

## Chapter 2

# The Portuguese Forest Based Chains: Sector Analyses

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**Abstract** The present chapter describes and analyses the context of the productive chains based on Portuguese forest. The description focuses in the macroeconomic relevance and in the production flows of the Portuguese forest sector. The characterization of the productive chains is based on the aggregation of the forest sector in three main categories. The first category is composed by chains with historic activity in Portugal, including wood for furniture and construction, wood for pulp, paper and paperboard, and the cork based chain. The second category, termed emerging chains, includes economic activities that only recently are viewed as integrated chains, from raw material up to the end product. The chains based on chestnuts and pine nuts are included in this category. Forest biomass for energy is also considered as an emerging chain, mainly because of its new context and strategy, in connection with climate change and energy policies. A perspective of other potentials, based on forest ecosystems, is also presented in terms of a sector analysis approach. For each chain, the explanation follows a sequence where production and markets are first analyzed followed by a description of the characteristics of labour and enterprises. The dominant characteristics of the ecosystems supplying raw-material for industrial transformation are also analyzed.

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Express the author opinion, not the World Bank position

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**Keywords** Forest ecosystems • Wood • Construction • Furniture • Pulp • Paper and paperboard • Cork • Chestnut • Pine nut • Forest biomass • Chain • Forest products • Forest markets

## 2.1 Highlights of the Portuguese Forest Sector

### 2.1.1 Main Production Flows

In Portugal, the historic forest based chains are: wood for furniture and construction, wood for pulp, paper and paperboard, and the cork based chain.

Recently, other forest economic activities are being regarded as integrated chains, from raw material up to the end product. These activities, termed emerging chains, are increasing their economic relevance: chestnuts, umbrella pine nuts and resin are included in this category. Forest biomass for energy is also considered as an emerging chain in connection with climate change and energy policies.

Other potential chains based on forest ecosystem services, namely those linked to carbon economy, nature conservation and energy, are essential to the accomplishment of international commitments signed by Portugal. In the same perspective, fruit producer species like strawberry and carob trees are considered relevant for the total economic value of forests. Also, holm oak, traditionally managed through agro-forestry practices, is a supporting element in degraded lands susceptible to desertification, having positive effects on soil and on carbon sequestration.

### 2.1.2 A Macroeconomic Review

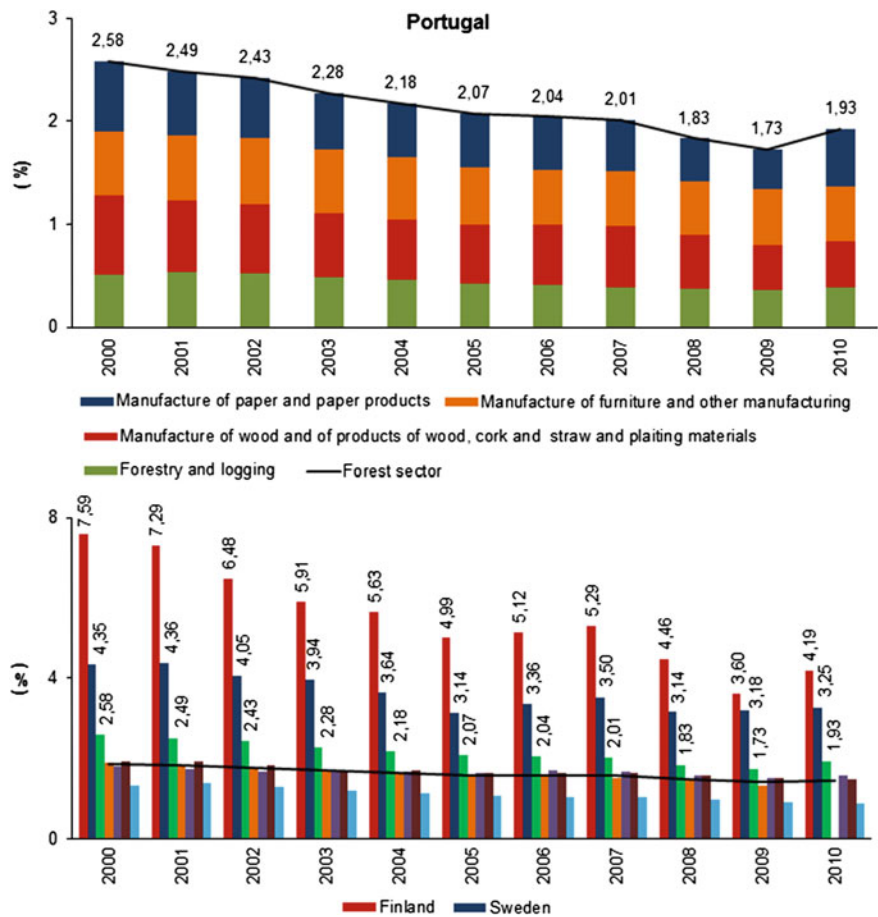
#### National Accounts

The contribution of the Portuguese forest sector gross added value (GAV) to the gross domestic product (GDP) is larger than the correspondent average for European Union (EU). From 2000 to 2010 Portuguese forest GAV represented 2.1 % of the national GDP. Only forest GAV of Finland (5.5 %) and Sweden (3.6 %) had higher contributions to the corresponding national GDP (Fig. 2.1).

Similarly, in EU countries, only in Finland (24.6 %) and Sweden (18.3 %) the contribution of the forest sector to industrial GAV is higher to the one observed in Portugal (13.3 %).

#### International Trade

The forest sector represents, on average, 10 % of the Portuguese exports, and the flows are characterized by the dominance of transformed products, with larger national added value. Only 2 % of forest exports are products of forestry, logging and related services (Table 2.1).

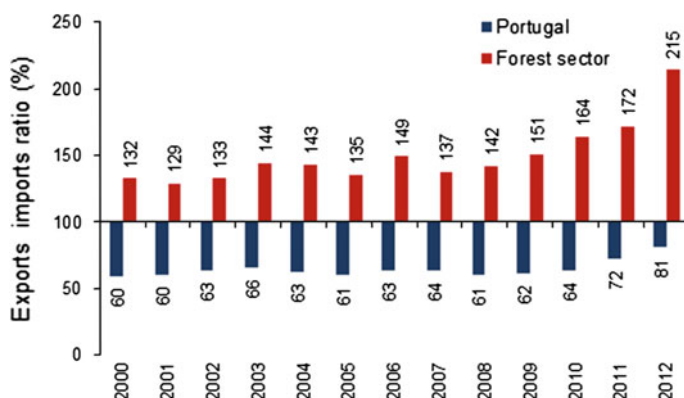


**Fig. 2.1** Contribution of forest sector GAV to national GDP in Portugal and selected EU countries (Eurostat 2013)

**Table 2.1** Structure of Portuguese forest sector exports (Statistics Portugal 2013)

|                                                    |      |
|----------------------------------------------------|------|
| Paper and paper products                           | 51 % |
| Wooden furniture                                   | 12 % |
| Cork and articles of cork                          | 20 % |
| Wood and articles of wood and wood charcoal        | 15 % |
| Products of forestry, logging and related services | 2 %  |

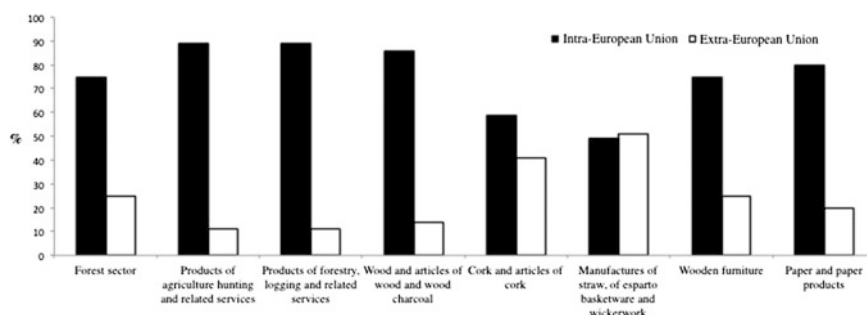
The Portuguese forest sector is sustained by national raw material. This aspect is underlined by a historic trade surplus in balance sheets, with more exports than imports (Fig. 2.2). Since 2000, the balance (Table 2.2) was above 1,000 million €,



**Fig. 2.2** National and forest sector and imports ratio (Statistics Portugal 2013)

**Table 2.2** Portuguese, national and forest sector, commercial balance (Statistics Portugal 2013)

| Commercial balance (Million €)                              | 2006    | 2007    | 2008    | 2009    | 2010    | 2011    | 2012    |
|-------------------------------------------------------------|---------|---------|---------|---------|---------|---------|---------|
| Portugal                                                    | −20,654 | −21,632 | −25,347 | −19,682 | −21,379 | −16,373 | −10,667 |
| Forest sector                                               | 1,079   | 916     | 1,033   | 1,030   | 1,485   | 1,718   | 2,248   |
| Products of agriculture, hunting and related services       | −1,459  | −1,863  | −2,007  | −1,518  | −1,745  | −2,044  | −1,913  |
| Products of forestry, logging and related services          | −4      | −11     | 3       | −28     | −71     | −93     | −75     |
| Wood and articles of wood and wood charcoal                 | 102     | 107     | 68      | 2       | −72     | 9       | 155     |
| Cork and articles of cork                                   | 713     | 717     | 700     | 607     | 661     | 676     | 713     |
| Manufactures of straw, of esparto basketware and wickerwork | −6      | −7      | −6      | −6      | −7      | −5      | −3      |
| Wooden furniture                                            | −32     | −14     | 26      | 111     | 165     | 220     | 308     |
| Paper and paper products                                    | 308     | 123     | 241     | 344     | 809     | 911     | 1,150   |



**Fig. 2.3** Portuguese forest sector exports major destinations (Statistics Portugal 2013)

exceeding in 2012, 2,000 million €. Forest based products are essentially (75 %) exported to EU countries (Fig. 2.3).

### Enterprises and Employment

In Portugal, since 2000, the economic activities directly related with forest chains are, on average, responsible for 82,000 jobs, corresponding to 3 % of the total employment. The employment is larger when wholesale and retail trades are included with around 110,000 employees (Table 2.3).

Employment in the forest sector is larger in coastal areas (ICNF 2013a). Nevertheless, forest jobs are also significant in the remaining territory, having an essential role in the mitigation of economic structural fragilities in inland regions.

## 2.2 Traditional Chains

### 2.2.1 Wood Based Chains

#### 2.2.1.1 Main Characteristics of the Forests Provisioning Wood

The perception of the good capability of the Portuguese mainland for timber production has sustained forest expansion policies during the twentieth century. These policies led to an increase of production forests, mostly in pure stands (Fig. 2.4), with dominance, in composition, of maritime pine (*Pinus pinaster* Aiton) first and eucalyptus (*Eucalyptus globulus* Labillardière) later (Rego et al. 2013). These forests have been the main supporters to the establishment and development of wood based industries (sawn, pulp and paper). The recent forest inventory, from 2010 (ICNF 2013b), estimated an area of 715,000 ha for maritime pine (8 % of the country; 23 % of the forest area) and 811,000 ha for eucalyptus (9 % of the country; 26 % of the forest area).

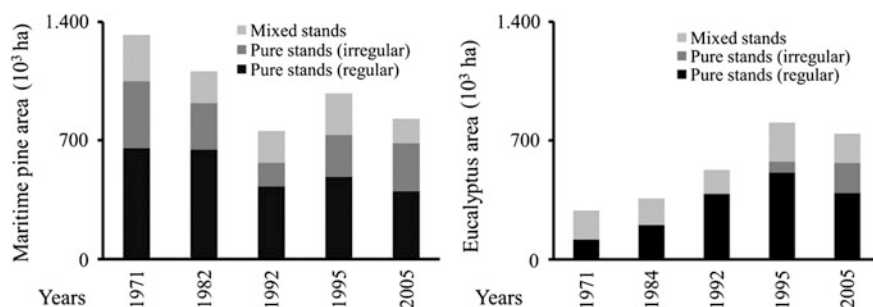
The strong relation of investments on capacity, made by wood based industries, with the increase of timber availability (Louro et al. 2009, 2010a, b; Rego et al. 2013)

**Table 2.3** Forest sector employment (GEP 2012)

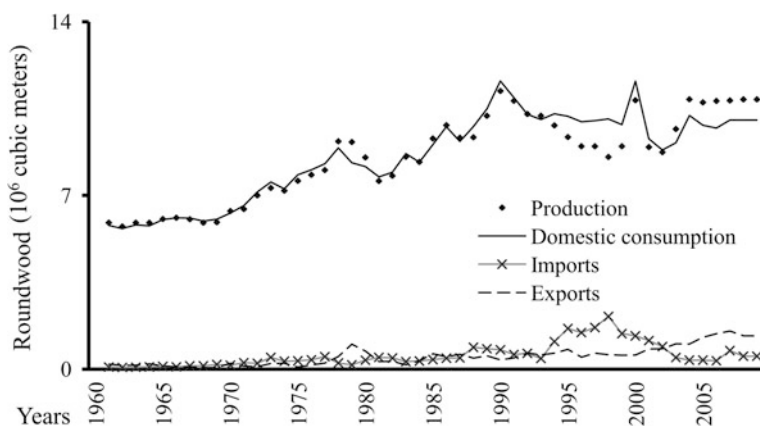
|                                                      | 2000    | 2008    | 2010   | 2011   |
|------------------------------------------------------|---------|---------|--------|--------|
| Products of forestry, logging and related services   | 3,962   | 6,660   | 5,908  | 6,093  |
| Sawnwood                                             | 9,499   | 6,830   | 5,241  | 5,163  |
| Particle board                                       | 1,384   | 793     | 674    | 671    |
| Fibreboard                                           | 625     | 612     | 346    | 443    |
| Other panels                                         | 814     | 647     | 736    | 727    |
| Builder's joinery and carpentry of wood              | 14,692  | 10,133  | 8,397  | 7,708  |
| Wooden wrapping and packing                          | 948     | 1,122   | 1,066  | 1,108  |
| Wooden furniture                                     | 38,487  | 33,185  | 28,159 | 26,277 |
| Other manufactured wood products                     | 3,285   | 3,000   | 2,384  | 2,288  |
| Wood pulp                                            | 2,251   | 1,339   | 1,524  | 1,538  |
| Construction paper and paperboard                    | 4,183   | 3,485   | 2,662  | 663    |
| Packaging and wrapping paper and paperboard          | 5,207   | 5,340   | 4,803  | 5,028  |
| Sanitary and household papers                        | 346     | 422     | 1,190  | 1,168  |
| Printing and writing paper                           | 488     | 632     | 460    | 2,461  |
| Straw and plaiting materials                         | 80      | 80      | 44     | 50     |
| Cork                                                 | 12,780  | 10,667  | 8,147  | 8,335  |
| Resins and resin products                            | 510     | 172     | 205    | 208    |
| Forest sector (without wholesale and retail trade)   | 99,541  | 85,119  | 71,946 | 69,929 |
| Wholesale of logging products                        | 3,082   | 4,817   | 4,145  | 3,965  |
| Wholesale of cork, resin and others                  | 293     | 223     | 190    | 256    |
| Wholesale of furniture                               | 4,063   | 3,966   | 2,815  | 2,289  |
| Retail sale of furniture                             | 11,439  | 11,989  | 10,113 | 9,453  |
| Wholesale of builder's joinery and carpentry of wood | 697     | 1,548   | 1,214  | 1,096  |
| Wholesale of printing and writing paper              | 3,493   | 2,819   | 2,377  | 2,019  |
| Retail sale of printing and writing paper            | 6,606   | 6,880   | 5,756  | 5,540  |
| Forest sector (with wholesale and retail trade)      | 129,214 | 117,361 | 98,556 | 94,547 |

is confirmed by the historic proximity observed between timber production and the domestic consumption of wood (Fig. 2.5).

Although the availability of wood within Portugal is an important advantage of the forest sector compared to other important economic activities that are based on imported raw materials, the sustainability of timber supply to the industries is associated to risks and uncertainty. This is a result of different factors, caused by natural, social and economic transformations, at international and national levels (DGRF 2007).



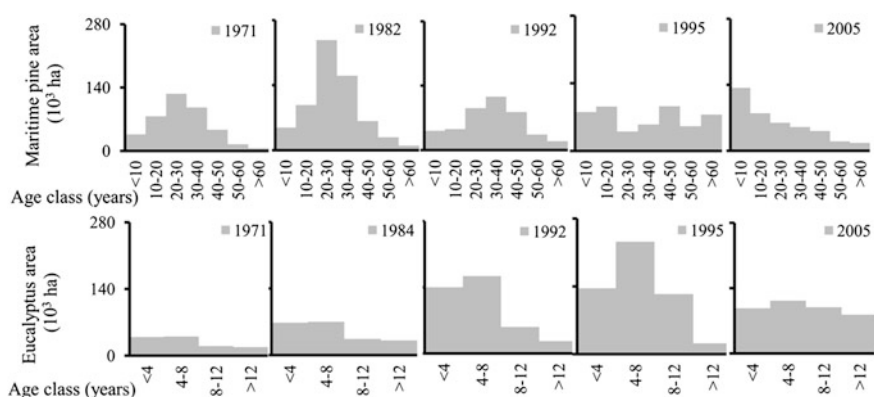
**Fig. 2.4** Forest composition (*pure* and *mixed* stands) and structure (*regular* and *irregular*), for maritime pine and eucalyptus, reported by National Forest Inventories (NFI), between 1971 and 2005 (Rego et al. 2013)



**Fig. 2.5** Production, domestic consumption, imports and exports of roundwood (mainly maritime pine and eucalyptus) in Portugal (Rego et al. 2013)

The first phenomenon of change of context in forests is climate change. Expressions of the effect of climate change are the increasing high risks of wildfires and of pests and diseases. On average, between 1996 and 2005, pine and eucalyptus forests were burning, respectively, at an annual rate of 4.9 and 3.4 % (DGRF 2007). In maritime pine the loss of vitality and mortality due to pine wood nematode, parasite classified as quarantine organism by Community legislation, is also a threat to the sustainable supply of the wood of this species.

A possibility to increase wood availability is the enhancing of productivity through sustainable forest management. This objective can be accomplished with actions to promote forest active management, genetic improvement and better allocation of wood producing forest species, namely maritime pine and eucalyptus.



**Fig. 2.6** Distribution of areas by age classes (years) in pure regular stands of maritime pine and eucalyptus, reported by National Forests Inventories (NFI) between 1971 and 2005 (Rego et al. 2013)

The combined and continuous effect of wildfires, biotic agents and lack of accurate management practices has resulted in forest stands less interesting for wood processing activities. This state is expressed by the analyses of the age classes' distribution in pure stands (Fig. 2.6), which show:

- (1) In maritime pine, a decline in the availability of round wood for sawn, especially in older stands.
- (2) In eucalyptus, an increase of areas of older stands (more than 12 years), less interesting for industrial transformation to produce wood pulp, maybe a result of less active management and harvesting practices.

In this context great concerns are posed about the sustainability of the national supply of wood to forest industries. As a consequence, the National Forest Strategy (DGRF 2007) recognized as main policy objectives the minimization of wildfires and biotic agents' risks, as well as the enhancement of productivity.

### 2.2.1.2 Wood Construction and Furniture Chains

Following the methodology established by Buongiorno et al. (2013) the structure of wood based chains is described by grouping wood products in primary, intermediate and end products. In the case of wood construction and furniture chains, these classes include (Fig. 2.7):

1. As primary products, wood/timber production and roundwood
2. As intermediate products, sawn wood and wood panels (particle board, fibre board and veneer sheets, plywood and other board)
3. As end products, wooden furniture, builder's joinery and carpentry of wood, wooden wrapping and packaging and other wood products



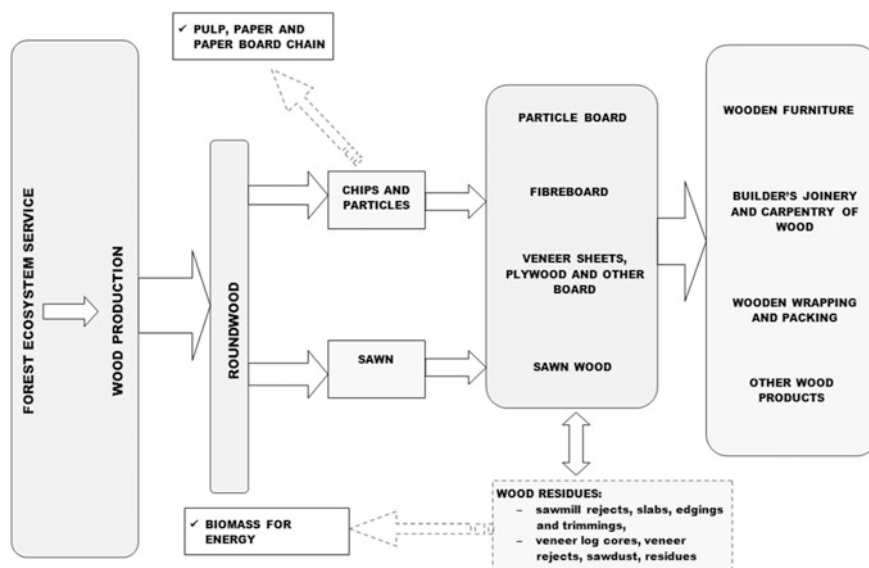


Fig. 2.7 Structure and flows in wood construction and furniture chains (Louro et al. 2013)

In wood construction and furniture chains, the wood residues generated in the processing activities as well as recycled wood products are reutilized as raw materials (Fig. 2.7). The industrial transformation of roundwood into intermediate and end products produces about 10–15 % of wood residues. The reutilization of wood residues in processing activities is particularly relevant in wood panel industries.

## Production and Markets

Since 2000, the production of sawn wood represents, on average, 12 % of the domestic consumption of roundwood. Only 31 % of sawn production is exported, confirming that the domestic consumption, producing end products with high national added value, is more important (Louro et al. 2009).

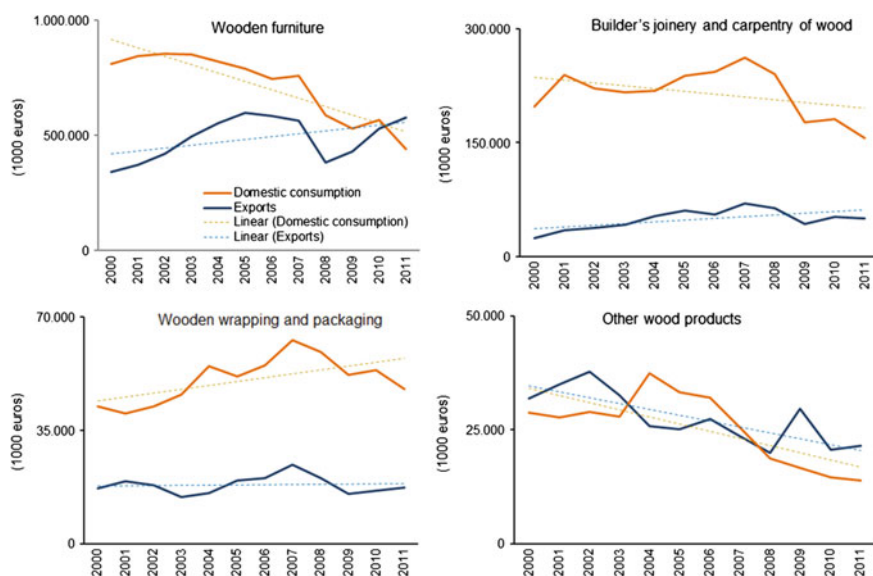
In wood panels the market flows are different, with about 59 % of the wood panels' production exported. Since 2000, particle board represents, on average, 62 % of the panels produced, fibreboard 34 % and veneer sheets, plywood and other board 4 %.

Historic data shows that the end products are mostly consumed in domestic markets. They represent 82 % of the consumption in builder's joinery and carpentry of wood, 74 % in wooden wrapping and packaging and 59 % in wooden furniture (Table 2.4 and Fig. 2.8). These characteristics reinforce the strong link of Portuguese wood based industries with the construction activities. However, in the last product, the trend for increasing exports must be highlighted (Fig. 2.8).

**Table 2.4** Domestic consumption and exports in the end products of wood construction and furniture chains (Statistics Portugal 2013)

|                                         | Domestic consumption (%) <sup>a</sup> | Exports (%) <sup>a</sup> |
|-----------------------------------------|---------------------------------------|--------------------------|
| Wooden furniture                        | 59                                    | 41                       |
| Builder's joinery and carpentry of wood | 82                                    | 18                       |
| Wooden wrapping and packaging           | 74                                    | 26                       |
| Other wood products                     | 47                                    | 53                       |

<sup>a</sup> % of total sales, average since 2000

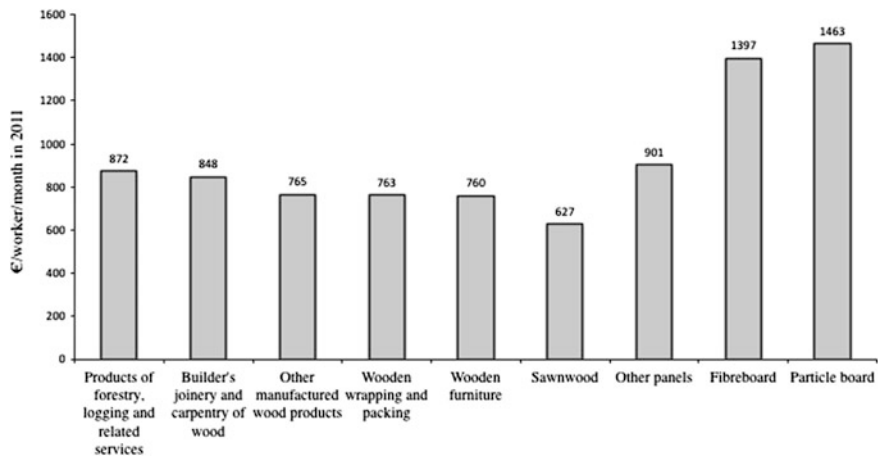


**Fig. 2.8** Domestic consumption and exports in wood based end products (Statistics Portugal 2013)

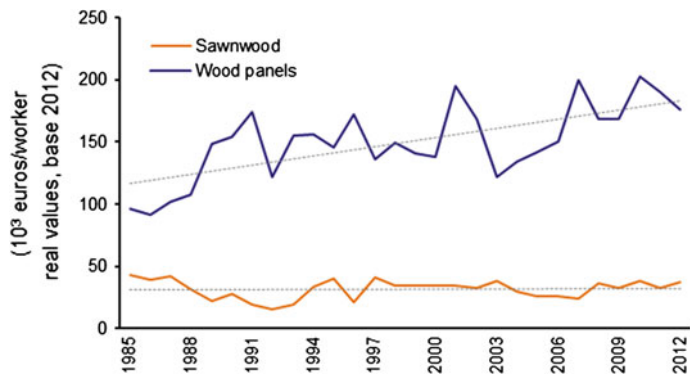
### From Labour Intensive to High Productivity Chains

In what concerns labour characteristics, two different realities are perceived in the wood construction and furniture chains (Figs. 2.9 and 2.10):

- Sawnwood, carpentry of wood, wrapping and packing and other wood products, as well as wooden furniture, representing, respectively, 8, 13, 4 and 39 % of forest jobs, are labour intensive activities, having low salaries and productivities per worker;
- Wood panels, although representing only 3 % of forest jobs, have higher salaries, much larger than the medium national wage (about 1.000 €/month), and higher productivities per worker.



**Fig. 2.9** Monthly wages in wood construction and furniture chains (GEP 2012). National minimum wage: 485 €



**Fig. 2.10** Productivities per worker in wood construction and furniture chains (GEP 2012; Faostat 2013)

The importance of sawn, carpentry and wooden furniture in creating jobs must be underlined, particularly in the actual context of high unemployment levels, reported in Portugal. Nevertheless, the performance of these activities can yet be improved, namely by increasing the productivity levels. In wood panels, the high productivities per worker emphasises a performance based on high levels of technology investments, with results in the good capacity to compete in international markets.

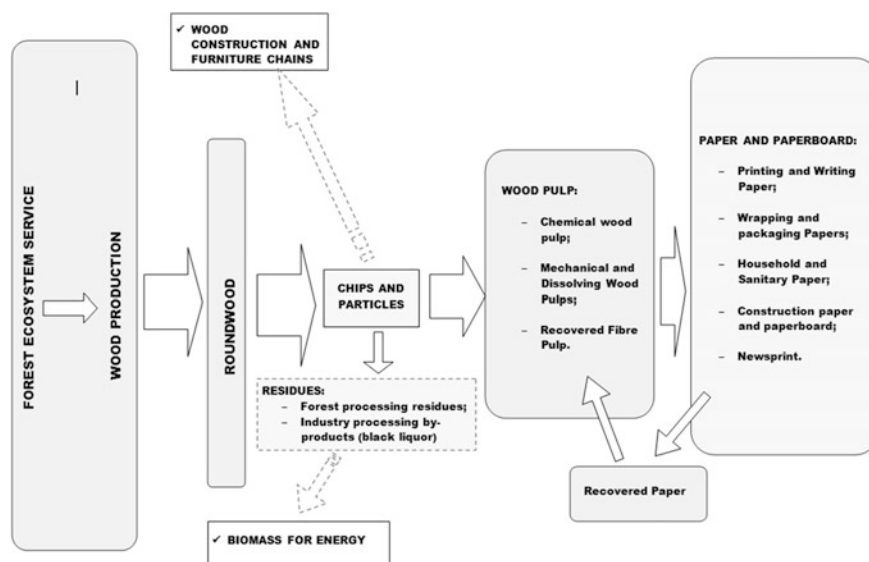


Fig. 2.11 Structure and flows in pulp, paper and paperboard chain (Louro et al. 2013)

### 2.2.1.3 Pulp, Paper and Paperboard Chain

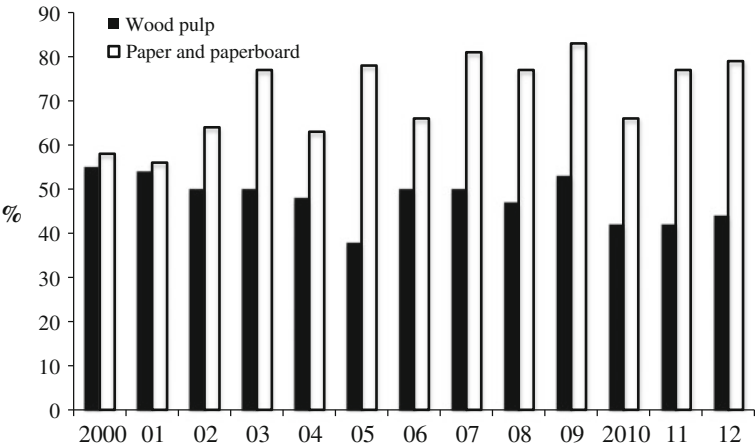
The structure of pulp, paper and paperboard chain (Fig. 2.11) is described by aggregating the products as in Louro et al. (2010a):

1. Primary products—wood/timber production and roundwood
2. Intermediate products—wood pulp
3. End products—printing and writing paper, wrapping and packaging papers, household and sanitary paper, construction paper and paperboard and newsprint

In this chain, recovered fiber pulp and recovered paper and paperboard are important sources of raw material (Fig. 2.11). Recovered fiber pulp is equivalent to 25 % of the wood pulp produced in Portugal. Paper recovered rates<sup>1</sup> are superior to 60 % and on average the utilization rate<sup>2</sup> of recovered paper is 20 % (CELPA 2011). A possible explanation for these good figures may be linked to the growing recycling behavior of the population. However, it must also be underlined the investments of the pulp industries in technology, enabling the use of more recycled raw materials.

<sup>1</sup> Recovered rate: domestic recovery of paper in relation to the whole consumption of paper.

<sup>2</sup> Utilization rate: recovered paper used as raw material in relation to the whole production of paper.



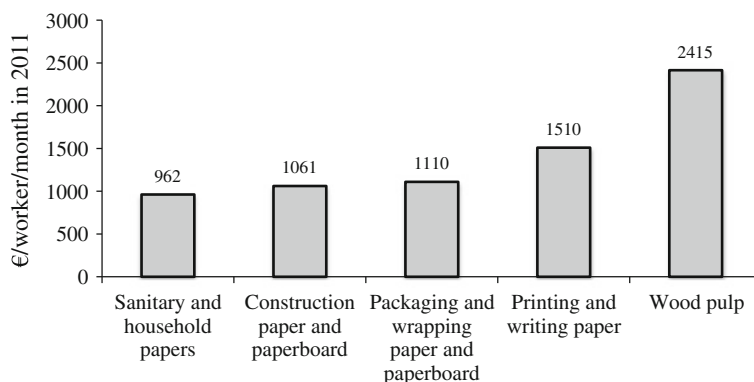
**Fig. 2.12** Wood pulp and paper and paperboard exports as a percentage of their respective production (Faostat 2013)

**Table 2.5** Significance of production, exports, imports and domestic consumption of the different types of paper and paperboard relatively to the global paper and paperboard (Faostat 2013)

|                                   | Production (%) | Exports (%) | Imports (%) | Domestic consumption (%) |
|-----------------------------------|----------------|-------------|-------------|--------------------------|
| Printing and writing paper        | 63             | 72          | 33          | 36                       |
| Newsprint                         | 0              | 0           | 13          | 8                        |
| Household and sanitary paper      | 5              | 1           | 3           | 7                        |
| Wrapping and packaging papers     | 31             | 27          | 49          | 47                       |
| Construction paper and paperboard | 1              | 0           | 2           | 2                        |

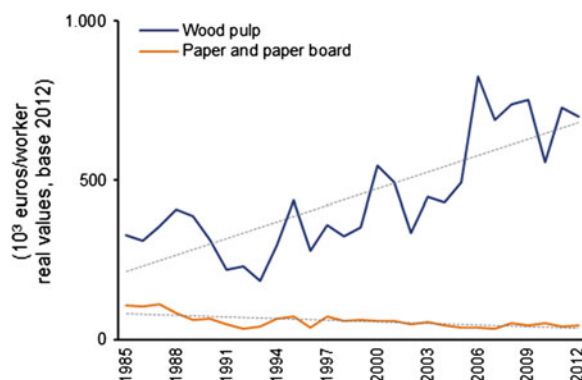
From National to International Markets

Since 2000, the production of wood pulp represents, on average, 88 % of the domestic consumption of roundwood, with chemical wood pulp representing 100 % of the Portuguese pulp production. Historic data shows, unequivocally, the dominance of exports in the market flows, with more than 50 % of the national production of paper and paperboard being exported (Fig. 2.12). The slight trend to decreasing export volumes of wood pulp (Fig. 2.12) confirms that paper and paper board industries are investing in capacity, with results in more pulp transformed in paper and paper board at national level.



**Fig. 2.13** Monthly wages in pulp, paper and paperboard chain (GEP 2012). National minimum wage: 485 €

**Fig. 2.14** Productivities per worker in pulp, paper and paperboard chain (GEP 2012; Faostat 2013)



The Portuguese production of paper and paper board (Table 2.5) consists essentially in printing and writing paper (63 %), followed by wrapping and packaging papers (31 %). Similarly, these two products represent 99 % of paper and paperboard exports, with 72 % corresponding to printing and writing paper. The domestic consumption of wrapping and packaging papers (47 %) is sustained by the national production of the product and by imports, which represent 49 % of paper and paperboard imports.

### A Labour Efficient Chain

Although pulp industries represent only 2 % of forest jobs, they have good productivity levels and one of the best wages in the forest sector wages (Figs. 2.13 and 2.14). These characteristics confirm wood pulp as a labour efficient chain.

The labour performance of paper and paper board industries is quite different. Although they have a great importance in creating jobs (12 % of forest jobs), they are sustained by lower salaries. A direct consequence of this characteristic is perceived in the lower levels of productivity, comparatively to the case of wood pulp.

## 2.3 Cork Based Chain

### 2.3.1 Main Characteristics of the Cork Oak Forests

Cork oak (*Quercus suber* L.) was unanimously recognized by the Portuguese parliament as a national symbol, along with the flag and the national anthem. In the Portuguese mainland, cork oak is the native broadleaved tree more represented and expanded, having a prominent place in forest ecosystems composition, in pure or mixed stands, mainly with other oaks or with pines, and in natural or semi-natural formations.

It is also one of the most valued native species for its unique botanic characteristics. The tree forms a thick, rugged bark containing high levels of suberin. Over time the layer of bark can develop considerable thickness and can be harvested every 9–12 years to produce cork. Once the bark is cut and removed, a new layer of cork regrows. Cork oak can live on average 150–200 years, despite its bark being stripped periodically. The economic value of the species is considerably increased because of its cork production. The exceptional properties of cork allow multiple possibilities in the industrial processing of this natural product.

Nevertheless, cork oak ecosystems produce other services, like wood fuel, including wood for charcoal, with historic importance in the development of Mediterranean civilizations, and fruits and leaves, key elements in the agro-forestry management practices traditionally followed in these systems.

The list of services provided by cork oak stands is almost endless and they are essential to human well-being. Pasture and hunting are examples of these other values, as well as mushrooms. The supporting service concerning soil development (conservation, formation) has a huge ecological significance, especially for the results in degraded lands susceptible to desertification; the positive impacts in agriculture production are also relevant. The cultural potential of cork oak is equally notable. Frequently the monumentality of the trees is remarkable and their spiritual, aesthetic and inspirational value is unique and valued in recreation and tourism activities. The quality and character of cork oak landscapes is a differentiated characteristic of its ecosystems.

The multiplicity of cork oak benefits, with special emphasis on cork economic value, has resulted in policies for afforestation with this species, first with major private support and later with public subventions. These investments are perceived

**Table 2.6** Areas of occupation for cork oak stands reported by National Forest Inventories (NFI), between 1965 and 2010

| Areas (thousand ha) |      |
|---------------------|------|
| 637                 | 1965 |
| 655                 | 1974 |
| 669                 | 1985 |
| 687                 | 1990 |
| 747                 | 1995 |
| 731                 | 2005 |
| 737                 | 2010 |

in the results of National Forest Inventories (NFI), showing a continuous and sustained increase of the areas occupied with cork oak stands (Table 2.6).

The recent forest inventory, from 2010 (ICNF 2013b), estimated an area of 737,000 ha for cork oak stands. The species has a prominent place in the global Portuguese forest area, as well as in the world area of cork oak, representing:

- 34 % of the world area of the species
- 23 % of the Portuguese forest area
- 8 % of the mainland area of Portugal

There are however, signs of concern for cork oak:

- Decrease of density, a direct consequence of the cumulative effect of aging and absence of natural regeneration in the stands
- Decline in the annual production of cork.

The incidence of wildfires and pest and diseases, intensified by the growth of drought and heat wave hazards results in more tree mortality, which is not being fully compensated by investments in afforestation. The slight reduction in the areas of cork oak stands (2 %) between 1995 and 2005 must be highlighted (Table 2.6). This decrease probably expresses the incidence of drought and pathogenic agents. Nevertheless, after 2005, the area has recovered.

### 2.3.1.1 Trends in Production and Markets

Cork is the raw material of a sector where Portugal is unquestionably the world leader in the production, processing and market activities. The structure of cork chain is presented in Fig. 2.15.

The production of national cork is, on average, 150,000 tonnes per year (Table 2.7) equivalent to half of the world cork production (Table 2.8). Cork and cork products represent about 30 % of forest sector exports, and 3 % of the national exports.



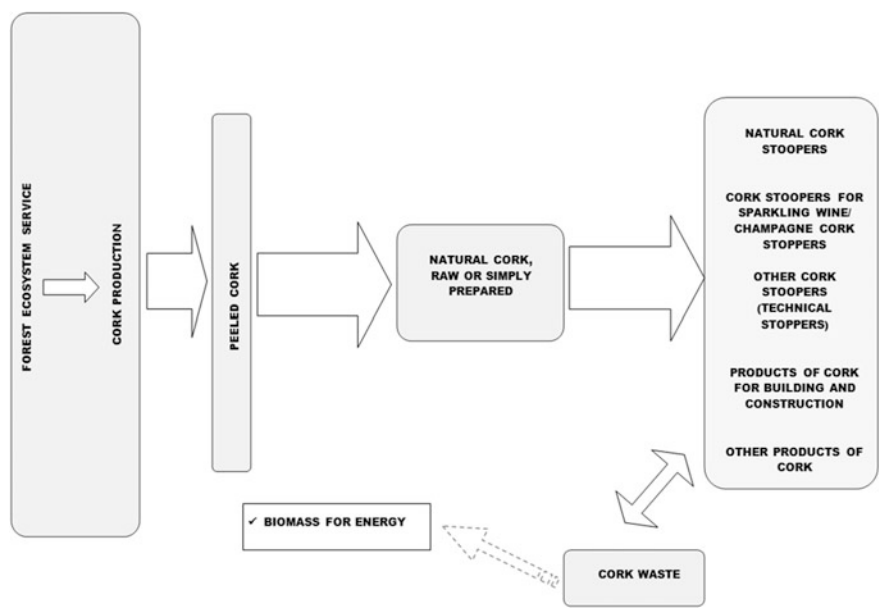


Fig. 2.15 Structure and flows in cork chain (Louro et al. 2013)

Table 2.7 Annual cork pro-  
duction (APCOR 2011)

|      | Annual cork production<br>(10 <sup>3</sup> tonnes) |
|------|----------------------------------------------------|
| 2000 | 176                                                |
| 2001 | 158                                                |
| 2002 | 147                                                |
| 2003 | 141                                                |
| 2004 | 156                                                |
| 2005 | 141                                                |
| 2006 | 180                                                |
| 2007 | 157                                                |
| 2008 | 137                                                |
| 2009 | 100                                                |
| 2010 | 140                                                |
| 2011 | 150                                                |

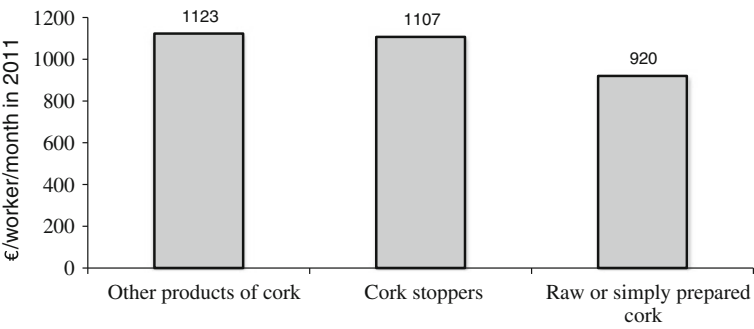
The analyses of imports and exports per type of product reinforce the positive performance of cork chain in the creation of national added value. The example of 2012, in Table 2.9, shows in the imports, the dominance of natural cork, raw or

**Table 2.8** Cork production in Mediterranean countries (APCOR 2011) cork

|          | Cork production (%) |
|----------|---------------------|
| Portugal | 50                  |
| Spain    | 31                  |
| Italy    | 3                   |
| France   | 3                   |
| Morocco  | 6                   |
| Algeria  | 5                   |
| Tunisia  | 3                   |

**Table 2.9** Types of products in the external trade of cork and cork products (Statistics Portugal 2013)

|                                                           | Imports (%) | Exports (%) |
|-----------------------------------------------------------|-------------|-------------|
| Cork waste                                                | 20          | 4           |
| Natural cork, raw or simply prepared                      | 57          | 3           |
| Natural cork stoppers                                     | 13          | 42          |
| Cork stoppers for sparkling wine/ Champagne cork stoppers | 2           | 13          |
| Other cork stoppers (technical stoppers)                  | 2           | 13          |
| Products of cork for building and construction            | 2           | 21          |
| Other products of cork                                    | 4           | 4           |



**Fig. 2.16** Monthly wages in cork chain (GEP 2012). National minimum wage: 485€

simply prepared (57 %) and of cork waste (20 %). In the exports, there is a clear supremacy of manufactured products (93 %), with a strong dominance of cork

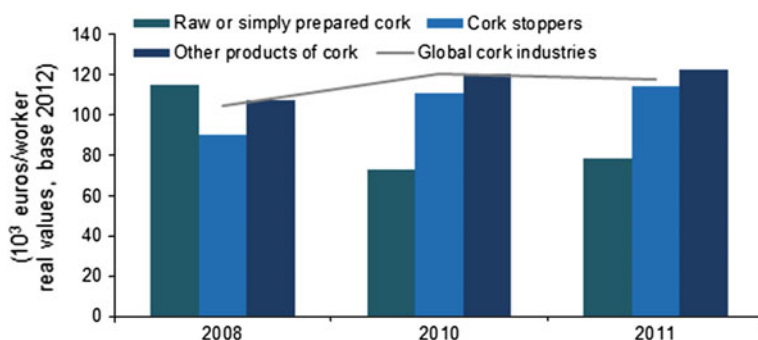


Fig. 2.17 Productivities per worker in cork chain (GEP 2012; Statistics Portugal 2013)

stoppers, especially of the natural cork stoppers (42 %). The balance sheets, with historic positive values superior to 700 million of € must be underlined, and corroborates the good performance of the cork chain.

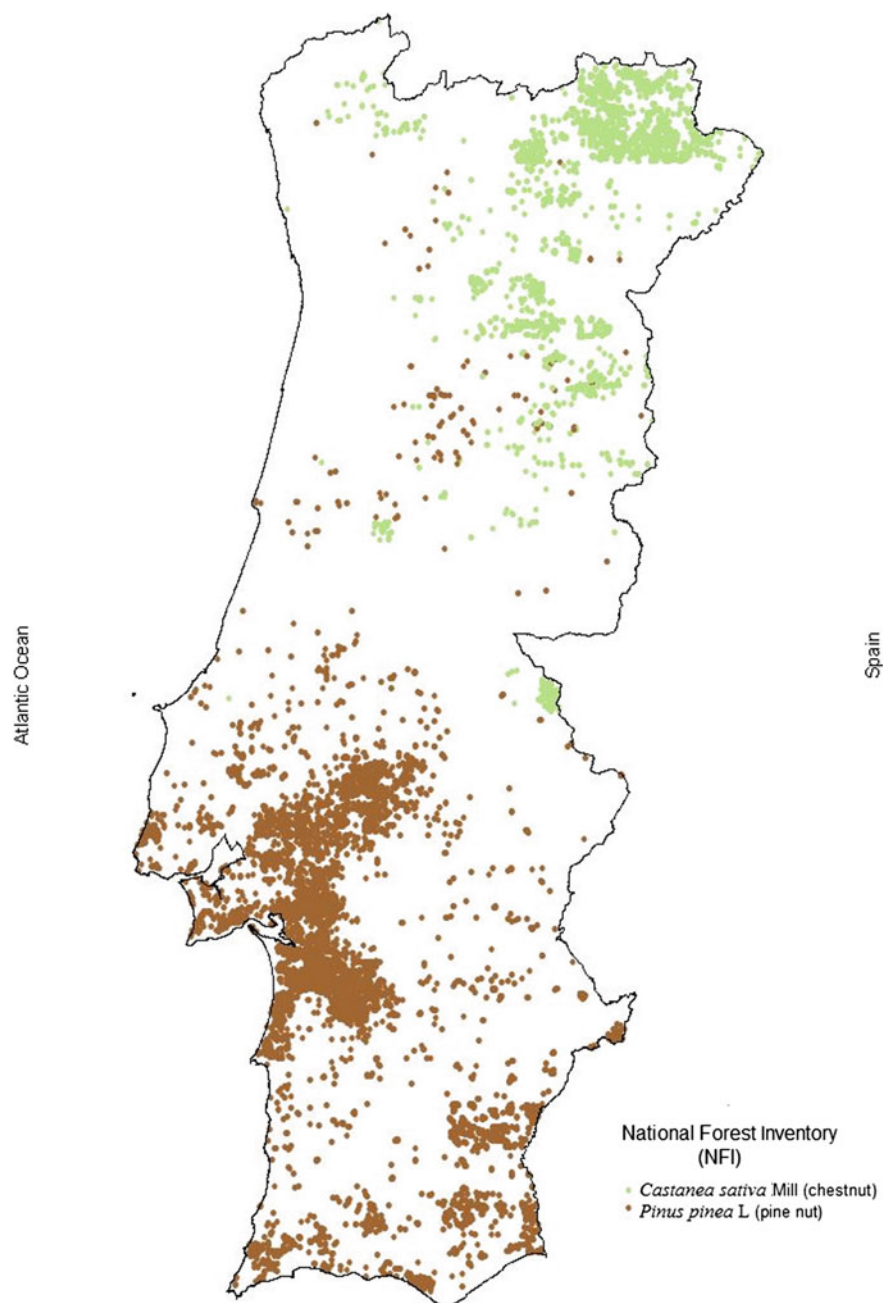
### 2.3.1.2 A Specialized Labour Chain

The cork chain represents 12 % of the forest employment. But the importance of its activities in creating jobs is differentiated. Cork stoppers industries have a superior contribution to employment (8 %), comparatively to the ones of raw or simply prepared cork (2 %) and other products of cork (2 %). It can be assumed the cork based chain labour is specialized in cork stoppers. The good figures for the total number of jobs are also observed in the wages, which are relatively good in the context of Portuguese economy (Fig. 2.16). Nevertheless, these positive characteristics are not reflected in the productivities per worker, which are yet relatively low (Fig. 2.17). This aspect must be considered in the actions to improve labour performance. Future investments in this issue must have the increase of productivity as a priority.

## 2.4 Emerging Chains

### 2.4.1 Fruits and Nuts

Usually the analyses based on a sector approach is limited to wood and cork based chains, but presently this perspective includes other forest products, such as fruits and nuts.



**Fig. 2.18** Distribution of chestnut and umbrella pine reported by the national forest inventory (ICNF 2013)

**Table 2.10** European chestnuts production by country in 2011 (Faostat 2013)

|          | Production (tonnes) | Production (%) |
|----------|---------------------|----------------|
| Spain    | 172.310             | 61.66          |
| Turkey   | 60.000              | 21.47          |
| Greece   | 21.467              | 7.68           |
| Portugal | 18.271              | 6.54           |
| France   | 7.026               | 2.51           |
| Hungary  | 334                 | 0.12           |
| Romania  | 32                  | 0.01           |

#### 2.4.1.1 Main Characteristics of the Forests Provisioning Fruits and Nuts

The importance of forest fruits and nuts is particularly relevant in areas with low potential for wood production, where the concept of multi-functionality rooted on agroforestry practices is the guiding line of management practices.

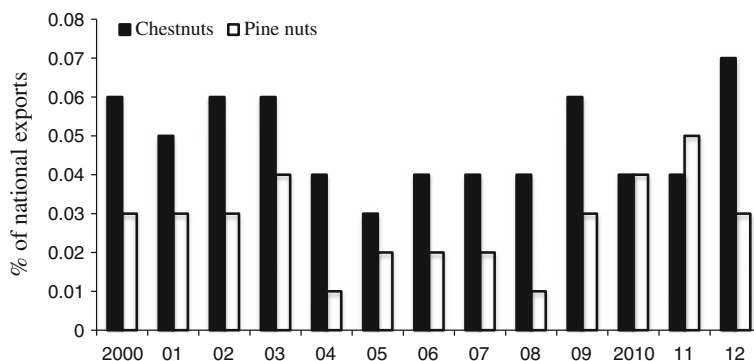
A multiplicity of forest species are fruit and nuts producers. In Portugal, strawberry tree (*Arbutus unedo* L.), carob tree (*Ceratonia siliqua* L.), chestnuts (*Castanea sativa* L.) and umbrella pine (*Pinus pinea* L.) are considered forest/ agro-forestry species with a major interest for these productions. These species are already the basis of important agro industries activities, particularly at a local or regional scale.

The last National Forest Inventory (ICNF 2013b) reported an area of 176,000 ha for umbrella pine nut, 6 % of the forest area, 41,000 ha for chestnut, 1 % of the forest area, and 12,000 ha carob tree, 0.4 % of the forest area. The inventory has no results for strawberry tree. In Portuguese mainland, the geographic distribution of these species is very different:

- (1) Umbrella pine is concentrated in the south, southwest
- (2) Chestnut in the north, northeast and at the center of Portuguese mainland, having a good adaptation in the inland cold areas near Spain (Fig. 2.18)
- (3) Carob tree is well delimited in the south, at Algarve region
- (4) Strawberry tree is dispersed all over the country.

#### 2.4.1.2 Chestnuts

Since prehistoric times, chestnut is used because of its nuts as a basis in human diet, being, for this reason, a well disseminated species. At world scale there are several species that produce chestnuts, but, in Europe, the fruit is only produced by the European chestnut (*Castanea sativa* Mill). Portugal is included in the group of the larger producers of European chestnut (Table 2.10), with an average annual production of 30,000 tonnes. REFCAST the Portuguese Association of Chestnut



**Fig. 2.19** Importance of chestnuts and umbrella pine exports in the national exports (Statistics Portugal 2013)

has estimated a production of 47.5 thousand tonnes per year (REFCAST 2013). The annual productivity per hectare is around 860 kg. The statistics show a trend to increasing prices of chestnuts in the country.

At national level, the macroeconomic relevance of fruit producer species might be less evident than the one of wood and cork based chains. For example, chestnuts represent less than 0.1 % of the Portuguese exports (Fig. 2.19). But, at a regional scale, this chain is important in promoting the economy. The different regional performance of the chain is also reflected by regional asymmetries in the production of chestnuts. Even so, at national scale the results of the balance sheets are quite positive, with the exports exceeding the imports in over 26 million €. The quality of Portuguese chestnuts is recognized at international markets where this nut has high levels of demand (Laranjo 2013).

#### 2.4.1.3 Umbrella Pine Nuts

Since pre-historic times, umbrella pine has been disseminated in abundance because of the preference of its nuts as food to humans. At world scale, other species produce pine nuts. In Europe *Pinus pinea* disseminated through the Mediterranean region, is the only one that produces this nut, with a better quality than those from other species. At a local and regional scale umbrella pine is relevant to the mitigation of historic economic fragilities. Even so, at national scale the exports although representing less than 0.1 % of the global Portuguese exports (Fig. 2.19), have very good results in the balance sheets, with the exports exceeding the imports in 10 million €.

2.5 Forest Biomass for Energy

2.5.1 The New Context of Forest Biomass for Energy:  
Strategy and Targets

Forest biomass has been used by men as a source of energy since ancient times. However, today, the context associated with this use is different and is straightly connected with the policies on climate change mitigation and reduction of global greenhouse gases (GHG).

In Portugal, the chain of biomass for energy uses as raw materials the residues of forest management and harvest activities, as well as the wastes of forest chains processing activities, like sawmill residues, black liqueur and cork waste. In this sense, forest biomass for energy increases the efficiency and sustainability of the whole forest sector (Fig. 2.20).

2.5.2 Industrial Capacity

The industrial capacity related to the production of energy from forest biomass has increased significantly in the last years as a direct result of the new policies and strategies associated with the activity. The capacity already installed and projected is summarized on Table 2.11 for dedicated cogeneration, concrete, pellets and briquettes plants.

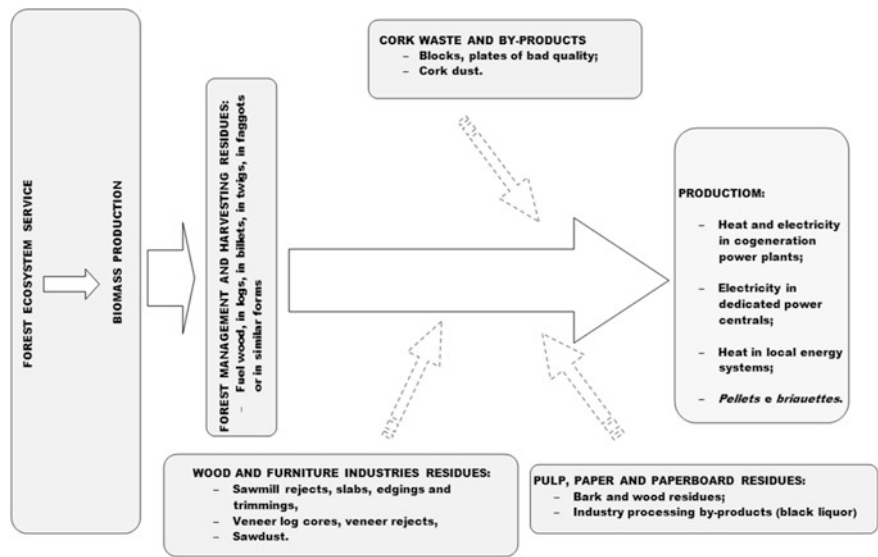


Fig. 2.20 Structure and flows of forest biomass for energy (Louro et al. 2013)

**Table 2.11** Forest biomass for energy, industrial capacity (ICNF 2013a)

| Type of plants            | State<br>(January<br>2012) | Number | Installed<br>capacity (MW) | Biomass consumption in<br>2010 (tonnes/year) |
|---------------------------|----------------------------|--------|----------------------------|----------------------------------------------|
| Dedicated                 | Operating                  | 9      | 110.4                      | 1,268,831                                    |
| Dedicated                 | Approved                   | 12     | 96.8                       | 1,166,355                                    |
| Dedicated                 | Project                    | 8      | 82                         | 619,845                                      |
| Cogeneration              | Operating                  | 7      | 51                         | 715,910                                      |
| Concrete                  | Operating                  | 2      | –                          | 35,000                                       |
| Pellets and<br>briquettes | Operating                  | 6      | –                          | 169,500                                      |
|                           | Construction               | 3      |                            |                                              |

## 2.6 Perspectives for New Forest-Based Chains

As mentioned before, other potential chains, based on forest ecosystems, namely those associated to carbon economy and nature conservation have interest in terms of sustainable development. For carbon, the results of the national forest inventory, from 2005 (Direcção Nacional de Gestão Florestal 2010), show the potentiality of Portuguese forest space for carbon sequestration, reporting a total of 280,000 kilo tonnes of equivalent carbon sequestered by forest species (Table 2.12).

The importance of holm oak (*Quercus rotundifolia* Lambert) in agro-forestry systems (“montado de azinho”) must also be underlined. This species is essential as supporting element in degraded lands susceptible to desertification, having positive effects on soil and on carbon sequestration and is adapted to the arid areas, common in the inland region of Portugal, near Spain (Fig. 2.21). Holm oak ecosystems are characterised by the multiplicity of services they provide. They are traditionally submitted to multifunctional management, with integration, in the same area, of agro forestry extensive practices like grazing, based on indigenous species, and hunting, with firewood harvesting.

The last forest inventory, from 2010 (ICNF 2013b), reported an area of 331,000 ha for holm oak, being the fourth forest species with more area in the Portuguese mainland.

## 2.7 Final Synthesis

Forests represent about 36 % of the Portuguese territory. These spaces have market and non-market values, namely for the regulating and supporting services they provide. Forest ecosystem productions (provisioning services) are the basis of important processing chains of the Portuguese economy, as showed by the historic macroeconomic figures, namely those related to:

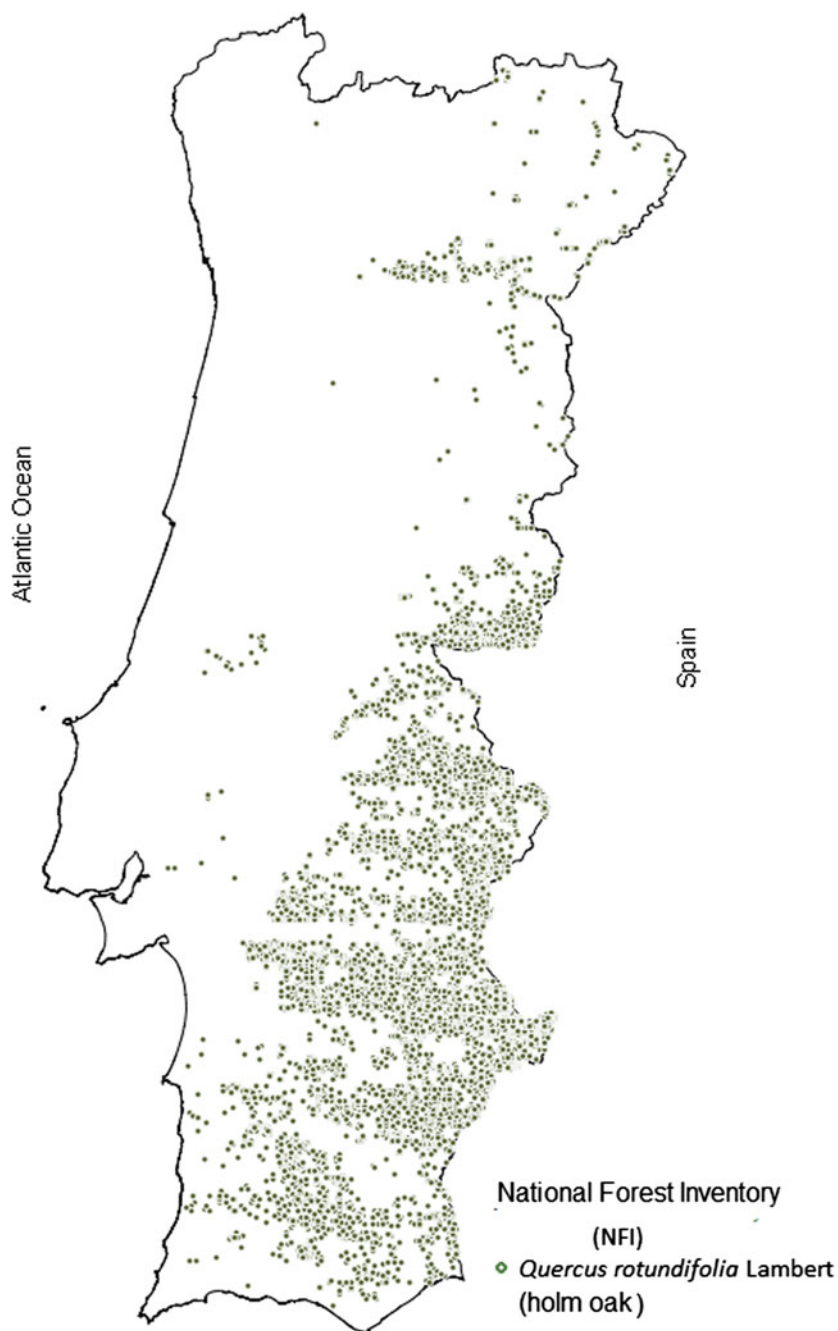


**Table 2.12** Total carbon sequestration on forest species

|                   | Living trees         |                                 | Dead trees           |                                 | All trees            |                                 |
|-------------------|----------------------|---------------------------------|----------------------|---------------------------------|----------------------|---------------------------------|
| Species           | Carbon (kilo tonnes) | Equivalent carbon (kilo tonnes) | Carbon (kilo tonnes) | Equivalent carbon (kilo tonnes) | Carbon (kilo tonnes) | Equivalent carbon (kilo tonnes) |
| Maritime pine     | 23,619               | 86,601                          | 1,227                | 4,497                           | 24,845               | 91,098                          |
| Eucalyptus        | 17,114               | 62,750                          | 1,013                | 3,713                           | 18,126               | 66,462                          |
| Cork oak          | 16,324               | 59,853                          | 1,139                | 4,176                           | 17,463               | 64,029                          |
| Holm oak          | 5,227                | 19,164                          | 109                  | 400                             | 5,336                | 19,564                          |
| Other oaks        | 3,146                | 11,535                          | 118                  | 431                             | 3,264                | 11,966                          |
| Umbrella pine     | 2,607                | 9,557                           | 56                   | 205                             | 2,663                | 9,763                           |
| Chestnut          | 1,116                | 4,090                           | 88                   | 323                             | 1,204                | 4,413                           |
| Acacia            | 343                  | 1,258                           | 15                   | 55                              | 358                  | 1,313                           |
| Other broadleaves | 2,395                | 8,782                           | 100                  | 365                             | 2,495                | 9,147                           |
| Other conifers    | 464                  | 1,700                           | 18                   | 66                              | 482                  | 1,766                           |
| Total             | 72,352               | 265,289                         | 3,881                | 14,230                          | 76,233               | 279,519                         |

- (a) The added value of intermediate or end products, which are essentially based on national raw material (paper and paper board; cork stoppers; wood panels; chestnuts; umbrella pine nuts, etc.)
- (b) The trade on international markets, with the exports exceeding the imports in the national balance sheet
- (c) Job creation and economic and social promotion in all counties, with a particular significance in depressed and fragile areas, namely in the interior of the country.

The whole forest sector is dynamic, showing good rates of investment on capacity, frequently with introduction of new technologies. The efforts made to increase the sustainability of the production process must be underlined, enabling the industries to have a better use of recycled products and to increase their energy efficiency. Also, there are new possibilities and emerging chains that can be promoted based on wood and no-wood products, as well as indirect values contributing to the increase of the economic, social and environmental value of the Portuguese forests.



**Fig. 2.21** Distribution of holm oak reported by the national forest inventory (ICNF [2013b](#))

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