



**EG041: “Encomienda de Gestión para actividades relacionadas con la conservación y promoción de recursos genéticos forestales contempladas en el programa nacional de desarrollo rural”**

**Línea Ae.f.3. Plan de obtención y utilización de recursos genéticos mejor adaptados.**

### **Informe sobre Necesidades sobre materiales de reproducción mejor adaptados**

Production and use of Forest reproductive material in Spain Period 2006-2015.  
Needs of FRM.

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#### **1. Introduction**

This information is influenced by different factors, as socioeconomic changes during these years, seed production, homogeneity in the reporting from the different regional governments, etc. However, the best available estimate of the needs of Forest reproductive material (FRM) for different categories, is the past use of the species when the expected scenario (afforestation policy, economic context) would be similar, and a prospective estimation based in the needs from different sources (e.g. measured as the willingness to pay -in comparison to identified and selected material- by forest owners, seed companies, nurseries, forest companies, forest managers, regional and national governments). Therefore, we analyse the production of FRM by species, and region of provenance (deployment zone) for some of the most important ones, the afforestations, the

supply from seed centers (El serranillo, Vivero JCYL), and the relationship among Base Material (BM) and FRM production.

We used the term adapted FRM as FRM that could be locally adapted to the environmental conditions where it is grown (Identified and Selected Material where the region of provenance is the basic unit for marketing of FRM), and as material that is productive for the traits under consideration during the selection process (qualified and tested material). The production in the last case would be for different traits of interests: eg. growth, resistance/tolerance, and cone/resin/cork production.

## **2. Data available**

The statistics are based on the FRM used with forestry purposes (including forestation, reforestation, restoration and biomass production, but other purposes as ornamental are excluded) (Directive 1999/105) for different species regulated by the EU and by Spain (RD 2003).

We have used the information obtained from the annual statistic of forest reproductive materials and afforestations ([https://www.mapa.gob.es/fr/desarrollo-rural/estadisticas/forestal\\_anuarios\\_todos.aspx](https://www.mapa.gob.es/fr/desarrollo-rural/estadisticas/forestal_anuarios_todos.aspx)). We used the information from ten years (2006 to 2015, the last available year), and 2009-2016 for part of plants (the only available). For FRM the information is provided by species, category of Forest reproductive material, and also for seed and fruits, plants and part of plants. For afforestation the information is provided at the species level, and only for some years at the province level. We do not have any information at the deployment region level.

We estimated an average value for the different categories and type of material. We also used the number of ha equivalent in an afforestation (as the mean value of viable plants obtained from a kg of seeds and considering 1000 plants/ha) and weight corrected by the fruit or seed size (we did not take into consideration possible differences in germination or emergence).

For one provider (MAPA, Servicio de Material genético) the data is also available at the region of provenance level, and for different corps. This provider represent

the 64% of the total seed/fruit production in Spain (with large variation among species).

The base material approved in Spain were obtained from the National register of base material (OCDE report 2017) for the different categories.

For improved material we also obtained some information concerning the area of use and needs for each material.

We classified the species according to the regulation applied (UE, Spanish Regulation or none), the existence of base material. We also consider conifers and broadleaves, and autochthonous and non-autochthonous species (those with or without native base material in Spain) due to the importance in the production of FRM.

### **3. Results**

#### **3.1. Afforestation and reforestation**

There are three main objectives for the afforestation: Program for abandoned rural areas, production and protection. The values for the period are summarized in the table 1.

The species differ greatly in the objective of the plantation. Protection plantations represent 61.3 percent of all the plantations, and mixed plantations represent 41.2 % of the afforested area. When considered individual species, the non autochthonous species are mostly used in productive plantations, and represent 12.9% of all the plantations during the considered period. It is not clear any trend in the use of the species. The annual variation is quite high (coefficient of variation greater than 60% for autochthonous species) and less important in productive plantations (non-autochthonous species). Also, in this variation, we can detect a larger variation in broadleaves than in conifers, probably related to the availability of seeds (difficulty in storing the seeds).

The large differences in the objective would have also some implications in the use of forest reproductive material (in terms of category of the FRM or the number of seed sources). It is not easy to understand this relationship, as there are not a precise information on the use of FRM in the plantations at the national level.

Table 1. Summary of afforestations in Spain during the period 2006-2015. [**Mean**: mean value for the period. **CV**: Coefficient of variation, **Public/Private**: Ratio of afforestations in Public vs private forests; **AML**: afforestations of agricultural marginal lands; **PR**: Productive afforestations, **PT**: Protection afforestations]

SPECIES	Mean	CV	Public/Private	AML	PR	PT
	ha/year	%	%	%	%	%
<i>Pinus pinaster</i>	2785	77	41.4	11.6	61.8	26.6
<i>Pinus sylvestris</i>	1218	83	59.0	8.6	29.9	61.4
<i>Pinus halepensis</i>	552	83	80.7	6.4	0.7	92.9
<i>Pinus nigra</i>	481	111	60.5	24.2	10.3	65.5
<i>Pinus pinea</i>	457	86	58.5	41.1	0.5	58.3
<i>Pinus canariensis</i>	43	190	100.0	0.0	0.0	100.0
Conifers Autot. others (14)	325	77	85.5	3.2	15.4	81.4
<i>Pinus radiata</i>	1343	74	16.7	10.4	82.6	7.1
<i>Pseudotsuga menziesii</i>	125	33	16.1	7.6	84.3	8.0
Conifers No Autot. others (10)	50	97	79.5	0.0	69.5	30.5
Conifer Mixed plantation	215	50	43.5	36.7	27.9	35.4
<i>Quercus suber</i>	815	120	16.9	16.9	1.9	81.2
<i>Quercus ilex</i>	725	97	50.8	38.9	5.1	56.1
<i>Quercus robur</i>	121	108	48.6	0.3	65.7	34.0
<i>Castanea sativa</i>	98	131	20.5	16.7	57.7	25.6
<i>Fagus sylvatica</i>	88	60	55.0	11.7	7.9	80.4
<i>Quercus pirenaica</i>	85	126	92.1	7.8	0.0	92.2
Broadleaves others Autot. (67)	1101	81		10.5	13.4	76.1
<i>Castanea sativa</i> híbridos artificiales	190	208	0.00	2.7	97.3	0.0
<i>Eucalyptus</i> sp.	214	86	22.8	0.0	91.3	8.7
<i>Populus</i> sp. híbridos artificiales	796	47	87.0	3.3	94.1	2.6
<i>Quercus rubra</i>	126	254	3.3	2.0	95.0	2.9
Broadleaves others Non Autot. (5)	82	155		11.9	87.7	0.4
Broadleaves Mixed plantation	3534	118	60.8	12.3	7.7	80.0
Shrubs	87	125	95.6	2.4	0.0	97.6
Mixture (conifer+broadleaves)	5614	128	79.5	20.0	0.7	79.3
Total general	22743	64	60.4	14.0	24.7	61.3

## Production of FRM

The values of FRM production are quite low in comparison to previous values in Spain but we cannot assume an expected big change in these values in the next years.

According to these values, Identified and selected forest reproductive material represent the most important part of the production in Spain for forest purposes.

Autochthonous species represent both in conifers and broadleaves the most important FRM, and in both cases identified and selected material represent more than 90% of all the FRM produced in Spain. For non autochthonous broadleaves, tested material (plants or part of plants) are important sources (Poplars, Castanea, Juglans).

Table 1. Percent of the annual production of FRM (in kg) according to the type and Category,

	N	Identified		Selected		Qualified		Tested	
		Seeds kg	Plants (x1000)	Seeds kg	Plants (x1000)	Seeds kg	Plants (x1000)	Seeds kg	Plants (x1000)
<b>Conifers</b>									
Autocht.	19	48514.5	5930.0	24329.6	8213.8	802.7	602.3	5.0	13.2
%		65.9	40.2	33.0	55.7	1.1	4.1	0.0	0.1
Non Autocht.	18	85.256	741.9	2488.8	908.3	133.2	521.3	92.1	648.4
%		3.0	26.3	88.9	32.2	4.8	18.5	3.3	23.0
<b>Broadleaves</b>									
Autocht.	61	94499.5	49118.1	6741.3	969.4	790.5	62.0	3160.0	147.6
%		89.8	97.7	6.4	1.9	0.8	0.1	3.0	0.3
Non Autocht.	7	1108.6	648.9	843.3	46.1	144.5	2.3	0.0	1173.8
%		52.9	34.7	40.2	2.5	6.9	0.1	0.0	62.7
<b>Total</b>	<b>105</b>	<b>144207.9</b>	<b>56439.0</b>	<b>34403.1</b>	<b>10137.7</b>	<b>1870.9</b>	<b>1188.0</b>	<b>3257.1</b>	<b>1982.9</b>
%		78.5	80.9	18.7	14.5	1.0	1.7	1.8	2.8

N: number of species or genera considered in the study. Autocht: autochthonous species, Non Autocht. Non autochthonous species. %: Percent respect of the total in the category (seeds or plants)

### **Identified and selected material**

In the Annex 1 there is a summary of production of FRM at the national level and for one main provider (MAPA) in Spain, and the use of forest reproductive material. This use represent for this provider the 81.3% of all the production for the period analysed (with large variation among species). We cannot precise the demand not satisfied by the producers, but we assume that is not important for a large period of time as the analysed.

However, there are 10 species under regulation without base material approved but a weak consumption. And only one species with base material and no consumption.

Table 2. Summary of the Production of FRM for the period 2006-2015 according to the regulation.

		Directive EU	RD289/03	Other species from a regulated genus	Non regulated	Total
<b>BM and FRM</b>	Nb species	38/54	25/26	0/11	0/13	61/104
	Seeds (kg)	147,012	23,730	0	0	143,284.338
	Plants (x10 <sup>3</sup> )	37,897	25,688	0	0	56,203.847
<b>No BM and FRM</b>	Nb species	10/54	1/26	11/11	5/13	24/104
	Seeds (kg)	0.67	910	6,943	11	923.607
	Plants (x10 <sup>3</sup> )	101	49	2.824	30	234.938
<b>No BM, no FRM</b>	Nb species	6/54	0/26	0/11	8/13	18/104
	Seeds (kg)	0	0	0	0	0
	Plants (x10 <sup>3</sup> )	0	0	0	0	0

BM: Base Material, FRM: Forest reproductive material

For the most important species in relation to the afforestation, the production of FRM can be summarized in table 3.

SPECIES	Production of FRM- Seeds				Production of FRM- MAPA			Supply of FRM-MAPA			
	Ident.	Selec-	Qual-	Test.	RP	# CR	Kg	RP	#CR	Kg	% sell
<i>Pinus pinaster</i>	22030.5	5540.7	48.4	0.0	22	10	2404.4	20	18	1570.5	65.3
<i>Pinus sylvestris</i>	15833.5	2909.2	342.9	0.0	16	10	1117.6	9	15	736.7	65.9
<i>Pinus halepensis</i>	2494.0	902.7	22.3	0.0	20	10	2560.7	19	17	1514.9	59.2
<i>Pinus nigra</i>	2432.0	4511.9	377.6	0.0	11	8	469.6	11	14	591.3	125.9
<i>Pinus pinea</i>	2429.8	9901.1	0.0	0.0	7	9	12519.4	8	14	12183.2	97.3
<i>Pinus canariensis</i>	55.1	0.104	0.0	0.0	2	6	118.7	2	5	119.7	100.8
<i>Pinus radiata</i>	80.8	2488.3	133.2	92.2	1	1	33.6				
<i>Pseud. menziesii</i>	4.3	0.0	0.0	0.0	2	1	0.2	2	2	2.9	1278.3
<i>Quercus suber</i>	14867.0	5414.5	0.0	0.0	7	10	8478.0	19	10	6461.8	76.2
<i>Quercus ilex</i>	48646.5	0.0	0.0	0.0	17	10	52545.1	4	10	44393.8	84.5
<i>Quercus robur</i>	1509.0	929.2	0.0	0.0	4	8	2270.0	4	7	1719.0	75.7
<i>Castanea sativa</i>	6096.5	0.0	0.0	10.0	4	10	6865.0	4	10	5367.7	78.2
<i>Fagus sylvatica</i>	64.4	113.6	0.0	0.0	4	5	54.0	3	5	33.5	61.9
<i>Quercus pireaica</i>	8431.1	0.0	0.0	0.0	3	10	8913.5	3	10	6482.8	72.7
<i>Quercus rubra</i>	695.7	843.4	0.0	0.0	4	9	1655.7	4	7	1283.0	77.5

In general in terms of availability for those species, the collection and supply is coming from a large number of regions of provenance and years of collection, that would be related to a high genetic variation of the species.

The analysis of the needs at the region of provenance level, however, cannot be made based in this information, but according to the Seed National Centre.

The actions proposed to increase the efficiency is to register the demand, and the final offer, and to check where the material is being used. In CyL there is a register of this information at the regional scale.

### **Recommendation about the needs of Identified and selected FRM**

The available sources of identified and selected material would satisfy the needs of identified and selected material. The needs for most of the species are limited, and the seed stands could allow the recollection of material. The only concern is about the masting years, and conservation needs of fruits and seeds for most of the species. This factor require a planning of the future afforestations in order to define more precisely the needs according to the species and region of provenance.

Concerning the origin of the material, the number of regions of provenances defined for most of the species is high, and therefore, they are similar in genetic background. We can use the transfer guidelines of FRM to select the region of provenance in absence of the desired source, with some limitations.

### **Qualified and tested material**

We can distinguish among those species with untested seed orchards, whose main objective is the frequent and easy collection of seeds based. The selection is based on a masal selection, usually without testing, and obtaining a reduced genetic gain for the traits of interest. There are 7 species of subspecies with this type of programs (*Acer pseudoplatanus* L., *Pinus halepensis* Mill., *Pinus nigra* subsp. *nigra*, *Pinus nigra* subsp. *salzmannii*, *Pinus sylvestris* L., *Pinus uncinata* Mill. and *Pseudotsuga menziesii* Franco). The ones of *Acer pseudoplatanus* do not

produce seeds. The main characteristics of the programs with these species are summarized in table S3.

Table S3. Description of the actual programs based on untested seed orchards.

Species	Base material		Responsible	FRM		Main traits	Perspectives /Needs
	Seed Orchards			Production (2006-2015)	Use (2006-2015)		
	N*	S**					
<i>Acer pseudoplatanus</i> L.	3	2.915					
<i>Pinus halepensis</i> Mill.	1	4.310	MAPA	1055.7	213.796	Form, Growth	Not needed
<i>Pinus nigra subsp. nigra</i>	2	3.680	MAPA	108.8	25.64	Form, Growth	For production purposes
<i>Pinus nigra subsp. Salzmannii</i>	2	3.910	MAPA	128.6	177.225	Form, Growth	Maintain
<i>Pinus pinaster</i>			MAPA	394.9	278.69		Increase the area
<i>Pinus sylvestris</i> L.	4	11.760	MAPA	907.2	589.574	Form, Growth	Maintain for production and protection
<i>Pinus uncinata</i> Mill.	1	1.710	MAPA	102.3	14.02	Form, Growth	Not needed
<i>Pseudotsuga menziesii</i> Franco	2	2.600	Lourizan			Growth	Maintain

There are breeding programs for 8 species or group of species with testing and selection of genotypes: *Castanea* spp., *Juglans* spp., *Pinus pinaster*, *Pinus pinea*, *Pinus radiata*, *Populus* spp., *Prunus avium* and *Ulmus minor*. The description of the programs are summarized in table S4.

Table S4. Main characteristics of the Advanced breeding programs in Spain.

	Strategy	Traits	Deployment area/B. zone	Limitations	organism
<i>Castanea</i> spp.	CS	Growth Resistance	Galice	Reduced # clones	Lourizan
<i>Juglans</i> spp.	CS	Growth, wood quality	Northern Spain	Reduced # clones	IRTA
<i>Pinus pinaster</i>	SO	Growth	Northern Spain	Fusarium presence	Lourizan
	CS	Growth, wood quality	Central and northern Spain	No BM	Cetemas
	CS	Resin production	Castilian plane	No BM	JCYL
<i>Pinus pinea</i>	C	Nut production	Castilian plane	Reduced # clones	MAPAMA



	C	Nut production	Catalonia	Reduced # clones	CTFC
<i>Pinus radiata</i>	SO	Growth	Basque country	Fusarium	Neiker
<i>Populus</i> spp.	Testing	Growth		No new materials	CyL, INIA
<i>Prunus avium</i>	CS	Growth	Northern Spain	Reduced # clones	CyL, Bosques N.
<i>Ulmus minor</i>	CS	Form, resistance	Spain	Reduced # clones	ETSIM-MAPAMA

## Needs of FRM and Base material of Qualified and tested categories

We need to focus in species of high productivity and with interest in afforestation.

As a final part of the analysis, there are 12 species with production of qualified or tested plants, but without base material approved in the National Register of Base Material: *Betula pendula* Roth., *Betula pubescens* Ehrh., *Cedrus atlántica*, *Fraxinus excelsior* L., *Ilex aquifolium* L., *Larix kaempferi*, *Larix x eurolepis*, *Pinus nigra* Arn. ssp *Corsicana*, *Populus alba* L., *Populus tremula* L., *Quercus rubra* L., *Sorbus domestica*, and *Juniperus phoenicea* L.) This material should come from importations.

However, the amount of FRM produced is too low, and they do not justify starting a new breeding program in Spain. We will rely in importations from species with no autochthonous populations in our country (*Cedrus atlántica*, *Larix kaempferi*, *Larix x eurolepis*, *Pinus nigra* Arn. ssp *Corsicana*, *Quercus rubra* L.), and for the other species, we would use material from identified or selected categories.

### *Perspectives*

At present, we lack detailed information on the needs of improved FRM for the different species and breeding zones, and also the type of breeding program implemented in the different species, the organization, etc.

However, there are new demands for different species based in the presence of new pest or diseases of new products.

We can define 8 special cases for which new material of qualified or tested material would be necessary.

Species	Objective	Deployment area
<i>Fraxinus angustifolia</i>	ash dieback tolerance	Northern Spain
<i>Fraxinus excelsior</i>	ash dieback tolerance	Northern Spain
<i>Pinus pinaster</i>	Resin production	Central Spain
<i>Pinus pinaster</i>	Pitch canker /pine nematode tolerance	Northern Spain

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Pinus pinea	Cone Pests tolerance	Central Spain
Pinus radiata	Pitch canker /pine nematode tolerance	Northern Spain
Quercus ilex	"seca" syndrome tolerance	Southern Spain
Quercus suber	"seca" syndrome tolerance	Southern Spain

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Within the framework of the Operative Group on Improved material, we need to advance in defining this activities. Also, we can organize a meeting to discuss about these topics in the framework of the AEG-17/041 and the B4EST Project as a stakeholder event.