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Consumer populations and nutritional transition in Spain in the 20th century: A methodology for their reconstruction[1]

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Abstract

One feature of the modern nutrition transition is the growing consumption of animal proteins. The most common approach in the quantitative analysis of this change used to be the study of averages of food consumption. But this kind of analysis seems to be incomplete without the knowledge of the number of consumers. Data about consumers are not usually published in historical statistics. This article introduces a methodological approach for reconstructing consumer populations. This methodology is based on some assumptions about the diffusion process of foodstuffs and the modeling of consumption patterns with a log-normal distribution. This estimating process is illustrated with the specific case of milk consumption in Spain between 1925 and 1981. These results fit quite well with other data and indirect sources available showing that this dietary change was a slow and late process. The reconstruction of consumer population could shed a new light in the study of nutritional transitions.

1. Introduction

One feature of the modern nutrition transition is the growing consumption of animal proteins. Noteworthy amongst these are the contributions of foodstuffs such as meat and milk. In Western Europe this process was accompanied by changes in the organization of agricultural and livestock farming, as well as in consumption habits, under the momentum of industrialization and urbanization[2]. A quantitative piece of information about consumption patterns is a basic approach in order to illustrate changes in nutritional status.

However, the study of a nutritional change of this nature comes up against a significant limitation. An accurate description of this process requires knowledge, not only of the evolution of average consumption, but also of the number of consumers. If a dietary change is considered in terms of a process of diffusion, it is therefore essential to take both parameters into account. This second

[1] Financial support from the Spanish Ministry of Education. SEJ 2007/60845 Project “Standard of living, health and food: Spain in historical perspective” and HAR2010-20684-CO2-01 Project “Inequality, Standard of living and Health: Spain 19th - 20th centuries”. This WP is related to a previous WP “Población y Consumo. Una Reconstrucción de las poblaciones consumidoras de Leche en España 1925-1981”. UAB. 2009..Some previous results have been changed due to modifications in some criteria used throughout the estimation procedure. The biggest change has occurred in the distribution of consumption for 1954-55.

[2] Popkin, B. M, 1993; Crigg, D,1995

parameter -number of consumers- despite its obvious relevance, is only rarely estimated. The historical statistics permit a mean consumption to be calculated but not the proportion of consumers One of the major consequences is the lack of information about patterns of distribution of food consumption and, then, of the population nutritional status. The hypothesis and the evidence that in the initial stages of industrialization and urbanization that nutritional status was unequally distributed has been topic of intensive research. A way of approaching these difficulties has been the anthropometric perspective, because the pattern of distribution of heights reflects the underlined effects of levels of food consumption plus other environmental factors[3].

The fact that research on the nutritional status of population needs some distributional assumptions is well illustrated by Fogel's article on economics of nutrition[4]. But in terms of empirical research if individual data on consumption is not available, which is the most common in historical studies, the basic indicators stem from aggregate statistics and they compute average levels of consumption. In these cases main differences in indicators are a consequence of the geographical detailed provided by the published sources. Thus, those levels of consumption can reflect averages from local to national level. But, beyond all these spatial scales, these averages have the same problem. If some foodstuff does not have a pattern of universal consumption, the average got from the tabulated data will not estimate accurately the "true" or effective level of consumption. This is because all average ($\overline{X}$) is a division of the whole output consumed by the total population (O/P) and, when the number of consumers is lower than the population as a whole it is easy to see that $\overline{X}$ -statistical < $\overline{X}$ -"true" value. A simple and hypothetical example may illustrate this problem. There are two countries A and B with the same population, one million inhabitants, but different consumptions levels. In country A it is about 70 kg per person per year and 130 Kg in country B. If the proportion of consumers is 50 per cent of the whole population in country A and 100 per cent in B, universal consumption, it is obvious that effective consumption level would be greater in country A (around 140 Kg) than in country B (130 kg). As the historical process shows, not only do changes in consumption involve an increase in the consumption per capita of certain products but also a growing incorporation of new consumers[5]. Because of these two dimensions researchers must be very cautious when they are comparing patterns of food consumption between countries. In fact, without a previous "standardization" (or statistical adjustment) in some basic indicators, such as the means, any conclusion about differences in levels of consumption will be contaminated by differences in the number of consumers.

[3] Steckel, R. and Floud, R, 1997, p.1-16
[4] Fogel, R,1992
[5] A historical perspective on these changes in the demand of goods and the behavior of consumers in De Vries, J,2008. See chapter 4.

This article deals with this problem. First of all it is important to warn that despite the simple way the problem can be set out its solution is not easy. In fact, this article does not provide a complete or "definitive" solution to this problem. It is going to develop a methodological approach under some hypothetical and realistic assumptions with the purpose of estimating this consumer population. Because this kind of population will be different according to the foodstuff consumed this estimating process will be illustrated with the specific case of milk consumption in Spain. The evolution of the consumption of this food covers central years in the nutritional transition in this country throughout the 20th century[6].

This article has three main sections. In the first one, the basic problem is introduced as well as the strategy followed in these pages to resolve it. Then, in the second one, the methodology for correcting and adjusting the average consumption levels computed from the published statistics is presented. Finally, in the third section, the methodology is applied to the Spanish data on milk consumption in order to estimate patterns of consumer population distributions from 1925 to 1981. The main results will be related to the information available on the evolution of milk consumption in Spain in the 20th century. The conclusion briefly summarizes the basic principles and results in the methodological strategy applied with some final remarks on their strengths and weaknesses.

2. Posing the problem and exploring a solution: the case of the evolution of milk consumption in Spain

As it has been indicated in the previous section, the problem and proposed solution will be illustrated by the evolution of milk consumption in Spain between 1925 and 1981. The choice of this food can be justified from three factors - a) Milk is one of the food "indicators" of nutritional transition, because fresh milk is a kind of animal protein. b) As it has been previously pointed out, changes in milk consumption are placed in the central decades of the Spanish nutritional transition c) Basic data are provided by consumption statistics from official sources published in relationship with agriculture and livestock activities. This is not always the same with other foods because the available data used to be published only as statistics of production.

The main type of animal milk consumed in Spain during the period studied here was cow milk. Accordingly, the evolution of the percentage of this type of milk can be estimated at between 79 and 91 percent of the total amount consumed between 1925 and 1981. The rest basically consisted of goat milk. Table 1 shows the mean consumption levels per person and per year and the associated standard deviation, calculated using the provincial data and the mean consumption levels

[6] Cussó, X, 2005. Cussó, X and Garrabou R, 2007.

calculated for the entire Spanish population between 1925 and 1981. These data belong to two kinds of sources: livestock statistics and household budget surveys[7]. The first type of statistics usually provide data about the number and type of livestock, the total amount of production and milk consumption levels from each province, while the second statistics, by their very nature, offer data about the quantities consumed and family expenses. In short, the first group pertain, in chronological order, to the statistics published by the *Asociación General de Ganaderos del Reino* (General Association of Livestock Owners of the Kingdom) in 1925[8], the *Censo de la ganadería en España* (Livestock Census in Spain) with data for 1933[9] and the first data from the new series on direct human consumption of animal milk published in the *Resúmenes estadísticos de la producción, destino y valor de la leche* (Statistical summary of the production, destination and value of milk) from 1954 and 1955, published by the Ministry of Agriculture[10]. In terms of the second group, the data from 1965 and 1981 on the consumption per person per year on a provincial level correspond to those published in the "Household Budget Surveys"[11]. As we can see in this chronology, there is a significant lack of information between 1933 and 1965, this can be explained by the event of the Spanish Civil War (1936-39) and the post war period that lasted until the mid 1950s. The rationing imposed on the population during this period quite logically made statistics on consumption unnecessary[12]. With the exception of the estimates for provincial consumption per capita provided directly by the results from the Household Budget Surveys (HBS) the remaining values have been calculated using the consumption data provided by the source and provincial population corresponding to that year, which were obtained by linear interpolation between the two censuses that were closest together chronologically. In all cases data have been used at a provincial scale because this is the way it was collected.

Table 1 distinguishes two features of the evolution of milk consumption in the long term; the increase in average levels of consumption, and the progressive reduction in provincial differences.

[7] The Statistical Yearbooks, published regularly in the 20th century since 1912, also record data about livestock, production and, to a lesser extent, annual consumption, and come from the aforementioned livestock statistics.

[8] AGGR 1925This involves a publication that is normally dated around 1923. However, according to the bibliography of the *Revista de Higiene y Sanidad Pecuarias* (Livestock Health and Hygiene Magazine), published in February 1926, page 138, the actual date of publication is 1925 (Thanks to Ismael Hernández for facilitating this information)

[9] Ministerio de Agricultura 1934

[10] Ministerio de Agricultura 1954, 1955

[11] INE 1969, 1983

[12] Provincial data on provincial production and consumption of milk were published in the first yearbooks after the Spanish Civil War, but they only covered the years 1941 and 1943. The estimates derived from this data show almost a 50% drop in the production and consumption of fresh milk. The reduction in head of cattle (beef and goat) approaches 20%. However, it is surprising that in this context, according to the same data, the production per head of cow milk rose between 1941-1943, compared to 1929-33, by almost 50% and that of goat's milk rose by 30% .

The provincial differences become more noticeable in what seems to be a strong period of growth between 1925 and 1933. Then it progressively decreased towards what suggests improvements in the mean consumption levels together with a major universalization of these.

TABLE 1

Milk consumption in Spain (1925-1981)
(Litres per person per year)

Year	Mean Consumption Total Population	Mean(1) Consumption Provinces	Standard Deviation
1925	36.46	34.05	38.80
1933	63.32	60.99	70.80
1955	65.89	69.87	57.72
1965	79.14	78.49	40.25
1981	128.39	138.30	42.25

(1) Arithmetic mean, all Spanish Provinces.
Source: Asociación General de Ganaderos del Reino, 1925, Ministerio de Agricultura 1934, Ministerio de Agricultura 1934, Ministerio de Agricultura, 1954 and 1955, Instituto Nacional de Estadística (INE), 1969 INE, 1981.

Given that the basic data are provincial, Table 2 offers a panoramic view of the evolution of the distribution of consumption at this scale between 1925 and 1981, in accordance with some intervals of consumption and highlights the values of the maximum and minimum consumption levels at each point and the name of the provinces to which they correspond. The minimum consumption levels in some Spanish provinces, between 1925 and 1965, were always below 20 liters and in the years 1925 and 1933, they were always below 10 liters, in the same way that on those two dates a considerable proportion of the provinces had constant levels of consumption that were below 25 and 50 liters per person per year. The data reflect how the distances between minimum and maximum consumption increases between 1925 and 1933 and then go on to decrease from 1955 onwards. These distances do not only reveal differences in the consumption magnitudes of this foodstuff, but also the different habits of consumption. Moreover, from a territorial point of view, which cannot be studied here in detail, these differences between maximum and minimum consumption levels are very stable. As we can see in Table 2 some provinces reappear throughout these years in both extremes of distribution. All of this could be interpreted as evidence of a process

of diffusion of consumption through which a stage of low and homogenous average consumption levels is followed by another stage of expansion accompanied by a growing territorial disparity culminating in one of the highest average levels of consumption and again even more homogenous. This represents a typical inverted U shaped trajectory, highlighted by other aspects in the regional historical and economic evolution[13].

TABLE 2

Distribution of Spanish provinces according to consumption intervals (Litres per person per year)

Intervals	1925	1933	1955	1965	1981
< 25	29	17	5	4	0
25 - 49	12	15	18	6	0
50 - 74	3	8	11	17	0
75 - 99	1	1	5	10	9
100 - 124	1	1	5	7	11
125 - 149	0	0	2	3	13
150 >	3	7	4	3	17
Number of provinces	49	49	50	50	50
Maximum consumption	175	309	278	202	203
(Name of province)	Guipúzcoa	Guipúzcoa	Lugo	Santander	Santander
Minimum consumption	4	5	14	15	78
(Name of province)	Cuenca	Cuenca	Cuenca	Cuenca	Alicante
Consumption Differences	171	304	264	187	125

Source: Statistics cited in Table 1

All these data serve to illustrate some of the limitations in average estimates. In some Spanish provinces in the 1930s the mean consumption was around 5 liters per person (Table 2), it was quite a low value. Obviously it reflects low consumption standards but more probably it is a consequence of high proportions of population that were not consuming this food. In fact, a contemporary observer wrote: “Thousands of Spanish households don’t usually have milk with the exception of sick people”[14]. Thus, the comparison of averages of milk consumption between Spanish provinces or within the same provinces, but in two different periods of time, may induce wrong conclusions if the consumer population is not taken into account.

[13] Williamson, J. G, 1965.
[14] Carrasco, E, 1934.

There are other aspects in average estimates to consider. On this point it might be useful to distinguish between two parameters: the quantities consumed and their frequency. In terms of the first parameter the most reasonable thing would be to think of some magnitudes that could be expressed according to the fractions of a basic and viable unit of consumption. With regard to the second parameter, it would be reasonable to accept that in the case of this foodstuff regular, daily, occasional or the total lack consumption could occur. The evidence from the data advises taking these elements into account when analyzing them. For example, if the mean annual consumption per inhabitant in a province in 1925 is 4 liters (the province of Cuenca in Table 2) this would mean some 11 ml a day, which is an unrealistic quantity in practical terms. It doesn't seem likely that the consumption of a product, in a time when prolonged conservation was not possible, would have occurred using utensils that were not cups or glasses, the normal size of which, due to their own design, exceeds such quantities. These modalities of consumption should be expressed in equivalences, or fractions, of a bowl of milk (250 ml), for example, of a half or a quarter its size. This way, this level of provincial consumption would only make sense if it meant expressing a frequency of consumption that was not daily, if, for example, it were once a month, the quantity would be closer to 250 ml, or as it has already been reasoned in the previous argument, if the proportion of the non-consumer population was very high.It is obvious that, in the other extreme of consumption levels, the provinces with more than 150 liters per person per year would involve a daily consumption close to half a liter of milk.Under this value is highly likely to be almost a universal pattern of consumption in all the provincial population.

All this previous discussion and the problem to be resolved can be expressed formally:

$$\overline{X}_{Observed-Consumption} = \frac{\text{Total Consumption}}{\text{Total Population}} \times \frac{1}{f_c} = \frac{\text{Total Consumption}}{\text{Consumer Population}} = \overline{X}_{Effective-Consumption} \quad (1)$$

The way the problem is set out is how to adjust specific average levels of observed consumption, computed from published statistics, ($\overline{X}_{Observed-Consumption}$), which could even be rather improbable, to other more realistic ones: the effective consumption levels ($\overline{X}_{Effective-Consumption}$).In short, this would mean transforming the likely difference between these two means into an equality as a consequence of the introduction of a correction factor (f_c) into the average consumption level obtained from the statistics, where such a factor would be the equivalent to the proportion of the

consumer population[15]. Logically, if the entire population is also the consumer population, this factor would be equivalent to the unit. This relationship between consumption levels and the proportion of the existing consumer population for the entire Spanish population would be applied in the same way to each "j" province, because at this scale the disparity $\overline{X}_{C-Observed(j)} < \overline{X}_{C-Effective(j)}$ would also be met and the "correction" or adjustment of this could be obtained by estimating the proportion of the consumer population of each of the provinces.

This expression also illustrates the main difficulty to deal with, which is the presence of two unknowns. If an estimate of the effective consumption were available then from expression (1), calculating the consumer population would be straightforward[16]. The adjustment of observed consumption to an effective one seems to be an arbitrary solution if it is taken without reference to a particular food. It involves the need of some assumptions and data about patterns of distribution and diffusion of consumption in the population. In this case the evolution of milk consumption in Spain from 1925 to 1981 will illustrate this approach and methodology.

3. Methodology for adjusting the consumption levels and the estimate of the number of consumers: basic principles and approach

In the first place, it seems necessary to have a statistical model for the distribution of consumption that would permit us to infer what proportions of the population would consume particular quantities. On this point, the use of Log-Normal distribution would be the most appropriate one because it has been used in the formation of various economic activities, including the consumption of different types of products or services[17]. This way, the distribution of the consumer population of this foodstuff could be estimated using the following density function applied to the data of the Spanish provincial statistics:

[15] $f_c = \frac{\text{Consumer population}}{\text{Total population}}$ because when it is replaced in (1) it guarantees the identity between both sides of the equality, that is statistical and effective mean consumption.

[16] From expression (1) if the total output consumed and the effective consumption per capita are known, the estimate of consumer population would be : $\text{Consumer Population} = \frac{\text{Total Consumption.}}{\overline{X}_{Effective-Cons.}}$

[17] A revision of various applications in economic studies in Raymond Lawrence 1988. In the specific case of historic populations, the study made by Robert Fogel 1992, assumes this same distribution in the analysis of the nutritional state of the population. A critical evaluation of this hypothesis in Trevon .D Logan 2006.

$$f(x_j) = \frac{1}{x_j \sigma \sqrt{2\pi}} \exp\left[-\frac{1}{2\sigma^2} (\ln x_j - m)^2 \right] \quad (2)$$

Where $f(x_j)$ corresponds to the total population that consumes a quantity of milk on a daily basis in province "j", x_j corresponds to the averages of consumption of each "j" province and the two parameters "m" and "σ" make reference to the averages and standard deviation of the distribution obtained from all the provincial values. The $f(x_j)$ values will describe a theoretical distribution of consumers for all the Spanish population according to the mean and variance provincial values. One of the characteristics to remember about this distribution is its asymmetric nature, deviated towards the left, and therefore, the mean, mode and median do not present identical values[18]. This property would be of greater interest if a study of the temporal evaluation of consumption habits were to be considered, because this leaves the fact that the variations in mean or mode do not have to be of the same magnitude and therefore follow similar trajectories open to consideration.

Obviously, it would be better to verify that the statistical model adopted for reconstructing the distribution of the consumption of this foodstuff were the most appropriate option. For lack of individual data the only way of confirming this is the provincial values. Table 3 displays the results of the two statistics that test the hypothesis where the distribution of the logarithms of the aforementioned provincial consumption averages adjusts itself to the normal distribution[19]. In any event, as the significance levels show, the null hypothesis cannot be rejected. Therefore, it seems reasonable to suppose that the consumption of milk follows this model of distribution.

[18] In Log-Normal distribution the median is included between the mode and the mean, closer to the first than to the second. In short, the median is twice as close to the mean than to the mode.

[19] Remember that a random variable follows the log-normal distribution if its logarithm follows the normal distribution. Formerly, therefore, the null hypothesis to test is $H_0 : \log x_j \approx N(\mu_{(\log x_j)}, \sigma^2_{(\log x_j)})$, where x_j corresponds to the mean consumption of milk for each province.

TABLE 3
Spain (1925-81)
Distribution of average provincial consumption of milk
Normality Tests

	Statistics Kolmogorov-Smirnov-Lilliefo		Statistics Shapiro Wilk	
Year	**D (n)**	**Sig. Level**	**W**	**Sig. Level**
1925	0.086	0.200	0.967	0.181
1933	0.091	0.200	0.972	0.295
1955	0.085	0.200	0.983	0.687
1965	0.100	0.200	0.968	0.198
1981	0.112	0.169	0.965	0.156

Source:Statistics cited in Table 1

Moreover, knowledge about patterns of consumption cannot be approached without being considered, as it has been advised, as a process of diffusion. From a theoretical point of view, the most basic representation of a process of diffusion is when the people adopting it follow a normal distribution pattern where the different categories of these people are located [20]. Therefore, a hundred percent of the population included within the function would have been integrated in the initial stage by 2.5% of the innovators and 13.5% of the early adopters. In this phase the rest of the population would either have practiced sporadic consumption or they wouldn't have consumed milk at all. In the following stage 34 percent of the denominated early majority and 34 percent of the late majority of adopters would have joined. Consumption as well as its frequency would have become generalized, and the distance between the sectors consuming more and those consuming less would have increased. Finally, in the final stage, 16 percent of late adopters would have joined, then the generalization of consumption would have been accompanied by higher average levels and a greater uniformity in consumption habits.

The adoption of milk as a foodstuff for daily use in Spain, according to the quantitative and qualitative information available, should be understood as a process of these characteristics. This is a foodstuff that for reasons of technology, health and food culture at the end of the 19th and beginning of the 20th century was an object of restricted consumption, often related to therapeutic

[20] Rogers, E M. 2003, p.279-283.

purposes, it went on gradually to form part of the diet of particular social groups and sections of the population, for example, children and young people[21].

It is beyond scope of this article to introduce a detailed account of this diffusion process. Unfortunately, sources of data are scarce. For example, Medical Surveys[22] carried out by medical doctors in many Spanish localities in the 19th and first half of the 20th centuries used to give most qualitative than quantitative information about nutritional habits and conditions of the inhabitants[23]. More quantitative sources are available in hospitals, but this kind of data have not been always published[24], or in some special surveys. Two documents can be mentioned here. One is the report written by The Commission on the Reform of Consumption Tax in 1908[25] (Table 4) and the other one, a research on the nutritional status of the population living in rural areas of the province of Jaen (in the region of Andalusia) in the first years of the 30s carried out by the physician F.Jiménez and the pharmacist M. Jiménez[26].

The report from the Commission in 1908 surveyed only 79 families (434 individuals) and this document can obviously not be considered as something representative of the entire Spanish population of the time; however it does offer two types of results that are of interest to the present discussion. On the one hand, an average level of consumption per annual capita of 42 liters would not be too far above the averages known for the beginning of the 20th century, estimated around 35 or 45 liters (Table 1[27]). On the other hand, this permits an estimate to be made of the social differences in consumption, depending on the various levels of income of the "breadwinners", and, as a result, it illustrates the different modalities of consumption. An aspect of particular interest is the considerable disparity between the annual (and daily) milk consumption averages from the social groups of higher and lower income. In the case of the first group this would mean taking around the equivalent of a quarter of a liter a day, while in the rest of the groups these daily quantities would be so meager that they could be interpreted as evidence of an irregular or occasional type of consumption. Additional information in the report shows that the high income group was composed by entrepreneurs, owners and stockholders, whereas civil servants, service

[21] Nicolau-Nos, R, Pujol-Andreu, J and Hernández, I, 2010.
[22] These surveys known as "Medical Topographies" or "Medical Geographies", submitted to the Royal Academy of Medicine were not always published.
[23] For example, out of the 45 surveys carried out in Catalonia from 1798 to 1907, only 7 gave quantitative information on milk consumption, R. Nicolau, R, J. Pujol-Andreu, and I. Hernández 2010.
[24] References to different amounts of milk consumed in Spanish health centres and hospitals prior to 1936 can be found in R. Nicolau, J Pujol-Andreu, and I Hernández 2007. In the case of data on milk consumption in hospitals, around 200 liters per stay, per year, would be compatible with daily averages situated in the maximum levels of 350 ml adopted here.
[25] Documentos y trabajos de la comisión consultiva para la transformación del impuesto de consumos, Vol IV, 198(Documents and works by the consultative commission for the transformation of the consumptions tax).
[26] F.Jiménez and F.Jiménez, 1934
[27] Cusso estimates a consumption of 36 liters per person per year in 1865 X.Cussó, 2001, p.322 and I. Hernández ,2005, p.156, of 44 liters per person per year in 1917.

workers, liberal professions and other middle class occupations were surveyed as mid income group.

TABLE 4
Distribution of milk consumption according to the breadwinner's income level circa 1908

Income level	Individuals	(%)	Milk consumption per capita/year (litres/kg)	Milk consumption per capita/day (ml/gr)
Low	183	43.26	10	28
Intermediate	134	31.68	43	119
High	106	25.06	97	266
Total	423		42	116

Mean Income level per family (pesetas 1908): Low, 1,838; Intermediate:6004; High: 25,781.
Source: "Documentos y trabajos de la comisión consultiva para la transformación del impuesto de consumos" (Documents and studies from the consultative commission for the transformation of consumption tax). Tome IV. Madrid 1910, pag 198.

The research on the nutritional status of population living in rural area of the province of Jaen carried out in the first years of the 30s surveyed 3,592 persons older than 8 years old. Data were collected from 70 out of 98 villages of the province. Detailed information on daily consumptions of every food was even collected at household level, unfortunately the estimates were not published. However the abstract with the main results show the proportions of daily consumers in some foods such as meat, eggs and milk. In this last foodstuff, around 97% of the families from the high social class used to consume milk daily whereas this proportion was 63% in middle class families and 9% in the working class. According to the first aforementioned consumption data of around 1908 and those available for the rest of the first third of the 20th century, there would exist social groups with daily consumption of that foodstuff. In other words, the consumption of that new foodstuff would have started its irreversible trajectory of diffusion.

The idea that, within the entire Spanish population, these groups of new consumers could have represented about 16% of the population – the proportion of adopters in the basic diffusion model – seems plausible in the mid 1920s in the light of the census data of 1920[28]. With some 21,338,381 inhabitants, this would mean accepting that close to three and a half million people would have formed part of this group of daily consumers. An indirect clue for calibrating this is the classification

[28] Ministerio de Trabajo Comercio e Industria 1922, Vol 4, p. 421-424.

of the population by profession. Despite the corresponding problems of interpretation, the total amount of registered "employers" in agriculture, industry and trade, plus those linked to the administration, liberal professions and rentiers adds up to almost two million individuals (1,921,917 persons). These groups have a social profile close to the high income group surveyed in the Commission report of 1908. Around 70% were enumerated as married, if each one of these people is interpreted as being a breadwinner of a household, when they are multiplied by a number of members, for example 3 or 3.5, the percentage of potential daily consumers fluctuates between 18 and 22%.

TABLE 5
Spain (1964-65): Household Budget Surveys
Levels of milk consumption per socioeconomic category of the main breadwinner

Socioeconomic category	Average Household Size	Consumption per person per household Litres Annual	Millilitres (gr) Daily
Farmers (Landowners)	4.18	81.49	223
Agricultural Workers	4.30	43.70	120
Entrepreneus and the self-employed	4.30	90.29	247
Liberal professions	4.36	121.29	332
Managers and company directors	3.97	115.93	318
White collar workers	3.38	133.27	365
Industrial Workers	4.25	74.65	205
Sector Service Workers	3.70	73.27	201
Military personnel	4.42	98.67	270
Not classified	3.55	91.23	250
Non usually economically active persons	2.22	90.27	247

Source: Household Buget Survey 1964-65, INE 1969.

The first Household Budget Survey for the period 1964-65 collected the most complete evidence of consumption patterns of the Spanish population in the 20th century. Here, detailed information is gathered about the quantities of milk consumed in various groups from within the population[29]. The data tabulated per socioeconomic category of the main breadwinner of the household allows an established range to be estimated, (considering *averages* only) see Table 5, between 120 ml for farm workers and 365 ml for white collar workers; this is between the equivalent of half and a cup and a half of milk a day. These values could be considered as evidence of quite a complete process of diffusion of this food because 8 out of 11 social groups were having next or more than 250 ml per person per day. Only one group still remained at low consumption levels -120 ml per day- which would be the result of either irregular consumption or a remarkable proportion of non-consumers.

[29] This statistics does not compute consumption of other related foods like cheese, butter etc.

Despite the scarce data available from the beginning of the 20th century, when it is compared with that of the first Household Budget Survey from 1964-65, the best evidence available would be that the diffusion of milk consumption in the Spanish population was based, on the one hand, on the existence of consolidated groups of regular consumers and on the other hand, on the fact that it socially extended in both the increase in the quantities consumed and in the number of consumers. It is important to notice that high consumption standards seem to converge to similar levels between 100 and 130 liters per person per year. In this case, these values fit to the historical statistics of high consuming countries or, even for the most recent periods, to the information collected from surveys on consumption. Here all the data available seem to suggest that with consumption above 350 ml per day per person (130 liters per person per year), more than 90% of the population should have been consuming (always in terms of mean values)[30]. In the other extreme, data on minimum consumption do not converge to similar levels. This result could be expected because, as it has been previously observed, these means would be computing no only irregular –not daily- consumption but also lack of consumption at all. This last observation suggests that the search for a "reasonable" level of minimum consumption, under a general pattern of diffusion more than a task of collecting data would be the result of a simulation exercise. Therefore a simulation exercise could be put forward based on modeling consumption patterns through a log-normal distribution. The results should justify the final choice of a minimum average level of consumption related to a "critical mass" of daily consumers.

Graph 1 presents the different levels of daily consumption that correspond to the first, second (median) and third quartiles of distributions of consumption. These have been calculated using some levels that would situate the average consumption per person per year within 25, 35, 45, and 55 liters, and magnitudes of standard deviation of 20, 40 and 60 liters, which cover a large part of the provincial variations in the observable consumption patterns of the 20th century (see Table 1). Tables 6A and 6B show the estimates of proportions of consumer populations having more than or equal to 250 ml and 125 ml a day according to the same values of average consumption and standard deviation as Graph 1.

In the lowest levels of consumption, 25 and 35 liters per person per year (Graph 1), distributions would not have reached average daily quantities which can be fractions of 250 ml, the equivalent to one cup a day (marking the limits with some discontinuous lines between 125 and 250 ml). These

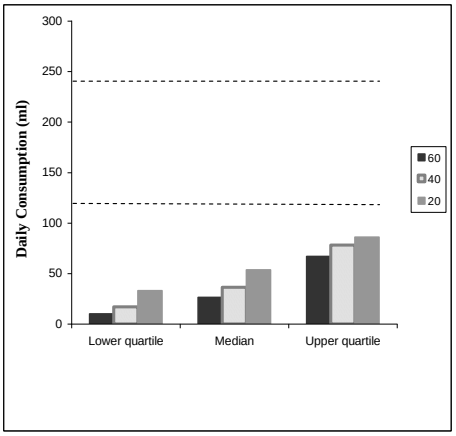
[30] Data from the statistics of the FAO published in 1953, cited in C. Agenjo, 1957, p. 315 indicate that in the five-year period of 1930-34 the countries with consumption levels above 130 litres/inhabitant/year were Austria, Denmark, Ireland, Holland and the United States and those with consumption levels close to 200 litres were Sweden, Switzerland, New Zealand, Norway and Canada. In fact, this would be a high estimate, if the most recent data were taken into account (the data corresponding to the year 2007) which would situate the average consumption per person per year in Spain at around 88 kg, calculating that 96% of the population consume milk on a daily basis (see the report from FENIL ,2008).

distributions suggest, at the very best, sporadic consumption. At the most, according to the levels that correspond to the higher quartiles, we could talk about a weekly amount, especially in the 35 liters section, of something more than three quarters of a liter, which would not actually add up to more than three cups a week. Under these conditions there would be no regular or stable consumer population. Tables 6A and 6B confirm these appreciations. Estimates of proportions of consumers with 25 liters on average show how, on that low level of consumption, a critical mass of daily consumers hardly might ever exist, less than a 4% (see mean values) would be consuming 250 ml or more a day and 13% 125 ml or more a day. With 35 liters, patterns of consumption are improving but still people consuming more than 125 ml a day represent a mean lower than 25% The coexistence between occasional and other kinds of consumption patterns might be better reflected between the 45 and 55 liters of average consumption per person per year. In both cases, the higher quartiles would have included the consumer populations of 125 ml and above.

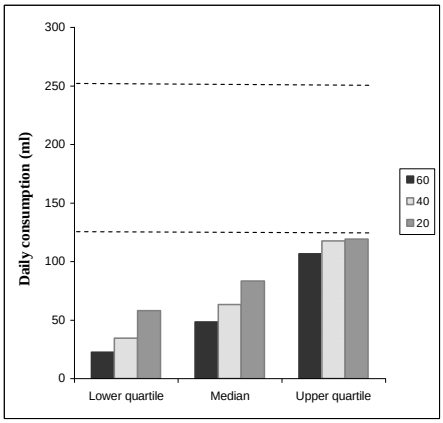
GRAPH 1

Proportion of the consumer population in quartiles according to average dispersion levels of consumption of milk per person per year

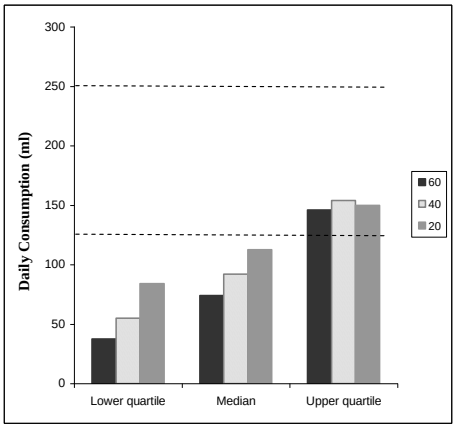
Average annual consumption= 25 L/per/year



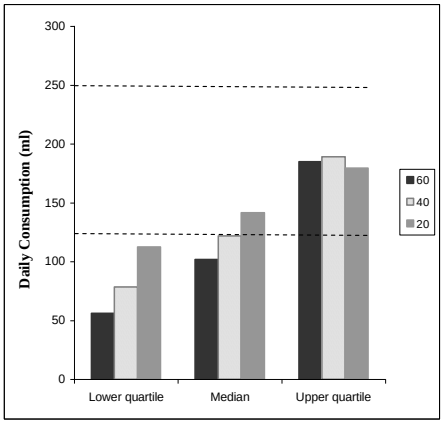
Average annual consumption= 35 L/per/year



Average annual consumption= 45 L/per/year



Average annual consumption= 55 L/per/year



Source: own elaboration

Tables 6A and 6B show how, with 45 liters and 55 liters per person per year, between one third and a half of the consumer population would be having 125 ml or more a day and between 10 and 16% 250 ml o more. All these values are close to the theoretical percentage of innovators and early adopters mentioned before. This group of results illustrates how the gradual increase in consumption levels per person per year would have lead to distributions in which the upper quartiles, given the daily levels that they would have reached, would have facilitated daily habits of milk consumption.

The confirmation of this trend can now be verified by the distributions associated with levels of consumption that are higher than those used, for example, from 65 to 75 liters per person per year (graph 2).In both cases, at least 50 percent of the population could have been drinking 125 ml or

more of milk a day, as it is confirmed by the estimates in tables 6A and 6B. In the case of 75 liters this percentage of consumers almost achieves 80%.

TABLE 6A

Proportion of consumers of 250 ml or more a day according to average and dispersion levels of consumption of milk per person per year

Average levels	Standard Deviation			
	60	40	20	Mean
25	5	4	1	3.7
35	8	7	2	5.5
45	11	10	3	8.0
55	16	13	5	11.5
65	21	19	10	16.6
75	26	26	19	23.9
130	72	85	99	85.3

TABLE 6B

Proportion of consumers of 125 ml or more a day according to average and dispersion levels of consumption of milk per person per year

Average levels	Standard Deviation			
	60	40	20	Mean
25	13	14	11	12.7
35	21	29	22	24.0
45	30	35	40	35.1
55	41	49	64	51.2
65	52	64	85	67.0
75	64	77	96	79.2
130	99	100	100	99.5

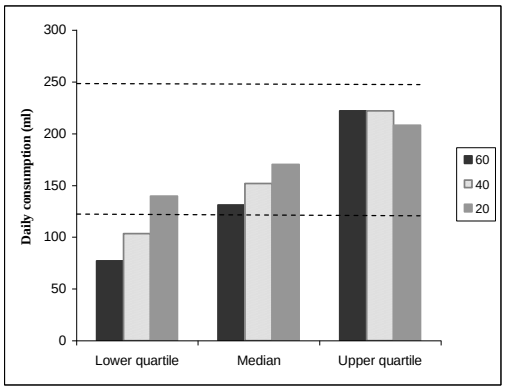
Source: Own elaboration

In terms of maximum levels of consumption, a guarantee of generalized diffusion of consumption, the simulation has been applied to some mean values of 130 liters per person per year (approximately the average consumption of the Spanish population in 1981). The results displayed in graph 2 show how, under the same magnitudes of standard deviation as in previous cases, practically the entire population would have managed to consume a quarter of a liter a day of this

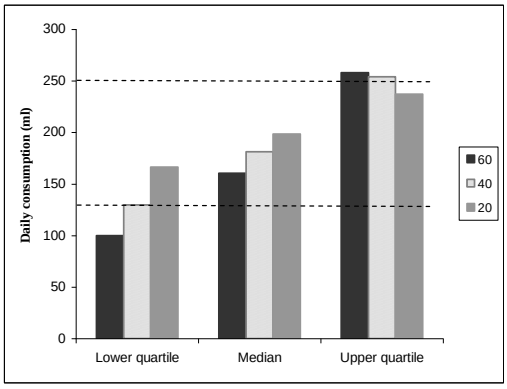
product. The estimates in Tables 6A and 6B illustrate this observation with values close to the 90%.

GRAPH 2
Proportion of the consumer population in quartiles according to average and dispersion levels of consumption of milk per person per year

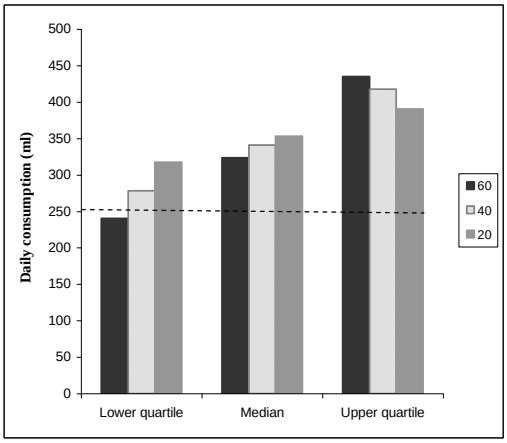
Average annual consumption= 65 L/per/year



Average annual consumption= 75 L/per/year



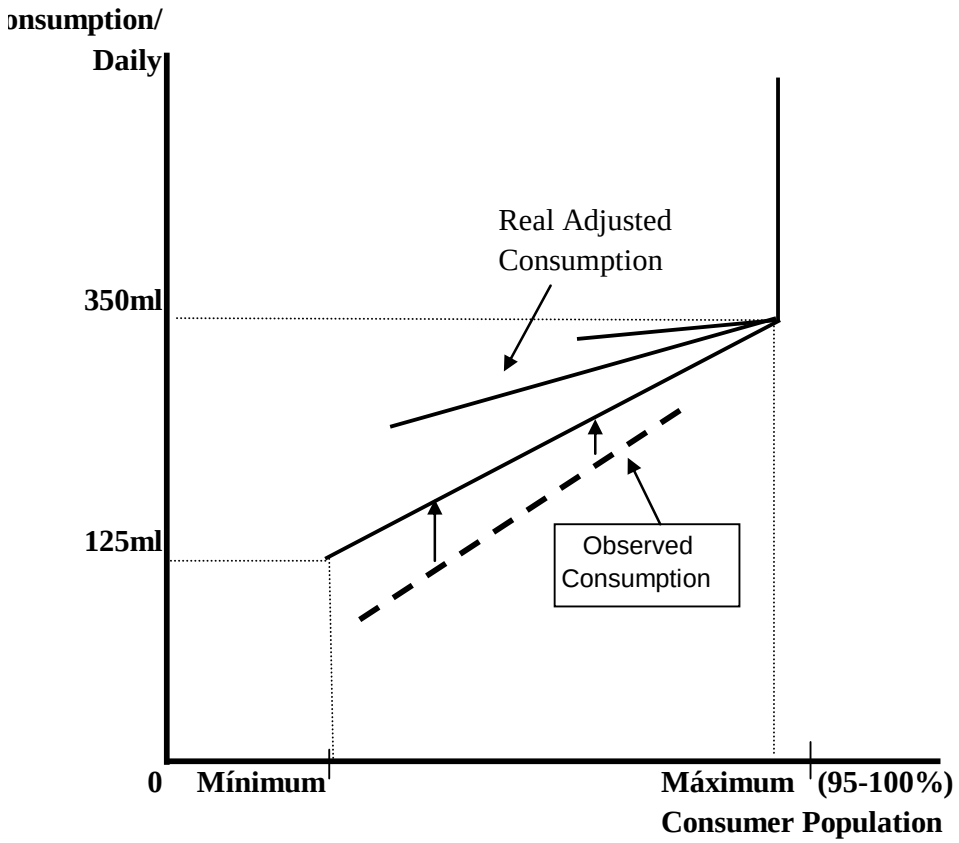
Average annual consumption= 130 L/per/year



The results from this simulation exercise suggest that under the assumption of the existence of a small group of early and innovator consumers in the Spanish population the scale of minimum to maximum consumption might span between 45 and 130 liters per person per year. 45 liters has been chosen as a minimum value because, according to the previous results already analyzed and the scarce historical information available, it represents a sort of threshold between a first stage of reduced number of daily consumers and a second one of a greater proportion which seems to fit better to the likely consumption patterns of milk in the Spain of the first decades of the 20th century.

In view of all the results and observations put forward so far, the methodological strategy to be followed would be the one represented in Graph 3. As we can see here, the methodological strategy is based on displacing the initial levels of consumption upwards or to apply a direct correction to the observed data. More specifically, the basic characteristics of this methodology of evolution and correction of data are the following:

GRAPH 3
Relationship between daily consumption and the percentage of the consumer population



a) The scale of variation of consumption is delimited within that of the proportion of the associated consumer population, between a minimum of 125 ml and a maximum of 350 ml a day or their equivalents in terms of average levels of 45 or 130 liters per person per year (Annex 1). Adopting this minimum value means accepting, first, that consumption of this foodstuff was in "discrete" units equivalent to a cup (250 ml) or half a cup (125 ml); second, there was a group of stable, daily, consumers of this foodstuff in all the Spanish territory and so in each of its provinces. In terms of the maximum value, it is understood that there would not be as much of an increase in the number of consumers as in the quantities consumed when the consumer population was close to the 100%

b) The populations do not reach a universal consumption of this foodstuff. For reasons of preference or the taste of the consumer or associated digestive diseases a particular percentage of the population would have been impeded from drinking milk on a regular basis (here this would be situated between 95-100%)[31].

c) As a consequence of the same process of diffusion, the relationship between the average levels of consumption and the proportion of the consumer population is changeable over time. Therefore, as graph 3 shows, with the increase in average levels of consumption of the total number of inhabitants not only would the distance between the minimum and maximum levels decrease, but its slope would change, tending towards a more horizontal position as an effect of the growing homogeneity of consumption habits.

4. Applying the methodology: reconstruction of consumer population of milk in Spain (1925-1981)

This approach allows a transformation of the observed to the effective levels of consumption for each province and from here to follow a path that ends up in the final estimate of the magnitude of consumer populations, on a provincial scale also. The stages required by the entire procedure will be illustrated step by step with the reconstruction of consumer population in 1925 (Tables Annex 2A, 2B and 2C), other tables will present summary statistics and indicators for all the years.

1st. The observed consumption average is identified with one that is equivalent to one within the scale mentioned previously between 125 and 350 ml [32] (see Annex 1 with the table of

[31] Data on the population that do not consume certain foodstuffs, in the specific case of milk consumption, is not always collected in dietary surveys. In the case of Spain, in the entire population only the estimate provided by a survey from the Foro Interalimentario (Interfood forum) of 2006 (see FENIL, 2008) was found, which places the amount of people who never consume milk at 2% of the Spanish population. On the other hand, the biological-anthropological studies on Spanish adult populations detect some rather low percentages compared to Nordic populations made up of lactose positive individuals – individuals who persist in continuing intestinal lactase activity initiated in infancy – of around 45% compared to 95% in the Scandinavian countries.. J. Peña, et al. 2002. Other estimates for Spain situate this amount at 70% , R. Mace, F. Jordan and C.Holden, 2003.

[32] The averages of consumption for each province are set in the new scale through the use of linear interpolation.

equivalences). For example, in Table Annex 2.A provinces with less than 5 litres per person per year in column (2) were replaced by 45 liters in column (3), which is the minimum consumption adopted according to the discussion on simulations in the previous section. In the opposite extreme of the consumption scale, those provinces with computed milk consumptions greater than 130 liters per person per year practically remain unchanged; only get a slight increase in order to introduce the assumption that there is no universal consumption (a 100% of all the provincial population consuming this product).

Obviously, the average level of consumption and its standard deviation from the basic data change to the new statistics in the new scale. Table 7 presents the differences between the averages and the standard deviation of the provincial consumption observed from published statistics and those proposed in the table of equivalences, these values in the year 1925 can also be observed at the end of columns (1) and (2) in Table Annex 2.A. As expected, these differences between observed and adjusted values are remitted as the general levels of consumption rise.

TABLE 7

Spanish provinces (1925-1981): Average milk consumption and standard deviation (Observed and adjusted values at provincial level) (litres/person/year)

Year	Statistical Data		Adjusted data according to consumption scale	
	Average consumption	Standard deviation	Average consumption	Standard deviation
1925	34.05	38.80	66.41	30.24
1933	60.99	70.80	88.08	61.64
1955	69.87	57.72	79.73	21.03
1965	78.49	40.25	93.04	33.45
1981	138.30	42.25	137.5	29.85

Source: Statistics cited in the text

2nd. Based on the new statistics, the distribution of the consumer population can be generated through the log-normal distribution (according to the formulation (2)[33]). This theoretical consumer population is presented using an accumulative function in column (6) Table Annex 2.B. The results of this operation for each province in the year 1925 are shown sorted in increasing order in both columns in this table. The pattern of variation in the corrected consumption levels in relationship with the increasing proportion of consumer population allows to estimating in this case the

[33] Mean (m) and variance (σ^2) of the distribution have been calculated from the empirical -provincial data- mean ($\overline{x}$)and variance (V) according to the following expressions: $m = \ln\left(\frac{\overline{x^2}}{\sqrt{\overline{x^2}+V}}\right)\ \sigma^2 = \ln\left(1+\frac{V}{\overline{x^2}}\right)$

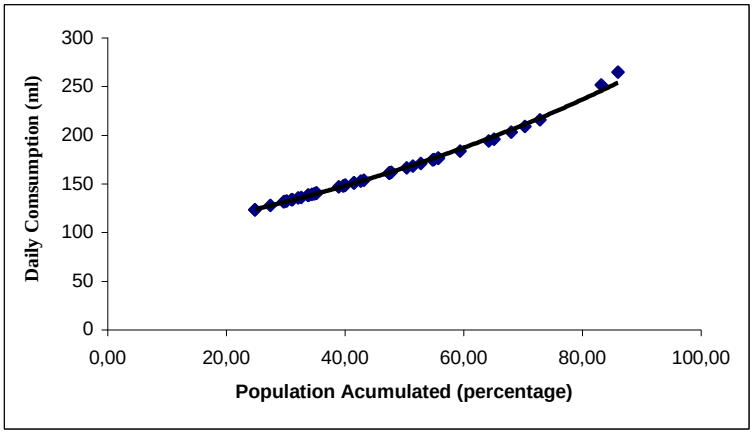
functional relationship between these two variables. Graph 4 shows the kind of function adjusted, which is exponential and not linear, as it was assumed in applying the initial scale in Annex 1. The results for the rest of years have been displayed in Table 8. They make evident how, in the first place, basic levels of consumption have been increasing over the decades, as the progressive increase in the constant value of the equation reveals. At the same time, new consumers are being incorporated, as it would be indicated by the decreasing tendency of the exponent and which, therefore, causes the relationship between levels and proportions of consumers to approach a horizontal line.

TABLE 8
Daily consumption and proportion of the consumer population
(Adjusted using log-normal distribution)

Year	Adjusted equation	R-Squared
1925	y(j)= 92.5 exp (0.0117x(j))	0.997
1933	y(j)= 87.6 exp (0.0166x(j))	0.999
1955	y(j)= 119.1 exp (0.0131x(j))	0,999
1965	y(j)= 146.7 exp (0.0098x(j))	0,994
1981	y(j)= 267.1 exp (0.0064x(j))	0.991

y(j)= Corrected medians for provincial consumption
x(j)= Proportion of consumer population according to lognormal distribution
Source: Own elaboration

GRAPH 4
Relantionship between daily consumption and acumulated Spanish provincial population in 1925



y= 92.5 exp(0.0117x)
R-Sq= 0.997

3rd. The slope of the function can be seen in Table 8, it is not of a linear nature. The parameters of the functions adjusted in this table will be a starting point for the aforementioned readjustment of the initial scale. Given that the basic data are provincial averages and logically the proportion of the consumer population is unknown, such parameters can only be applied now to the totals of provincial populations, organized in hierarchic order (from the smallest to the largest) for each year studied according to the following formulation:

$$\overline{X}_{\text{real-C(j,k)}} = \alpha \text{Exp}\left(\beta \sum_{k}^{n}\left(\frac{\text{Pop}_{(j,k)}}{\text{Total Population}}\right)\right) \quad (3)$$

Where "α" and "β" correspond to the two parameters estimated in Table 8 and the component of the exponent represent the percentage of accumulated population from each province "j" according to an established hierarchical order of consumption "k". In Table Annex 2.C column (9) applies this procedure to the 1925 data. In this case, the expression (3) applied to the column (8) gives a result of 101 ml, for example in the case of the province of Almeria (37 liters per person per year)[34] .The

[34] This estimate is $101 = 0.0925e^{(0.0117 \times 7.84)}$ where 0.0925 and 0.0117 are the parameters of the adjusted equation in Table 8 and 7.84 the percentage of accumulated population of Spanish provinces in table A2.C.

result obtained will be the final adjusted provincial consumption average per person per day (column 9) and per year (column 10)

4th. Once these final corrected levels of consumption have been established, the rest of the procedure is immediate. Therefore, in the first place, the consumer population can be calculated for each province according to the expression:

$$\text{Consumer Pop.}^{\text{est}}{}_{\text{j}} = \frac{\text{TC}_{\text{j}}{}^{\text{obs}}}{X_{Effective-Cons(j)}} \qquad (4)$$

Where the numerator corresponds to the Total Consumption (TC) of the province "j" according to the published statistics and the denominator to the effective or adjusted average level of consumption of the same province, obtained in (3). So, finally, it will be possible to obtain the final percentage of the total consumer population from the sum of the estimated consumers in each province, according to expression (4), divided by the total of the Spanish population, for each of the years under study. In the case of the Spanish consumption for the year 1925, this procedure is applied in columns (12) and (13) in Annex 2.C. The final estimate of consumer population was 43% of all the Spanish population and the adjusted level of consumption per person per year was 84,53 liters.

The final results of this procedure are presented in Table 11, corresponding to the percentages of the consumer population, the observed levels of consumption per capita and those for adjusted consumption for the entire Spanish population. Finally, the log-normal distribution permits to calculate the distribution percentage for the consumer population of milk during the various intervals of consumption for each year, presented in Table 12 and Graph 5. Before the analysis of results it could be useful to evaluate, through a sensitivity analysis, some of the basic assumptions made in this reconstruction procedure.

As it has been stated, a central step in this approach is the adjustment made upon the statistical means with the scale presented in Annex 1. In spite of the final adjustment practiced in the third step of the procedure it is quite obvious that this initial scale might have strongly conditioned the results. Table 9 and Table 10 display the results of a sensitivity analysis for the years 1925 to 1965, before the proportion of consumer populations achieves 95%. This analysis evaluates the effects caused by a change in the initial scale, particularly in minimum levels of consumption on the final estimates of consumers and their statistics of consumption (mode, median and mean).Two different assumptions about the range of variation in the scale of adjustment have been adopted: (A) Between 35 and 130 liters per person per year and (B) Between 55 and 130 liters per person per

year. These are 10 liters above and below the 45 liters as the minimum consumption level in Annex 1.

TABLE 9
Sensitivity analysis in the estimates of consumer populations
1925, 1933 and 1955

Item	1925	1933	1955	1965
Consumer population (%) (Table 11)	43	56	59	78
Change in minimum consumption Consumer population (%):				
(A) 55 liters	39	51	55	72
(B) 35 liters	49	59	63	80
Differences Estimates-(A)	4	5	4	6
(%)	9.04	7.07	6.78	7.69
Differences Estimates-(B)	-6	-3	-4	-2
(%)	-14.64	-7.98	-6.78	-2.05

Source: Own elaboration

As it could be expected, if minimum consumption had been higher (55 liters), the proportion of consumers would have been overestimated (Table 9). For example in the year 1933 it would have been 51 instead of 55%. If minimum consumption had been lower (35 liters), these effects would have run in the opposite direction. However, differences between estimates shown in table 9 suggest that changes in the initial scale of adjustment do not involve strong variations in the estimates of population proportions. Most differences are less than 5% and, in general, intervals do not change appreciations about consumption patterns in each year. For example, an interval of consumers estimated in 1925 would be between 39 and 49%, always showing that less than half of the Spanish population did not consume milk. At the end of this period, 1965, a range of variation in consumer population between 72 and 80% does not modify any basic conclusion about the fact that three quarters of the population were drinking milk daily.

TABLE 10
Sensitivity analysis in the estimates of statistics of consumption
1925, 1933 and 1955
(daily consumption per person ml/gr)

Item		1925	1933	1955	1965
	Mode	131	135	212	226
	Median	163	203	258	248
	Mean	182	249	284	259
Change in minimum consumption:					
(A) 55 liters	**Mode**	161	157	231	241
	Median	188	223	275	257
	Mean	204	266	300	266
(B) 35 liters	**Mode**	99	115	190	222
	Median	136	184	240	242
	Mean	159	234	271	253
Diff Mode-Mode(A) (%)		-22.48	-16.70	-8.89	-6.53
Diff Mode-Median(A) (%)		-15.13	-9.99	-6.56	-3.90
Diff Mode-Mean(A) (%)		-11.69	-6.78	-5.41	-2.60
Diff Mode-Mode(B) (%)		24.46	14.96	10.77	1.96
Diff Mode-Median(B) (%)		16.85	9.14	6.81	2.38
Diff Mode-Mean(B) (%)		12.76	6.08	4.76	2.59

Source: Own elaboration

As far as the estimates of basic statistics of consumption is concerned, Table 10 shows how they change, according to the levels of minimum consumption, in the expected way. The magnitudes of the statistics are higher with 55 liters instead of 35 liters. In any case, these sets of estimates seem to converge through along the years when consumption was increasing. Differences between those minimum levels and the initial scale (45 liters) are greater in the lower consumption levels than in the higher ones, for example if 1925 and 1933 are compared to 1955 and 1965. Between the three statistics, the range of variations in the estimates of the mean consumption is lower than the other

two. In absolute values, the error would be around 15% in the worst estimate. Mode seems to be the statistics with a less accurate estimate, especially in 1925 when the results varied between 99 to 161 ml per person per day. In all these observations Table 10 is showing that the most difficult consumption patterns to reconstruct are the lower ones, but it is important to notice that in any case, the rank of variations obtained does not change the conclusions about the probable scale of consumption. For example, in 1925, all the estimates were far from the daily cup of milk

Two general conclusions can be drawn from all these results. First, that data correction for low levels of consumption seem more difficult and are subject to greater uncertainty. Second, that this range of variation around +10/-10 liters around the minimum scale of 45 liters per person per year does not seem to modify significantly the initial conclusions.

Unfortunately the lack of estimates of proportions of consumers requires testing the validity of the results in an indirect way. The basic criteria will be to put these results in connection with other published data on consumption of milk in the Spanish population.

From a more historical perspective it is advisable to remember that animal milk, cow or goat, do not seem to have been particularly important in the traditional Spanish Mediterranean diet. But, as it has been mentioned in previous section this foodstuff was incorporated into the diet of the Spanish population, especially during the first third of the 20th century[35]. The results obtained from this study affirm that this process of diffusion was relatively slow and unequal, in terms of its evolution in the average consumption levels and the number of consumers. These results fit general appreciations about the difficulties faced by the Spanish agriculture in the first half of the 20th century in reallocating resources to livestock production and in specializing its production to develop a national milk market[36] .

[35] Nicolau-Nos, R, Pujol-Andreu, J and Hernández, I 2010.
[36] Simpson, J, 1995, 257-262; Domínguez Martín, R (2003).

TABLE 11
Spain (1925-1981)
Reconstruction of basic statistics indicators of milk consumption of the population

	1925	1933	1955	1965	1981
Consumer population(%)	43	56	59	78	95
Non-Consumer population(%)	57	44	41	22	5
Average consumption litres/pers/year (Observed mean) Population level	35.43	65.00	64,56	79.14	125,2
Average consumption litres/pers/year (Corrected mean) Population level	84.53	115.22	111.9	101.32	135.99

Source: Statistics cited in Table 1 and own elaboration

Before the Spanish Civil War, in the middle of the 1930s, almost 45% of the population did not consume milk (Table 11). Observations on both the lack of consumption and the lack of some nutrients contributed by milk, such as calcium, were carried out using modern food science techniques since the 1930s[37] demonstrate this fact. In any case, the magnitudes obtained confirm the opinion held by contemporary researchers in connection with the fact that a substantial part of the Spanish population would not have consumed this food at the beginning of the thirties[38]. From a broader perspective not restricted to milk consumption, these estimates of around 1925 give empirical support to general assumptions about the distribution of the calories in the Spanish population around 1900. According to these, about 50% of the population were under the minimum required[39]. According to the distribution frequency of consumers in 1925, practically three quarters of the consumer population would have consumed less than 225 ml per day (the equivalent to approximately one cup a day) with 27%, consuming less than half this amount (Table 12).

[37] See Bernabeu-Mestre, J, Esplugues-Pellicer, J.X and Galiana-Sánchez, E. 2007. Another element that could be highlighted is the contrast between the estimates for nutritional requirements of calcium for the Spanish population between 1930 and 1960, around 850 Mg, and the availability of this within the diet, between 418 and 518 Mg according to the year (Cussó, X, 2005).

[38] Carrasco, E ,1934.

[39] Simpson, J, 1995, p.371-379.

TABLE 12

Spanish Population (1925-1981)
Distribution of Daily Milk Consumption
(Percentage of Consumers)

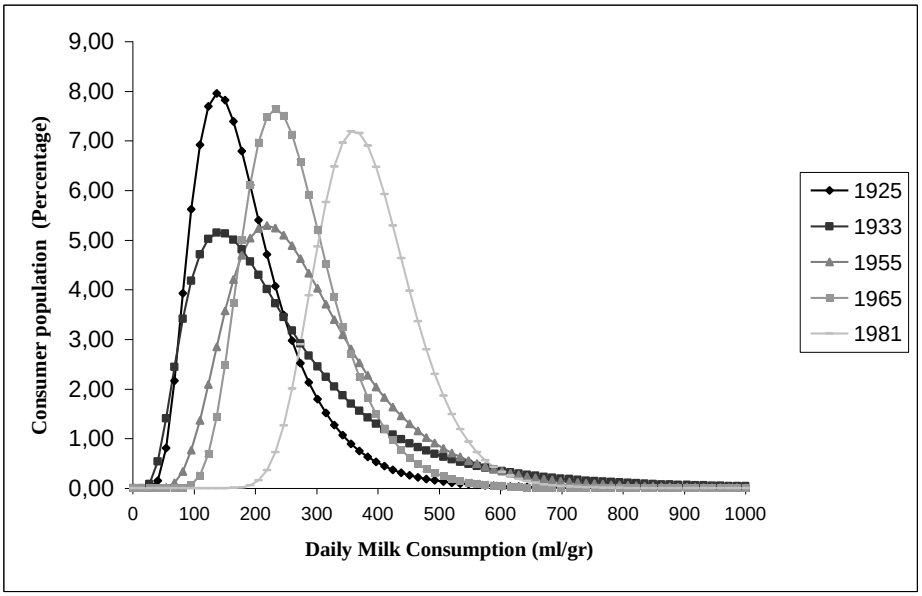
Milk	**1925**	**1933**	**1955**	**1965**	**1981**
< 125 ml	28.28	22.62	5.00	1.16	
125-174 ml	27.50	18.92	13.92	11.29	
175-225 ml	19.49	15.92	18.90	25.04	0.86
225-274 ml	11.43	12.00	17.96	26.07	6.89
275-324 ml	6.33	8.65	14.23	18.06	18.91
325-374 ml	3.29	6.14	10.21	9.93	25.78
375-424 ml	1.74	4.34	6.93	4.78	22.09
425-474ml	0.92	3.07	4.56	2.13	13.80
>=475 ml	1.12	7.83	8.18	1.54	11.67
(a) < 225 ml					
50% Cons	55.78	50.00	52.49	51.11	48.70
	< 175 ml	**< 200 ml**	**150-299 ml**	**175-274 ml**	**300-399 ml**

Source: Statistics cited in Table 1 and own elaboration

Between 1925 and 1933, a considerable expansion would have taken place in consumption. Average consumption –corrected mean- increased from 84,5 to 115 liters (Table 9). The change inferred by the 1933 distribution resides basically in the extension of consumption towards higher daily quantities. Graph 5 shows this change in the shape of distribution. The comparison of the figures for consumption between 1925 and 1933, hints that a double process of generalization and polarization of consumption was consolidated in the 1930s. Differences between mode and mean achieved the highest level in the century. Although approximately 25% continued consuming less than the equivalent of one cup a day, now the rest acceded to higher quantities; so 8% of the population would have consumed over 475 ml a day, this is the equivalent to almost 175 liters per person per year[40] (Table 12).

[40] Magnitudes that are very close to the consumption averages in the 1930s from Austria and Denmark see C. Agenjo, 1956, p.315.

GRAPH 5
Spain (1925-1981)
Distribution of consumer populations according to daily milk consumption intervals



	Mean and mode of daily milk consumption (ml/gr)				
	1925	**1933**	**1955**	**1965**	**1981**
Mode	131	135	212	226	351
Mean	182	249	284	259	375
Mean-Mode Difference(%)	39	84	34	15	7

Source: Statistics cited in Table 1 and own elaboration

The return to the pre-Spanish war levels of consumption took time to occur as the slight increase in the proportion of the consumer population (around 3%) and the stability of averages of the effective estimate consumption from 1933 to 1955 (situated between 115 and 112 liters per person per year) confirm it. This trend contrasts with the changes observed in the distribution of 1955. 52% would have consumed between 150 and 299 ml then and almost 45% of the consumers would have drunk more than 275 ml a day.

From the second half of the fifties and the first half of the following decade, the average effective consumption did not show relevant changes, but the proportion of consumers entered a stage of expansion reached, according to estimates made from the HBS, almost 80% of the population, therefore, leading to a phase of generalized consumption in the eighties. It is important to observe that between 1965 and 1981, unlike what had occurred in previous stages, a double process of increase in consumption in the number of consumers took place. In this point, however, it should be

remembered that the average consumption estimated for 1981, close to 136 liters per person per year was equivalent to that reached by the German population in the 1930s[41]. The HBS of 1965 and 1981 infer distributions of consumption of very different tendencies to the years 1925 and 1933. The distribution of 1955 could be described as closer to the patterns of the next than the past years. Graph 5 shows a displacement to the right and a remarkable increase in the mode. The distribution of 1965 could contribute evidence of a step forward in the nutritional transition in Spain. Indeed, in those years a substantial part of those who consumed milk did this in quantities that were close to the equivalent of one cup a day, 50% of the population would drink between 175 and 275 ml a day, when in 1955 it was only 37%. In fact, in 1965 around 63% would be consuming more than 225 ml a day (Table 12). The distributions estimated from the years 1965 and 1981 demonstrate both a growth and generalization of consumption, the progressive approximation of the mode and average consumption reveal this fact (Graph 5). From the sixties, together with the regular improvement of levels of income in Spain, this foodstuff, just like all other animal based foodstuffs, would begin a trajectory of growing averages of consumption per capita as well as the universalization of milk consumption

This last characteristic, according to the results obtained, should have been reached in the 1970s. Milk and products derived from milk were, between 1969 and 1984 a regular proportion, around 55%, of the total animal based foodstuff consumed per person per year, which in terms of its calcium attributes represented 7 and 9% of the total diet[42]. Towards 1981, the rise in consumption was consolidated in levels above 351 ml. So it was necessary to wait until the last decades of the 20th century to witness the growing importance of dairy products in the national diet[43].

5. Conclusions

Not only do nutritional transitions involve changes in levels of consumption, but also in numbers of consumers. The reconstruction of consumer populations is not an easy task because most of the historical statistics do not publish this kind of data. In countries with statistical yearbooks, the data available only allow the computation of statistical means at some spatial scale, according to the administrative units defined in each country. In order to overcome this limitation a methodological approach has been presented here. This methodology has been illustrated with the case of milk consumption, because the increase in the use of milk and derivatives, as well as animal proteins in

[41] Agenjo, C, 1956,p. 315
[42] Rodríguez, F et al. 1996.
[43] Varela, G, 2000; Moreno, L.A. et al. 2002.

general constitutes one of the main components of the modern nutritional transition, as it was so in the Spanish case too. A basic step in the approach implemented in these pages has been the initial adjustment applied to the observed consumption levels to become effective consumption levels, where the latter were the main unknown. In order to avoid an arbitrary solution this paper has presented an approach based on the combination of certain hypothesis about the diffusion of this food in the Spanish population with some results obtained from simulations of log-normal distributions. This combination has given a reasoned solution but not a definitive one. This would explain why these results should be viewed as a reconstruction. Unfortunately these estimates only can be tested indirectly, but when it has been done they seemed to fit very well in the information and evidence available about the evolution of Spanish milk consumption in the 20th century. Basically they stand that, from the point of view of the number of consumers, this was a slow and late process. Because this is a reconstruction the assumptions made can be a source of error. This has been evaluated through a sensitivity analysis. The effects of variations in more or less 10 liters in minimum consumption levels around the adopted scale of adjustment, between 45 and 130 liters, have shown that the conclusions previously obtained should not be changed significantly.

This kind of reconstruction has some drawbacks to consider. On the one hand, missing more historical information about consumer habits in the population makes it difficult to evaluate effective consumption levels; on the other hand, the published statistics used to present two types of important limitations. First, the data were published according to some administrative units, for example provinces. In the best cases, consumption means can be estimated but not variances, so any calculation requires accepting variance at national scale as representative of provincial level. Second, a lack of information on internal trade underestimates or overestimates levels of consumption. If all these aspects above mentioned are taken into account this approach could be extended to other foods involved in the same process of nutritional change. The possibility to estimate levels and trends in the evolution of consumer populations may shed new light in the study of the nutritional transition.

References

Agenjo , Cesar, *Enciclopedia de la Leche*, Madrid, Espasa Calpe, 1956.

Asociación General de Ganaderos del Reino, *Leche, queso y manteca. Estadística de la producción en España*, Madrid, 1925

Bernabeu-Mestre, J., Espulgues-Pellicer, J.X and E. Galiana-Sánchez, “Antecedentes históricos de la nutrición comunitaria en España: Los trabajos de la Escuela Nacional de Salud 1930-1936”, *Revista Española de Salud Pública*, 81, 2007, p.451-459.

Carrasco , E. “Lo que se come en España. Interés sanitario de este problema”, *Archivos de Medicina, Cirugía y Especialidades* ,XXXVII, 25, 23 June 1934, p. 669-675.

Crigg, David, “The nutritional transition in Western Europe”, *Journal of Historical Geography*, 22, 1995,p.: 247-261.

Cusssó, Xavier, *Alimentació, mortalitat i desenvolupament. Evolució i disparitats regionals a Espanya des de 1860*, Doctoral Dissertation, Universitat Autònoma de Barcelona, 2001.

Cussó, Xavier, “El estado nutritivo de la población española 1900-1970. Análisis de las necesidades y disponibilidades de nutrientes”. *Historia Agraria*, 36, August, 2005,p. 329-358.

Cussó, Xavier, and Garrabou, Ramon, “La transición nutricional en la España contemporánea: las variaciones en el consumo de pan, patatas y legumbres”. *Investigaciones de Historia Económica*, Winter, 2007,p.69-100.

De Vries, Jan, *The Industrious Revolution. Consumer Behavior and the Household Economy, 1650 to the Present.* Cambridge. Cambridge University Press, 2008

Domínguez-Martín, Rafael, “La Industria Láctea en España, 1830-1935”, in C. Varicela and V. Di Vittorio (Ed), *Las industrias agroalimentarias en España e Italia durante los siglos XIX y XX*, Alicante: Publicaciones Universidad de Alicante. 2003. p. 457-495

FENIL. *Plan de Nutrición, Salud y Comunicación de Productos Lácteos 2007-2010.* Madrid : MAPA-FENIL. 2008.

Fogel, Robert W, “Second Thoughts on the European Escape from Hunger: Famines, Chronic Malnutrition, and Mortality Rates”, In S. R. Osmani (Ed), *Nutririon and Poverty*, Oxford, Clarendon Press, 1992.p. 243-286.

García-Barbancho, Antonio, “Análisis de la alimentación española”, *Anales de Economía*, XVIII, 66 and 67, 1960. p. 73-120, p. 271-367.

Hernández, Ismael *La leche en el cambio nutricional de la España contemporánea, 1865-1935.* Master Thesis, Universitat Autònoma de Barcelona, 2005.

Instituto Nacional de Estadística (INE), *Encuesta de Presupuestos Familiares*, (March 1964- March 1965),Madrid, 1969.

Instituto Nacional de Estadística (INE), *Encuesta de Presupuestos Familiares 1980-81*, Madrid, 5 vols, 1983.

Lawrence, Raymond, “Applications in Economics and Business”. In E. Crow and K.Shimizu (Ed), *Lognormal distributions. Theory and Applications,* New York, Marcel Bekker Inc, 1988, p. 230-264.

Jiménez, F; Jiménez, M “La alimentación en la provincia de Jaén. Deducciones sanitarias”,_*Archivos de Medicina, Cirugía y Especialidades* XXXVII, Num 19, 12 Mayo 1934, p. 503-506.

Logan, Trevor.D. “Is the Calorie Distribution Log Normal?”. *Historical Methods*, Summer, 39-3, 2006,p.112-122.

Mace, Ruth. Jordan, Fiona, Holden, Clare. “ Testing evolutionary hypothesis about human biological adaptation using cross-cultural comparison”. *Comparative Biochemestry and Physiology.* Part A, 136, 2003, p. 85-94.

Ministerio de Agricultura, *Censo de Ganadería en España en 1933*, Madrid, 1934.

Ministerio de Agricultura. *Resúmenes estadísticos de la produción, destino y valor de la leche*,Madrid, 1954 and 1955.

Ministerio de Trabajo, Comercio e Industria, *Censo de Población de España. Madrid*, Madrid, Tome V,1922.

Moreno, L.A., Sarría, A., and B.M. Popkin.. “The nutrition transition in Spain: A European Mediterranean country”, *European Journal of Clinical Nutrition*, 56, 2002,p. 992-1003.

Nicolau , Roser, Pujol-Andreu, Josep and Hernández, Ismael, “El consumo de leche fresca en Cataluña entre mediados del siglo XIX y 1935: la difusión de un nuevo alimento”, *Historia Agraria*, 42, August 2007,p. 303-325.

Nicolau , Roser, Pujol-Andreu, Josep and Hernández, Ismael, “Milk, social acceptance of a new food in Europe: Catalonia, 19th-20th centuries”, *Dynamis: Acta Hispanica ad Medicinae Scientiarumque Historiam Illustrandam*, 30, 2010, p. 119-140.

Peña, José.A., Alfonso-Sánchez, Miguel A., Garcia-Obregón, Susana and Pérez-Miranda, Ana, "Persistencia de actividad lactasa en población residente en el País Vasco (Lactase persistente in residing population of the Basque Country)", *Antropo,* 3,2002, p.51-60.

Popkin, Barry, "Nutritional Patterns and Transitions", *Population and Development Review*, 19-1, 1993, p. 138-157.

Rodríguez Artalejo, F., Banegas, J.R, Graciani, M.A., Hernández-Vecino, R and Rey Calero, J, "El consumo de alimentos y nutrientes en España en el período 1940-1988. Análisis de su consistencia con la dieta mediterránea". *Medicina Clínica*, 106, 1996, p.161-168.

Rogers, Everett M, *Diffusion of Innovations*, Fith edition, New York, The Free Press, 2003.

Simpson, James, *Spanish agricultura: the long siesta, 1765-1965*, Cambridge, Cambridge University Press, 1995.

Steckel, Robert H. and Floud, Roderick (Ed), *Health and welfare during industrialization*, Chicago, University of Chicago Press, 1997.

Varela, Gregorio, "Evolución de la alimentación de los españoles en el pasado siglo XX", *Cuenta y Razón*, 114,2000,p. 1-6.

Williamson, Jeffry G., "Regional Inequality and the Process of Nacional Development: A Description of Patterns", *Economic Development and Cultural Change*, 13- 4, 1965, p. 3-52.

Annex 1

Linear scale od adjustement of the consumption observed in the estimate

Litres observed person/year	Estimate Daily Millilitres	Litres Person/year
5	0.125	45.6
7.5	0.130	47.3
10	0.134	49.0
12.5	0.139	50.7
15	0.143	42.4
17.5	0.148	54.1
20	0.153	55.7
22.5	0.157	57.4
25	0.162	59.1
27.5	0.167	60.8
30	0.171	62.5
32.5	0.176	64.2
35	0.180	65.0
37.5	0.185	67.6
40	0.190	69.2
42.5	0.194	70.9
45	0.199	72.6
47.5	0.204	74.3
50	0.208	76.0
52.5	0.213	77.7
55	0.217	79.4
57.5	0.222	81.1
60	0.227	82.7
62.5	0.231	84.4
65	0.236	86.1
67.5	0.241	87.8
70	0.245	89.5
72.5	0.250	91.2
75	0.254	92.9
77.5	0.259	94.5
80	0.264	96.2
82.5	0.268	97.9
85	0.273	99.6
87.5	0.278	101.3
90	0.282	103.0
92.5	0.287	104.7
95	0.291	106.4
97.5	0.296	108.0
100	0.301	109.7
102.5	0.305	111.4
105	0.310	113.1
107.5	0.315	114.8
110	0.319	116.5
112.5	0.324	118.2
115	0.328	119.9
117.5	0.333	121.5
120	0.338	123.2
122.5	0.342	124.9
125	0.347	126.6
127.5	0.351	128.3
130	0.356	130.0

Annex 2A
Estimate process of consumer population year 1925

Spanish Provinces	Total Population (1)	Consumption p/cap/year observed (2)	Consumption p/cap/year adjusted (3)
Álava	101,524	30	62
Albacete	311,597	4	45
Alicante	527,557	8	48
Almería	357,045	9	48
Ávila	215,949	25	59
Badajoz	672,792	11	50
Baleares	349,413	21	56
Barcelona	1,545,304	54	79
Burgos	344,203	28	61
Cáceres	429,164	11	49
Cádiz	539,359	13	51
Canarias	490,791	33	64
Castellón	306,341	10	49
Ciudad Real	455,918	9	48
Córdoba	602,439	17	54
Coruña	736,7	43	72
Cuenca	296,302	4	45
Girona	327,408	25	59
Granada	596,211	32	64
Guadalajara	203,854	10	49
Guipúzcoa	282,101	175	184
Huelva	335,549	12	50
Huesca	241,247	19	55
Jaén	552,447	13	51
León	423,955	25	59
Lleida	304,741	20	56
Logroño	200,423	33	64
Lugo	465,998	73	92
Madrid	1,157,766	47	74
Málaga	577,659	13	51
Murcia	647,132	24	59
Navarra	341,365	81	97
Ourense	419,662	50	76
Oviedo	741,258	151	160
Palencia	220,101	13	51
Pontevedra	547,555	32	64
Salamanca	334,633	17	54
Santander	344,753	117	121
Segovia	172,076	27	61
Sevilla	743,174	19	55
Soria	152,229	18	54
Tarragona	351,413	13	51
Teruel	248,802	6	47
Toledo	463,431	18	54
Valencia	1,001,983	12	50
Valladolid	294,608	42	71
Vizcaya	440,474	154	164
Zamora	276,119	12	50
Zaragoza	509,569	37	67
Mean		34.05	66.41
Standard Deviation		38.80	30.24

Source: Column (1) and (2) statistics cited in Table 1 and own elaboration.

Annex 2B
Estimate process of consumer population year 1925

Spanish Provinces Sorted	Consumption per cap/year adjusted - sorted (liters) (4)	Daily consumption (ml) (5)	Consumer Population Accumulative Percentage (6)
Albacete	45	123	25
Cuenca	45	123	25
Teruel	47	128	27
Alicante	48	131	30
Almería	48	132	30
Ciudad Real	48	132	30
Castellón	49	134	31
Guadalajara	49	134	31
Cáceres	49	135	32
Badajoz	50	136	33
Huelva	50	138	34
Valencia	50	138	34
Zamora	50	138	34
Málaga	51	139	34
Cádiz	51	140	35
Palencia	51	140	35
Jaén	51	140	35
Tarragona	51	140	35
Córdoba	54	147	39
Salamanca	54	148	40
Soria	54	148	40
Toledo	54	149	40
Huesca	55	151	41
Sevilla	55	151	42
Lleida	56	153	43
Baleares	56	154	43
Murcia	59	161	47
Girona	59	161	47
León	59	161	48
Ávila	59	162	48
Segovia	61	166	50
Burgos	61	168	51
Álava	62	171	53
Granada	64	174	55
Pontevedra	64	175	55
Canarias	64	176	56
Logroño	64	176	56
Zaragoza	67	184	59
Valladolid	71	194	64
Coruña	72	196	65
Madrid	74	203	68
Ourense	76	209	70
Barcelona	79	216	73
Lugo	92	251	83
Navarra	97	265	86
Santander	121	332	95
Oviedo	160	438	99
Vizcaya	164	449	99
Guipúzcoa	184	504	100

Source : Own elaboration

Annex 2C

Estimate process of consumer population year 1925

Spanish Provinces Sorted	Population (%) (7)	Population Accumulated (8)	Consumption p/cap final estimate Daily (ml) (9)	Yearly (liters) (10)	Provincial Consumption (liters) (11)	Consumer population estimates Consumers (12)	Consumers (per cent) (13)
Guipúzcoa	1.27	100.00	298	184	49,361,661	268,27	95
Vizcaya	1.98	98.73	294	164	67,834,700	413,626	94
Oviedo	3.34	96.75	287	160	111,581,548	697,385	94
Santander	1.55	93.41	276	121	40,315,127	333,183	97
Navarra	1.54	91.85	271	99	27,507,369	278,152	81
Lugo	2.10	90.32	266	97	34,188,451	351,986	76
Barcelona	6.96	88.22	260	95	83,427,640	880,279	57
Ourense	1.89	81.26	239	87	21,106,489	241,598	58
Madrid	5.21	79.37	234	85	54,630,582	639,318	55
Coruña	3.32	74.15	220	80	31,971,748	397,69	54
Valladolid	1.33	70.83	212	77	12,477,264	161,346	55
Zaragoza	2.30	69.51	209	76	18,689,307	245,456	48
Logroño	0.90	67.21	203	74	6,559,750	88,497	44
Canarias	2.21	66.31	201	73	16,044,254	218,751	45
Pontevedra	2.47	64.10	196	71	17,508,868	244,974	45
Granada	2.69	61.63	190	69	18,921,173	272,485	46
Álava	0.46	58.95	184	67	3,016,636	44,829	44
Burgos	1.55	58.49	183	67	9,775,307	146,047	42
Segovia	0.78	56.94	180	66	4,701,635	71,53	42
Ávila	0.97	56.16	178	65	5,363,114	82,337	38
León	1.91	55.19	176	64	10,432,932	162,005	38
Girona	1.47	53.28	173	63	8,186,437	129,993	40
Murcia	2.91	51.81	170	62	15,823,683	255,637	40
Baleares	1.57	48.89	164	60	7,170,581	119,862	34
Lleida	1.37	47.32	161	59	6,119,244	104,189	34
Sevilla	3.35	45.95	158	58	14,140,272	244,656	33
Huesca	1.09	42.60	152	56	4,574,635	82,312	34
Toledo	2.09	41.51	150	55	8,210,206	149,617	32
Soria	0.69	39.43	147	54	2,671,000	49,878	33
Salamanca	1.51	38.74	146	53	5,797,078	109,126	33
Córdoba	2.71	37.23	143	52	10,069,224	192,918	32
Tarragona	1.58	34.52	139	51	4,701,741	92,987	26
Jaén	2.49	32.94	136	50	7,354,495	148,17	27
Palencia	0.99	30.45	132	48	2,891,904	59,984	27
Cádiz	2.43	29.46	131	48	7,008,453	147,065	27
Málaga	2.60	27.03	127	46	7,303,472	157,674	27
Valencia	4.51	24.43	123	45	12,162,733	270,697	27
Zamora	1.24	19.91	117	43	3,368,425	79,033	29
Huelva	1.51	18.67	115	42	4,046,819	96,342	29
Badajoz	3.03	17.16	113	41	7,430,439	180,052	27
Guadalajara	0.92	14.13	109	40	1,981,292	49,743	24
Cáceres	1.93	13.21	108	39	4,553,123	115,546	27
Castellón	1.38	11.28	106	39	2,941,616	76,358	25
Ciudad Real	2.05	9.90	104	38	4,062,548	107,171	24
Almería	1.61	7.84	101	37	3,085,212	83,368	23
Alicante	2.38	6.23	99	36	4,440,350	122,265	23
Teruel	1.12	3.86	97	35	1,589,849	45,011	18
Albacete	1.40	2.74	96	35	1,216,154	34,885	11
Cuenca	1.33	1.33	94	34	1,075,370	31,358	11
Spain				84.53	809,391,911	9,575,641	43

Source: Column (7) calculated from column (1) Table Annex 2A; column (11) statistics from "Asociacion General de Ganaderos del Reino" published 1925 and other columns own elaboration