of stands.

4. References

BANCO MUNDIAL, 1991. The forest sector. World Bank, Washington D.C.

BENITO PARDO, J., 1995. Cuando el eucalipto va sin control. AFRIFOGA, 12, 11-12.

CIS MADERA., 2001. Proceso del cluster de la madera de Galicia: análisis-diagnóstico, selección de factores críticos, estrategias y acciones de mejora. CIS MADERA y Universidad de Vigo.

DANS DEL VALLE, F., 1999. Aspectos básicos de la ordenación de montes privados. O monte, 34, 14-15.

DÍAZ-MAROTO HIDALGO, I. J., VILA LAMEIRO, P., 2002. *Eucalyptus globulus* y producción de pasta de papel en Galicia. Montes, 68, 39-46.

FERNÁNDEZ LEICEAGA, X., 1990. Economía (política) do monte galego. Monografía nº 158 de la Universidad de Santiago de Compostela.

HUMMEL, F. C., HILMI, H. A., 1989. Forestry policies in Europe. An analysis. FAO.

KELLISON, R. C., 1992. Forest technology developments in the 1990s. Tappi Journal, 75(7).

MOLINA, F., 1985. Forestación con especies de crecimiento rápido: su problemática. El campo, 98.

PITA ANDREU, P., VALERO MORENO, J., 1992. El centro de la propiedad forestal y los planes técnicos de gestión para fincas de titularidad privada. Revista Forestal Española, 4.

SAUSSAY, C. de., 1987. Land tenure systems and forest policy. FAO.

TOUZA, M., 1999. Nuevas posibilidades de mercado de productos de madera de eucalipto blanco (*Eucalyptus globulus*) de Galicia. Actas del Congreso de Ordenación y Gestión Sostenible de Montes, vol. II, 347-353.

VEGA, G., 1996. Inventario de la Sierra de Invernadoiro.

ZUGASTI ENRIQUE, G., 1993. La concentración parcelaria, instrumento para la mejora de los montes en Galicia. I Congreso Forestal Español Lourizán 93.