# Between specialization and globalization. The marketing of agrarian products and its environmental impacts seen from a historical perspective: the province of Barcelona in the mid-nineteenth century[1]

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## *1. Trade and environment: some theoretical grounds*

Ecological economics has five good reasons to consider that economic globalisation, spurred by commercial and financial fluxes, to be one of the main driving forces responsible for causing environmental degradation to our planet.[2] The first, is the energy consumption and the socio-environmental impacts which long-distance haulage entails.[3] The second, is the ever-increasing flow of goods to far-away destinations which renders their recycling practically impossible. This is particularly significant, because it prevents the metabolic lock of the nutrients present in food and other agrarian products from taking place. The third, is that the high degree of specialization attained in agriculture, forestry, cattle, mining and industry in each region, generates deleterious effects not only on the eco-landscape structure of the uses of the soil, but on the capability to provide habitat and environmental functions to maintain biodiversity as well.[4]

This reason makes recycling more difficult still, because territorial synergies characteristic of both industrial and agrarian ecology cannot occur. These negative environmental consequences concerning energy consumption, goods, pollution and biodiversity interact with two other negative effects of social nature. On the one hand, consumers cause a series of environmental impacts far from their sight, due to the increasing physical and cultural distance which separates them from producers or intermediaries. On the other, these producers and intermediaries have to endure the damage on their territories foreseeing no compensation, which brings us to the fourth

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[2] Daly and Cobb (1990:209-235); Daly and Goodland (1994:73-92); Anderson, Folcke and Nystrom, (1995); Costanza, Cumberland, Daly, Goodland and Norgaard (1999:172-194).
[3] Veen-Groot and Nijkamp (1999:331-346); Fischer-Kowalski, Krausmann and Smetschka (2004:307-342).
[4] Gale (2000:285-292); Giljum (2004:241-261); Giljum and Eisenmenger (2004:73-100) .

reason. The difficulty to establish common strategies which may reduce the external costs of the transactions.[5] The ones who could do more to alleviate these socio-environmental impacts ignore their existence, thus see no reason to put a stop to them. The others, who suffer the consequences of these impacts cannot find a remedy either.[6] This large gap, in which common cultural and political policies cannot be drawn to entitle with equal rights all the parts involved in trade, highlights the fifth and final reason which ecological economics points out. The growing asymmetry in opportunity costs, between the rich and the poor facilitates that relative prices conceal non-paid external factors so that an unfair ecological-economic trade is generated.[7] This unfair socio-ecological interchange fosters polarization amongst wealth, poverty and environmental degradation through the deterioration of the terms of trade, reinforced by the prevailing foreign debt.[8]

These five reasons concerning the negative effects of international trade are often reduced to two: the ones that multiply socio-environmental degradation because of *the growing scale* of the problems associated with social metabolism, and the ones arising from the *unfairness of trade*. Both of these phenomena have been empirically assessed and its interactions statistically measured by various studies. However, ecological economists also wonders which are the deep-rooted causes behind these phenomena, in order to seek alternative solutions. Does the increase in the circulation of goods, *necessarily* cause, in any degree or situation, deleterious environmental effects? Is there a *necessary* relationship between its environmental and social impacts, so that any trade circulation implies that its terms of trade should be socio-environmentally unfair? We

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[5] Norgaard (1997:175-193).

[6] "*In sum, we believe it is folly to sacrifice existing institutions of community at the national level in the supposed service of nonexistent institutions of community at the world level. Better to build and strengthen the weakening bonds of national community first, and then expand community by federation into larger trading blocs among national communities that have similar community standards regarding wages, welfare, population control, environmental protection, and conservation. True efficiency lies in the protection of this hard-won community standards from the degenerative competition of individualistic free trade, which comes to rest at the lowest common denominator*" Daly and Cobb (1990:235). As many other questions studied by present ecological economics, this point of view comes from Nicholas Georgescu-Roegen who had already pointed out, in his analysis of the old peasant institutions that regulated some basic rights to exist for all the members of the traditional rural communities, that a cultural and social bond like this could not be indifferent to the community size, although useful lessons may be drawn from it for the future (Georgescu-Roegen, 1967:620 and 1976:214). See also Tello (2005:93-103).

[7] Hornborg (1998: 127-136); Carpintero, Echeverría and Naredo (1999:325-381); Carpintero (2005:429-484).

[8] Proops, Atkinson, Schlotheim and Simon (1999:75-97); Martínez Alier and Roca Jusmet (2000:418-474); Muradian and Martínez Alier (2001:281-297); Muradian, O'Connor and Martínez Alier (2002:55-67); Machado, Schaefeffer and Worrell (2001:409-424); Andersson and Lindroth (2001:113-122); Hubacek and Giljum (2003:137-151); Pérez (2003:95-120; 2006 and in print); Martínez Alier (2005:274-316).

believe that the theoretical groundwork to answer these important queries remains still unclear, especially for ecological economists, in spite of the impressive wealth of empirical data analysed statistically.

It is sometimes said that, from a biophysical point of view, trade should be regarded as a zero-sum game (and sometimes this assumption is sustained by resorting to the Principles of Thermodynamics). However, if this were literally true, then the *environmental scale effect* of trade over the throughput of materials and energy of the social metabolism should also have to be minimized (except in the case of haulage). But if we consider that the participation in trade networks which are widening day by day, actually increases the amount of goods *in the interior of each region forming part of this network*, and the materials and energy embodied on them, we are acknowledging implicitly that trade is not only a game whose positive and negative effects sum adds to nought, since it increases, directly or indirectly, the availability of the products at the end of the process. This is precisely what the *scale effect* describes. Anyhow, if this were not so, it is hard to understand why marketing is marked by a distinct tendency to widen.

This actually occurs, from a biophysical point of view, because interchange entails a backward movement of the limitative factors known in ecology or agronomy as "Liebig's minimum factors". Indirectly, through product specialization for which each bioregion has an "ecological optimum", or directly by transferring limitative goods from one bioregion to another.[9] Most certainly as well, haulage consumes energy and materials, generates pollution and provokes important disturbances on the ecological functioning of the natural systems. So, it seems at least that prior to pronouncing a downright judgement for or against this trading transfer of limitative factors, that reduce biophysical situations of *natural* poverty, we should confront each effect against each other.

This is precisely what Leopold Pfaundler did, when in 1902 he determined to assess in a very original manner the sustainable capacity of the Earth from the satisfaction of human needs point of view. "*Pfaundler* –as Joan Martínez Alier indicates— *came to the conclusion that the sustainable capacity of the Earth lay between two limits. For each territory, we would calculate how many people could live on it, by dividing the amount of available materials over the average needs per person (considering perhaps only those materials whose availability were lowest). The sum*

[9] Grigg (1982:47-67).

*total of the above results would enable us to calculate the sustainable capacity of the Earth. Likewise, the Earth could be considered as a single territory, though this implies that the transfer of materials is free of charge. If we use the first method, the sustainable capacity of the Earth proves to be too low, since the possibility to overcome local shortages by means of trade is not considered. With the second method, the sustainable capacity turns out to be too high, because the assumption that transfer of materials is free of charge is unrealistic, since it entails energy costs*."[10]

If we admit that trade may sometimes be regarded as a game whose sum is positive from a biophysical standpoint, but that this result depends on a "*global optimum scale*" beyond which negative energy costs and environmental impacts will exceed this positive result, then, Pfaundler's calculation seems to us more realistic than the sharp assumption that considers that any kind of trade is a game whose sum adds to nought (and even more, needless to say, if this trade includes unfair terms, energy costs and environmental degradation in an overall negative global balance). It is worthwhile stressing, that that former standpoint not only would run counter to the conventional opinion held by the majority of economists and economic historians. Taking it at face value, it should also question the view supported by those who, as an alternative to the current globalisation process, favour fair local or regional trade networks in order to ensure food security, agro-biodiversity and peasant culture diversity. If *any* interchange gave as a result a negative balance from a biophysical standpoint, on account of the energy and materials expense which would merely redistribute the pre-existing wealth (besides unfairly), then why should local trade be considered good and an unrestrained one bad? Are we not facing a sheer contradiction when expressing the idea of "fair trade"?

Pfaundler's thesis may shed new light into the debate over trade, equity, and environment because, as Joan Martínez Alier and Jordi Roca suggest, *another* theory regarding socio-environmental advantages of certain levels of trade could be evolved from it. This new theory could be regarded as an alternative to the current economic theory of international trade: "*even from a strict bioregional point of view, it could be argued as Pflaunder did in 1902, that if a territory lacks an indispensable material likely to be found in abundance in another one, then according to Liebig's law of minimum factors, interchange would be advisable, therefore the total load capacity of the*

[10] Martínez Alier and Schlüpmann (1991:131-132).

*territories would be greater than the sum of the load capacities of all the autarchic territories. Between these two extreme views, that of total globalisation of trade and regional autarchy, a sound ecological attitude based on recent proposals of fair trade may find its place*."[11]

Together with the idea of an "optimum scale" for human economics in the biosphere, Pfaundler's thesis implies the existence of a threshold of "optimum interchange" beyond which, socio-environmental costs will exceed the increase in the availability of biophysical resources generated by trade. The determination of this threshold that separates sustainable levels of trade from an unsustainable globalization of the economy, becomes an interesting empirical matter which requires a great deal of environmental history research based on ecological economics.

This text wishes to contribute to this effort, by analysing the level of trade attained by the province of Barcelona in the production and consumption of staple agrarian products during the second half of the nineteenth century. Based on the reconstruction of the energy balances of the agrarian system of the Vallès county towards 1850-1860, and those of nowadays, on the changes in land uses and its positive or negative impacts in the environmental structure of agrarian landscape, together with the distribution and ownership of the land, we intend to identify the turning points that changed an already specialized Catalan agriculture into a globalized one, before and after the agrarian crisis at the turn of the nineteenth century.

## *2. Production, consumption and the marketing of cereals in the province of Barcelona in the mid-nineteenth-century: sources, data and facts*

We will try to establish the degree of specialization and trading attained by the province of Barcelona in the mid-nineteenth century combining two main sources of information. With our first source, we will analyse the spread of vineyards, olive trees and other woody or shrub plantations and consequently, the reduction in the area allocated to cereals and woodland it entailed. This transformation in the use of land, forced the need to import growing amounts of cereals. Socio-economically wise, the spread of these woody plantations can be explained by the existence of an important number of farm units held by peasants who either willingly, or due to the limited access

[11] Martínez Alier and Roca Jusmet (2000:396).

to the land, had given up the idea of achieving self-supply by means of polycultivation. The cost of specializing in wine production was paid by having to acquire most of their basic needs in the market.

The second source, consists of a gamut of statistics of the production and marketing of the main agrarian products drawn in all municipalities, and carried out under the supervision of a commission created by the Junta Provincial de Agricultura of the province of Barcelona between 1859-1867.[12] This precious data, seldom used before, because some historians and other contemporary authors have deemed them to be somewhat unreliable, might afford us directly the information we are seeking to establish on the degree of specialization and trading of the agrarian production mentioned above. The relevance of the doubtful reliance of these statistics has led us to study them in detail. For this purpose, we contrasted the data of every municipality with the one registering the number of inhabitants and the uses of the soil. In this way, we managed to introduce a series of corrections matched against other sources, that enabled us to establish a far more reliable calculation of the cereal consumption per inhabitant. Thus, modifying the previous known data of agricultural production. To do so we have also used as references the figures given for the total sown land and the yields of the main crops, taken from cadastral data matched against other sources as well.[13] Finally, these three basic parameters –number of inhabitants, cereal production per inhabitant and uses of the soil— have also helped us to introduce changes in the estimates of the incoming and outgoing trade known of the municipalities. We are persuaded that having implemented all these corrections and modifications, the final data obtained is highly reliable.

How big was the production and the area allocated to cereals in the mid-nineteenth century? According to our estimates, supported by information concerning population, cultivated land and yields, it was as follows:

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[12] The manuscripts are in the Catalan Library in Barcelona (Biblioteca de Catalunya, Fondos de la Junta de Comerç, *Estadístiques de la producció i consum de cereals als partits judicials de la província de Barcelona*, bundle CXXVI, boxes 163 and 164).

[13] The box 164 includes some manuscripts on the surface land sowed with cereals, and their yields and crops, in almost every municipality of the Barcelona province. They were accounted from the data collected and sent to the Statistical Commission from the Treasure's Delegation (*Delegación de Hacienda*). Although it is not said explicitly, from our previous research work done on some of this municipalities using the original cadastres and census, we may be confident that the origins of this information were the cadastral records (*amillaramientos*).

| **Table 1.** ***Area allocated to cereals in the district councils of the province of Barcelona in the mid-nineteenth century*** | | | |
|---|---|---|---|
| **Sources/ District Councils** | **Statistics of *Junta Provincial* (1859-1867) (hectares)** | **Data gathered by *Llovet Mont-ros* (in the 1860s) (hectares)** | ***Avance* of the *Dirección General de Agricultura, Industria y Comercio* (1885-90 in hectares)** |
| **Arenys de Mar*** | 4,543.3 | 6,067.0 | 4,903.0 |
| **Outskirts of Barcelona** | 3,461.7 | 2,240.0 | 4,298.0 |
| **Berga** | 10,213.7 | 8,646.0 | 8,697.0 |
| **Granollers** | 12,146.7 | 13,236.0 | 10,304.0 |
| **Igualada** | 10,849.0 | 9,456.0 | 9,874.7 |
| **Manresa** | 9,451.1 | 8,582.0 | 12,407.0 |
| **Mataró** | 2,516.4 | -- | 1,558.0 |
| **Sabadell** | -- | -- | 3,328.0 |
| **Sant Feliu de Llobregat** | 9,158.5 | 6,358.0 | 7,248.0 |
| **Terrassa**** | 7,223.5 | 6,485.0 | 2,020.0 |
| **Vic** | 17,680.7 | 17,213.0 | 17,716.0 |
| **Vilafranca del Penedès** | 6,205.1 | 7,276.0 | 6,565.1 |
| **Vilanova i la Geltrú** | 1,745.5 | 2,121.0 | 1,868.0 |
| **TOTALS** | **95,195.2** | **87,680.0** | **90,786.8** |

Sources: our own based on the information of sown area and productivity compiled by the *Junta Provincial* for the study of the production and consumption of cereals in Barcelona, *Llovet Mont-Ros* (1948) and the *Avance* of the *Dirección General de Agricultura, Industria y Comercio* (1891).
* *Llovet Mont-Ros* includes Arenys de Mar in the data of the district council of Mataró.
** In both the data of the *Junta Provincial de Agricultura* and of *Llovet Mont-Ros* Sabadell is included in the district council of Terrassa.

The approximately 95,000 Has obtained from the data of the *Junta Provincial* for the 1859-1867 period, practically match those obtained by *Llovet-Monrós* for the same period. They also match those obtained from the *Avance* of 1885-90, bearing in mind that the *Junta* estimates did not include the land allocated to herbaceous crops in 25% of the municipalities nor the land used for dry-farming in 7% of them.[14] The comparison of the *Junta* data with those of the *Avance* seems quite reasonable, as long as we take into account that the total sown land during the years 1885-90 had most likely been reduced. We have also matched the data gathered by the *Junta Provincial* concerning mean yields per district councils, with the ones of the *Avance* of the *Dirección General de Agricultura, Industria y Comercio* gathered twenty years later.[15]

[14] Llovet Mon-ros (1948, vol. VII) points out that his estimates of the extension sown by herbaceous crops only included the ones referred to irrigated lands in 75% of the municipalities and 93% to dry-farming. This could entail an underestimation of some 7.000 or 8.000 hectares. Nevertheless, there are some additional missed hectares in our estimates.
[15] We have only swolled the data upwards in the Vic District Council and downwards in the Manresa one.

| **Table 2.** ***Mean yields of cereals estimated for the different district councils using the statistics of the*** **Junta Provincial** ***(1859-67) and of the*** **Avance de la Direccion General de Agricultuta,Industria y Comercio** ***(1885-90)*** | | |
|---|---|---|
| **Sources/ District Councils** | **Statistics of *Junta Provincial* (1859-1867 in hectolitres/hectare)** | ***Avance* of the *Dirección General de Agricultura, Industria y Comercio* (1885-90 in hectolitres/hectare)** |
| **Arenys de Mar*** | 15.6 | 8.6 |
| **Outskirts of Barcelona** | 22.2 | 17.6 |
| **Berga** | 16.7 | 11.9 |
| **Granollers** | 16.7 | 15.8 |
| **Igualada** | 9.6 | 12.5 |
| **Manresa** | 17.0 | 21.1 |
| **Mataró** | 14.8 | 13.4 |
| **Sabadell** | -- | 13.3 |
| **Sant Feliu de Llobregat** | 17.5 | 17.9 |
| **Terrassa**** | 15.3 | 13.7 |
| **Vic** | 18.7 | 13.0 |
| **Vilafranca del Penedès** | 17.9 | 15.6 |
| **Vilanova i la Geltrú** | 12.3 | 7.4 |
| **MEAN** | **15.5** | **14.7** |

Sources: our own based on the information about areas and productivity compiled by the *Junta Provincial* for the study of the production and consumption of cereals in Barcelona, and the *Avance* of the *Dirección General de Agricultura, Industria y Comercio* (1891).

* *Llovet Mont-Ros* includes Arenys de Mar in the data of the district council of Mataró.

** In both the data of the *Junta Provincial de Agricultura* and of *Llovet-Mont-Ros* Sabadell is included in the district council of Terrassa.

Table 2 shows that mean yields at provincial scale were very much alike in both sources. They also coincided largely with the ones gathered by the *Junta Agronómica* at the beginning of the twentieth century. Though in this case, we discovered that in some district councils the figures disagree. For this reason, we have established a more reasonable mean yield that has enabled us to adjust the data of production, local consumption and trading of the main agrarian products. This thorough adjustment in the data, together with the information on cultivated land and mean yields (which were swollen when appropriate) has permitted us to estimate the cereal production in every municipality and district council to be the following:

**Table 3.** ***Production of wheat and rye according to the*** **"Estados",** ***and other complementary information extracted from the statistics of the*** **Junta Provincial** ***(1859-1867) and our own swollen data based on other contemporary sources***

| Sources/ District Councils | According to the "*Estados*", in hectolitres | Our own swollen data, in hectolitres |
|---|---|---|
| **Arenys de mar** | 23,921.96 | 35,490.82 |
| **Berga** | 44,608.50 | 85,460.08 |
| **Granollers** | 78,490.00 | 100,962.63 |
| **Igualada** | 26,017.50 | 50,151.07 |
| **Sant Feliu Llobregat** | 70,060.55 | 60,487.08 |
| **Manresa** | 20,044.00 | 80,367.15 |
| **Mataró** | 6,137.26 | 23,252.97 |
| **Outskirts of Barcelona** | 20,238.50 | 31,269.82 |
| **Terrassa** | 25,109.95 | 55,354.20 |
| **Vic** | 102,594.93 | 162,947.17 |
| **Vilafranca** | 26,017.50 | 45,898.35 |
| **Vilanova** | 5,234.50 | 10,694.93 |
| **TOTAL** | **448,475.14** | **742,336.28** |

Sources: our own, based on the Statistics of production and consumption of cereals, and on the information of areas and productivity compiled by the *Junta Provincial* for the study of the production and consumption of cereals in Barcelona.

Table 3 allows us to compare the estimates of the production as registered in the statistics with our own figures, obtained from data concerning population, cultivated land and yields. In favour of our swollen figures, it may be said that the commission responsible for elaborating the statistics mentioned that production in various district councils had been undervalued when registered. Table 4 has also permitted us to contrast our own estimates of the cereal production of the province of Barcelona in the mid-nineteenth century with other sources or historical studies of the same period, or from the beginning of the twentieth century.

| **Table 4.** ***Other estimates of wheat production in the province of Barcelona between the mid-nineteenth century and the beginning of the twentieth century*** | | | |
|---|---|---|---|
| | **Wheat production in hectolitres** | **Rye production in hectolitres** | **Production of wheat and rye[16] in hectolitres** |
| *Our modification of the data of the* Junta Provincial *(1859-67)* | | | 742,336.0 |
| *Avance* (1885-90) | 668,136.0 | 137,804.0[17] | 805,940.0 |
| Customs Report (1890-94) | 679,315.0 | | |
| Public Finance delegates (1895-96) | 844,615.0 | | |
| GEHR (1890-94) | 686,737.7 | 124,744.6 | 811,482.3 |
| GEHR (1895-99) | 680,374.1 | 103,296.4 | 783,670.5 |
| GEHR (1900-04) | 953,849.7 | 93,165.7 | 1,047,015.4 |
| GEHR (1905-09) | 545,333.1 | 66,440.5 | 611,773.6 |

Sources: Simpson (1989 y 1995), Morgades (1935), Junta Consultiva Agronómica (1904-06), Dirección General de Aduanas (1896), Comisión extraparlamentaria (1910), GEHR (1991), and the information of areas and productivity compiled by the Junta Provincial (1859-67) for the study of the production and consumption of cereals in Barcelona.

We believe that the results obtained confirm the validity of our estimates of cereal production. The fact that some figures are inferior to the ones obtained at the turn of the century makes sense, because it was precisely at that time when vineyard specialization was abandoned due to the phyloxera crisis and probably sown land increased. So that our estimates, modified with the support of the statistics from the Junta Provincial, have established that local cereal consumption was the one shown on Table 5. The first column indicates the volume of the consumption according to the Junta Provincial statistics. The second column the probable consumption, based on the assumption that each inhabitant consumed an average of 2.4 Hl, a figure generally accepted by most contemporary sources:

[16] In both products we have assumed an equivalence of 78 Kg by Hl.
[17] It includes more than 37,000 Hl sown by mixed cereals attributed to the Vic District Council.

**Tabla 5.** ***Cereal consumption in 1859-67 according to the statistics of the*** **Junta Provincial,** ***and our own modified by assuming a consumption of 2.4 hectolitres per person per year***

| *Sources/ District Councils* | *Total consumption according to the* **Junta Provincial**[18] *in hectolitres* | *Ditto per inhabitant a year Hl/inhabitant* | *Total consumption according to our own swollen data assuming a per capita consumption of 2.4 Hl/inhabitant/year* |
|---|---|---|---|
| **Arenys de mar** | 73,014.4 | 1.82 | 96,283.2 |
| **Berga** | 61,409.0 | 1.57 | 93,741.6 |
| **Granollers** | 85,633.6 | 2.23 | 92,044.8 |
| **Igualada** | 103,674.3 | 2.11 | 118,123.2 |
| **Sant Feliu Llobregat** | 117,128.6 | 2.68 | 104,817.6 |
| **Manresa** | 107,478.2 | 1.92 | 134,438.4 |
| **Mataró** | 56,416.0 | 1.35 | 100,557.6 |
| **Outskirts of Barcelona** | 83,431.7 | 0.32 | 632,844.0 |
| **Terrassa** | 106,137.7 | 2.06 | 123,482.4 |
| **Vic** | 108,995.1 | 1.81 | 144,326.4 |
| **Vilafranca** | 45,711.0 | 1.48 | 74,294.4 |
| **Vilanova** | 47,127.9 | 2.12 | 53,289.6 |
| **TOTAL** | **996,157.4** | **--** | **1,768,243.2** |

Sources: our own, based on the Statistics of production and consumption of cereals, and on the information of areas and productivity compiled and duly modified, of the *Junta Provincial* for the study of the production and consumption of cereals in Barcelona.

On Tables 6 and 7 we have compiled the existing information concerning the trade of cereals and flour used in the bakery industry during the mid-nineteenth century, so as to be able to contrast our estimates of the volumes of imports required to meet local consumption.

[18] There are some differences in consumption of cereals reckoned in this data coming from the Provincial Statistics, that can be partially understood as a result of the absence of Barcelona city and other medium-size towns like Vic or Mataró.

| **Table 6.** ***Net entries by coastal trading of cereals and flour into the province of Barcelona during the mid-nineteenth century*** | | |
|---|---|---|
| **Period** | **Hectolitres** | **Source** |
| **1845-47** | 468,871 | Figuerola (1849) |
| **1846** | 714,243 | *Información arancelaria de cereales y de lana, 1847*, quoted from Garrabou (1979) [only wheat and flour] |
| **1859-63** | 810,487 | quoted from Garrabou y Sanz (1985) |
| **1862-64** | 624,538 | quoted from Pere Pascual (1990) |
| **1875-79** | 124,897 | quoted from Garrabou y Sanz (1985) |
| **1884-85** | 111,384 | quoted from Pere Pascual (1990) |
| **1885-89** | -148,935 | quoted from Pere Pascual.(1990) |
| **1885-89** | -169,397 | citado en Garrabou y Sanz (1985) |
| **1890-94** | -806,461 | Dirección General de Aduanas, *Informe sobre producción, consumo y comercio* (1896) |
| **1890-94** | -796,205 | quoted from Garrabou y Sanz (1985) |
| **Table 7.** ***Net entries by railway of cereals and flour into the province of Barcelona during the mid-nineteenth century (given in MT in the original source ).*** | | |
| **Period** | **Hectolitres** | **Source** |
| **1862-64** | 232,615 | |
| **1870-74** | 483,846 | |
| **1882-86** | 126,614 | |
| **1884-85** | 221,192 | quoted from Pere Pascual (1990) |
| **1890-94** | 645,384 (only wheat) | Dirección General de Aduanas, *Informe sobre producción, consumo y comercio* (1896) |

Sources: our own based on the ones mentioned on the right hand column.

According to these figures net imports of cereal and flour may have amounted to 1,043,102 Hl per year during the period (1860-70), 810,487 Hl may have come by coastal trade, and the remaining 232,655 Hl by railway. As can be seen on Table 8, the imports we have believed to be necessary to meet local consumption, based on the modified data from the statistics of 1859-65, may have also amounted to practically 1,091,804 Hl per year:

| **Table 8.** ***Degree of trade coverage of the provincial consumption of cereals and M-X balance, according to the statistics of the*** **Junta Provincial de Barcelona** ***in 1859-67 and our own rough estimates*** | | | | |
|---|---|---|---|---|
| ***District Councils*** | ***Total consumption (modified by assuming a consumption of 2.4 Hl/inhabitant)*** | ***Coverage degree by the provincial production of the regional consumption of cereals in %*** | ***Imports (M) – exports (X), (assuming a yearly consumption of 2,4 Hl/inhabitant)*** | ***M-X according to the Statistics of the production and consumption of cereals in Barcelona*** [19] |
| **Arenys de mar** | 96,283.2 | 32.6% | 64.881,4 | 49.092,4 |
| **Berga** | 93,741.6 | 81.4% | 17.473,8 | 16.800,5 |
| **Granollers** | 92,044.8 | 97.8% | 2.014,2 | 7.143,6 |
| **Igualada** | 118,123.2 | 34.2% | 74.114,6 | 77.656,8 |
| **Sant Feliu Llobregat** | 104,817.6 | 51.7% | 50.608,9 | 47.068,1 |
| **Manresa** | 134,438.4 | 53.5% | 62.577,2 | 87.434,2 |
| **Mataró** | 100,557.6 | 20.4% | 84.660,2 | 50.278,7 |
| **Outskirts of BCN** | 632,844.0 | 4.5% | 604.123,2 | 519.068,4 |
| **Terrassa** | 123,482.4 | 39.6% | 74.629,4 | 81.027,7 |
| **Vic** | 141,744.0 | 102.1% | -26.359,9 | 6.400,2 |
| **Vilafranca** | 74,294.4 | 54.6% | 19.583,0 | 19.693,5 |
| **Vilanova** | 53,289.6 | 17.1% | 44.165,7 | 41.893,4 |
| **TOTAL** | **1,765,660.8** | **42.0%** | **1.072.471,5** | **1.003.557,5** |

Sources: our own, based on the Statistics of production and consumption of cereals, and on the information of areas and productivity compiled and duly modified, of the *Junta Provincial* for the study of the production and consumption of cereals in Barcelona.

Besides estimating the balance of trade of cereals, Table 8 allows us to confirm that our own figures coincide to a great extent with the ones of the *Junta Provincial*, and with the net entries of coastal trade and railway. With all this data at hand, we may finally calculate the degree of cereal consumption coverage by local production, and indirectly the degree of trading of the main products that the agrarian production yielded. With the exception of the district council of Vic, which registered a modest surplus, the remaining district councils were obliged to import cereals in order to meet their needs. For some of them, the amount of imports was small, but a great many of them imported more than half of what they needed, and in some cases imports supplied 70-80 % of their needs.

This estimates regarding the degree of cereal consumption coverage by local production have allowed us to come up with two important conclusions. First, that the land sown with cereals had been reduced considerably in the province of Barcelona between 1859-67 owing to the major role played by vineyard specialization, which took

[19] We have added to the Provincial Statistical data the imports corresponding to the Barcelona city, assuming a yearly per capita consumption of 2.4 Hl.

up a greater share of the land. Second, that an important number of farm units had switched partially or totally from agricultural production to vineyard specialization, thus abandoning polycultivation as a means of self-supply. This reduction in the production of cereals for their own subsistence, forced them to seek this product in the markets. The fact that local cereal production in the province of Barcelona could only meet 42% of the needs, becomes an apparent figure of the low coverage degree of the regional consumption by the agrarian production and the corresponding high dependence upon market for their staple consumption already reached in the mid-nineteenth century.

**Table 9.** ***Land allocated to vines and cereals in the district councils of the province of Barcelona between the 1850's and 1880's***

| *District Councils* | *during the 1850s, according to* **Llovet Mont-ros** | | | *Hectares planted with vineyards (in the 1880s, according to* **Roig Armengol***)* | *New plantations of vines between the 1850s and the 1880s, in hectares* |
|---|---|---|---|---|---|
| | *Hectares sown with cereals* | *Hectares planted with vineyards* | *Number of hectares sown with cereal for each planted with vineyards* | | |
| **Arenys de mar** | -- | -- | -- | 4.183 | -- |
| **Berga** | 8,646 | 328.6 | 26,3 | 1.252 | 923,4 |
| **Granollers** | 13,236 | 5,265.5 | 2,5 | 7.404 | 2.138,5 |
| **Igualada** | 9,456 | 16,196.8 | 0,6 | 20.450 | 4.253,2 |
| **Sant Feliu Llobregat** | 6,358 | 11,092.5 | 0,6 | 14.306 | 3.213,5 |
| **Manresa** | 8,582 | 18,505.1 | 0,5 | 27.714 | 9.208,9 |
| **Mataró** | 6,067 | 5,729.8 | 1,1 | 7.319 | 1.589,2 |
| **Outskirts of Barcelona** | 2,240 | 848.9 | 2,6 | 2.928 | 2.079,1 |
| **Terrassa** | 6,485 | 16,181.9 | 0,4 | 20.258 | 4.076,1 |
| **Vic** | 17,213 | 194.4 | 88,5 | 329 | 134,6 |
| **Vilafranca** | 7,276 | 15,717.6 | 0,5 | 19.704 | 3.986,4 |
| **Vilanova** | 2,121 | 5,264.5 | 0,4 | 5.770 | 505,5 |
| **TOTAL** | **87,680** | **95,325.6** | **0,9** | **127.434** | **32.108,4** |

Source: Llovet Mont-Ros (1948), Roig Armengol (1890) and our own estimates.

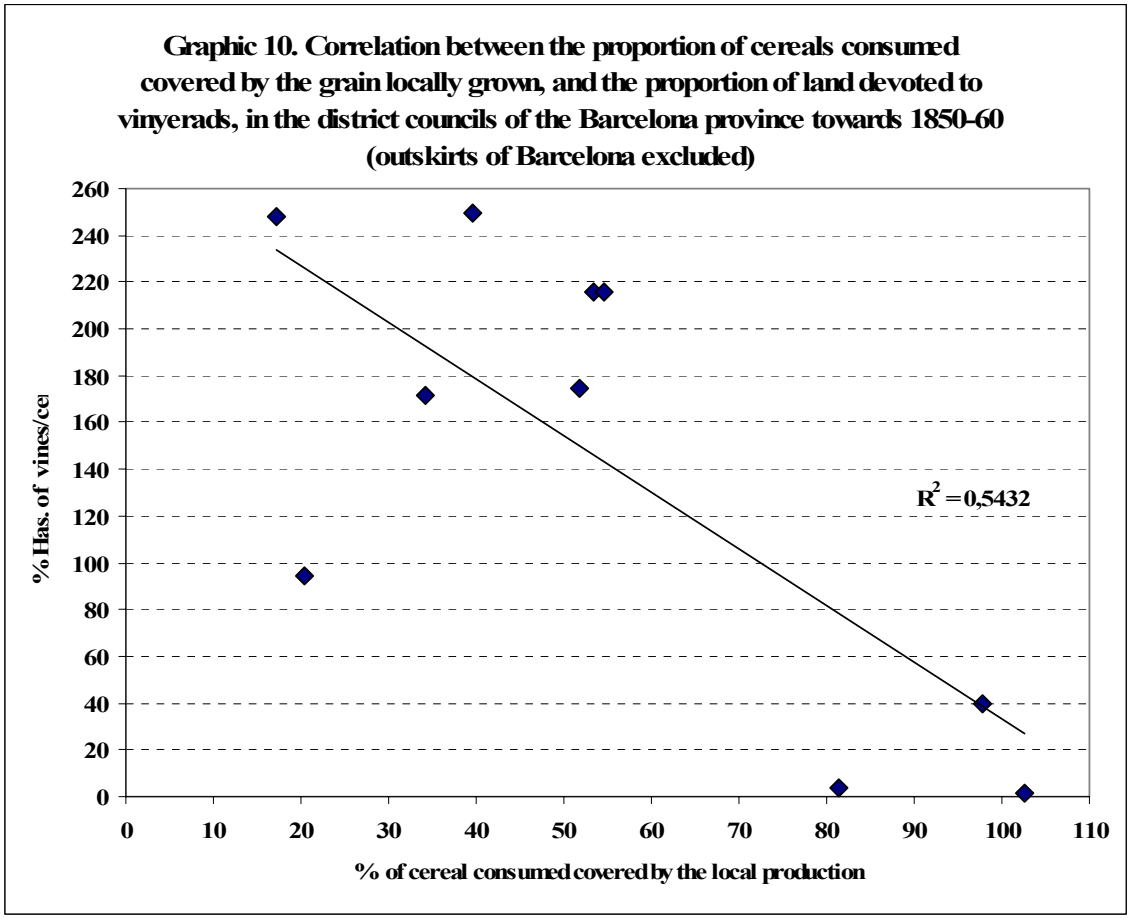
Vineyard specialization must have acted as the first driving factor to have caused such a high degree of trading. As can be seen on Table 9, the number of Has of land planted with vines, exceeded those sown with cereals and legumes in the province of Barcelona in the mid-nineteenth century. Furthermore, when French vineyards were infested by the phyloxera in 1867, this unleashed a vineyard rush among peasants who pushed the number of Has of land planted with vines 34% higher. This frenzy wave of wine specialization which lasted until the 1880's had a distinct geographical pattern. The wine fever was less intense in the counties which towards 1850-1860 had first reached a high degree of specialization, and whose vineyard plantations already doubled the ones

allocated to herbaceous cultivation, like Garraf (Vilanova District Council), Vallès Occidental (Terrassa), Penedès (Vilafranca) and Bagès (Manresa). It was only slightly intense in those districts whose lands allocated to cereals represented 60% of the one allocated to vines, like Baix Llobregat (Sant Feliu) and Anoia (Igualada). For the case of the Maresme (Mataró), one of the oldest county specialized in wine production, we mention that land allocated to vineyards and cereals was equal towards 1850 and the proportional increase was also slow afterwards. On the other side, for the Vallès Oriental (Granollers) and in the surroundings of the city of Barcelona, land allocated to cereals was then two and half times bigger than the one allocated to vines giving a wider room for the newly planted vineyards. Finally, in the inland counties Bergadà (Berga) and La Plana de Vic, which were colder and more humid, cereals and legumes predominated.

Between the mid-nineteenth century and the phyloxera crisis, 32,000 additional hectares of vineyards were planted in the province of Barcelona. The major increases measured in absolute values corresponded to the counties of the Bages (Manresa), Anoia (Igualada), Vallès Occidental (Terrassa) and Penedès (Vilafranca). These counties, which already had a clear vineyard specialization, may have probably sacrificed woodland for the sake of gaining land for vineyards. The rather comparatively low increases registered in the Garraf (Vilanova) or the Maresme (Mataró), after having been the first ones to switch to vineyard specialization, may suggest that there was no extra land available to increase vineyard plantations, and also of the convenience to maintain a minimum amount of land allocated to cereals and legumes. Between these two values, vineyard plantation was also quite relevant in the counties of Baix Llobregat (San Feliu), Vallès Oriental (Granollers) and in the outskirts of Barcelona. Notwithstanding that the land allocated to vineyards tripled in the Bergadà (Berga), and in La Plana de Vic it increased by 70%, their contribution to the global wine production of the province of Barcelona remained marginal.

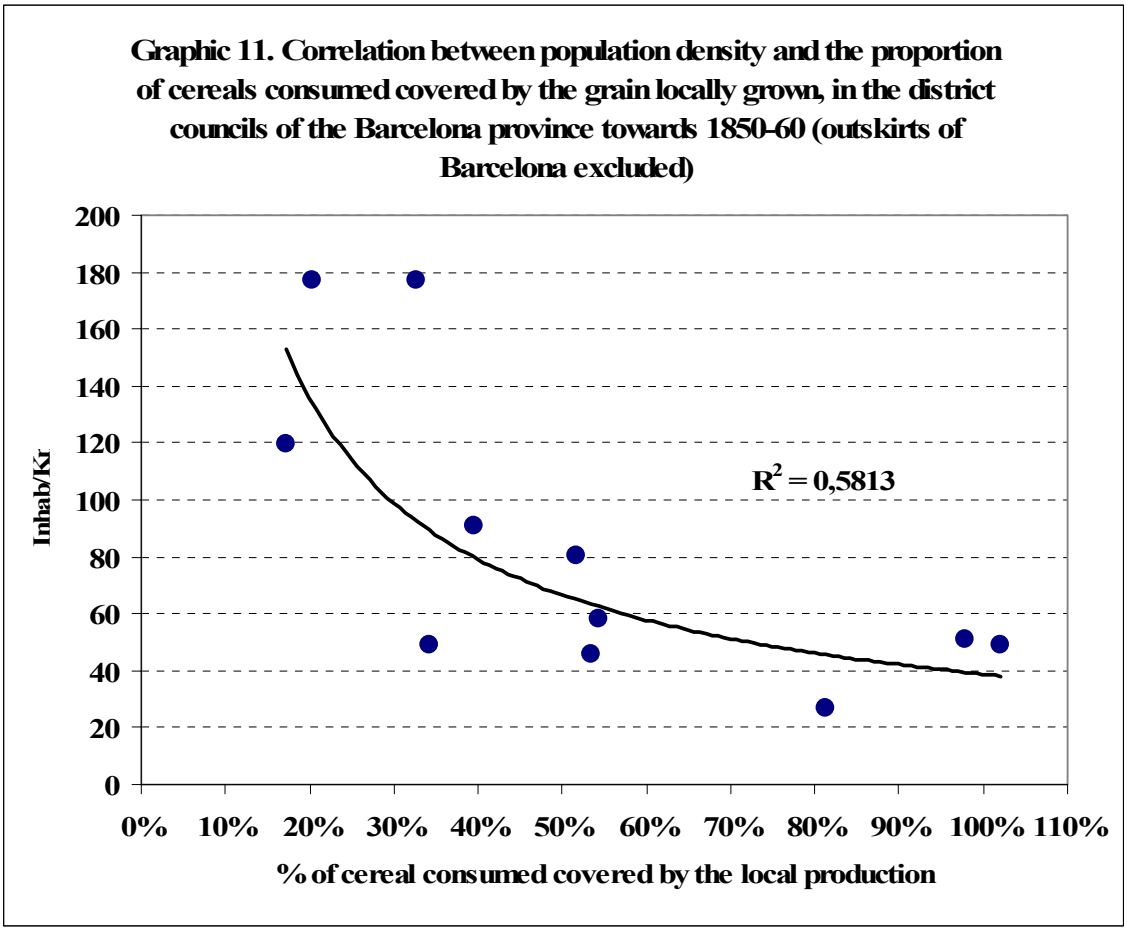
Logically, district councils which had the highest degree of vineyard specialization coincided with the ones that registered the lowest coverage of local consumption by locally grown cereal production. As can be seen on the Graphic 10, excluding the extreme case of the outskirts of the city of Barcelona, there exists a weak correlation between the percentage of land allocated to vineyards and the safeguard of local cereal consumption by regional production. District councils with a still low number of vineyards (Granollers) or marginal (Berga and Vic) registered a high local coverage, and (Vic) even had a slight surplus. On the contrary, in counties where land

allocated to vineyards equalled the one allocated to cereals, as in the case of (Mataró), or greatly exceeded it (Igualada, San Feliu de Llobregat, Manresa, Vilafranca, Terrassa and Vilanova), it was necessary to import between 50% to 80% of the grain and flour locally consumed:




Sources: our own based on the data of Tables 8 and 9.

However, this correlation is not as strong as was expected at first. The explanation lies on various factors: edaphoclimatic characteristics, different soil yields, the intensity degrees of land cropping and percentage of population involved in industry or services. The different levels of population density in the counties exerted a strong influence on these factors, as shown on Graphic 11:




Sources: our own with the data of Table 8 and the population census.

We find worth mentioning that this light relationship between the population density and the coverage degree of cereal consumption by local production, seems to reach a breaking point near the 60-70 inhab/Km$^2$ density. Above this point, reduction of the coverage accelerates to levels close to 20% where it seems to remain stable. As a result the relationship "curves". This curving could be explained for two reasons. The first, the threshold level of 64 inhab/Km$^2$, equivalent to one and a half Has per person, was pointed out by Ester Boserup as being a critical level beyond which transition from a highly intensive agrarian economy to an urban-industrial one would occur, thus forcing the need to import practically all its staple food.[20] The second, most cities have maintained until recent times an agricultural belt which bore no relationship with the number of inhabitants living in them. This cropped belt depended basically on the size of the township and the longest distance to toil the land that was considered to be energetically or economically feasible. This would explain why in counties with a high

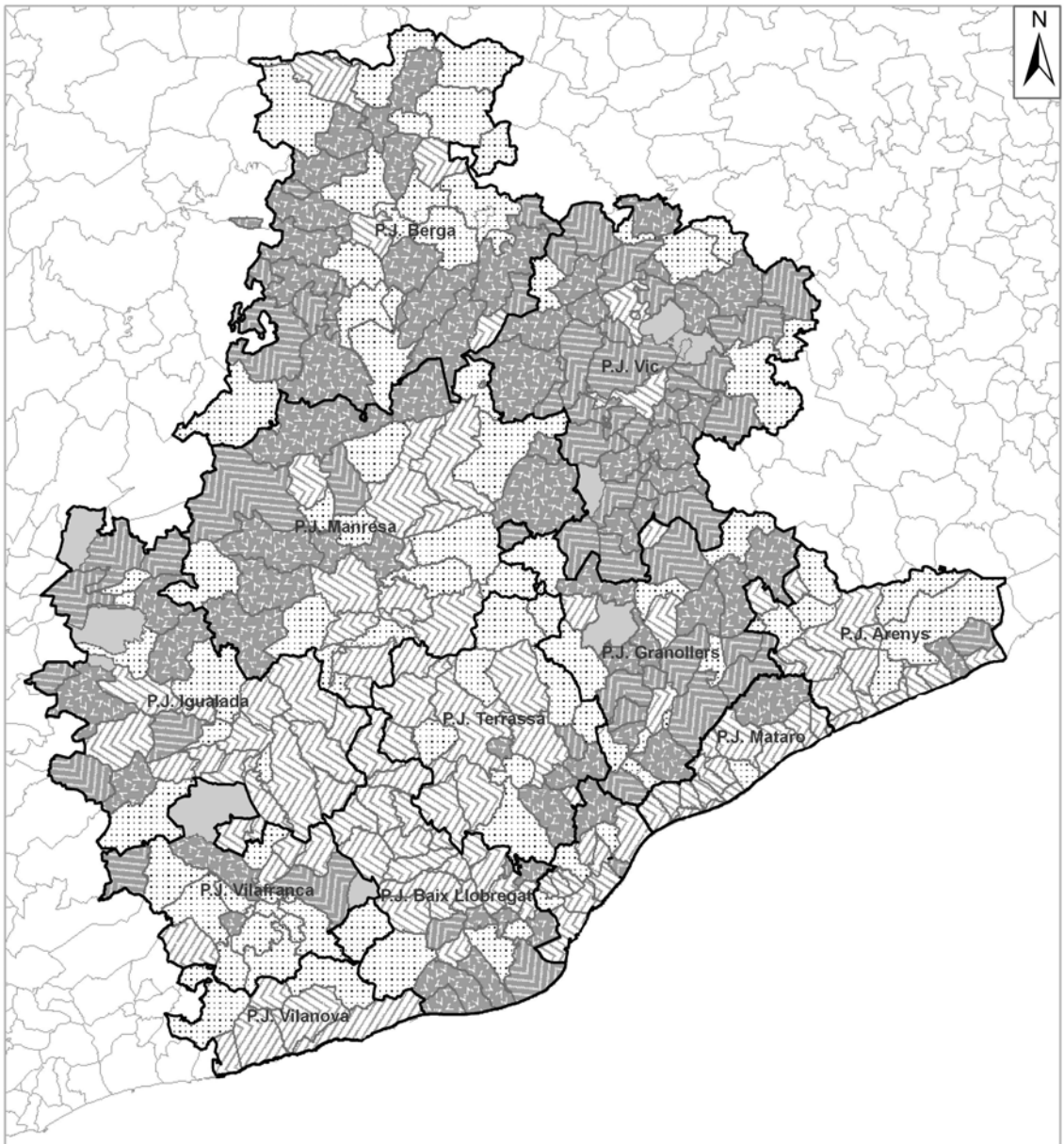
[20] Boserup (1981).

degree of vineyard specialization, such as Garraf (Vilanova) and Maresme (Mataró), the coverage degree by locally grown cereal did not fall below 20%. So that we may identify vineyard specialization, increase in population density, or high degrees of urbanization and industrial developments to be other driving factors responsible for the reduction of the coverage of grain or flour consumption by the local cereal production.[21]

It is only when we analyse the complex interaction of all these socio-economic factors i.e. population density, degree of vineyard specialization, role of urban population and non-agrarian activities, together with their characteristic geographical patterns, that the differences in the degree of marketing of the agrarian production of the various counties and townships become apparent. The shortage of cereals to meet local consumption in the various townships is shown on Map 12.

[21] We have studied in depth the weight of industrious or industrial activities, together with agricultural work and domestic chores, applying the methodology of time and land budgets on an overall time balance (LTB analysis) in our case study in the Vallès county (Garrabou, Tello and Cussó, in print).

**Map 12.** ***Shortage degree in the production of cereals to meet local consumption in the municipalities and district councils of the province of Barcelona according to the statistics of the Junta Provincial modified by us (1859-67)***



Source: our own, made out with the municipal data in the Statistics of production and consumption of cereals compiled by the *Junta Provincial* in 1859-67, after being duly modified following the same methods explained in Tables 1 to 9.

As shown in this map, municipalities that could still produce any surpluses of wheat or rye, once their needs were met, lay in the mountainous regions of the pre-littoral hillside (Granollers), in some isolated parts of the littoral hillside (Vilafranca, Mataró and Arenys) or around the deep valleys of the counties of Anoia (Igualada), Bagès (Manresa), Bergadà (Berga) and very particularly in La Plana de Vic. The only exception to this rule was found to be the fertile land of the Llobregat Delta. So that we can see that this distribution, with all its local peculiarities, matched the one vineyard specialization in the mid-nineteenth century compounded. Particularly in municipalities or counties with a population density range equal or lower than 60 inhab/Km$^2$ (Graphic 11). Undoubtedly, vineyard specialization was the overriding factor that caused the degree of marketing of staple agrarian products to fluctuate from a shortage of cereals between 20-50% or to a slight surplus.

Thus, we come to the conclusion the rapid growth that the process of vineyard specialization took in the province of Barcelona in the mid-nineteenth century must have exerted a strong influence on the cereal market, closely linked to the exports of wine or liquor. To allow such an important number of peasant farmers to switch from sowing cereals to planting vines, it must have been indispensable for food imports to have been fluid, safe and economical. Even as far back as in the Middle Ages, but more so by the end of the eighteenth century, the marketing of cereals in Barcelona constituted a major lucrative activity. The foreign cereal was at first consumed in the city of Barcelona, but gradually it became accessible to the nearby towns and counties where vineyard specialization was taking a major role.

A great deal of this imported cereal came from the Mediterranean or the Baltic Sea through Holland.[22] Pierre Vilar and Josep M. Fradera have estimated that at the beginning of the nineteenth century cereal and flour imports amounted to approximately 350,000 Hl per year. When in 1820 cereal imports were prohibited, the "ecological footprint" of this regional economic development extended to the inlands of Spain: Aragon, the two Castillas, Extremadura and even partly Andalusia became the new

[22] Vilar (1966); Fradera **(**1987); Valls (2003); Garrabou, Manera and Valls (2006:249-304).

supplying centres of cereals.[23] We have already mentioned that in the mid-nineteenth century net entries of cereals into the province of Barcelona, either by coastal trade or railway exceeded one million Hl. An amount which tallies with the shortage we have estimated based on the modified 1859-67 municipal records. This means that vineyard specialization in this part of Catalonia required for its mainstay at least 100,000 Has of "ecological footprint" from the inlands of Spain.

From an exports point of view, vineyard specialization required markets to be wide enough so that their surplus could find a place in them. Between the seventeenth and eighteenth century wine and its secondary products, particularly liquor, had become leading products in the markets of Barcelona. Pierre Vilar, Josep M. Fradera and Francesc Valls, have explained that from the beginning of the seventeenth century important amounts of liquor were exported from Catalonia to the Atlantic Europe, while in the mid-nineteenth century exports to Great Britain, Holland, the north of France and the Spanish colonies in America gained a rapid growth. When the deep commercial crisis that broke out in the first decade of the nineteenth century forced liquor prices to fall because of a severe lack of demand, wine exports became the pillars on which Catalan exports to American markets settled upon. Towards 1820, part of the liquor extractions were sent to Cantabria and Andalusia thus balancing the wheat imports that were coming from the inlands of Spain.[24]

However, as Pere Pascual, Josep Pujol and Francesc Valls have proven, the liquor crisis in the beginning of the 19$^{th}$ century was largely overcome owing to the wine exports to the last redoubts of Spanish colonies in America, Cuba, Puerto Rico, and even Brazil and the River Plate. This was probably the driving force that pushed vineyard specialization, previously limited to the littoral counties of Barcelona and Tarragona, into the inland of Catalonia. Vine plantations, either substituting land previously allocated to cereals or woodland, rapidly spread along the counties of the Penedès, Anoia, Bages, the Vallès Occidental and the Baix Llobregat. Parallel to this process, a more dynamic wine market was formed, which supplied wine not only to Catalan counties with a scant production but to far-away markets as well.

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[23] The historical use of the concept of "ecological footprint", or a "ghost acreage" that supplied "extra-territorial dietary resources", can be found in Ross (1987), Pomeranz (2000) and Sieferle (2001). For the accounting methods to calculate historical ecological footprints see Haberl, Erb and Krausmann (2001:25-45).

[24] Pujol (1984:57-78); Fradera (1987), Valls (2003), Pascual (1990 y 2000) and Garrabou, Manera and Valls (2006:249-304).

From the small peasant's point of view, it can be said that vineyard specialization prevailed because the economic results obtained were clearly superior to the ones obtained from cultivating cereals, at least in poor quality soils.[25] Though it also must be brought to mind that large or middle-size owners of polycultivating farms (*masies*) forced small peasants to plant vines by means of a leasing contract. This tenancy, known as *rabassa morta*, was an emphiteutic copyhold contract which obliged peasants to plant vines exclusively, and it expired when these died. As Pierre Vilar pointed out, rather than stemming from exact calculation in order to achieve the highest rent, vineyard specialization seems to have come about as a result of a long process of spontaneous adaptation.[26] We believe that among the factors which played an important role in this adaptation, was the need to harness a growing underlying conflict which aroused between *masia* owners and new immigrant levies or descendants with no land inheritance, whose growing numbers were becoming more and more threatening.[27]

*3. Between specialization and globalization: an economic and ecological interpretation of the intensification of the marketing of regional products in the province of Barcelona until the crisis of the turn of the nineteenth century*

As Manuel González de Molina and Gloria Guzmán Casado have formulated, sustainability of an agro-ecosystem does not only depend on the fact that metabolic flows of energy and materials have reached a certain efficient balance to ensure a good ecological state for natural resources, but on its capability to accrue meaningful incomes for peasants so as to prevent social unrest as well.[28] In our case study of the province of Barcelona, we have found out that agrarian systems that became highly specialized in vineyards remained profitable as long as the demand kept a high relative price for the wine. When the phyloxera crisis broke out, this situation changed drastically, because the replanting following the death of all the old vines was carried out under a new unfavourable context, were worldwide wine prices had fallen sharply and overproduction was dominant in an already global market. This devaluation rendered

[25] Colomé and Valls (1994:47-68).
[26] "*The coastal situation of Catalonia offered an opportunity: importing and exporting were feasible solutions. Importing wheat, to avoid shortages. Exporting wine, to sustain the prices. But we have to notice that these was not a pure rational operation of compensation, although several contemporary texts claimed for its virtues; instead, it had to wait for an spontaneous adaptation that it was already in motion between 1674 and 1710, or even before*" (Vilar, 1966:629).
[27] Garrabou and Tello (2004:83-104).
[28] González de Molina and Guzmán (in print).

vineyard plantations economically unsustainable in practically the whole area of the province of Barcelona, so that farmers had to resort again to sowing, livestock breeding or woodland.

From the point of view of equality, we would like to stress that the *rabassa morta* contract had enabled a number of peasants who had no land or hardly any, to gain access to temporary ownership of land. It also allowed them to earn as tenants higher incomes than the ones they could obtain selling their labour in return for wages, or either cultivating less profitable crops. This bounty situation changed drastically when the phyloxera crisis broke out causing wine prices to fall sharply, thus forcing many of these small winegrowers to give up planting vines. While some of these peasants renounced the ownership rights stated in the *rabassa morta* contract, and sought jobs in the nearby new-born industries, others fought a desperate legal battle in order to gain recognition of these rights of property over the vineyards they had planted. As a result a long period of social unrest ensued in most of the areas were vineyards had been planted in the province of Barcelona, and in other parts of Catalonia as well.

The new hard market conditions in which wine production had to be carried on after the phyloxera crisis, shrunk even more the profit margins of these small winegrowers. The decline in the relative price of wine forced them to increase the productivity, using greater amounts of fertilisers and pesticides. These chemicals were scarce locally, whilst imported ones were soaring in price. Thus, a new widening gap in the economic and environmental conditions was opened. On the one hand, peasants had to rely heavily on high-cost imported new chemicals. On the other it made some of the farm units economically precarious or unfeasible.

As we have seen, from an ecological-economic perspective, market networks constituted a double-edged sword. In the Mediterranean context, at least at first, development of a wine growing, or oil and almond growing too, entailed to take advantage of an ecological optimum, owing it to the increasing integration into the market networks that, at the same time, allowed a supply of cereals and legumes being regular and price-stable enough to rely on this staple food imports.[29] However there are also environmental reasons that let us to assume that any process of vineyard, oil or dry fruit specialized growing that became close to monocultivation, would led to an inevitable deterioration in the final energy performance of the agrarian system.

[29] This notion of ecological optimum in land uses can be seen in Grigg (1982:45-67). The historical process of grain market integration in Europe can be seen in Persson (1999).

Furthermore, it would also render the management of the agro-system more inefficient because it would disrupt the integration between cultivation, livestock breeding and woodland uses.

We can use as a good example of that turning point the energy return on energy inputs (EROI) of 1.67 attained in a Catalan case study of the Vallès county towards 1860 that we have carefully studied.[30] That high EROI could only have been maintained if all the branches pruned from the vineyards were used as fuel, serving as a substitute in the absence of firewood following the loss of woodland to the growing number of vineyards. This was probably the case while the agrarian system remained one based on polyculture, wine being only a partial specialization that coexisted with many other land uses in a diverse agrarian mosaic. Such an agro-ecological patchwork would fit with the interpretation put forward by a number of landscape ecologists who see the replacement of woods with vineyards, and olive or almond trees, as a sound human adaptation to the Mediterranean environment.[31]

We may also wonder if in any measure, or to what extent, this specialized vineyard process may had disrupted its sustainability by turning agro-systems more and more dependant on foreign imports of biomass, especially cereals. Some authors, relying on ecological economics or environmental history, formulate that marketing and specialization processes can only exist as long as there is an unfair trading, with inputs and biomass coming from other territories which entails a concealed ecological debt.[32] But we had to we aware that such an unfair trade between highly specialized agro-systems would occur or not depending on the favourable or unfavourable slant in the relative prices, and it would be reflected on the corresponding "ecological footprint".

Since the process of vineyard specialization that took place in the province of Barcelona only became viable owing to the cereals and legumes imports, we may also ask ourselves whether the trade it ended up establishing with inland Spain was unfair as well. We might also ponder that, for the same reason that vine spread in Catalonia was decided because it was a more profitable crop, the other inevitable side of the coin had to condemn inland Spain to become specialized in less profitable crops, as had occurred in Russia and other Mediterranean countries as well, whose outcome may have well originated a divergence in their long-term economic path of development. Though many

[30] Cussó, Garrabou and Tello (2006:49-65).
[31] González Bernáldez (1981 and 1995:131-149).
[32] This is what suggest Gonzalez de Molina and Guzmán Casado (in print), in his historical case study on the lowland of Santa Fe in the Andalusian province of Granada.

examples taken from the past and present times seem to comply with this formulation, it is also important to mention that there exist other historical cases, like the Nordic countries and the United States, where an initial process of specialization such as the exports of primary products did not act as a barrier for its further economic development.

Are we actually facing a situation of unfair trade and ecological debt, or an opportunity which could be mutually beneficial? Did the increasing demand for cereals that Catalonia exerted over inland Spain actually discard other possibilities of intensive cultivation and specialization in this regions, or did it act as a favourable stimulus? Traditionally exports of cereals from inland Spain to its periphery have been viewed by historians as a path that led to agrarian development, instead as a negative disruptive factor. Prior to the prohibition laws of 1820, the agricultural production of Castilla and Extremadura had no markets were to place their surpluses, hence there were barely no incentives to increase their production. The consolidation of a wheat market, that span the whole of the Peninsula, opened a new outlet for this inland production which fetched better prices. This new situation generated stimuli that increased agrarian productivity. If we were to argue that the success of this wheat market may have inevitably acted as an obstacle to prevent the inland region of Spain from becoming specialized in more profitable crops, then we should bring to mind that specialization processes require powerful market networks in order to place supplies, and in these times the inland region of Spain could only rely on a local markets. This seems to suggest that what matters most, is not so much to precise whether this interchange and the specializations it gave rise to were unfair or not, but the degree which both reached.

Our energy balances also show that if the increase in demand for wine triggered a complete regional specialization in a single export product, as it was the case in some municipalities in the province of Barcelona during the infestation of the French vines with phyloxera between 1867 and 1890, we might consider that this might have led to a shortage of livestock and manure. In such circumstances, the pruning of vineyards might have become a poor substitute for manure, owing to their highly inefficient combustion in *hormigueros* –bonfires in the fields covered over with earth.[33] This would involve a

[33] In Mediterranean environments, summer water stress means that large quantities of dead biomass cannot be fully decomposed, and it tends to accumulate in forests or scrubland until ignited by lightning. This accounts for the fact that Mediterranean forests have always had to coexist with natural fires. The removal of this firewood from scrub and forests in order to burn it in *hormigueros* on the agricultural land, can be seen as a sound human adaptation to these natural conditions. But in order to provide soil nutrients, the

rapid reduction in the EROI index to a value of around one. These local tendencies could have been offset by increasing fertilizer imports, or by substituting tractors for animal traction**;** but, once again, this might have meant increasing the amount of external inputs and assuming the costs caused by the deterioration of the return on the energy invested.

In other words: the ecological virtues of growing wine, oil, almonds or hazel nut plant, so characteristic of the Mediterranean agrarian area, could only be kept as long as they remained integrated to a diverse polycultural mosaic, like the one practised in the *masies* of the Vallès until the mid-nineteenth century.[34] When this stage was overcome by a monocultural specialization which grew rapidly in some areas, it may have caused in these cases the nutrient and energy cycles to disintegrate in the territory. Anyhow, our estimates of the degree of trading of the agrarian production in the whole of the province of Barcelona during the second half of the nineteenth century, seem to indicate that despite the sharp growth in the process of vineyard specialization the cereal and legume production did not disappear entirely. Although in some municipalities monocultivation became a reality, it must be said that it remained local in character. Rather than ending traditional Mediterranean polycultivation, this process of vineyard specialization tended to increase its radius to a regional scale. Undoubtedly, this must have provoked important changes to the agrarian landscape, i.e. a great number of even patches of vines covered the plains and hillsides, which could offer no biological resistance when were hit by the unbeatable advance of the phyloxera plague.

However, seen from a wider scale, it does not seem likely that this relatively brief episode of monocultural growth could have spoiled entirely the diverse agrarian soil uses and the integrated management of the West Mediterranean territory. In spite of the paramount importance of the vine spread, no clear evidence has been found so far to prove that during the second half of the nineteenth century it could have caused an agro-environmental damage so severe that led to a serious soil degradation and a decrease in land fertility. Though nutrient exports were scarce, cereal yields in the whole of the North-West Mediterranean area seem to have been kept stable in a relatively high levels

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burning process was a much more inefficient way of decomposing biomass than a humid process using compost or manure.

[34] The polycultural diversification kept by the traditional Catalan farms (*masies*) until the middle of the 19th century should not be confused with a close autarkic economy. It had been for a long time compatible with some degree of partial specialization that activated local and regional commercial networks, although they were nearer and different in nature than the wider ones triggered off by, for example, the opening of the new railways between Barcelona and Granollers in 1854, Barcelona-Terrassa in 1856, or the narrow gauge branch-line between Granollers and Caldes de Montbui in 1880 (Pascual, 1990 y 1999; Garrabou, Planas and Saguer, 2000 and 2001).

without suffering sharp falls. Cereals and legumes were the main crops which might have been affected by the shortage of fertilisers, because vineyard specialization saved on manure except for the time when vines were first planted. At the same time vine shoots and leaves, together with the pruned fresh branches of oil and almond trees, were used as substitutes for the firewood and pastures no longer available from the woodland and untilled land. Although the increase of the population and trading pushed the spread of the cultivated area, vineyard specialization helped in fact to reduce the pressure exerted on the nutrients' bottleneck. The spread of vines towards poor sloping soils also involved a huge amount of peasant labour investment in land terracing, in order to preserve them from erosion.[35]

This arises a very important question for the European and global environmental history: to what extend the labour and land intensive agricultures developed in the most market-integrated and populated regions of Europe reached or not some unsustainable stages towards 1850, or during the second half of the 19th century, while they still remained mainly organic economies from the energy and material point of view. This involves a big ongoing debate, and requires more specific research, because there is not yet a plain answer. On one side it seems clear that these advanced organic economies exerted an increasing overall pressure over their local and regional biomass resources. Kenneth Pomeranz and Rolf Peter Sieferle have argued so, stressing the fact that only the last resort to fossil fuels, together with the "ghost acreage" provided to England by America and the British Empire, could overcome the unavoidable diminishing returns in that "Smithian-type" of growth, opening a path towards the new "Shumpeterian-type" of development during the industrial revolution.[36]

The impressive study on the aboveground human appropriation of biomass net primary production (HANPP) in Austria from 1830 to nowadays, undertaken by the Social Ecology IFF research group in Vienna, leaves almost no doubt that the pressure on the domestic territories were higher in these European biomass-based economies of the 19th century than at present.[37] But on the other hand, it remains unclear whether that bigger human appropriation of local or regional biomass fluxes led or not to specific ecological stresses that involved some kind of general environmental crisis. Whereas

[35] For a general historical and agronomic approach on terracing, see Blanchemanche (1990). And in our Catalan case study, see Olarieta, Rodríguez and Tello (2006).
[36] See Pomeranz (2000), Sieferle (2001) and Wrigley (2004). The differences between a "Mathusian", "Smithian" and "Shumpeterian" types of economic growth are explained in Vries (2001:177-194)
[37] Haberl, Erb, Krausmann, Loibl, Schultz and Weisz (2001:929-942).

some evidences of that have been found in certain areas or countries, like Denmark, or for some specific sides of the question like deforestation, overgrazing and local soil degradation, there are no clear proofs of a general trend in diminishing agricultural yields.[38] At least by the then most advanced organic agricultures in Europe, the actual challenge seems to have been this other one: how to attain further increases in the higher yields already achieved.

Also in our Mediterranean case study the absence of a generalized environmental stress does not exclude that it may have been present in some extreme local situations. When effectively such a local growing unsustainable situation took place, it could only be countered by increasing the trading and transport bonds mainly with areas which had wider spaces of woodland, bushes or grass, and had developed a complementary cereal specialization. So it could be true that the increase of the entropy in places with greater marketing would have to be compensated with energy imports from far away territories, where the human pressure over the ecosystem would be inferior, as it is usually asserted by some ecological economists. But we have to keep in mind that this would lead to a systematically unfair interchange only if the terms of trade evolved permanently biased in favour of one option and against the complementary one.[39]

Vineyard spread reached its highest point between the phyloxera infestation in France in 1867 and its arrival to the Catalan Vallès county in the 1880's. Following the plague, many plantations which had occupied marginal land were abandoned. As a result, the agrarian landscape of the province of Barcelona recuperated part of its previous polycultural mosaic. This seemingly could have contributed to relax environmental pressures which had been previously generated on the land by the wine rush. But instead, a series of powerful driving forces contributed later on to put an end of advanced organic agriculture which had developed in the Western Mediterranean area, thus initiating the greatest economic and environmental rupture ever endured by the millennial history of agriculture.

The first driving factor that contributed to set of this rupture was the then never ending fall in the relative prices of the agrarian products. Once the whole production was placed in global markets, there were no turning back. The only viable response to this deterioration in the terms of trade consisted in increasing the production per unit area, up

[38] Blaikie and Brookfield (1987); Kjaergaard (1994); Ambrosoli (1997); McNeill and Winiwarter (2006).
[39] See the recent analysis of the long term historical evolution in the international terms of trade during the first globalization process before 1950, in Williamson (2006).

to levels which were hardly sustainable for any traditional agriculture based on organic fertilisers. This forced farmers to seek recourse on mineral fertilisers or synthetic ones, and also to new seed varieties or different livestock breeds. Thus, closing the dependency circle of the peasants to market factors.[40] Another pushing factor towards this new global-type of agriculture, increasingly dependant on fossil fuels, was the building of bigger dams and irrigation works, which also helped to increase the agrarian production and trading.[41] The rise in the population and urbanization increased the shortage of staple food production which came from the inland of the province of Barcelona. Hence, triggering the demand of agricultural raw material which had to come from outside the agrarian sector. The growing availability of cheap fossil fuels also led to transport networks multiplying, while the pressure on the woodlands to seek firewood and fuel diminished.

The final blow to the millennial capacity of the rural world to maintain an integrated management of the territory was rapidly given in the 1950s by the massive spread of technologies of the "green revolution", when dependency on fossil fuels and economic globalisation had completely overcome the previous local or regional circumscription of the main socio-environmental flows. The present low energy return on the energy input of 0.21 that we found in our Catalan case study of five municipalities, would appear to be in keeping with Pfaundler's argument previously discussed in section 1. The most apparent feature in this 1999-2004 energy balance in the Vallès county is the fact that the current energy flows in the eco-system are not in proportion to the territory in which the agro-system takes place.

The metabolic streams are shown to operate in a monoculture system, or in a linear livestock breeding system, that are virtually disconnected with their surrounding environment. It appears that the majority of imported inputs-fertilisers, petrol, fodder, and the like merely passed through a territory that operated as an inert platform, and that they barely interacted metabolically with it. Ironically, the massive consumption of

[40] Van Zanden (1991:215-239); Koning (1994).

[41] Nevertheless, not all the irrigation systems built or enlarged after the agrarian crisis in the end of the 19th century do entailed heavy environmental impacts. For example, the irrigation systems developed in the Catalan Ebro and Llobregat deltas could even imply some ecological improvements through a new mixture of fresh and salty waters in marshlands or bays that increased local biodiversity. In the Catalan county of Camp de Tarragona vineyards were substituted by a hazelnut growing irrigated through and enlarged use of the old Mediterranean technique of "water mines" (*qanat*, *minas* or *foggaras*), that get to the surface small but regular streams from the under-bed water table in order to guarantee a high and regular crop of a shrub that can also be grown using dry-farming (Cuchí, Arcas, Casals, Pagès and Navarro, 2005).

cheap fossil fuels has turned much of the woodland area into a disused derelict space. Here again, we se on that abandonment a very close link between a low energy performance and an inefficient use of the land, both of which giving rise to increasing levels of pollution and ecological degradation –the ecological footprint of what is now known as globalisation.[42]

Thus any discussion of the relationship between markets and ecological impacts cannot be viewed in black and white terms. Depending on the type and on the extent of the markets under consideration, market insertion might promote a greater efficiency of land uses and agrarian biophysical flows, or perhaps just the contrary. A number of current approaches to the relationship between human development and markets in poor developing countries seem to draw similar conclusions, not only in relation to the natural but to the social environments as well. While a network of local and regional markets may have been, and remains, an important tool for sustainable human development, a direct and deregulated connection to globalised markets may sometimes become little more than a trap.[43]

To gain a better understanding of this important question, we should perhaps undertake more historical studies of the past organic agrarian economies from an ecological-economics standpoint, like the early North-West Mediterranean agro-systems here analysed. However, above all else, we need to incorporate transport as a key component in the hidden ecological side that lay beneath any "Smithian" growth fostered by significant increases in urban population, their consumer baskets, and trade. Marina Fischer-Kowalski, Fridolin Krausmann and Barbara Smetschka tackle this important issue by adopting a socio-metabolic approach, and conclude that "the volume of transport necessarily rises faster than both the size of the society (in terms of population of urban centres and their hinterland) and its material wealth, and this not only constrains but limits the possible size of urban populations. The core mechanism behind these limits is the agrarian energy metabolism: In order to overcome distances, agrarian societies need more land to feed the human and animal labour power required for transportation. So they have to enlarge their territory, thereby again increasing the distances that have to be overcome. Fossil fuels provide a two-edged benefit: they allow to span larger distances, and to manage reproduction within a smaller area. So under

[42] Fischer-Kowalski and Amann (2001:7-47).
[43] For an interesting, and at times controversial, economic approach to this issue from an economic historical perspective, see Chang (2002).

industrial conditions, size-constraints for urban centres and for freight transport disappear: transport volumes 'explode'".[44]

In short, on studying the various paths of economic growth taken by early pre-industrial societies from an ecological perspective, we should adopt as our working hypothesis the one outlined by John McNeill: "In any case, human history since the dawn of agriculture is replete with unsustainable societies, some of which changed not to sustainability but to some new and different kind of unsustainability."[45]

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[44] Fischer-Kowalski, Krausmann and Smetschka (2004:307-342).

[45] McNeill (2000:358).

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