

SUCELLOG: IEE/13/638/SI2.675535

D3.2a Summary of the regional situation, biomass resources and priority areas of action in Spain

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About SUCELLOG project

The SUCELLOG project - Triggering the creation of biomass logistic centres by the agro-industry - aims to widespread the participation of the agrarian sector in the sustainable supply of solid biofuels in Europe. SUCELLOG action focuses in an almost unexploited logistic concept: the implementation of agro-industry logistic centres in the agro-industry as a complement to their usual activity evidencing the large synergy existing between the agro-economy and the bio-economy. Further information about the project and the Partners involved are available under www.sucellog.eu.

Project Coordinator



Project Partners



About this document

This report corresponds to D3.2 of the SUCELLOG project – Summary of the regional situation, biomass resources and priority areas of action in Spain. It has been prepared by:

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1. Introduction

SUCELLOG focuses on the implementation of biomass logistic centres into agro-industries as complement to their usual activity with minor investments. Agro-industry facilities can be utilised in their idle periods to handle and pre-treat biomass feedstock (mainly from their own residues or agricultural residues nearby) to produce solid biomass to be introduced into the market.

This document shows the results of the work carried out within SUCELLOG WP3-“Regional framework and stakeholders’ engagement” in Spain. During this WP, four main actions were carried out in the project target regions (Aragón, Castilla y León, Cataluña, Extremadura y Galicia):

- Allocate biomass resources.
- Evaluate with the stakeholders both the technical and the non-technical barriers of the implementation of SUCELLOG concept in the agro-industries.
- Determine the potential areas for the development of agro-industry logistic centres.
- Engage agro-industries to the project.

For the first action, an evaluation of the real potential of primary agrarian biomass has been carried out inside Task 3.1. The methodology selected corresponds to a “Resource focussed approach”, as described by BEE standardised classification (project Biomass Energy for Europe), which starts with statistical data from agrarian inventories. This data has been complemented with the real availability indices (the share of biomass that is not currently being used for other aims including soil sustainability issues) gathered in the regional workshops with the agrarian sector during Task 3.3. As a first result, primary biomass resources have been firstly catalogued according to existing competitive uses and relevance in terms of current unused quantities. This assessment has been performed in by country level since no regional differences has been observed. Secondly, a map of the distribution of real available primary resources and a table of the available tons per year in dry base were built per target region. Even though the use of agro-industry residues is a target of SUCELLOG, the data of the inventories was not sufficient to produce a reliable inventory of the biomass residues produced in the agro-industries processes. Therefore the maps and tables presented do not include this type of resources, which will be deeply assessed for particular cases of logistic centres monitored or audited during in WP4-WP6.

As a second action, an assessment of the barriers and opportunities for the development of logistic centres was carried out through personal interviews with each target sector in Task 3.2. Existing agro-industries from the potential sectors (those owning compatible equipment for the conditioning and storage of raw material) were asked about: idle periods, residues produced in their facilities and upstream in the crop cultivation, the economic situation of the sector and possible upcoming changes

due to the Common Agricultural Policy, practical and legal incompatibilities in using their facilities for the production of solid biomass, social barriers for the development of this new activity and, finally, opportunities detected. Section 2 presents the situation of the country since no regional differences were appreciated. After this analysis, target sectors were identified per region and specific agro-industry locations were included inside the biomass resource map.

To determine the potential areas inside each target region for the development of agro-industry logistic centres, it has taken been into account the diversity and quantity of available agrarian resources (both woody and herbaceous) and of agro-industries present in the region as well as the compatibility among them. Compatibility has been defined according to their seasonality (matching the months of biomass production with the idle period of the agro-industry) and their technical compatibility of use. Logistic issues such as good communication networks and proximity to consumption areas has also been taken into consideration. Potential areas have been identified per region and are shown in this document. However, it is important to highlight that the selection of a potential area does not mean that an agro-industry non belonging to it could not start a new activity and the opposite. The size of the future logistic centre has not been a limiting factor for the selection of the potential area (even if SUCELLOG target is a production of 10 kt/yr per centre) since no data of the total amount of biomass is available (agro-industry residues missing as mentioned before).

The following sections show the results obtained about the above mentioned issues (passing from a country to a regional perspective). A summary of the situation in Spain is included in the last part.

As a last activity belonging to this WP, workshops and personal contacts were carried out with agro-industries in Task 3.3 with the aim of engaging them to the services offered by the project (technical and decision-making support to become biomass logistic centres). The result of this action is shown in the document “D3.1-Report on engagement actions”.

2. Agro-industries: profile, barriers and opportunities

The main potential agro-industry sectors to become a solid biomass logistic centre in Spain have been evaluated in the following lines, describing the equipment they usually own and their idle period, as well as the residues produced both in the agrarian practice and the production process. Finally the barriers and opportunities they would face when thinking to start this new activity have been identified. The information has been provided through interviews with representative industries of the sector and agrarian experts.

Forage dehydration:

Forage dehydration sector presents an important opportunity to become a logistic sector due to two synergies: it has an important idle period of 5 months (from November to April approximately) and owns compatible equipment (horizontal dryers, pelletisers and silos) for the production of solid biomass. Additionally, in some cases the agro-industries are consumers of biomass to supply their energy demands.

The forage dehydration facilities do not produce any important biomass residue, either in the agrarian or processing phase, meaning that the raw material for the production of solid biomass should be acquired. However, since this activity is in many cases integrated with cereal dryers, they have easy access to the residues produced during the agrarian and processing phases (like maize, wheat and barley straw or grain dust).

The sector do think that there is no social or technical barriers to start this new activity within their installations, presents a high degree of professionalization and is used to ask for funding schemes.

Cereal dryers (winter cereals and maize):

This sector shows an interesting potential to become a solid biomass logistic centre from a technical point of view, offering a long idle period of around 8 months (from February to October approximately) as well as proper equipments such as vertical dryers, screening equipment and silos for storage.

Regarding the raw material available for a possible logistic centre, cereal dryers are located in areas where there are important cereal extensions. Farmers supplying the grain to be dried in the facilities produce important quantities of straw which main market is the livestock feeding, bedding and champignon substrate. Depending on the year, a considerable amount of straw is not able to enter the market, being left on the soil (even if it is not considered as a proper agrarian practice) or burnt. The agro-industry itself does not produce important amounts of residues, just the broken grains and grain dust, which is normally given to the stockbreeder as animal feeding material without costs.

These industries are familiarised in using biomass as fuel during their process and no legal or practical incompatibility to become a biomass logistic centre has been observed. Economically, is a sector used to ask for financing and even some of them may have own funds to perform the investment.

As mentioned previously, cereal dryers are in many occasions integrated with the forage dehydration facilities in the same agro-industry, increasing their potential to initiate this new activity as a logistic centre of agrarian biomass due to the variety of idle periods and equipment available.

Sugar industry

The sugar industry presents, on the one side, an important idle period which goes from January to October (9 months) approximately and, on the other side, compatible equipment for the production of solid biomass such as horizontal dryers and pelletizers.

These equipments are used in the production of beet pulp, a by-product from the sugar production, which is highly appreciated by the livestock sector and commercialized in a pellet format. They do not produce residues during their process neither during the agrarian practice.

In Spain, all the installations have become very efficient energetically co-generating with natural gas their own electricity during their process, while the biomass is not used for supplying heat demands.

Sugar industry is a highly entrepreneurial sector, used to diversify to be able to adapt to changes and invest in research. No practical or legal incompatibility has been detected to become a logistic centre.

Nowadays, the industry face an important uncertainty since on the 2016/2017 campaign the quotes system in Europe will finish, becoming then a free commerce product worldwide. A prediction on how the sugar market will be in the future is not possible. For these reasons it can be a good sector to implement the logistic centre as an opportunity for diversification. However, more effort should be paid in order to engage them since they are not familiar with bioenergy issues.

Rice dryers:

The rice dryer industry has an idle period of around 8 months (from December to August approximately) and counts with vertical dryers presenting an interesting synergy to become a logistic centre.

In what concerns the residues associated to this type of agro-industry, the straw is not harvested due to the technical difficulty of working in waterlogged areas in which rice is produced generating. In Cataluña, for example, rice straw is not available since the crop is inside a Natural protected Area. However, in some cases anaerobic and pests problems are a consequence of the lack of harvesting. Husks and broken grain obtained during the rice processing is sold as poultry bedding and as feedstock for animals. In some regions like Extremadura, rice dryers and maize dryers share the same facility.

New regulations will make the situation even more delicate than it is now, reducing the production. Therefore the sector could see in the development of a logistic centre an opportunity to diversify the activity and maintain the employees.

As it has been mentioned already, vertical dryer does not seem so versatile as horizontal ones and are only compatible with granulated materials.

Nut industry:

The sector of the nut industry performs their activity during the whole year but their dryers are not working from December to August approximately (9 months idle period). Dryers are the main equipment compatible with the production of solid biomass they usually own, apart from silos and handling systems.

Nut industry produces nut shell during the months of September to June, a valuable residue that can be used as solid biomass and nowadays is really appreciated for that purpose. Therefore they are not only target industries from SUCELLOG but also producers of residues to be considered in a resource assessment. Apart from that, fruit tree prunings are an important wood source to be taken into consideration.

The sector has not perceived any technical or legal incompatibility if cleaning processes are correctly applied. In the case of the almond sector, their situation is highly unstable and subject of variation according to the international market (more concretely depend on the prices fixed by the Almond Board of California). The creation of a logistic centre can be seen as a good opportunity although the sector is not in the best conditions to make high investments.

Tobacco dryers

The agro-industry of the tobacco remain open the whole year but their dryers have an idle period of 8 months per year (from December to August approximately) presenting a good opportunity to become a biomass logistic centre.

The sector is highly familiar with biomass issues since most of the tobacco facilities use biomass during their drying process from 2010, when specific regional aids (83/2010) for the sector fostered the investments for the use renewable energy sources.

The sector has not identified any incompatibility (technical or legal) on producing solid biomass together with their current activity and they have shown interest on studying the possibility of becoming a solid biomass logistic centre although economic incentives for the sector currently do not exist.

Wine sector:

The wine sector includes the cellars and the distilleries, the latter processing the residues obtained from the cellars. From both, it is only the distilleries the ones owning equipment (horizontal dryers) compatible with the production of solid biomass. The idle period of these dryers is short compared to other agro-industries, from June to October (4 months) approximately.

Nevertheless, it has been selected as a potential sector to become a logistic centre because of their easy access to the agrarian residues such as the pruning or to the agro-industry residues obtained during the wine and distillate elaboration. During the wine production there is the production of grape stem in the cellar. During the

distillate process the grape pits/pomace, the vinasse and the fermentation sludge are produced, being the last two valorised as fertilisers. Vineyard prunings are also incorporated into the soil, although the sector shows a high interest in providing them a value as solid biomass once overcome the harvesting barrier. Therefore, the grape pits, the grape marc and the grape stem could be used as solid biomass. At the same time, also the prunings could be commercialised once chipped and dried in the same distillery or in a new production line implemented in the cellar.

Technically and socially they do not see any trouble for initiating a new activity as a logistic centre. Moreover, they find it as an interesting opportunity since it might help to create employment in the area.

Olive oil sector:

The olive oil sector includes oil mills and oil pomace extraction industries. Similarly to the wine sector, the latter is processing the residue obtained in the oil mills owning horizontal dryers and pelletisers for this purpose. Even though the idle period is reduced (4 month approximately, from June to October), it is considered an interesting sector to develop a biomass logistic centre due to the capacity of using its own residues.

In what concerns the residues produced, the most interesting ones from the bioenergy point of view are the olive pits and pomace. The last one is produced in the olive pomace industries. The olive pit can be produced in the oil mil (if the mil own as system to extract it, which is common in Cataluña region) or in the olive pomace industry (common in Extremadura since most of the mills do not have the possibility to extract the pit from the pomace).

Olive pits are widely used as biomass source for households or in the oil mills for heating purposes. The extracted olive cake has also good properties to be used as biomass source but sometimes is commercialised as an animal feed product. During the agrarian phase, the olive orchards produce important amounts of prunings to be transformed in high quality biomass in a new production line, enforcing this sector as a potential solid biomass logistic centre.

Both the olive mill and the olive pomace industry do not see technical or social incompatibilities to become biomass logistic centres. In the case of the olive mill, a drying system should be implemented since the facility does not normally present this type of equipment.

Feedstuff producers

This sector has been identified as a potential one to become a solid biomass logistic centre. Even though it does not have idle periods, it counts with many proper equipment types that might be used for the new activity such as: pelletizes, silos for storage, screening and chipping equipments.

Additionally, the sector produces interesting amounts of residues, around the 2 – 10% of their production, although some are already formulated feedstuffs which might contain antibiotics. Therefore their use as possible solid biomass source needs to be studied in order to produce no dangerous emissions for the environment.

The sector presents a high degree of professionalization and is used to ask for financing. However, the logistic centre should be implemented whether in a line not used at the moment or in a line specifically installed for this purpose. This sector has only to be considered as potential in the Galicia region where production is significant.

3. Evaluation of available resources

SUCELLOG has considered that the development of an agro-industry logistic centre should rely on agrarian biomass coming both from agrarian practices (like straw or prunings) and from the agro-industry process (for example distilleries residues). The fact is that, for the first case, agro-industries have already a network with farmers providing the raw feedstock to be processed. For the second case, the use of their own residues is the opportunity to reduce their fuel consumption or avoid the cost of disposal if there is no market for it. Quantifying the biomass resources up-stream and down-stream the agro-industry is the object of this section since it is strategic for establishing new commercial relations with usual providers and clients.

A study about the available biomass resources has been performed, focusing in the agrarian biomass since it was not possible to have data about the production of agro-industries residues per region/country. When talking about availability of the residue, it is meant the amount of resources that do not have a market or that is not left on the soil to improve organic content, therefore having the opportunity to be used for energy purposes. Three examples to explain what availability is (see more detail about the methodology of work in section 3.3 and availability percentage in Annex I):

- If a farmer, after taking the wheat grain, leaves the straw on the soil due to agrarian recommendations then availability should be considered 0%.
- On the contrary, if the farmer leaves the straw on the soil just because the cost for harvesting does not cover the value in the animal feed market then availability is 100%.
- It can also happen that in one region the 40% of the straw is commercialized for animal feed (so it has a market), a 20% is left on the soil as a recommended agrarian practice. Therefore, 40% of the straw is available for other uses like the production of solid biomass.

3.1. Agricultural residues:

Biomass resources can be catalogued in three groups in the Spanish target regions, according to next two criteria:

- Competitiveness: existing competitive uses
- Amount of available biomass: relevance in terms of current unused quantities

From this scope, agricultural biomass resources in Spanish target regions can be catalogued in average as next:

Table 1: Classification of biomass resources in Spain.

Criteria		Biomass resources
Competitiveness	Available unused biomass	
Competitive uses make biomass unavailable for energy	None	Beans and pulses stalks
Many competitive uses	Some source still available	Cereal straw
Some competitive uses	Important source still available	Maize and sunflower stalks
Few or non-competitive uses	Relevant resource available	Woody prunings
Some or few competitive uses	Marginal local amounts (may play a role in a singular facility)	Tobacco stalks, rape straw.
None due to technical barrier to be collected	None	Rice straw

As observed, in general, the resources with lowest risk derived from competitive uses are maize and sunflower straw, as well as prunings from permanent crops. The state of these resources being practically unused also implies a risk in terms of implementation of new supply chains due to social or technical barriers. In case of maize, it has been stated in Spanish target regions that farmers usually leave it on the field as organic amendment. The reason does not usually respond to a need of balancing nutrients, but to the application of the most economical way to dispose the crop leftovers due to the absence of an alternative market. In these cases, the availability must be checked locally with farmers and cooperatives, which may take the decision to change their current agricultural practices to start a new supply chain to the local agro-industry biomass logistic centre.

With respect to woody agricultural prunings, they are an appealing source due to its relevant high availability in several provinces of the Spanish target regions. In fact is its woody structure, which is an advantage for the preparation of solid biofuels, usually with better quality in terms of quality composition and suitability for existing energy conversion systems compared to herbaceous residues. Its high availability

(more than 80% of the existing resources without any use), makes pruning a more secure fuel in terms of price stability. However, it also involves the challenge to local farmers to start a new logistic chain although most of them have already shown interest in using them as a fuel and several initiatives have been carried out.

Other feedstocks like tobacco or rape straw can be locally interesting for future logistic centres, but not an issue when doing a regional analysis since they are really located.

Resources as rice straw, or bean and pulses stalks shall not be considered as a resource when setting the regional strategy. That does not mean that it may be found locally from neighbour farmers. The reason for rice straw is its difficulty to be harvested in waterlogged, being usually integrated into the field as amendment. In the case of beans and pulses, the straw is either integrated to improve soils or sold for animal feeding due to its nutritive properties.

3.2. Other biomass resources

Even though in SUCELLOG a comprehensive list of agro-industries has been compiled by region, the data of the inventories was not sufficient to produce a reliable inventory of the biomass residues produced in the agro-industries processes. Agro-industry residues are interesting in the case of the oil, wine and nut fruit sector because of their amount, while in the case of the cereal, rice and feedstuff sector, for example, these residues could be a complement in the production of the solid biomass since their production is not of significance in amount. The use of agro-industry residues is a target of SUCELLOG, but its actual use will be decided for the particular cases of logistic centres monitored or audited during WPs 4, 5 and 7. There, the local reality and capacity of neighbour facilities to become reliable biomass suppliers will be assessed.

With respect to forestry biomass, SUCELLOG has not carried out any specific assessment since the project is focused on fostering agricultural residues as a source of solid biomass. However, the feedback obtained from the target regions shows that forestry residues may be at the reach of future logistic centres, and can be an option in few provinces for upgrading the properties of biomass mixtures to be commercialised. Biomass directly from forestry exploitation for energy purposes can be done under the framework of regulated forestry management plans but it has been considered that it is not a source for the short-time term in SUCELLOG.

An analysis performed by regions instead of by resources is carried out in section 1. Biomass assessment in the present work involves the study of 5 autonomous regions of Spain, adding a total area of 244.900 km², about 48% of the total area of Spain. For this scale of work the use of existing data from inventories was needed as an input data source. The aim of the approach is to provide a framework of the available

sources in the region. It is not aimed to be the specific biomass assessment for a facility, which will be object of task 4.2, and which requires other type of approaches.

3.3. Methodology of work

The methodology selected corresponds to a “Resource focused approach”, as described by BEE standardised classification (see project BEE in www.eu-bee.info). It starts with statistical data from agrarian inventories, and complemented with the availability indices and utilization for soil preservation leads to a technical potential, including soil sustainability issues. The work done also represents biomass explicit in the territory, and so the type of assessment can be named technical spatially explicit technical potential, including sustainability of soils.

The method followed is based on ratios of residual biomass production per hectare of cultivated area (tons of residue per hectare). The use of ratios is a widespread methodology for biomass assessments, appropriate for both large and small scale. The main issue is to account with reliable inventories and ratios. By multiplying the cultivated area (ha) by the ratios (t/ha) the theoretical potential is obtained:

$$\text{Biomass Potential [t]} = \text{Ratio [t/ha]} * \text{Area [ha]}$$

The methodology used here brings a step forward in the country analysis by including the competitiveness for biomass resources. For that purpose it is necessary to know the share of biomass that is currently being used for other aims, and that will be considered as not available for the present study. The availability index (I_{AV}) expressed as percentage is defined as next:

$$I_{AV} = 100 - I_{COMPET} - I_{SOILS}$$

Where :

I_{COMPET} : is the percentage of the total biomass in a region that other uses (power plants, cattle, industry) already are using.

I_{SOILS} : is the percentage of total produced biomass that remains in the soil. E.g.: if farmers prefer to leave part of the straw as soil organic amendment.

By using these indices it is possible to obtain the final biomass available by doing next operation:

$$\text{Available Biomass [t]} = \text{Potential Biomass [t]} * I_{AV} = \text{Ratio [t/ha]} * \text{Area [ha]} * I_{AV}$$

The data sources have been obtained as next:

- **Agricultural areas:** the biomass has been calculated on the base S2Biom project land areas (www.s2biom.eu) given by NUTs3 (Spanish provinces), in order to have same base units than ongoing referential projects like S2Biom is. Since NUTs3 is a too large scale for the purposes of the SUCELLOG work,

the biomass obtained by NUTs3 has been downscaled at LAU2 (former NUTs5) geographical resolution (Spanish municipalities), by assigning each LAU2 unit a biomass share proportional to the area occupied by crop type.

- **Land distribution:** Corine Land Cover version 2010. Biomass per municipality has been allocated to land parcels actually used for agriculture
- **Ratios and availability indices:** a specific work has been carried out by region. For each region ratios have been obtained from direct contact with specialists and cooperatives, and in few cases, complemented with literature. The purpose of this effort has been to use ratios and availability indices representing the reality of the region, and not just ratios found in literature. The workshops done in task 3.3 have served to include the feedback from the sector to improve the final datasets. Ratio and availability percentage are shown in Annex I.

3.4. Summary of results per region

Next table classifies provinces according to the most strategic resources for SUCELLOG.

Table 2: Most strategic resources by target region.

Region	Cereral straw	Maize + Sunflower straw	Olive + Fruit + Vineyard prunings	Others
Aragón	ALL	ALL	Mainly Zaragoza	----
Castilla y León	ALL	León, Palencia, Salamanca, Valladolid, Zamora	Burgos, León, Valladolid, Zamora	----
Cataluña	Lérida	Gerona, Lérida	Barcelona, Lérida, Tarragona	----
Extremadura	Badajoz	ALL	ALL	Tobacco (Cáceres)
Galicia	Orense	ALL	Orense, Pontevedra	----

4. Regional Framework of ARAGÓN

4.1. Identification of agro-industries in Aragón

The interesting agro-industries to become a logistic centre in Aragón are:

- **Cereal dryers:** Aragón is one of the most important grain producers in Spain and therefore the facilities drying this resource are very important. More concretely, Aragón is the second region in surface cultivated with maize in Spain (being the area of Monegros of importance) and it is the third and the fourth region of surface cultivated with barley (the area of Ejea de los Caballeros) and wheat (the area of Zaragoza) respectively. Cereal dryers are very often sharing installations with the forage dehydration facilities.
- **Forage dehydration facilities:** Aragón is the first Spanish region in surface cultivated with Lucerne, being Zaragoza, La Litera, La Hoya de Huesca and Monegros the most important areas. The facilities drying this resource are numerous.
- **Rice dryers:** mainly located in the area of Ejea de los Caballeros but also in La Hoya de Huesca, Monegros and La Litera.
- **Distilleries:** in the agrarian area of Almunia de Doña Godina and, more concretely in Cariñena area, most of the wine sector and one of the distillery of the region are sited. The other distillery is located in la zona de producción de vino de Somontano.

Other agro-industries identified as biomass resources suppliers are: wine sector (grape stem; grape pits y grape pomace), olive mills (olive pits).

4.2. Identification of biomass resources in Aragón

From a general perspective, Aragón has an annual amount of available agricultural residues of more than 1 Mt, permitting still a progress in the use of biomass, and therefore room for further mobilization of herbaceous and woody agrarian feedstock. Next graph summarizes the main figures on agrarian residues.

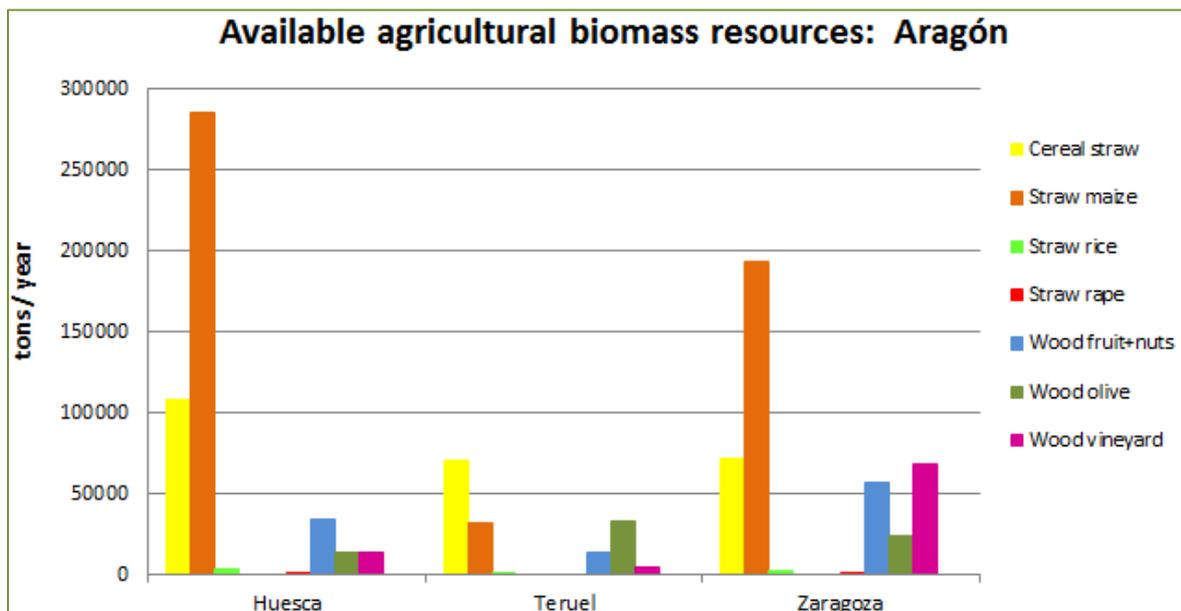


Figure 1: Summary of available agricultural biomass residues in Aragón.

Main conclusions in ARAGÓN:

- As in most of the Spanish regions, the most extended crops are annual cereals (wheat and barley mainly) and maize.
- Maize becomes there an important feedstock, available in large quantities and still with minor competitive uses. In fact, maize stalks are the main source for energy still available in Zaragoza and Huesca provinces.
- Woody residues from prunings are however also a relevant source in Zaragoza province. Locally may be an important source of biomass to take into consideration.
- Agricultural by-products such as broken grain and dust (from cereal dryers), husks (from the rice sector), wine and olive production residues as well as residues from feedstuff producers should be also taken into account.

4.2.1. Localization of resources and agro-industries in Aragón

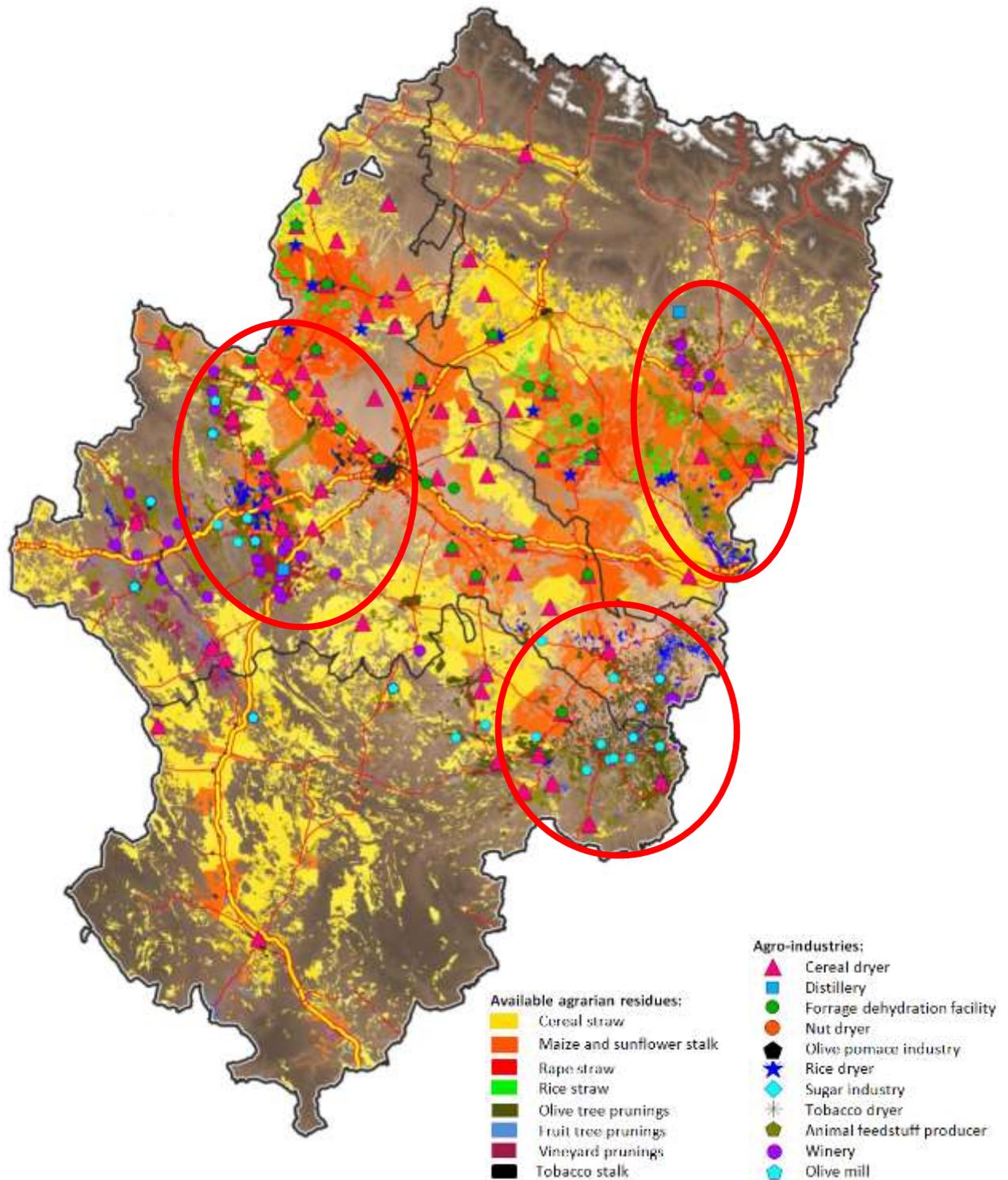


Figure 2: Localization and type of agro-industries and resources in Aragón.

4.2.2. Priority areas in Aragón

Potential areas detected in Aragón region for the implementation of SUCELLOG project are shown in Figure 2. As already mentioned in the introduction, these areas have been selected taking into account the diversity of resources (both woody and herbaceous) and agro-industries as well as the compatibility among them. Compatibility has been defined according to their seasonality, see Table 3, and to their compatibility of use. Logistic issues such as good communication roads and proximity to consumption areas has also taken into consideration.

Table 3: Availability of equipment and biomass resources in Aragón.

	Jan	Feb	Mar	April	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Cereal dryer												
Forage dehydration ind.												
Rice dryer												
Distilleries												
Cereal straw												
Maize stalks and cobs												
Permanent crop prunings												
Rice husks												
Grape stem												
Grape pits and pomace												
Olive pits												
Nut shell												

As it can be observed, the 3 potential areas are very similar. Here below are shown the main remarks:

- Cereal, maize, rice and nut could be compatible with the drying of olive pits, grape pits and almond shells.
- Forage dehydration facilities could process all type of residues existing in the area, especially maize stalks and permanent crop prunings (vineyard, olive tree or almond tree). The residues coming from the nut industry, the wineries, the olive oil industry, the cereal and rice dryers could also be of interest.
- Distilleries could process cereal straw and permanent crop prunings in their facilities, apart from their own residues (grape pits and pomace) and use the rice dryer residues as a complement.

In both cases (forage dehydration and distilleries) the conditioning could be drying only or both drying+ pelletising, depending on the type of residue and format demanded by the market. The production of pellets could be done from solely one residue or from a mixture of several residues. In the last case, it is highly recommended to consider a woody resource (permanent crop prunings for example) as a way to improve the chemical characteristics of the product.

4.3. Regional Framework of CASTILLA Y LEÓN

4.3.1. Identification of agro-industries in Castilla y León

The interesting agro-industries to become a logistic centre in Castilla y León are:

- **Cereal dryers:** Castilla y León is the first region in surface cultivated with maize mostly located in León and in cereals (wheat and barley), being the industries associated very important.
- **Forage dehydration facilities:** most of them sited in Palencia, Zamora and Valladolid.
- **Sugar industry:** Castilla y León is the most important sugar beet producer in Spain. This crop is cultivated under irrigated conditions mainly in Valladolid and León provinces. There are 6 facilities for extracting the sugar from the sugar beet crop, located in La Bañeza (León) in Toro and Benavente (Zamora), in Miranda de Ebro (Burgos), in Olmedo and in Peñafiel (Valladolid).
- **Distilleries:** la región de Castilla y León es importante por su producción vitivinícola en la zona del Duero y, por tanto, son de interés los residuos procedentes del sector. La destilería de la región sin embargo está situada en una de las zona de producción de vino de la provincia de León.

Other agro-industries identified as biomass resources suppliers are: wine sector (grape stem; grape pits y grape pomace), olive mills (olive pits).

4.3.2. Identification of biomass resources in Castilla y León

In the region of Castilla y León the quantity of resources that, from the evaluation performed by SUCELLOG Project, are considered as available agrarian biomass and without competitive uses rises to more than 1.5 Mt/yr. Even though all regions present important resources, it is León, Valladolid, Zamora and Salamanca the ones presenting higher availability, being the predominant residues the maize/sunflower stalks and the cereal straw.

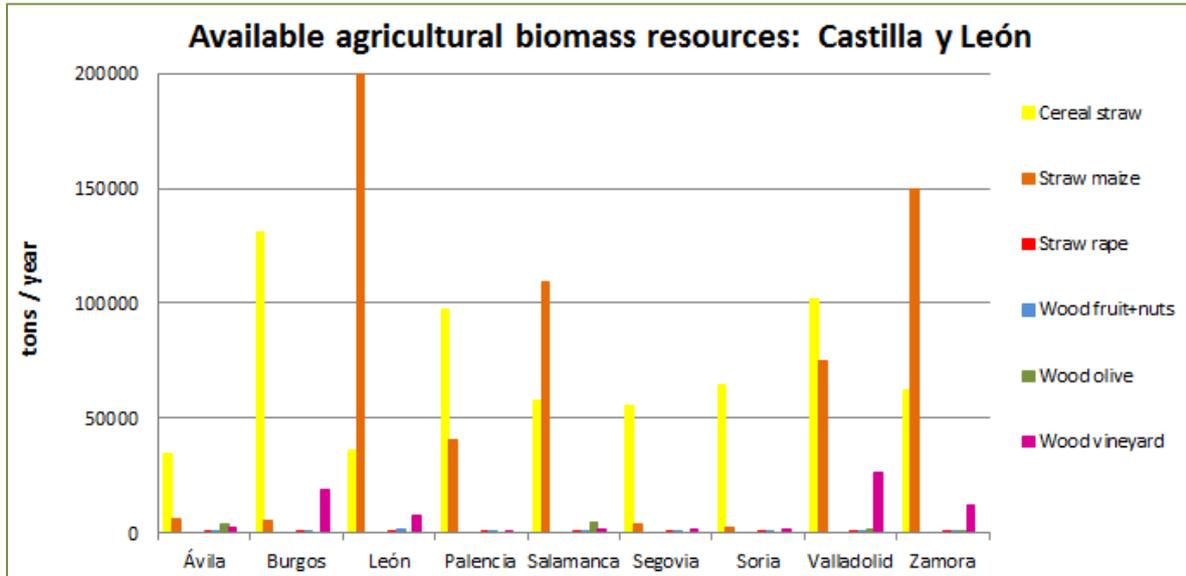


Figure 3: Summary of available agricultural biomass residues in Castilla y León.

Main conclusions in Castilla y León:

- In line with the rest of Spanish regions, maize stalks seem to be one of the main resources available in all provinces except in Ávila, Burgos, Segovia and Soria.
- Cereal straw is the other biomass resource to be considered, available in significant amounts in all regions.
- Prunings (more concretely vineyard prunings) are interesting sources in Burgos, Valladolid and Zamora. Special interest should be placed in the areas where the Designation of Origin of Ribera del Duero wine is produced.
- Regarding the residues from agro-industries, the main to be considered are coming from the wine and cereal industry.

4.3.3. Localization of resources and agro-industries in Castilla y León

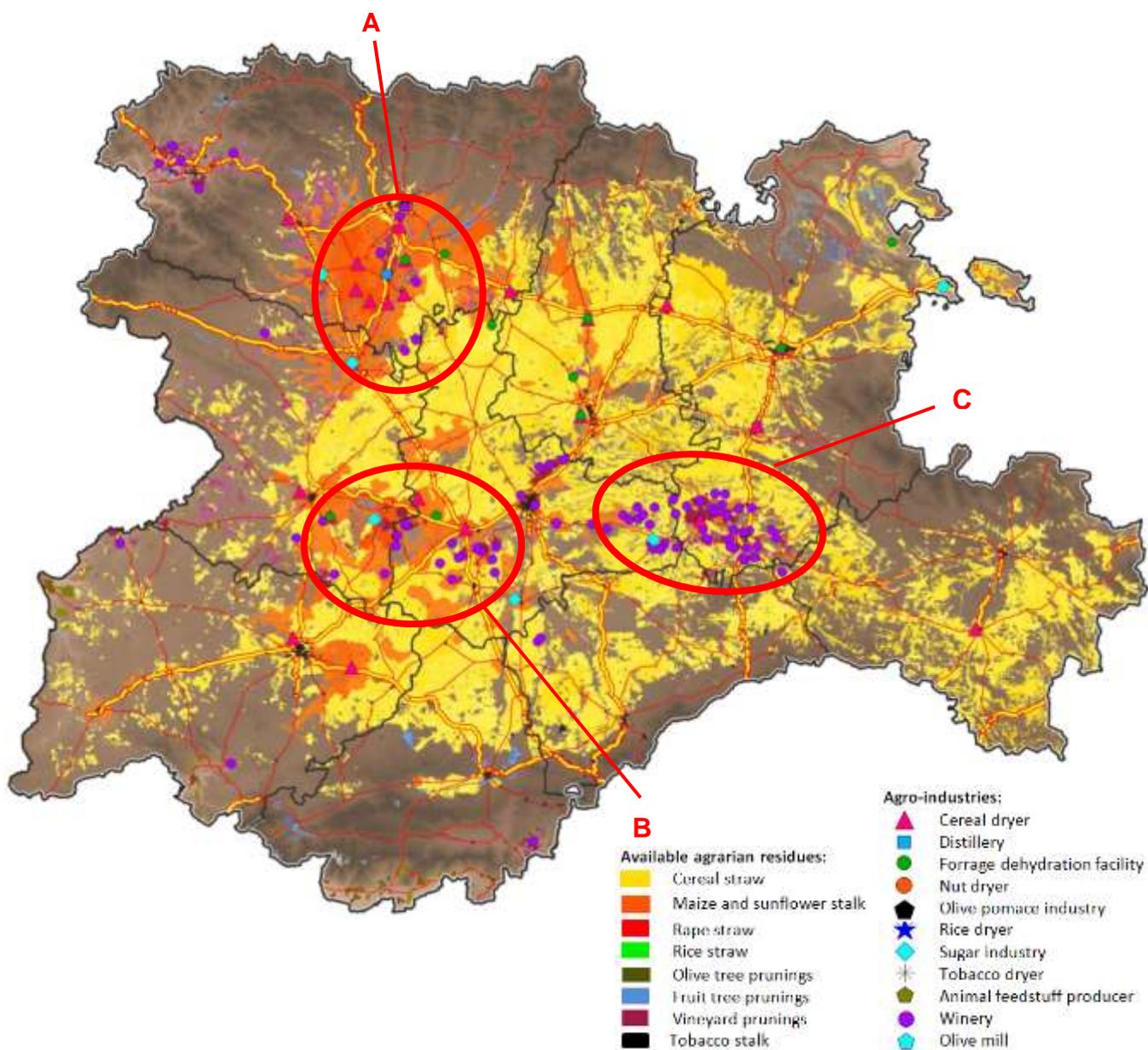


Figure 4: Localization and type of agro-industries and resources in Castilla y León.

4.3.4. Priority areas in Castilla y León

Potential areas detected in Castilla y León region for the implementation of SUCELLOG project are shown in Figure 4. As already mentioned in the introduction, these areas have been selected taking into account the diversity of resources (both woody and herbaceous) and agro-industries as well as the compatibility among them. Compatibility has been defined according to their seasonality, see Table 4, and to their compatibility of use. Logistic issues such as good communication roads and proximity to consumption areas has also taken into consideration.

Table 4: Availability of equipment and biomass resources in Castilla y León.

	Jan	Feb	Mar	April	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Cereal and maize dryer												
Forage dehydration												
Distilleries												
Sugar industry												
Cereal straw												
Maize stalks and cobs												
Permanent crop prunings												
Grape stem												
Grape pits and pomace												
Sugar beet pulp												

The potentiality of the selected zones is explained below:

- **Zones A y B:** both areas gather a large maize production being the stalks a priority residue available for biomass. Due to the season in which is generated, it could be dried in a forage dehydration facility or in a sugar industry, both owning horizontal dryers. These two facilities could be also compatible with cereal straw and vineyard prunings. Maize dryers, mainly present in zone A could provide the residue from their process (husk and flour at reduced moisture content) as a complementary raw material.
- **Zone C:** the main area of production of wine in the region presents also some sugar industry facilities in which a biomass logistic centre could be implemented working with vineyard prunings as feedstock.

4.4. Regional Framework of CATALUÑA

4.4.1. Identification of agro-industries in Cataluña

The interesting agro-industries to become a logistic centre in Cataluña are:

- **Cereal dryers:** Lérida province is the one in Cataluña which counts with more cereal presenting a large amount of facilities for the drying. The area of Urgel and Segria for maize and Segarra for wheat and barley are of importance.
- **Forage dehydration facilities:** Lérida is also the province of Cataluña with more Lucerne surface and where the agro-industries for their dehydration are located.
- **Rice driers:** are mostly located in the Delta del Ebro area.
- **Distilleries:** vine crop is important in all the territory, especially in the Penedés area where the only distillery of the region is placed.
- **Nut industry:** this sector is of special interest in this region due to the vast territory dedicated to the crop and the large number of facilities processing (drying) the nuts.
- **Olive pomace industries:** the only facility of this type is placed in the agrarian area of Les Borges Blanques.

Other agro-industries identified as biomass resources suppliers are: wine sector (grape stem; grape pits y grape pomace), olive mills (olive pits).

4.4.2. Identification of biomass resources in Cataluña

In Figure 5 it can be observed that Cataluña presents a higher diversification of agricultural activities with respect to other regions. Due to the climatology and conditions for the cultivation of fruit trees and vineyard, is the Spanish region (from the five regions assessed in SUCELLOG project) in which prunings can represent the most strategic resource when promoting the use of agricultural resources as biomass feedstock. The total potential is 0.7 Mt/yr, being half of it corresponding to prunings. Due to the diversity of the region, it is worth it to evaluate the provinces instead of the region as a whole.

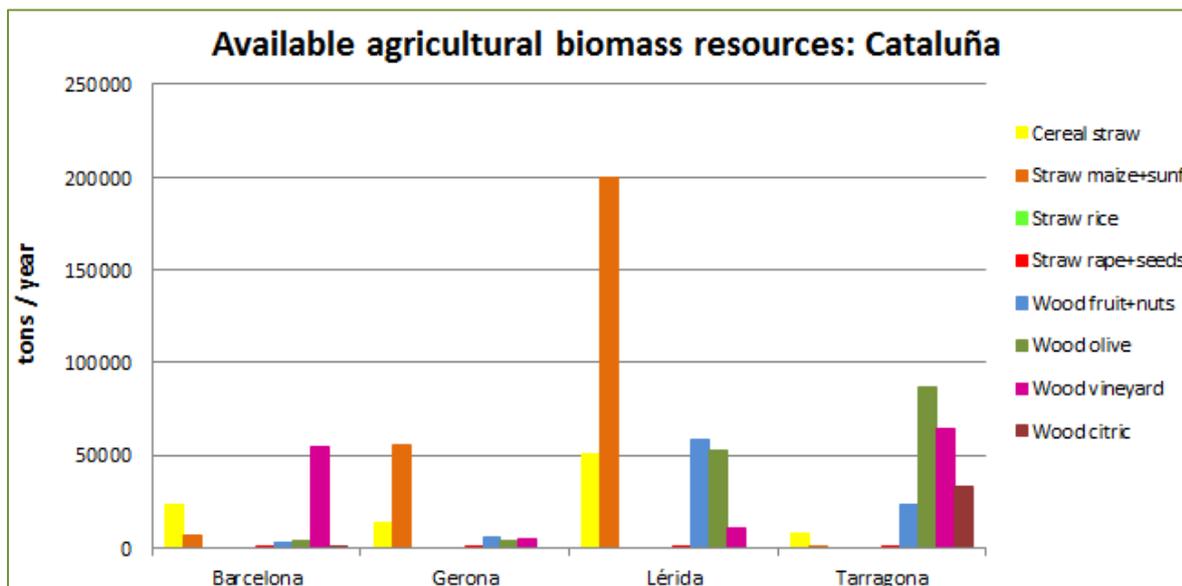


Figure 5: Summary of available agricultural biomass residues in Cataluña.

Main conclusions in Cataluña:

- Lérida province gathers the majority of resources available. Although wood prunings represent more than 120 kt/yr, it is the maize and cereal straw the main feedstock to take into account (250 kt/yr).
- Tarragona presents a unique situation in terms of type of available resources within SUCELLOG framework. Prunings is the by far the most interesting feedstock for a possible logistic centre.
- Barcelona presents a similar situation tan Tarragona does, being pruning the main resource to be considered.
- Gerona province is, however, more similar to what can be found in other Spanish regions, being the maize and cereal straw the predominant residues available.

Residues from the industries of olive oil, wine and nuts should also be considered together with the ones generated in the cereal and rice dryer industries.

4.4.3. Localization of resources and agro-industries in Cataluña

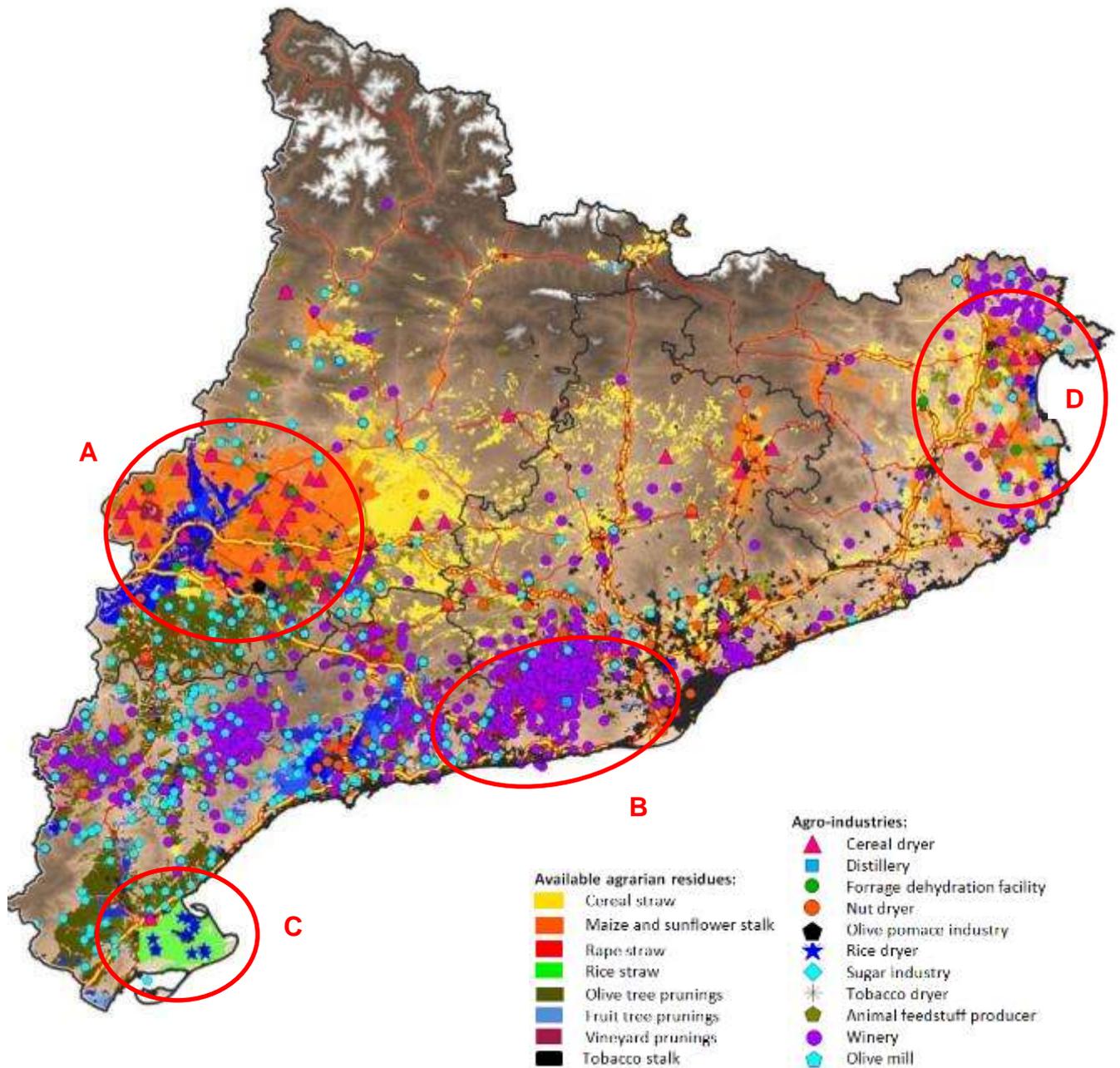


Figure 6: Localization and type of agro-industries and resources in Cataluña.

4.4.4. Priority areas in Cataluña

Potential areas detected in Cataluña region for the implementation of SUCELLOG project are shown in Figure 6. As already mentioned in the introduction, these areas have been selected taking into account the diversity of resources (both woody and herbaceous) and agro-industries as well as the compatibility among them. Compatibility has been defined according to their seasonality, see **Tabla 5**, and to their compatibility of use. Logistic issues such as good communication roads and proximity to consumption areas has also taken into consideration.

Tabla 5: Availability of equipment and biomass resources in Cataluña.

	Jan	Feb	Mar	April	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Cereal and maize dryer												
Forage dehydration												
Rice dryer												
Distilleries												
Olive pomace industry												
Nut dryer												
Cereal straw												
Maize stalks and cobs												
Permanent crop prunings												
Rice husks												
Grape stem												
Grape pits and pomace												
Olive pits												
Olive pomace												
Nut shell												

The situation in the region could be summarised as next:

- Zone A:** it should be highlighted the presence of herbaceous residues (wheat straw and maize stalks) and the woody residues coming from permanent crop prunings (from almond and olive tree mainly) that could be processed in the forage dehydration facilities.

Additionally, the olive pits and the almond shell should also be considered as a potential biomass source to be marketed. Both the nut and the cereal dryers could be the place where to condition the raw material to achieve market properties.

The residue from cereal dryers (husks and flour) could also be considered as a possible complement for a mixed pellet based on prunings for example.
- Zone B:** the area closest to Mediterranean sea presents the most important quantity of residues coming from the industries producing wine, olive oil and nuts as well as wood prunings, which could be conditioned in the nut and distilleries dryers present in the nearby area.
- Zone C:** the area of the Ebro Delta presents the possibility to make compatible the rice dryers and the cereal dryers with the processing of olive pits coming from the olive mills.

- **Zone D:** this zone gathers an interesting mixture of herbaceous crops (maize mainly) and permanent crops. Residues of both crops could be treated in the existing forage dehydration facilities. Olive pits could also be conditioned in rice dryers or in the dehydration industries.

4.5. Regional Framework of EXTREMADURA

4.5.1. Identification of agro-industries in Extremadura

The interesting agro-industries to become a logistic centre in Extremadura are:

- **Cereal and rice dryers:** in Extremadura the cereal and rice dryers are normally at the same installations. Extremadura is the second rice producer in Spain after Andalucía, being cultivated mostly in the agrarian area of Don Benito (Badajoz). This area is also the one presenting the largest maize surface in the region, together with the areas of Mérida and Badajoz and therefore dryer facilities are mainly located in them.
- **Oil pomace processing industry:** the agrarian areas of Almendralejo, Castuera and Llerena are the ones where the most important olive surface are located.
- **Distilleries:** there are two distilleries present in the región, one in the wine production área of Almendralejo and the other one in the north of Cáceres.
- **Tobacco dryer:** this type of industries are placed in the province of Cáceres and, more specifically in the areas of Navalmoral de la Mata and Jaraíz de la Vera, in which the 80% of the surface is used to produce tobacco (the main area in the region).

Other agro-industries identified as biomass resources suppliers are: wine sector (grape stem; grape pits y grape pomace), olive mills and olive pomace industries (olive pits and pomace).

4.5.1. Identification of biomass resources in Extremadura

Extremadura region presents a particular case in which the cereal crop production (mainly maize) and olive tree crop are the predominant agricultural activity. Both provinces (Cáceres and Badajoz) present a similar situation in this aspect. The residues from both crops (stalks and prunings) should be considered as the potential sources of biomass in the region together with the ones coming from the agro-industries. The assessment of SUCELLOG points out a total of 0,8 Mt/yr of residues available.

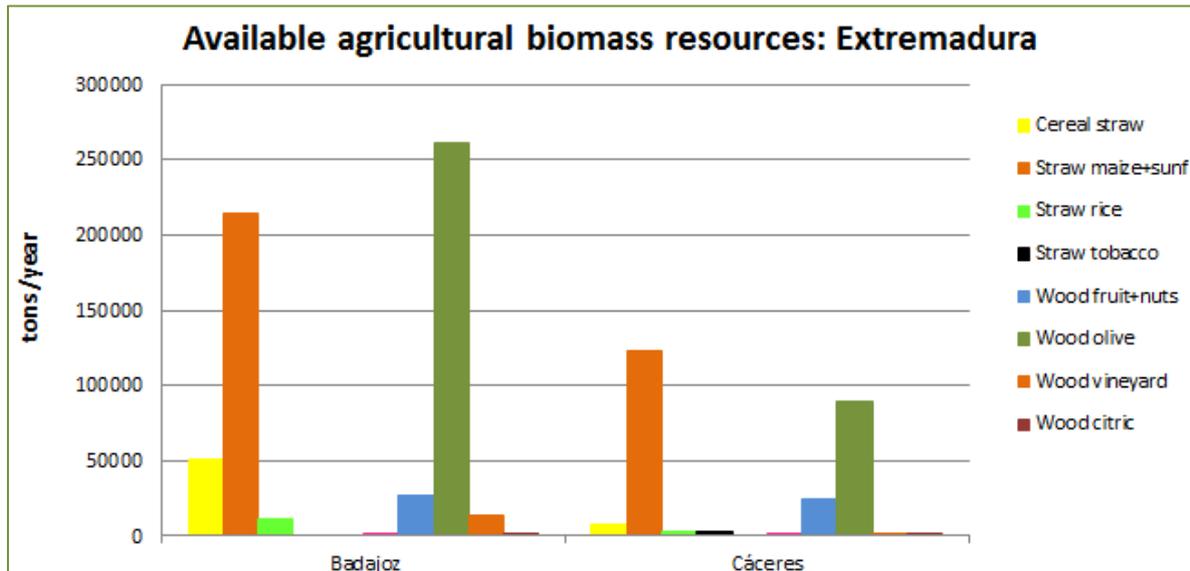


Figure 7: Summary of available agricultural biomass residues in Extremadura.

Main conclusions in Extremadura:

- Maize stalks are a very important source of biomass in the region.
- The vast extension of olive tree crop makes the prunings and sub-products of the olive oil industry (pits and pomace) a strategic resource to be considered in future logistic chains and solid biomass distribution centres.
- In comparison to other regions, Extremadura presents the possibility to consider the rice and soya straw as well as the tobacco stalks as a source of local interest.
- Residues from rice and maize dryers should also be taken into account as a possible complement in mixed pellets, as well as the ones coming from wine and olive oil sector.

4.5.2. Localization of resources and agro-industries in Extremadura

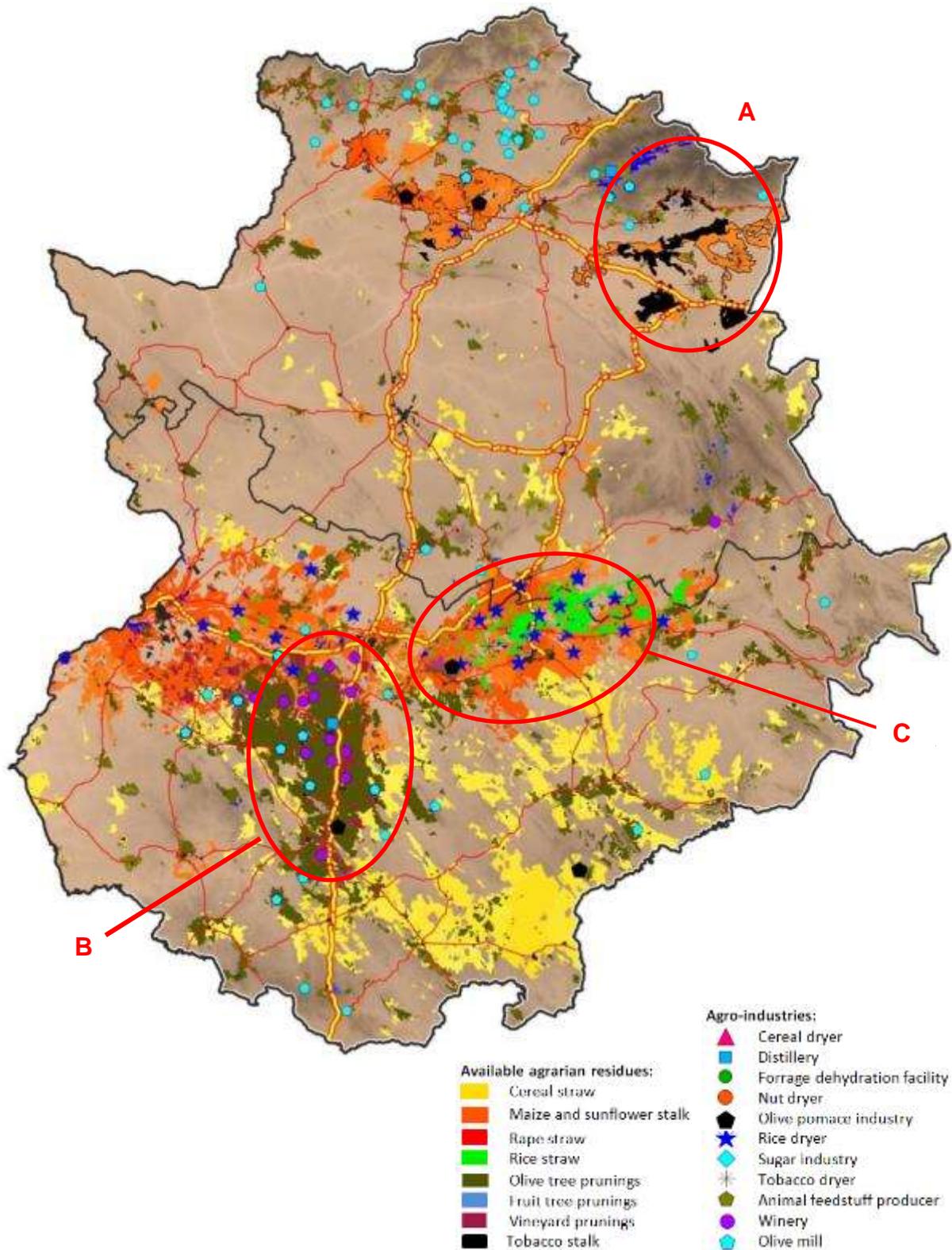


Figure 8: Localization and type of agro-industries and resources in Extremadura.

4.5.3. Priority areas in Extremadura

Potential areas detected in Extremadura region for the implementation of SUCELLOG project are shown in Figure 8. As already mentioned in the introduction, these areas have been selected taking into account the diversity of resources (both woody and herbaceous) and agro-industries as well as the compatibility among them. Compatibility has been defined according to their seasonality, see **Tabla 5**, and to their compatibility of use. Logistic issues such as good communication roads and proximity to consumption areas has also taken into consideration.

Table 6: Availability of equipment and biomass resources in Extremadura.

	Jan	Feb	Mar	April	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Maize and rice dryer	■	■	■	■	■	■	■	■	■		■	■
Distillery						■	■	■	■			
Olive pomace industry						■	■	■	■			
Tobacco dryer	■	■	■	■	■	■	■					■
Cereal straw						■	■	■				
Maize stalks and cobs										■	■	
Permanent crop prunings	■	■	■								■	■
Rice husks	■	■	■	■	■	■	■	■	■			
Grape stem										■		
Grape pits and pomace	■	■	■	■	■						■	■
Olive pits	■	■	■	■	■					■	■	■
Olive pomace	■	■	■	■	■					■	■	■
Tobacco stalks								■	■	■		

The potential areas of Extremadura region are:

- **Zone A:** The large amount of tobacco dryers present in the North of Cáceres province could be considered to condition the woody prunings from olive and almond trees to produce a good quality chip. A new line of pelletization could also be implemented as an alternative in order to produce solid biomass in pellet format.
- **Zone B:** the distillery and olive pomace industry could process their own sub-products and the pruning residues during their idle period.
- **Zone C:** both the rice and cereal dryers as well as the tobacco dryers could condition the olive pits. The olive pomace industry, apart from their own sub-products, could process the pruning residues to be sold in the biomass market as wood chips or pellets.

Even though the large amount of maize stalks available, their use seem to be unfeasible due to the incompatibility of the season when it is produced and the idle period of the existing agro-industries which could process an herbaceous residue.

4.6. Regional Framework of GALICIA

4.6.1. Identification of agro-industries in Galicia

The interesting agro-industries to become a logistic centre in Galicia are:

- **Distilleries:** In Galicia the wine cultivation is mainly located in Pontevedra (Litoral and Miño area) and Orense provinces, being the distilleries nearby these areas.

Other agro-industries identified as biomass resources suppliers are: wine sector (grape stem; grape pits y grape pomace), and the feedstuff industry (wrong formulated products).

4.6.2. Identification of biomass resources in Galicia

Galicia region presents large areas of forest and therefore some regions, like Lugo or La Coruña, do have reduced agricultural residues to be considered. Orense gathers more than half of the biomass resources available in the region (straw and vineyard residues).

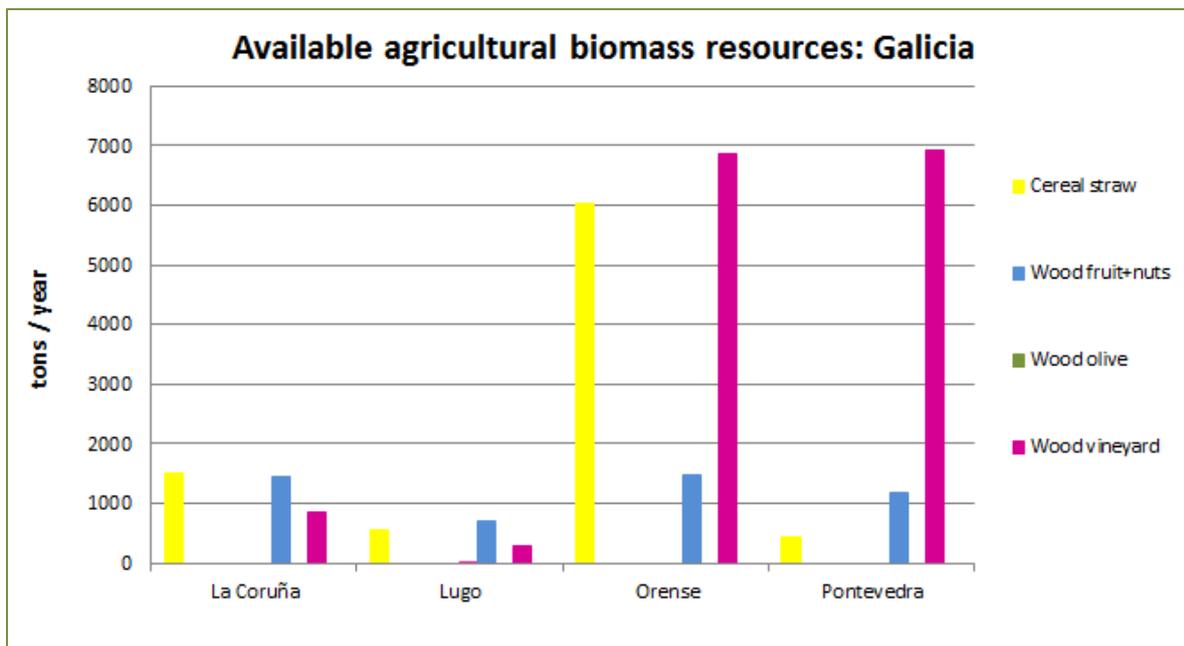


Figure 9: Summary of available agricultural biomass residues in Galicia.

Main conclusions in Galicia:

- The only herbaceous resource is cereal straw and of importance in Orense province.
- Vineyard prunings can be a relevant source of biomass in the vineyard areas of Pontevedra and Orense.

- The rest of resources can be considered as a minority and only of importance from the local point of view.
- Regarding residues produced in the agro-industries, it should be highlighted the ones coming from the production of wine and from the animal feedstuff industries (products with no commercial use, which represent around 2-10% of the total production).

4.6.3. Localization of resources and agro-industries in Galicia

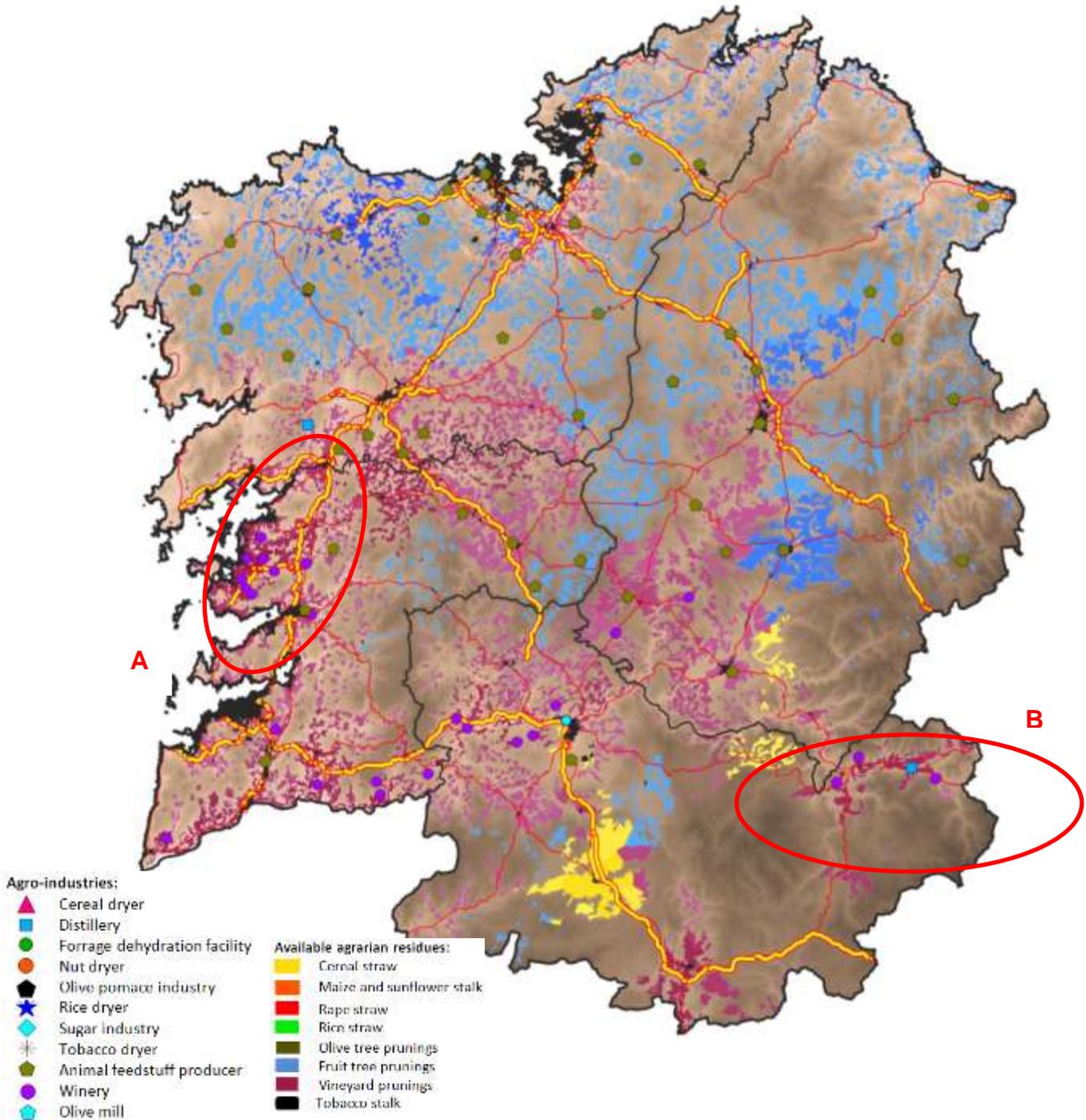


Figure 10: Localization and type of agro-industries and resources in Galicia.

4.6.4. Priority areas in Galicia

Potential areas detected in Galicia region for the implementation of SUCELLOG project are shown in Figure 9. As already mentioned in the introduction, these areas have been selected taking into account the diversity of resources (both woody and herbaceous) and agro-industries as well as the compatibility among them. Compatibility has been defined according to their seasonality, see Table 7, and to their compatibility of use. Logistic issues such as good communication roads and proximity to consumption areas has also taken into consideration.

Table 7: Availability of equipment and biomass resources in Galicia.

	Jan	Feb	Mar	April	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Distillery												
Cereal straw												
Permanent crop prunings												
Grape stem												
Grape pits												
Feedstuff residues												

As it can be observed, the only sector available in the region which could make compatible their own processes with the generation of solid biomass from the technical point of view is the distillery. This sector could work with cereal straw since it is the only resource available in time.

The East of Ourense province (zone A) would be therefore, the area is higher potential to develop SUCELLOG concept in the region. Vineyard prunings and cereal straw could be the feedstock for the production of a mixed pellet in the distillery of the area. The other distillery of the region, present in A Coruña (zone B), could process the prunings from the large vineyard area of Pontevedra. The forest residue generated in the large amount of industries of wood could be a complement for a mixed pellet.

On the other hand, the animal feedstuff industries, although not compatible due to their operation along the whole year, should also be taken into consideration if the market situation makes them reduce the production (making one line free) or if they want to diversify implementing a new line for biomass production.

5. Summary of the situation in Spain

SUCELLOG has evaluated the situation of the different target regions in Spain (Aragón, Castilla y León, Cataluña, Extremadura and Galicia) to host agro-industry logistic centres in terms of barriers/opportunities for their development and available agrarian biomass resources.

Regarding biomass resources and according to the criteria of competitiveness and availability, the maize straw and the woody prunings appear to be the most interesting agrarian sources to be taken into account in general with the exception of Galicia. A large number of types of residues do still not have a real market and are left on the soil or just given for free to avoid the costs of disposal. On the contrary to what happens in other regions, whose logistic centre could be entirely based on agrarian resources, the creation of a logistic centre in Galicia should rely on the supply of the important forest resources of the region together with the woody prunings.

In what concerns the main potential sectors for the creation of biomass logistic centres, they are: forage dehydration facilities, cereal dryers, rice dryers, sugar industry, nut industry, tobacco dryers, distilleries and oil pomace industries. They have been selected due to the existence of compatible equipment for the pre-treatment of raw material (dryers and/or pelletisers) that has idle periods and where no technical barriers for the development of the new activity as biomass logistic centre have been detected. Those sectors owning horizontal dryers (forage dehydration, sugar industries, distilleries and oil pomace industries) present most versatile facilities able to process a greater variety of raw material formats while vertical dryers are more limited to olive and grape pits and crushed almond shell. Additional sectors like cellars and oil mills have also been taken into account, even if they do not present compatible equipment, because of their important capacity to gather agrarian biomass and their high interest in the project. In this sector, a new line for the production of biomass should be implemented. Finally, the animal feedstuff producer sector has also been considered in Galicia, even though their dryers and pelletisers work all the year, since a possible decrease in their production could generate the existence of a line free for the production of solid biomass.

All target regions present potential areas for the creation of logistic centres and the interest of the sectors is high in general since they see it as an opportunity to consume their own residues (reducing fuel acquisition) and to diversify their activity. However, even if the agro-industry sector is the one of the largest consumer of solid biomass in Spain, being familiar with bioenergy issues, the most limiting barrier to be overcome in this country is the mistrust to changes in regulatory frameworks that could generate the stop of an industrial activity. Renewable energies arose as a good solution for the rural development and in some cases (like electricity production with solar systems) failed due to regulatory framework. The emission legal limits to start

being applied in the next years are one of the reasons that stop the sector from starting operating as solid biomass logistic centre. .

Annex I: Table of ratios y availability percentage per region

Table 8: Ratios of biomass production (t/ha) in SPAIN per region

Crop	Galicia	Aragón	Castilla y León	Extremadura	Cataluña
WHEat	1,84	1,7	1,95	0,68	1,84
Rye	1,96	0,64	1,03	1	0,88
Barley	1,66	1,95	1,32	0,85	1,29
Oat	1,48	0,65	0,99	0,95	0,79
Maize	20	20	20	20	20
Rice	3,8	3,8	3,8	3,8	3,8
Beans	1	1	1	1	1
Pulses_oth	1	1	1	1	1
Tobacco	1	1	1	1	1
Hemp	-	-	-	-	-
Rape	1	1	1	1	1
Sunflower	3	3	3	3	3
Soya	1	1	1	1	1
Linseed	-	-	-	-	-
Seed_other	1	1	1	1	1
Fruit_temp	3	3,5	2,5	3	2,5
Fruit_subtrop	3	3,5	2,5	3	2,5
Berry	1,5	1,5	1,5	1,5	1,5
Nuts	0,7	0,7	0,7	0,7	1,7
Citrus	-	6	6	6	6
Olive	-	3	3,75	3	3
Vineyard	3,75	4	3	0,5	3,75

Table 9: Percentage of availability of biomass in SPAIN per region

Crop	Galicia	Aragón	Castilla y León	Extremadura	Cataluña
WHEat	30	30	30	30	30
Rye	30	30	30	30	30
Barley	30	30	30	30	30
Oat	30	30	30	30	30
Maize	50	50	50	50	50
Rice	10	10	10	15	0
Beans	0	0	0	0	0
Pulses_oth	0	0	0	0	0
Tobacco	-	-	90	30	-
Hemp	-	-	-	-	-
Rape	50	50	50	50	50
Sunflower	10	10	0	10	10
Soya	-	-	-	70	-
Linseed	-	-	-	-	-
Seed_other	-	-	75	75	-
Fruit_temp	80	90	90	95	90
Fruit_subtrop	80	90	90	95	90
Berry	95	95	95	95	95
Nuts	99	99	99	99	50
Citrus	-	90	90	90	90
Olive	-	80	97	95	80
Vineyard	80	99	80	70	97