

Ecological and Socio-economic functioning of the Mediterranean agrarian systems in the middle of the nineteenth century: a Catalan case study (the Vallès county, 1850-70)¹

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All agro-ecosystems are the result of a human colonization of Nature, and cannot be fully understood if we split the study of their ecological structures and fluxes, from the driving and ruling forces that move or organize them. This is why our research project intends to analyze the functioning of an agrarian ecosystem in a West-Mediterranean advanced organic economy during the second half of the 19th century, from a double vantage point: socioeconomic and ecological. Our aim is to analyze, over a long term perspective, the relationship between the global changes experienced by the territory and the economic or social forces behind them. The hypothesis we are seeking to corroborate is the existence of a close connection between energy efficiency or inefficiency and territorial efficiency or inefficiency, that goes together with the land use management considering its environmental features, the entitlement rules (property rights, land tenure system, social distribution of resources, control over workforce, consumption patterns, and so on), or the connection with markets.

In doing so we are trying to open new transdisciplinary bridges between History, Economics and Natural Sciences in order to gain a co-evolutionary understanding of socio-environmental change: how natural resources have affected economic development, and which impacts economic development has left on the natural

¹ This work springs from the Project financed by the Ministry of Science and Technology (SEJ2006-15108-C02-01/GEOG counting on FEDER funds). We thank Núria Mallorquí for her dedication and enthusiasm as research student on the project, and professor Esteve Deu for his useful furnishing of data to estimate the non-agrarian labour.

resources in the territory. Our main goals are: 1) to reconstruct in a comparative long-term historical perspective the environmental and social processes of *global change* brought about by economic development on the territory of different rural areas in Catalonia; 2) to identify the main *driving forces* of such transformations, linking the use of energy and materials to the changes in land use systems; 3) to identify the main *ruling forces* of these changes, analyzing the role played by the structures of land property and tenancy, time use and labour mobilization, income distribution, and food consumption patterns; and 4) to analyze the present environmental impact of those pathways of energy and land-use changes, mainly from the viewpoint of biodiversity. Once this comparative analysis of several local case studies has been set up, we intend to apply this methodology to wider areas, in order to identify the main critical thresholds and historical turning points which have led, in the West Mediterranean bioregion, to the present socio-environmental crisis.

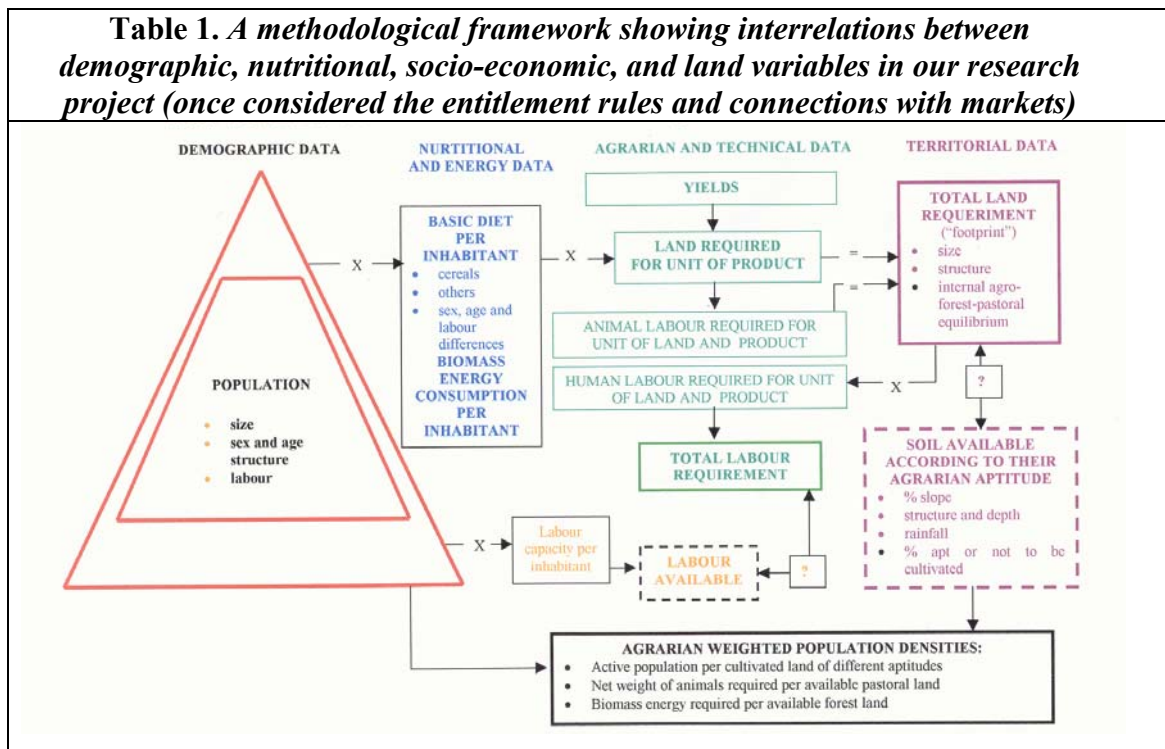
1. Linking together agrolological, ecological and socio-economic approaches

This approach does not imply the neglect of traditional views and methods of agrarian economic history, our main area of expertise, from which we are building interdisciplinary bridges with other disciplines. During the first stage of our project we have focused our analysis on the reconstruction of energy balances and nutrients' cycle in the agrarian systems studied, and their interrelations with land use management. Our objective was, and still is, to draw attention to the explanatory power of these variables in the historical evolution of agrarian systems. However we do consider that institutional and social variables have always played a decisive role in shaping the agrarian technologies and land-use systems.

This is why we distinguish between *driving* and *ruling* forces in agrarian change of territory. By *driving* forces we mean the energy or material flows and technical settings that operate these agrarian changes. By *ruling* forces we mean both the institutional frame set up in each historical context, with their entitlement rules, that gave access to the different social groups to use natural resources or not; and the decision making processes which were in the hands of ruling classes, except for the

counterbalance exerted by the powerless social groups either by their everyday resistance or punctual social revolts.

In order to study in depth the role of this socio-economic factors, that have determined the pathway of global change in agro-ecosystems, we will try to quantify the labour requirements of these agrarian systems during different historical periods through the analysis of historical sources on labour costs for various crops and on agricultural, livestock, and forestry management. This labour requirement will be compared with the available labour capacity, determined from active population in census data and from labour requirement in other economic activities (see diagram in Table 1).



Source: our own, in the research project SEJ2006-15108-C02-01/GEOG.

Another line of analysis delves deeply into the roles played by property relations and tenancy forms in the evolution of the agrarian systems studied, by means of cadastral information, census, and population surveys, in order to discuss whether or not they acted as a barrier to agrarian growth or caused social inequalities, food shortages, and human underdevelopment. There are several possibilities to study this relationship between eco-metabolic fluxes and their socio-economic rulers, but the one proposed by this seminar seems good and sound: to analyze the agrarian labour systems in the framework of the family peasant units. To do so, we will study the balance of time

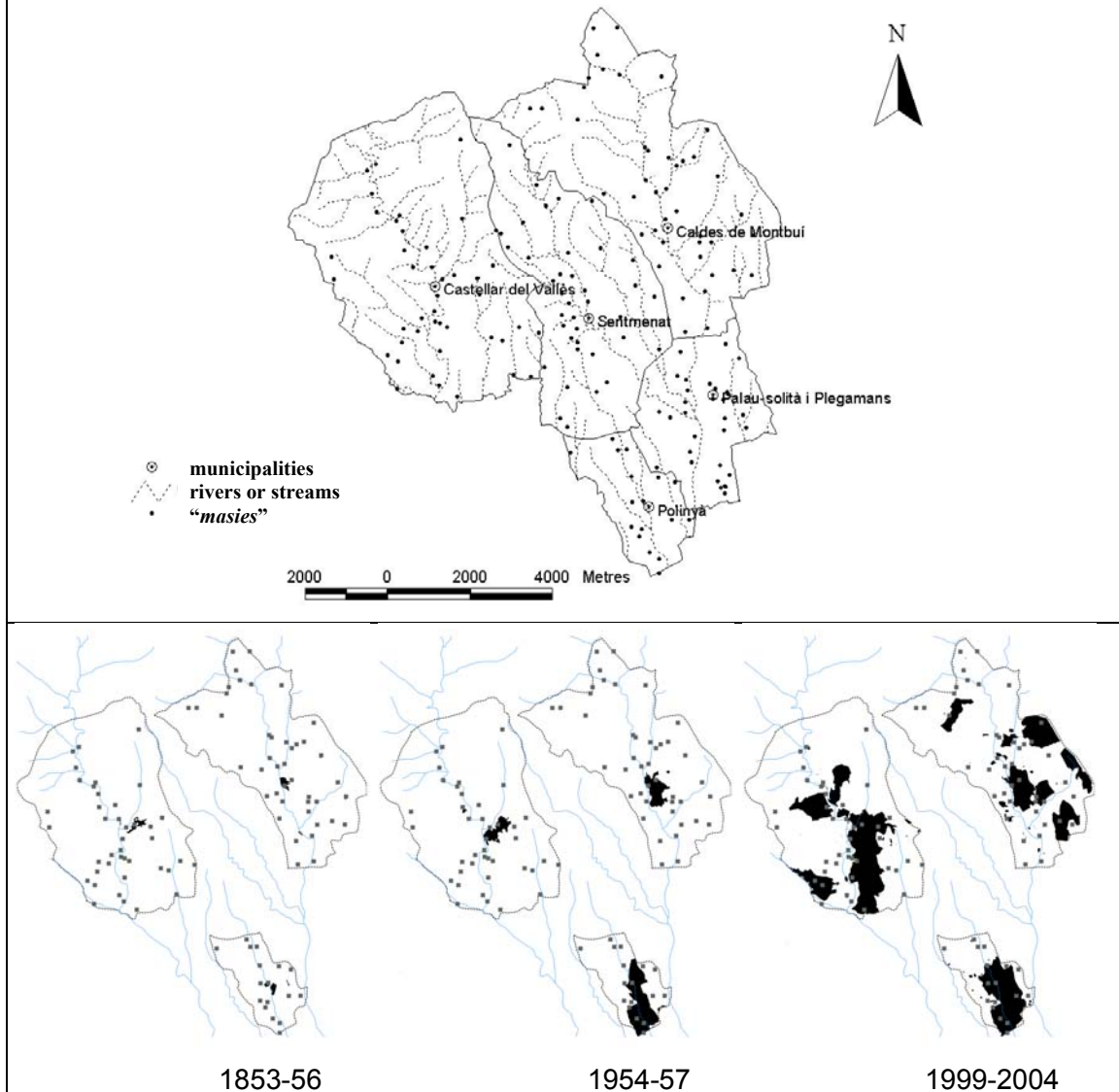
between the labour requirement for the different agrarian tasks throughout the year, and the labour availability in the different peasant families, bearing in mind the different gradient of human labour intensities in land uses and the agro-ecosystem integrated management.

2. Geographic and historical features of the study area

Our case study comprises five Catalan municipalities of the Vallès county with a common extent of 13,488 hectares: Castellar del Vallès, Caldes de Montbui, Palau-Solità i Plegamans, Polinyà and Sentmenat. They are located in a small plain situated in a tectonic basin between Catalonia's littoral and pre-littoral mountain ranges, whose diversity of geological substrata have led to the development of a considerable variety of soils. Average rainfall varies between some 600 or 650 mm in the Vallès plain up to 700 or 800 mm on the peaks of the pre-littoral range, in comparison to 440 mm in Barcelona. The potential evapotranspiration (Thornthwaite's PET) varies on an opposite gradient from 712-855 mm in the plain to 427-572 mm on the summits. This makes the slopes of the pre-littoral range a source of the run-off that feeds the river Besòs as far as the city of Barcelona.² Both the surface streams and groundwater springs are relatively more abundant in the fault zone between the tectonic basin and the mountains, where the oldest nucleated settlements were located: the town of Caldes de Montbui founded in roman times, and the medieval villages of Castellar del Vallès and Sentmenat set up during the 10th century (Map 2)

² Rodríguez Valle, F. L. (2003:12-16). This small water resources permitted the development of some orchards of vegetable gardens, and the cultivation of hemp. During the second half of the 19th century they also powered several local textile industries.

Map 2. Study area, settlement and evolution of urbanized soils (1853-2004)



Source: made with GIS by Marc Badia, Oscar Miralles and Enric Tello for the research project SEC2003-08449-C04.

Although the poorest share of population used to live in these small towns or villages, the most apparent feature of human settlement in that mid-northeast of Catalonia was a network of scattered poly-cultural farms, called *masies* in Catalan, structured into compact units around an isolated rural dwelling. From the end of the late medieval agrarian struggles, the landowners who held the *masies* gradually gained control of the rights of access to land and other natural resources over a complex and conflictive transition from feudalism to agrarian capitalism.³

From the 17th century onwards, population growth was fostered by increasing numbers of French immigrants coming from the Pyrenees. Immigrants, and non-

³ Serra (1988); Garrabou and Tello (2004: 83-104).

inheriting descendants, would establish themselves in the old villages or small towns placed between the *masies*, and founded new ones like Plau-solità i Plegamans or Polinyà. The owners of the scattered farms saw these landless immigrants and disinherited people as a new frightening “sub-peasant” class. But, at the same time, soon discovered that they also offered good opportunities to take advantage of the high relative prices of wine, by leasing them their marginal lands to plant vineyards. Many landless men became winegrowers through an emphyteutic leasing contract called *rabassa morta*, that lasted until the death of the vines. These tenants were called *rabassers* in Catalan, because they used to slash and burn forest or brushwood areas to plant vineyards.⁴

The closeness to Barcelona –between 5 to 12 hours on horseback, according to a timetable map of 1808-1809— meant that the Vallès was connected very early on with the commercial dynamics of Catalonia’s demographic and urban centre of gravity.⁵ Population growth, increasing peasant inequality, and market incentives added together to push ahead the extension of cultivated lands mainly through the plantation of vineyards in former woodland areas. Besides planting vines in poor soils, no manure was applied to them except at the time of initial planting. This meant that a partial wine-growing specialisation allowed the poly-cultural owners of the *masies* to concentrate the scarce manure on the better soils devoted to vegetable gardens, cereals, legumes or hemp. Vineyard pruning and green shoots even went towards fertilising other crops, either directly as compost, or indirectly as fodder and manure.

All of these were responses to the challenge of feeding a population that had tripled between 1787 and 1860, and attained 65-66 inhabitants/Km²: exactly the amount pointed out by Ester Boserup as the threshold between a highly intensive agrarian system and an urban-industrial one.⁶ This meant only 1,5 hectares per person to feed the local population with an organically-based intensive agriculture, in a Mediterranean bioregion subject to water stress where keeping livestock and obtaining fertiliser became severely limiting factors.⁷ Rises in the relative prices of

⁴ Garrabou and Tello (2004: 83-104).

⁵ Vilar (1964: 271).

⁶ Boserup (1981).

⁷ For the general characteristics of an ‘advanced organic economy’ see Wrigley (2004). For the key role played by water constraints in the Mediterranean agro-ecosystems see Pujol and others. (2001); and González de Molina (2002: 257–270).

wine, such as the one brought about by the oidium plague in 1840-50, encouraged vineyard planting. A second wave started in 1867, when the phylloxera plague hit French vineyards, causing relative prices for Catalan wine to soar. This grapevine fever suddenly displaced poly-cultivation, provoking the first episode of environmental and economic globalisation that linked the fate of that area to the international value of a single export product.

This ended suddenly with the arrival of the disease in the Vallès Oriental in 1883. By 1890 it had killed all vines, and the region's agriculture swung towards the production of fresh milk and vegetables for daily delivery to the nearby cities. The new model was consolidated circa 1930, when the available land had been reduced to a single hectare per inhabitant, with only one-third of it being arable. Then, after the 1950s a fast spreading of the so called "green revolution" put an end to the old rural culture and society.

3. Energy flows and land use

The agrarian landscape can be seen as the territorial expression of the metabolism that any given society maintains with the natural systems. One way of understanding when and why the human shape of the territory changes, consists of analysing the path of social metabolism that leaves its ecological footprint on its surroundings. Our results attained with this approach confirm that the ratio between the energy obtained and the one invested was much higher in the middle 19th century than at present.⁸ We have also gained a better understanding of the underlying reasons for that high energy performance attained in the middle of the 19th century, and its deterioration during the second half of the 20th century, through the discovery of a close connection between

⁸ This has already been found in many energy balances of past and present agrarian systems. See Pimentel and Pimentel (1979); Leach (1981); Naredo and Campos (1980: 17-114); Campos and Naredo (1980:163-256); Naredo (1996); Giampietro and Pimentel (1991: 117-144); Giampietro, Bukkens and Pimentel (1994: 19-41); Fischer-Kowalski (1998: 61-78); Fischer-Kowalski and Hüttler (1999: 107-136); Fischer-Kowalski and Amann (2001:7-47); González de Molina (2001:87-124); González de Molina, Guzmán Casado and Ortega Santos (2002: 155-185); Guzmán Casado and González de Molina (2006 and 2006: 437-470); Carpintero (2005 and 2006: 31-45); Carpintero and Naredo (2006:531-554); Krausmann (2006: 501-530).

energy and land-use efficiency.⁹ In spite of its unavoidable dependence on the inefficient animal bioconversion, past advanced organic agro-systems could maintain a high energy return on the inputs consumed due to the *integrated management* of cropland, forests, pastures and livestock husbandry (Table 3).¹⁰

Table 3. Summary of the energy balance of the agrarian system in five Catalan municipalities of the Vallès county towards 1860 (in thousand of GJ/year)			
Distribution of useful agrarian area (UAA)	<i>crops</i> (48%)	<i>pasture</i> (22%)	<i>woods</i> (30%)
Primary Solar Energy yearly fixed in the UAA	146,3	34,4	87,2
Distribution of Final Agrarian Output	<i>agricultural</i>	<i>livestock</i>	<i>forestry</i>
Energy Final Output (by type of agro-system area)	38,6	2,9	129,5 ^a
Total Herd in Standardized Livestock Units (LU500)	983 (LU500Kg)		
Energy devoted to livestock breeding	68,7		
Energy devoted to manure and fertilizers	23,9		
Total Energy Inputs Consumed (TIC)	102,4		
Energy Final Output (EFO)	171,0		
Energy Return on Inputs (EROI = EFO/TIC)	1,67		
% of Primary Solar Energy that went to EFO	63,8		

Source: Cussó, Garrabou, Olarieta and Tello, E. (2006: 485).

^a: The wood and firewood output was bigger than the net primary output in the available woodlands because it included the pruning of vineyards and other wooden crops.

30% of the useful agrarian area was covered by woodlands or brushwood, and produced 39% of primary energy output. 48% was then cultivated, and produced 54% of gross energy output although only 34% of that gross harvest was made from edible food or end-use products, the rest being straw, pruning, vine shots or leaves, skins and stones of grapes or olives after pressing, and other by-products reused as fodder, fuel or compost. In spite of the fact that only one third of the cultivated land was sown, 44% of the energy content of the edible harvest were cereals and legumes thanks to their high energy content. 55% of cultivated land were vineyards, but wine only brought 34% of net energy output due to its low energy content and its high proportion of by-products. The rest of the net cultivated output was obtained from olive oil (5%), fodder (5%) and vegetables, potatoes or hemp (12%). The practice of leaving land fallow had practically disappeared, and the predominant rotations in the un-irrigated areas combined wheat and maize with runner beans, broad beans and peas, fodder or potatoes. On irrigated lands two or three crops were obtained annually, alternating the growing of hemp and legumes or potatoes with wheat, other late-ripening fruit, and fodder. Average cereal

⁹ As a pioneering studies of this relationship between energy and territory, see the several works done by the Social Ecology IFF team at Vienna University: Haberl, Erb and Krausmann (2001: 25-45); Krausmann and Haberl (2002: 177-201); Krausmann (2001: 17-26 and 2006: 501-530).

¹⁰ Cussó, Garrabou and Tello (2006: 49-65); Tello, Garrabou and Cussó (2006:42-56).

yields reached 11 hectolitres or 9 quintals per hectare, multiplying the seed by between 5.5 and 10 times.

Livestock breeding played a crucial role in any organic agro-system, because it allowed to divert scarce nutrients from natural pastures, woods and brushwood towards crop lands, though with a high energy loss: 26% of photosynthetic primary energy captured in the agrarian useful area had to be devoted to livestock feed; but the net output of that animal bioconversion only contributed to 1.7% of total energy content of the final agrarian output. For each 100 energy units invested in livestock feeding, only 4 were edible or end-use products in the final consumer basket. Adding traction power and manure, the energy processed through animal bioconversion yielded 17% on inputs. Apart from becoming unavoidable in order to get motive power and fertilizers, the high energy cost of stock breeding had an interesting environmental virtue: it obliged to keep a sound integration between the three main sides of the agro-ecosystem. Crop land, pastureland and woodland had to be managed in an integrated way. First of all, because livestock could metabolize biomass indigestible for the human body, and this helped to import nutrients from uncultivated towards cultivated land. At the same time the scarcity of pastureland or brushwood, and its poor biomass production in the Mediterranean, meant that uncultivated land could only provide for 38% of biomass required to feed the cattle herd, sheep flocks, pigs, mules and horses, or poultry. The other 62% had to come from the cultivated area, through fodder, forage, straw and other by-products intensively reused as animal feed.

Only this sound integration between cropping and stock feeding can fully explain why, in spite of the inevitable energy loss that entailed the animal bioconversion, the overall energy efficiency was much higher than at present. The energy return on energy total inputs consumed was 1.67, meaning that the energy content of net final agrarian output still accounted for 64% of the primary energy fixed by photosynthesis in the whole useful agrarian area. This helps us to highlight the three main features of that advanced organic agrarian system that functioned in the Vallès county towards 1860: 1) the close integration between cropping and livestock feeding; 2) the intense reuse of almost any biomass by-product, that meant a negligible amount of external inputs other than human labour; and 3) vine or olive tree pruning and shots became a partial substitute for firewood or charcoal when they became increasingly scarce as a consequence of turning woods and brushwood into vineyards or other woody crops. In this sense, as the Spanish landscape ecologist Fernando González Bernáldez

(1981:13-33, 75-97 and 141-177; 1995:131-149) stressed, shrubbery or woody crops became in the Mediterranean a sort of “forestry transition” between natural and cultivated rings or patches.

The three main features mentioned above do make clear that the secret of its high energy efficiency lay in its territorial efficiency. Like in many other organic rural economies, towards 1860 the inhabitants of the Vallès county not only lived *in* that territory but, to some extent, they still lived *upon* the natural resources it had. Although they were far from an autarkic or closed economy, and combined agriculture with many other industrial or industrious activities, either directly or indirectly the majority of the population still obtained from the surrounding territory a large amount of the food and raw materials they consumed, and most of their fuel and fertilizers.¹¹

4. Terracing and improving soils

Thanks to the participation in our project of the agronomists José Ramon Olarieta and Fernando Luis Rodríguez Valle, we have also been able to analyze the role of soils in the historical agrarian management in our case study. We have evaluated the suitability of available land for the main agricultural uses (grain, fodder, vineyards, olive and almond orchards) considering the different land-use systems in the 1860s and at present. Each soil use has been fitted with its suitability through GIS analysis, and the results confirm the existence of a stronger relation between agrarian land-uses and soil availability in past times than at present. In the 1860s forty to sixty percent of the land was more or less suitable for the land uses then undertaken (Table 4).

¹¹ We have estimated that in 1859-67 local cereal production could only meet 42% of the cereal consumed in the province of Barcelona. Besides this provincial average, in the Vallès county the coverage rate ranged from 40% in the western side, nearby the village of Terrassa, up to 98% in the eastern side surrounding the village of Granollers, mainly depending on the agrarian specialization degree in wine production together with population densities, industrious activities and natural conditions. See Garrabou, Tello and Cussó (in print).

Table 4. Correspondence degree between agrologic suitability of soils and their agrarian uses in the Vallès study towards 1860					
Uses towards 1860	% very apt	% moderate aptitude	% marginal aptitude	% not apt at all	TOTAL
Cereal for bread	34,0	43,0	4,0	19,0	100,0
Fodder	5,0	34,0	1,0	60,0	100,0
Vineyards	51,0	15,0	14,0	20,0	100,0
Cereal with some vines	0,0	39,0	12,0	49,0	100,0
vines with some cereal	28,0	32,0	12,0	28,0	100,0
olive and almond trees	0,0	43,0	6,0	51,0	100,0

Source: Olarieta, Rodríguez Valle and Tello (2006: 75-103).

The GIS cover intersection analysis has also revealed some mismatches between soil capacities and agrarian land-uses: 34% of the vineyards and 23% of the area sown with cereals was located on non-suitable or poorly suitable land for these uses. The main reason for this was the increasing population densities that demanded the extension of the ploughed area. Towards 1860 land used for agriculture was 46% of the total area, including the unproductive one, and only 30% was forest (by the year 2000 the same figures turned round to 28% and 53%). To extend the cultivated area in poor sloping soils entailed a huge task of land improvement by building stone terraces.

This heavy labour cost helps us to highlight an interesting connection between land uses of different type of soils and the prevailing entitlement rules of the time. On the one hand stricter criterion for the location of cereal fields becomes apparent, because the owners of the scattered farms use to devote their best soils to grow wheat. But this land-owning class of the Catalan *masies* also tried to prevent further social conflicts, and decided to lease their least suitable land for sowing cereal to a new “sub-peasant” class of *rabassers* winegrowers, mostly of whom where immigrants or non-inheriting descendants. This explains why in the village of Caldes 85% of the cereal fields were sown on slopes less than 20%, while 30% of the vineyards were planted on slopes of more than 30%, and sometimes even 60-70%. Slopes protected with stone terraces occupied about 700 ha, 43% of the whole cultivated land in 1853, and 80% of that area was then used for vineyards. The building of these terraces, which were generally small, might have required some 120,000 work days.

5. Inequality in land ownership, counter-balanced through land tenancy

From the late Middle Ages onwards, the old emphyteutic tenants of that area obtained step by step the land ownership entitlement from their landlords. The Vallès rural society became increasingly split between the owners of the scattered *masies* and a new landless class made up of immigrants and non-inheriting descendants living in villages. The growing inequality was partly counter-balanced when the former started leasing to the latter small plots that turned them into winegrower tenants (*rabassers*). In order to be entitled to exploit the vineyard they had planted, tenants had to pay a rent to the owner of the *masia*; but it is interesting to note that official cadastral records considered the *rabassers* as if they were the true “owners” of their plots, as long as the vines were kept alive, forcing them to pay land taxes as well.

This explains why the proportion of land owners among the rural inhabitants, and the Gini index in the distribution of land ownership, both decreased when rural densities increased. This was true either in a cross-section comparison between municipalities or with the passing of time, until the phylloxera rush and crash put a sudden end to the tenancy redistribution of land at the beginning of the 20th century. While rural owners kept their *masies* poly-cultural, including different crops, woods and pasture lands, the small tenants were turned into specialized winegrowers. Inequality was higher in the distribution of total land ownership than in cultivated lands (Table 5).

Caldes de Montbui (total municipal area: 3,745.4 hectares)								
	<i>cadastral recorded surface</i>	<i>crop land</i>	<i>Gini index</i>		<i>number of land owners</i>	<i>number of inhabitants</i>	<i>% of land owners</i>	<i>inhab. /Km²</i>
			<i>in total useful area</i>	<i>in cultivated area</i>				
1718	--	--	--	--	--	1,391	--	37.1
1770	3,261.6	1,029.3	0.8344	0.6825	457	--	--	--
1787	--	--	--	--	--	1,694	--	45.2
1861	3,421.8	1,579.6	0.7218	0.5644	903	3,256	27.7	86.9
1944	3,556.0	1,464.1	--	--	--	--	--	--
1952	3,555.0	1,434.9	0.8318	0.7064	556	5,986	9.3	159.8

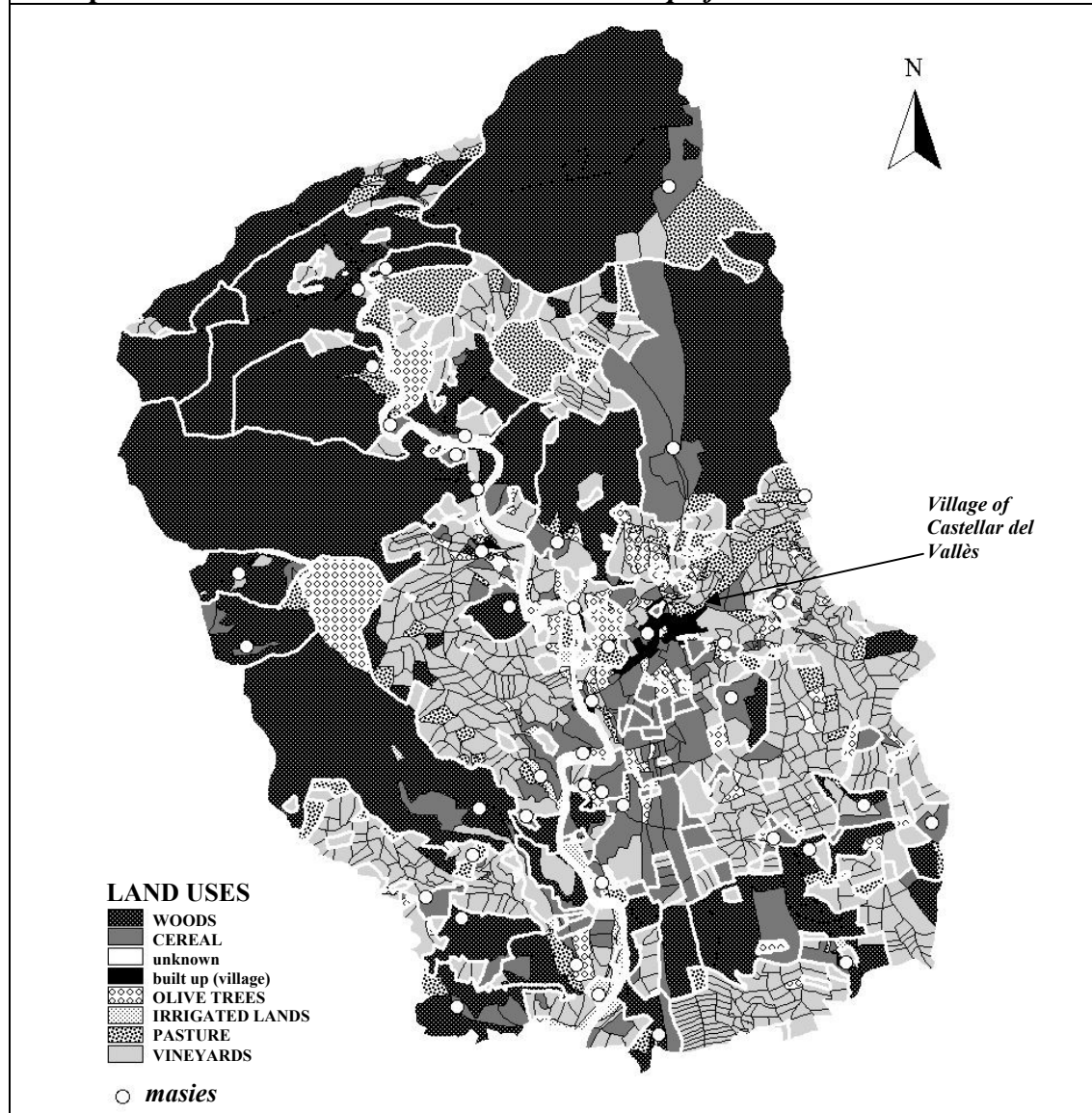
Castellar del Vallès (total municipal area: 4,490.8 hectares)								
	<i>cadastral recorded surface</i>	<i>crop land</i>	<i>Gini index</i>		<i>number of land owners</i>	<i>number of inhabitants</i>	<i>% of land owners</i>	<i>inhab. /Km²</i>
			<i>in total useful area</i>	<i>in cultivated area</i>				
1718	1,113.8	637.1	0.6084	0.4954	107	405	26.4	9.0
1787	--	--	--	--	--	850	--	18.9
1854	4,201.7	1,764.5	0.7766	0.5540	393	--	--	--
1862	4,094.2	1,096.1	0.7683	0.5369	491	2,544	19.3	56.6
1930	--	--	--	--	--	3,913	--	87.1
1952	4,397.5	981.3	0.8788	0.7726	403	4,858	8.3	108.2
Polinyà (total municipal area: 879 hectares)								
	<i>cadastral recorded surface</i>	<i>crop land</i>	<i>Gini index</i>		<i>number of land owners</i>	<i>number of inhabitants</i>	<i>% of land owners</i>	<i>inhab. /Km²</i>
			<i>in total useful area</i>	<i>in cultivated area</i>				
1718	--	--	--	--	--	124	--	14.1
1787	--	--	--	--	--	93	--	10.6
1856	814.9	627.2	0.6236	0.5318	208	--	45.7	--
1861	--	--	--	--	--	455	--	51.8
1930	--	--	--	--	--	469	--	53.4
1950	847.1	659.2	0.8182	0.7868	146	464	31.5	52.8
Sentmenat (total municipal area: 2,880.3 hectares)								
	<i>cadastral recorded surface</i>	<i>crop land</i>	<i>Gini index</i>		<i>Number of land owners</i>	<i>number of inhabitants</i>	<i>% of land owners</i>	<i>inhab. /Km²</i>
			<i>in total useful area</i>	<i>in cultivated area</i>				
1718	527.6	338.0	0.6839	0.6221	179	663	27.0	23.0
1735	1,059.3	336.6	0.7720	0.6669	210	--	--	--
1787	--	--	--	--	--	906	--	31,5
1859	2,185.9	1,485.3	0.5774	0.5116	464	1,686	27.1	59.5
1918	1,817.6	1,015.8	0.7643	0.6962	359	--	28.6	--
1953	2,738.6	1,219.3	0.7878	0.6903	337	1,987	17.0	69.0
Palau-solità i Plegamans (total municipal area: 1,493 hectares)								
	<i>cadastral recorded surface</i>	<i>crop land</i>	<i>Gini index</i>		<i>Number of land owners</i>	<i>number of inhabitants</i>	<i>% of land owners</i>	<i>inhab. /Km²</i>
			<i>in total useful area</i>	<i>in cultivated area</i>				
1718	235.2	79.6	--	--	12	221	5.4	14.8
1735	566.4	223.4	--	--	69	--	--	--
1787	--	--	--	--	--	429	--	28.7
1860	1,204.3	661.6	0.7454	0.6621	269	912	29.5	61.1
1932	1.156,6	575.3	0.8310	0.7919	155	1,319	11.8	88.3
1953	1.356,1	922.4	0.8152	0.7846	293	1,638	17.9	109.7

Source: our own, taken from the cadastral records and censues (ACA, Fons d'Hisenda, Caldes de Montbui: 1851 TER204, 1854 TER205, 1861 TER206, 1944 TER207 y TER208, 1946 TER 209, 1952 TER 210; Castellar del Vallès: 1854 TER319, 1862 TER320, 1919-20 TER321, 1925 TER320b, 1944 TER322, 1947 TER323, 1952 TER324; Polinyà: 1853 TER1084, 1859 TER1085, 1860 TER1086, 1919-20 TER1087, 1930 TER1088, 1944 TER1089, 1959 TER1090; Sentmenat: 1857 TER1758 1859 TER1759, 1861 TER2097, 1864 TER1760, 1918 TER1761, 1942 TER1762, 1944 TER1763, 1947 TER1764, 1953 TER1765; Palau-solità i Plegamans: 1854 TER1003, 1861 TER1004, 1932 TER1005, 1942 TER1006, 1944 TER1007, 1945 TER1008, 1953 TER1009).

Map 6 shows for the municipality of Castellar del Vallès in 1854, the complex social geography that rose when the old *masia* owners established among the interstices of their poly-cultural farms a new patchwork of small vineyard plots. While the shape of

the diverse compact fields of the *masies* tended to be higher, and tended to be located around each scattered dwelling, the small plots where the *rabassers* planted their vines used to be orientated towards the village where they lived, following the ways and roads.

Map 6. Masies and land uses in the cadastral map of Catellar del Vallès in 1854



Source: made with GIS by Marc Badia for the research projects BXX2000-0534-C03 and SEC2003-08449-C04, out of the cadastral map 1:5000 in the historical archive of the Catalan Cartographic Institute.

The contrasting of the cadastral information with the population census of the village of Sentmenat has thrown light upon relevant features to analyse the agro-system of this villages during the mid-19th century. The first aspect to be considered is the degree of access to land ownership among peasant families. As can be seen on Table 7, out of the 347 family units registered in the census, nearly 70% of the heads of the

families were classified as active in the agrarian sector, 20% as active in the secondary sector and the remaining 10% in services or other activities.

Table 7. Heads of family per economic sector of activity in Sentmenat (1859-60)					
Sector of economic activity	Men	Women	TOTAL	% of heads of family	
Primary sector	226	15	241	68.9	
Secondary sector	65	7	72	20.7	
Tertiary sector	13	1	14	4.0	
Total others*	4	16	20	6.3	
TOTAL	308	39	347	100,0	
7.1. Heads of families per activities and economic sectors in Sentmenat (1859-60)					
Sector of economic activity	Men	Women	TOTAL	% in each sector	% of total heads of family
Peasant or land owner	195	13	208	86.3	59.9
Ploughman tenant	20	1	21	8.7	6.1
Day labourer	11	1	12	5.0	3.5
Primary Sector	226	15	241	100.0	69.5
Building	11	--	11	15.3	3.2
Canvas-esparto shoe maker	10	3	13	18.1	3.7
Carpenter	2	--	2	2.8	0.6
Blacksmith	5	--	5	6.9	1.4
Food Industries	3	--	3	4.2	0.9
Textile Industries	34	4	38	52.8	11.0
Secondary Sector	65	7	72	100.0	20.7
Transport	4	--	4	28.6	1.2
Commercial business	3	--	3	21.4	0.9
Health care	4	--	4	28.6	1.2
Religious service	1	--	1	7.1	0.3
Others	1	1	2	14.3	0.6
Tertiary Sector	13	1	14	100.0	4.0
Others	4	16	20	--	5.8
TOTAL	308	39	347	--	100.0

Sources: our own, based on the cadastral census of Sentmenat of 1859 and the population census of Sentmenat of 1860.

Tables 7 and 8 indicate that the heads of families who were land owners represented nearly 60% of the total, a high percentage bearing in mind the relatively high number of families occupied in the secondary and tertiary sector. If we observe the heads of families of the primary sector alone, we find that 86% own land whereas only 14% of these peasant families, consisting of 21 ploughmen tenants and 12 labourers, did not own any land at all. Moreover, some of these had close family relationship with other peasant owners. Hence, we may consider that this peasant society enjoyed a high degree of access to the land. This is a relevant fact because land ownership constituted one of the main characteristics of peasant status.

Table 8. Family relationship of the heads of families (HF) with the agrarian active people (male and female) in Sentmenat (cadastral and population census, 1859-60)								
Family relationship with the HF	Male or female owner	% of active people	Ploughman tenant/or woman	% of active people	Day labourer	% of active people	Total	% of active people
HF	207	44.5	22	4.7	12	2.6	241	51.8
Husband/wife	--	--	2	0.4	--	--	2	0.4
Son/daughter	8	1.7	84	18.1	26	5.6	118	25.4
Mother/Father	1	0.2	2	0.4	1	0.2	4	0.9
Brother/Sister	--	--	10	2.2	2	0.4	12	2.6
Brother/Sister in Law	--	--	3	0.6	--	--	3	0.6
Daughter/ son in law	3	0.6	4	0.9	--	--	7	1.5
Grandson/daughter	--	--	7	1.5	1	0.2	8	1.7
No register	4	0.9	3	0.6	2	0.4	9	1.9
No relationship	1	0.2	11	2.4	49	10.5	61	13.1
TOTAL	224	48.2	148	31.8	93	20.0	465	100.0

Sources: our own, based on the cadastral census of Sentmenat of 1859 and the population census of Sentmenat of 1860.

However, such high levels of access to the land did not imply equality among the rural population. As we have mentioned above, the distribution of land ownership was definitely uneven. In spite of the fact that the high concentration of landed property existing in the 18th century had been reduced in Sentmenat (from 0.77 to 0.57 Gini index), it continued being significant during the mid-19th century.

As can be seen on Table 9, there existed a small group of property owners who held a high percentage of the land. According to our estimates, 10 hectares of land was an area which was considered to be large enough to yield revenues so as to provide comfortably for the basic needs of subsistence and reproduction. In Sentmenat the landowners who held over 10 hectares amounted to 39, representing 8,6% of the total. This small group of “large” landowners held basically medium size or big *masies*. They possessed one third of the total cultivated land, and nearly 44% of the total useful agrarian area with the woodland and pasturelands included. This segment of owners constituted undoubtedly a well-off and prosperous group, though their wealth was moderate. In point of fact only eight out of this group could be truly regarded as large owners. Four owned properties ranging between 30 to 40 hectares, the fifth 49 has, the sixth 63 has, the seventh 73 has and finally the eighth 132 has. So what we found are “large” owners holding only moderate extensions of land.

Range of land owned	Owners	Cereal irrigated land Hects.	Cereal dry land Hects.	Vineyard Hects.	Olive Trees Hects.	TOTAL cultivated area Hects.	Woodland, brushwood or pasture Hects.	TOTAL Hects.	% of total owned land
0-1.5	150	0.3	6.4	107.0	9.3	123.0	18.1	141.1	6.5
1.5-3	113	1.3	14.2	185.9	9.6	211.0	36.2	247.2	11.3
3-5	87	1.5	29.3	236.8	17.3	284.9	50.9	335.8	15.4
5-7	58	5.7	42.8	233.0	26.8	308.3	53.4	361.7	16.5
7-10	16	9.4	30.9	68.7	6.2	115.3	29.7	145.0	6.6
10-20	23	11.0	83.7	131.0	14.8	240.5	75.7	316.2	14.5
20-30	8	6.2	75.2	37.9	8.7	128.0	60.7	188.7	8.6
30-40	4	10.4	35.8	29.1	6.7	82.1	49.4	131.5	6.0
40-100	3	4.7	39.3	19.2	5.0	68.2	118.3	186.5	8.5
>100	1	--	4.4	0.6	--	5.0	127.3	132.2	6.1
Total	463	50.6	361.9	1,049.3	104.4	1,566.2	619.7	2,185.9	100.0

Sources: our own, based on the cadastral census of Sentmenat of 1859 and the population census of Sentmenat of 1860.

By looking only at the cultivated land held this feature is enhanced even more, because it confirms that more than half of the thirty-nine owners mentioned above cultivated between 7 to 10 hectares of land, eight between 10-15 has, only twelve exceeded this range, and out of these twelve only nine cultivated between 20-30 has, with the exception of one owner who cultivated 31.5 has of land. A great number of them use to live in the city of Barcelona or in nearby villages: for example, out of these 39 large owners, 14 had their residence elsewhere of Sentmenat and held over 10% of the cultivated land and 21% of the total area. Most of these “large” owners had already given up working as farmers, and leased their land to sharecroppers by means of a Catalan contract known as “*masoveria*”, which not only fixed the share of the crop but also forced the sharecropper to live with his family in a scattered *masia*.

However we have found that those “large” owners who resided in the village of Sentmenat, that we are using as a case study for our analysis, still run their farms by themselves. By looking at the population census data it was discovered that the majority remained active in the agrarian sector, and a high percentage owned draught animals. Their family structure included relatives who worked as farmhands, and more significantly a large share of the servants who were hired yearly can only be found in that families of larger owners. We suppose that these servants performed house chores together with farm work, and on some occasions daily workers were hired as well.

The use given to the soil by these well-off landowners differed from the rest of the peasants. A common feature of them was a proportion of woodland bigger than in

the rest of the farms, while the proportion of land planted with vines was smaller. Hence, the percentage of total land held by them was clearly higher than the one for cultivated land. Towards the mid-19th century these large owners held the main reserves of soil on which the agricultural frontier could move forward. Although we have only found three cases where the woodland occupied practically the whole farmland, uncultivated land was always bigger in the *masies* held by non-residents than in the ones of residents in Sentmenat. The same applied in the case of *masies* with large extensions of land. In eight *masies* the wood or scrublands took up over 20 hectares and in one of these it took up an exceptional 127 has. However this figure was extraordinary, as it was for the woodland to take up a large share of the farm (Table 10).

Table 10. Type of land uses according to the range of land owned in Sentmenat (1859-60)

range of land owned	% of total owners	% of total irrigated land	% of total dry land	% of total vineyards	% of total olive trees	% of total crop land	% of total uncultivated land	% of TOTAL LAND OWNED
0-1.5	32.4	0.6	1.8	10.2	8.9	7.9	2.9	6.5
1.5-3	24.4	2.6	3.9	17.7	9.2	13.5	5.8	11.3
3-5	18.8	3.0	8.1	22.6	16.6	18.2	8.2	15.4
5-7	12.5	11.3	11.8	22.2	25.7	19.7	8.6	16.5
7-10	3.5	18.6	8.5	6.5	5.9	7.4	4.8	6.6
10-20	5.0	21.7	23.1	12.5	14.2	15.4	12.2	14.5
20-30	1.7	12.3	20.8	3.6	8.3	8.2	9.8	8.6
30-40	0.9	20.6	9.9	2.8	6.4	5.2	8.0	6.0
40-100	0.6	9.3	10.9	1.8	4.8	4.4	19.1	8.5
>100	0.2	--	1.2	0.1	--	0.3	20.5	6.0
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table 10.1. Uses of land in each range of land owned in Sentmenat (1859-60)

range of land owned	number of owners	% irrigated land	% dry land	% vineyards	% olive trees	% crop land	% uncultivated	TOTAL LAND OWNED
0-1.5	150	0.2	4.5	75.8	6.6	87.2	12.8	100,0
1.5-3	113	0.5	5.7	75.2	3.9	85.4	14.6	100,0
3-5	87	0.4	8.7	70.5	5.2	84.8	15.2	100,0
5-7	58	1.6	11.8	64.4	7.4	85.2	14.8	100,0
7-10	16	6.5	21.3	47.4	4.3	79.5	20.5	100,0
10-20	23	3.5	26.5	41.4	4.7	76.1	23.9	100,0
20-30	8	3.3	39.9	20.1	4.6	67.8	32.2	100,0
30-40	4	7.9	27.2	22.1	5.1	62.4	37.6	100,0
40-100	3	2.5	21.1	10.3	2.7	36.6	63.4	100,0
>100	1	--	3.3	0.5	--	3.8	96.3	100,0
TOTAL	463	2.3	16.6	48.0	4.8	71.7	28.3	100,0

Sources: our own, based on the cadastral census of Sentmenat of 1859 and the population census of Sentmenat of 1860. Notice that in this Table 10.1 all the agrarian active people that in the census appeared in family units whose head was not classified in the primary sector are not included, so the totals are slightly different than the ones in Table 8 and Table 13.

Regarding the use of cropland, it was found that these farms always maintained the classical polycultivation pattern of cereals, forages and legumes together with vineyards and olive trees. But here again we found variety in the use of plough land. A group made up of 16 large owners belonging to the lower range, allocated part of their cultivated land to cereals for their own consumption, another part to olive trees and the largest share was devoted to vineyards. The remaining large owners shared a common pattern which was to allocate an important part of the cropland to cereals with the purpose of obtaining surpluses and yield benefits when sold in the market. We have also noticed that vineyards played different roles. In some *masies* it took up more land or the same as the one allocated for cereals, whereas in others it took up a smaller size. As a general feature, the proportion of vineyards increased when the size of the land held became small. The vine-growing specialization process was found to be less intense in the group of larger landowners than in other groups of smaller peasant owners. The 350 family units owing less than 5 hectares had 70 to 75% of their land planted with vines. Half of all the vineyards in Sentmenat belonged to them, the other half being held by families owing more than 5 hectares. On the opposite side, 94% of irrigated land belonged to the 113 family units with more than 5 hectares of their own.

By looking at the overall Tables 9 and 10 we can also discover the existence of an apparent polarization. The 8% of large owners who held 44% of the total land are opposed to the remaining 92% who held 56% of the useful agrarian area. This entailed the proliferation of a great number of small peasant landowners, often holding surfaces which proved insufficient to provide for their family reproduction. We have estimated, based on the family budget of an average family consisting of 4.5 people, that at least between 3 to 4 hectares of vines, or 4 to 5 hectares of cereals (in the case of cereals being the only crop), were needed to meet basic needs of subsistence. As can be on the Tables 9 and 10 above, 263 owners representing 57% of the total and holding 18% of the land did not meet this requirement. Furthermore 150 of them owned only 0.9 hectares, a fact which led them to seek other incomes, either by letting small plots of land or working as farmhands or in other tasks and economic activities. Still, another group of a 113 owners who held 1.5 to 3 hectares found themselves in a similar situation. Although for these the opportunities to let plots of land or to work as farmhands or in other tasks were slimmer. The figures indicating the overwhelming weight borne by small owners leave no doubt.

However the Tables 9 and 10 allows us to observe that inside this polarization between large owners and a majority of small owners of insufficient land there existed a group of landowners who held 3 to 10 hectares, a size big enough to provide for the basic family needs of subsistence. This group comprised 161 well-off peasant owners, representing 34% of the total and held 38% of the land. It is precisely the existence of this group, which has forced us to vary the view of an extremely polarized society, consisting of a small number of large owners on one end and a massive number of small “sub-peasant” owners on the other. The fact that 34% of peasant families owned land enough to remain autonomous must have undoubtedly acted as a cushion, reducing the unrest that this uneven distribution of land might have caused.

Another important aspect to point out on this particular group of autonomous peasant landowners is that the strategy they employed for the use of the soil differed from the one of the large landowners. In many cases the principle of polycultivation was broken, giving up cereal cultivation for the sake of allocating a great deal of the land to vineyards (Table 10). It is only in the specific group who held 7 to 10 hectares that an average surface allocated to cereals was kept in order to provide for their needs. In the rest of the groups this surface remained very tiny. A small surface allocated to olive trees was a common pattern for all groups. But by and large the most outstanding characteristic to mention was the vineyard specialization. For the first three groups vineyards took up 83 to 87% of the cultivated land, for the one who owned 5 to 7 has it still took 76%, and for the one who owned 7 to 10 has of land the percentage only went down to 60% in spite of the fact that this group allocate part of their cultivated land to cereals in order to provide for their basic needs.

As explained above, this massive number of small vineyard owners existed because large owners had decided to let part of their land to landless peasants by means of a Catalan emphyteutic contract known as “*rabassa morta*”. This contract demanded that vineyards be planted, hence the intense degree of vineyard specialization. However in other groups, particularly for the ones who held over 5 hectares of land we found that their existence was not merely due to the enforcing *rabassa morta* contracts but to other reasons like the aim to diversify risk, and make good use of the higher relative prices of wine, while maintaining a poly-cultural management of their farms in order to allocate the scarce manure on irrigated and cereal dry framing, or to provide pruning as a substitute for scarce firewood.

So, summing up the above, it could be said that the different ways farms were run, together with the prevailing division of labour, were complementary. On the one hand, large farms maintained the polycultivation model and sought hired labour, while on the other, small farms specialized entirely on vineyards. In order to meet basic needs the smaller “sub-peasant” owners often worked as farmhands or servants, and would let small plots of land as *rabassers* tenants or sharecroppers.

6. Peasant farming, labour management and the use of time

Even though the records consulted do not provide information about how farms were run, and the cadastral records only registered the property, we were able to establish with a fair amount of accuracy how farms were organized by checking the population census which registered the agrarian active people of each family. One salient characteristic was that the farm was basically run by the family members, relatives and only on occasions hired farmhands (most of them as yearly servants) who lived with the nuclear family or temporarily.

Table 11. Number of agrarian active people censused per farm in Sentmenat (1859-60)

Number of agrarian active people censused in each farm unit	Family relatives	Non relatives	Total active people censused in these type of farm	% of active agrarian people in the municipality	Number of farm units	% number of farms of these type over total
1	129	--	129	30.9	129	53.5
2	130	16	146	34.9	73	30.3
3	62	13	75	17.9	25	10.4
4	26	2	28	6.7	7	2.9
5	11	9	20	4.8	4	1.7
6	8	4	12	2.9	2	0.8
7	--	--	--	--	--	--
8	4	4	8	1.9	1	0.4
TOTAL	370	48	418	100.0	241	100.0

Sources: our own, based on the cadastral census of Sentmenat of 1859 and the population census of Sentmenat of 1860.

As can be seen on the Table 11, more than 50% of the farms only had one active agrarian person censused, 30% had two, 15% between three to five and only in 1.25% the number of agrarian active people reached six to eight. With respect to the “large” landowners, we mentioned before that the predominant feature among the ones living in the village was direct farming, though occasionally their land would be let to *masovers*

tenants when they move to nearby towns or cities. These *masovers* were responsible for the farm units whose heads of families registered as ploughmen, which use to have a very small number of agrarian active people because they often cultivated only part of the land while the rest of poorer soils would have been let in smaller plots to other wine-growers sharecroppers (*rabassers*) by the landowner. The medium-size landowners would reduce the amount of small plots let to *rabassers*, while keeping the polycultivation of the *masia* exploited by a *masover* ploughman. Smaller peasant landowners would engage themselves in a direct management of their farms using their own family workforce. So, land tenancy counter-balanced the inequality of land ownership and helped to adjust land management to the scope of the family peasant labour force.

The agrarian labour market would only make up the final adjustments between labour requirements and peasant family workforce availability throughout the year. Following this idea it seems obvious that farms belonging to small or middle-size owners did not require an important amount of hired farm labour either. Although the historical sources consulted only registered labourers who were hired for a full year, it seems likely that farms with large extensions of land would have hired daily workers as well. This number could have been seasonally increased, especially during harvest and vintage times, or when sowing or planting vines. One way to assess the size of the labour force of these farms consists of estimating the number of agrarian active people with respect to the cultivated land, and the labour which each hectare of cultivated land required. The results show that some farms had an excess of labour force whereas others had shortages (Table 12). If we consider that an active agrarian person could cultivate between 3 to 4 hectares of vineyards and a slightly larger area of cereals, we find that nearly 70% of the farms had a surplus of labour force.¹²

¹² See Table A1 of the Annex. If we consider that in order to cultivate an hectare of vineyard 73 day wages per year were necessary, and taking into account that an agrarian active person was paid 240 day wages per year, we may conclude that an agrarian active person managed to cultivate over 3 hectares a year, without taking care of the overwork which vintage time demanded.

Table 12. Number of farms classified according the acreage of cultivated land owned per each active agrarian people in the family unit (Sentmenat, 1859-60)		
Range of hectares per active agrarian person	Number of farms	% of these farm units over total
0-1	39	21.0
1-2	49	26.3
2-3	40	21.5
3-4	23	12.4
4-5	13	7.0
5-6	8	4.3
6-7	6	3.2
7-8	1	0.5
8-9	6	3.2
>10	1	0.5
TOTAL	186	100.0

Sources: our own, based on the cadastral census of Sentmenat of 1859 and the population census of Sentmenat of 1860. Notice that only the farms owned by heads of family registered in the census are included.

Only the groups which had 3 to 5 hectares of land per agrarian active person (19%) could fit their labour force to their land availability, whereas the remaining 11% had an excess of land with respect to the available labour force. The shortage of labour force in this case must have been filled by farmhands or, according to the census, by small landowners who had a surplus in labour force. This observation sheds light into another interesting aspect concerning these farms, which is the degree of “proletarianization” reached. As can be seen on Tables 7 and 8, only 12 heads of family were registered as labourers (3.5 % of the total heads of family). Together with their families they represented 42 agrarian active people. Besides, another 51 were registered as labourers who lived with the nuclear family and were known as yearly servants. On the whole they represented 93 people, which accounted approximately for 20% of the agrarian active people. As can be seen the degree of “proletarianization” was really low. However these figures do not represent all the paid work, because the one supplied by small landowners or tenants is missing. But even taking into account these daily workers who were actually landowners, the rate of hired labour continues being low, and hence we believe that these *masia* farms were run overall by nuclear families.

If we wonder what amount of work was needed to run the agro-system of Sentmenat in the middle of the 19th century, the answer that can be found in the records of the population and cadastral census appears in Table 13 and 14. A first aspect to highlight of this village is the importance that the industrious or industrial activity assumed. The total people employed in the secondary sector numbered 415, very close

to the number of agrarian active people which were 463. This is probably reflecting a situation where agrarian activities no longer stand as unique and perhaps the main source of income for a great part of the local population.

kinship/sector of activity		primary	secondary	tertiary	others	TOTAL
head of family (HF)	male	225	65	13	5	308
	female	14	7	1	17	39
	TOTAL	239	72	14	22	347
family relatives of the HF	male	132	65	10	258	465
	female	22	247	14	454	737
	TOTAL	154	312	24	712	1.202
no kinship with the HF	male	49	19	2	5	75
	female	12	2	0	8	22
	TOTAL	61	21	2	13	97
the kinship with the HF is unknown	male	7	3	0	7	17
	female	2	7	0	14	23
	TOTAL	9	10	0	21	40
TOTAL POPULATION	<i>male</i>	<i>413</i>	<i>152</i>	<i>25</i>	<i>275</i>	865
	<i>female</i>	<i>50</i>	<i>263</i>	<i>15</i>	<i>493</i>	821
	TOTAL	463	415	40	768	1,686

Sources: our own based on the cadastral census of Sentmenat of 1859 and the population census of Sentmenat of 1860. The category of "others" includes housewives, children and people without any activity recorded.

Land availability being reduced to 1.3 hectares per inhabitant, a large share of the population was forced to seek other incomes to meet their basic needs. Most significant was the importance assumed by women in industry, mainly in the textile trade but also in other activities such as shoe making with canvas and esparto.

Relationship with the head of family (HF)	Bricklayer	Tile layer	Canvas shoe maker	Carpenter	Blacksmith	Food industries	Textile industries	TOTAL
HF	9	2	13	2	5	3	38	72
Husband/Wife	--	2	23	--	1	1	63	90
Son/Daughter	1	4	40	--	2	--	119	166
Father/Mother	--	--	3	--	--	1	1	5
Brother/Sister	--	--	1	--	--	--	14	15
Brother/Sister In Law	--	--	--	--	--	--	2	2
Son/Daughter In Law	--	--	5	--	--	--	11	16
Grandson/Daughter	--	--	4	--	--	--	12	16
Father/Mother In Law	--	--	2	--	--	--	--	2
Niece/Nephew	--	--	--	--	--	--	1	1
No Register	--	--	2	1	--	--	6	9
None	--	--	4	2	3	--	12	21
TOTAL	10	8	97	5	11	5	279	415
%	<i>2.4</i>	<i>1.9</i>	<i>23.4</i>	<i>1.2</i>	<i>2.7</i>	<i>1.2</i>	<i>67.2</i>	<i>100.0</i>

Sources: our own based on the cadastral census of Sentmenat of 1859 and the population census of Sentmenat of 1860.

With respect to the active people engaged in the primary sector, we believe that the sources consulted do not register the total amount of farm labour required because as many as 208 women belonging to peasant families were recorded as having no professional activity at all. Surely, they must have contributed to a share of the farm work, besides running the household. Therefore we are talking of women who were officially registered as economically “inactive”, but if they were taken into account then the number of active agrarian people would climb to 671 (54% of the potentially active population from 10 to 79 years old, or nearly 40% of the total population in Sentmenat).

In order to obtain further information about the amount of work which the maintenance of the agro-system of Sentmenat required, we have considered useful to apply the methodology of time and land budgets on the time balances (LTB analysis) as suggested in the works of Giampietro, Pastore and Li (1999) and Grünbühel and Schandl (2005). These authors base their analysis on the assumption that each society has a total amount of time at its disposal, so that its use can be quantified and the fraction of the time devoted to work known. This methodology allows us not only to identify the strictly productive labour linked to the traditional sectors, but to allocate a length of time to the household chores and the time spent looking after the family members as well. Although these two activities which were basically in the hands of women were an absolute must to keep the agrosystem operating, they had remained hidden on most conventional analysis.

The majority of these LTB studies are based on surveys carried out on small populations to establish how the time is used throughout a long period of time. Naturally, when it comes to applying this methodology on past societies we cannot have at our disposal information sources as precise as the ones obtained from surveys. Anyhow, we consider that useful information can be gathered from population census, cadastral records, surveys on agrarian production and incomes (the cadastral “*cartillas evaluatorias*” in mid 19th century Spain) and other historical sources which provide with coefficients and indicators with a reasonable level of reliability. Based on the data gathered from the cadastral records we learn about the use of the soil and animal herds, assuming that each peasant family possessed an orchard, a pig, poultry and some rabbits, together with the estimates of the amount of work required for each crop.

Table 15 Time needed to perform all the activities by the population of Sentmenat in 1859-60					
Activities performed		Total hours	%		
Agrarian activities on cultivated land		871,577	5.9		
Woodland activities or on untitled land		72,138	0.5		
Livestock breeding activities		93,274	0.6		
Maintenance agrarian activities		41,245	0.3		
Secondary sector activities		1,132,950	7.7		
Tertiary sector activities		90,000	0.6		
Household chores (cooking, cleaning, fuel, water...)		569,948	3.9		
Caring of children, elder people and the sick		316,638	2.1		
Travelling to the markets and other destinations		290,175	2.0		
Gathering, hunting and fishing		63,327	0.4		
Leisure, religious activities, education and others		3,975,971	26.9		
Rest, meals, personal care		7,254,375	49.1		
TOTAL		14,771,620	100.0		
Table 15.1 Time needed to perform the agrarian and livestock labour in Sentmenat in 1859-60					
Working days		Total hectares	Working days/hectare	Total working days	Total hours
<i>Irrigated</i>	Wheat	23.48	35.5	833.7	6,670
	Corn	23.48	35.0	821.9	6,575
	Hemp	23.48	187.0	4,391.5	35,132
	Beans	23.48	41.0	962.8	7,702
<i>Dry farming</i>	Wheat	106.40	42.0	4,468.8	35,750
	Corn	35.54	38.0	1,350.3	10,802
	Mixture of cereals	17.96	42.0	754.3	6,034
	Barley	58.37	39.4	2,299.7	18,398
	Forage	73.60	11.0	809.5	6,476
	Green peas	73.60	81.0	5,961.2	47,690
	Olive trees	113.09	42.0	4,749.6	37,997
	Vineyards	1,066.10	73.0	77,825.1	622,601
	Orchards	26.03	142.9	3,718.7	29,750
	Woodland used for logging	42.56	11.0	468.1	3,745
	Woodland used for firewood	653.80	12.5	8,172.4	65,379
	Poplar trees	2.09	17.0	35.5	284
	Untilled land used for pasture	341.35	1.0	341.3	2,730
	Livestock breeding			11,659.3	93,274
	Building and maintenance			5,155.6	41,245
TOTAL				134,779.3	1,078,235

Sources: our own based on the cadastral census of Sentmenat of 1859, the population census of Sentmenat of 1860, and on the cadastral surveys of several municipalities of the West Vallès county during the second half of the 19th century, plus the IACSI surveys.

This information has allowed us to establish with a new light the amount of labour required to keep the agro-system running. We believe that this figures, regarding the amount of work necessary for the different uses given to the soil, to be quite precious because it may be used as a good indicator of labour intensity and productivity. This local productivity could also be compared with other agro-systems of other moments in history, or other geographical case studies. It also helps us to know more about the meaning of the technologies used and the methods of cultivation employed. The estimate of the amount of work necessary to carry out household chores is also

meaningful to us, though we are aware that in this case the information available is highly unreliable since historical records fail to mention it, so that the adapted coefficients may be uncertain. Finally, we have also studied the time work that was devoted to hunting and gathering. The overall results are summarized on Table 15, and for the agrarian activities to run the agro-system on table 15.1.

According to our estimates the time devoted to all types of work, including the household chores, amounted to 24% of the available time of population (or 35% of the available time of the active population or potentially active).¹³ Farm work took up 7.3% of the total, household chores 6%, and industrious activities together with hunting or gathering and services the remaining 10.7%. We see that the time devoted to industrious or industrial activities to be the longest between productive or reproductive tasks.

The total labour time availability was established based on the following assumptions. For the agrarian sector the agricultural active people found in the population census did 240 working days, to which we added the working days done by women whose activity remains unrecorded. For household chores we have established 7 daily hours per average family, whose responsibility lay mostly in the hands of women. Finally we have considered that the people involved in the secondary and tertiary sector had full dedication, although they participated in household chores and other heterogeneous activities such as hunting, gathering etc. The results appear on the Table 16. Once the hours allotted to the different productive activities have been discounted from the time availability, the remaining time left for activities such as sleeping, eating, social relationships or leisure has been set up in Table 16.1.

¹³ Gründbühel and Schandl (2005) obtain 32,13% out of the available time of the whole population for the small village of Nalang, and 33,8% for the whole of the population of Laos. For six village in China, Pastore, Giamprieto and Li obtain only 18%. For Catalonia nowadays, IDESCAT (2005) considers that the time devoted to total labour is close to 25%, distributed evenly between household chores and jobs.

Table 16. Total labour time availability of the active and potentially active population of Sentmenat, per sectors of activity in 1859-60				
Activity sector according to the municipal register	Number of active people	Hours a day	Days a year	Total in a year
Agrarian active people	463	8.0	240	888,960
Active people of the secondary sector	415	10.5	260	1,132,950
Active people of the tertiary sector	40	9.0	250	90,000
Others and jobless considered agrarian active people	209	2.2	365	169,284
Non-agrarian families with orchard and farmyard	108	0.5	365	19,993
Household chores (families)	347	7.0	365	886,585
Other productive activities	1,243	0.8	365	353,503
Total hours by the population aged between 10 to 79	1,243			3,539,015

Table 16.1 Distribution of the total available time per activities of the population of Sentmenat in 1859-60^a			
Activities performed	Hours a day/ inhabitant	Total hours	%
Agrarian activities	1.75	1,078,237	7.3
Secondary sector activities	1.84	1,132,950	7.7
Tertiary sector activities	0.15	90,000	0.6
Household chores	1.44	886,585	6.0
Travelling to the markets, gathering, hunting and fishing	0.57	353,503	2.4
Leisure, religious activities, education and others	6.46	3,975,971	26.9
Leisure, religious activities, education and others	11.79	7,254,375	49.1
TOTAL	24.00	14,771,620	100.0

Sources: our own based on the cadastral census of Sentmenat of 1859 and on the Municipal Register of Inhabitants of Sentmenat in 1860.

^a: Considering 24 hours*365 days*number of people.

7. Conclusions

Assuming that agro-systems can only be understood if one takes into account the environmental and socioeconomic variables, we have based our analysis of our Catalan case study on the co-evolution of these variables and their interactions. In the first place we have assessed the natural resources of our case study, particularly the land availability, its productive potential, the uses of the soil and productivity. By reconstructing the balance of energy and the main material flows we have been able to establish the degree of efficiency attained in energy and territorial managements.

Once the main *driving forces* that shaped the prevailing agro-system have been understood through the energy and material flow analysis, it became obvious that the results obtained cannot be explained exclusively with the help of environmental variables alone. A full understanding of the functioning of any agro-ecosystem can only be reached if human agency is brought to the foreground. In short, an agro-system differs from a natural ecosystem precisely because of the anthropic intervention. So, we

have to highlight the social and economic *ruling forces* as well. For this reason a great part of this chapter deals with the analysis of socioeconomic variables which have proven decisive in our case study.

The use of the soil, for example, can only be understood bearing in mind some specific technological know-how, land property entitlements and tenement arrangements, social relationships and marketing links. The outstanding process of vineyard specialization can only be highlighted by considering the prevailing land ownership inequalities, together with market incentives, soil aptitudes, ecological suitability and natural limiting factors. As has been shown, the existence of a great number of small landowners or labourers who were forced to plant vines, either because they were more profitable or because their tenancy access to the land forced them to do so, played a fundamental role in the process of intense vineyard specialization. But we must also bear in mind that *this wine specialization remained only partial*, because the well-off landed proprietors maintained the traditional Mediterranean poly-cultivation in their *masies*, keeping the sowing of wheat, corn, legumes, potatoes vegetables and hemp in the best soils, while devoting some patches to woodland and pasture.

The territorial outcome of this divergent but complementary options between landowners and landless rural people, was an interesting landscape made up of a thick agrarian mosaic with a lot of different patches of annual and wooden crops, woods, bushes and prairies. The energy and material flow analysis of this Catalan agro-system has allowed us to identify two main goals behind that divergent agricultural options, and the diverse agrarian landscape they kept: 1) to intensify the use of soils by means of substituting vineyards for woods allowed to feed the livestock herd with the leaves of vines or olive trees, and the green branches pruned, while at the same time concentrating the scarce manure on the best soils sown with cereals, legumes and vegetables; and 2) the pruning of vineyards and other wooden crops offered a substitute for the increasingly scarce firewood. Only a sound integration between annual and wooden cropping, together with livestock breeding and forestry, may explain the high performance of 1.67 energy return on energy inputs invested in this agro-system. The energy efficiency was a result of the territorial efficiency, both kept by the contractual agreement reached between the landed rulers of the *masies* and a new frightening landless class that grew in the villages.

The *partial* specialization in wine-growing was one of the paramount features of our case study, that can also explain the main characteristics of the labour requirements

and availabilities in this diverse agro-system. As shown above, the peasant family unit was the key factor to understand how agricultural labour demand and supply could meet each other. The farm unit relied basically on the labour force provided by the peasant family as a predominant feature, though on occasions external work was hired. The fact that a large share of the work carried out by non-family members was done by servants who lived with the family is a good indicator of the low rates of “proletarianization”, as it is the low number of agrarian active people per farm. Our analysis has also made apparent the existence of a certain balance between large and small owners, that adjusted the lack of farmhands by the former with the labour surplus of the latter through tenancy agreements and the labour market.

Finally, using the Land-Time Budget methodology we have estimated the time needed to keep the agro-system running and how the total available time was allotted. This was achieved accounting the time needed by every crop, according to the technologies applied. We have also been able to estimate the time required for household chores and family care, bringing to light an activity absolutely indispensable to sustain the satisfaction of human needs which had remained invisible in the records. As shown above, the fraction of time devoted to labour in the “economically productive” sectors was no longer exclusive of the agricultural one, on the contrary more than half of the available labour time was already allotted to industrious or industrial activities. It stands to reason that due to the demographic growth of the previous period an important part of the population could not live off the land exclusively, and had to seek other activities, basically on different types of manufactures and services.

The fact that the mean land availability had been reduced to 1.3 hectares per head appears as a crucial driving force which clearly explains that land resources became insufficient to guarantee the subsistence of the whole population. The demographic growth attained in the Catalan Vallès county was only made possible on account of the job opportunities offered combining various economic sectors, and increasingly in industry. In that sense economic diversification, through a growing investment of family labour in industrious and industrial activities, became an unavoidable feature of the high intensive organic agricultures we found in the Mediterranean Europe in the middle of the 19th century.¹⁴

¹⁴ For the distinction between an “industrious” or “industrial” revolution see De Vries (1994: 249-270; 2001: 177-194); Pomeranz (2000); Allen (2000: 1-25; 2001:411-447); and Van Zanden (2001: 9-87).

ANNEX I: Methodology used in drawing of time budgets

In order to draw the budgets or time balances corresponding to the population of the village of Sentmenat (in the Catalan West Vallès county) the following steps have been taken:

1. First, time availability was calculated as follows:
 - Starting from the information found in the Municipal Register of Inhabitants, the population was divided in two groups: active or potentially active, aged between 10 to 79, and the rest of the population aged under 10 or over 79.
 - The number of available hours per year for each group was established in the following way: number of inhabitants x 24 x 365.
2. The mean time devoted to each activity or groups of activities for the active or potentially active people was established according to gender for the ones performed at home. For the activities performed outside, the occupation attributed in the municipal register was taken.
3. Regarding labour activities performed outside home:
 - Agrarian active people have been assumed to work 8 hours a day on average during 240 days a year, taking into account the high number of holidays which appeared in the agrarian calendars and the limitations exerted on the length of the day work by the weather and/or available sunlight (see table 16.1).
 - Due to the lack of information of female labour activities, we have supposed that women living in families whose head was registered as an agrarian active person, and appeared as jobless in the municipal register, actually worked outside home an average of 2.2 hours a day throughout the year. This amount of female agrarian labour, devoted to specific agrarian activities concerning the growing of wheat, hemp, olive trees or vineyards, was estimated taking into account the tasks recorded as being performed by women in the cadastral surveys.¹⁵ This figure also includes the growing of vegetables in family orchards and feeding farm animals (pigs, hens and rabbits). The total amount of female agrarian labour here assumed tallies with the fact that the total work time needed to handle with the agro-system was higher than the one that could be provided only by the mainly male workforce recorded in the 1859 census, while we know that a great deal of unrecorded agrarian activities were performed by women.
 - We have assumed that families whose head was registered as an active person in the secondary sector possessed an orchard whose maintenance required 0.5 hours a day per family.
 - Secondary sector active people worked, according to the historical sources, an average 10.5 hours a day during 260 days a year. Finally, tertiary sector active people have been assumed to have worked 9 hours a day during 250 days a year (see Table 16.1).
 - An average of 7 hours a day per family unit has been assumed to be the time devoted to household chores, which were mainly performed by women. They included preparing meals, house cleaning, laundry (these took slightly less than half the time allocated to household

¹⁵ These tasks could be, for example, olive gathering or weeding sown fields.

chores), the caring of children (breastfeeding included) and the elderly and the sick (these took more than a third), and finally water and fuel supply (see Table 16.1).

- We have estimated a time, either daily or weekly, allocated to travelling, fruit gathering, hunting, fishing, or buying and selling in the markets, which does not exceed an hour per person per day as a yearly average (see Table 16.1).
 - Adding up the amount of time devoted to the labour activities recorded in the municipal register, the time estimated to carry out household chores, together with the time spent in travelling, gathering and so on, we obtained an average of 7.8 hours a day of total activity per inhabitant (10 to 79 years old) throughout the year. This figure turns out to be 5.75 considering the whole of the population unevenly distributed between men and women.
4. Regarding non labour activities such as rest and idle time (see Table 16.2):
 - 8 hours of sleep and 3 hours to eating and personal care have been allocated to each person of the group of active or potentially active people, regardless of gender, sector of activity or age.
 - The remaining time of 5.5 hours per inhabitant and day (unevenly distributed among men and women) has been allocated to idle, social, religious, education or other activities. This amount includes the non-working time of the sick and disabled people, or the one devoted to any other activity not mentioned in the above categories.
 - Regarding the group of people under 10 or over 79, we have assumed they spent all their time in resting, eating, education and leisure activities (indicated on Table 16.1).
 5. The total amount of labour needed to perform all the tasks and activities in growing any type of crop, orchards, woodland, untilled land and livestock breeding (see Table 15.1), together with road maintenance and building (see Table 15.2), has been calculated in order to match it with the total available time devoted to agrarian tasks (basically performed by agrarian active people, and women living in agrarian family units whose activity outside home is unrecorded).
 6. We have used as a reference the Giampietro et al. studies on Laos and China; the Ferre, Piani and Rossi studies for Uruguay; together with the Catalan Total Time Survey *Estadística de l'ús del temps 2002-03* compiled by the IDESCAT, the cadastral surveys of the IACSI, and the 1874 agricultural report *Estudio agrícola del Vallés*.

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