

GEOMETRIC FRAGMENTATION OF THE HUERTA OF VALENCIA, SPAIN: TOWARDS A SUSTAINABILITY MODEL

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ABSTRACT

The history of Valencia's Huerta Sur through a period of 91 years (1928–2019) and the specific area of Castellar, Valencia, valued for its low physical alteration over time, composes this analysis. The focus is on understanding the composition and, therefore, fractioning of the structure of Valencia's Huerta Sur. This study presents an understanding of the geometry of the plots, from historicism related to hereditary processes, and reflects on sustainable management and economic viability of agricultural heritage. The historical evolution of the transitions and the legislation governing the land introduces criticism of the operation of Valencia's Huerta and its fragmented functionality. Using illustrative maps, the proportions and portions produced by centuries of division that modified the structure of Valencia's Huerta configuration are explored. The presentation of new forms of organization of the Huerta is a necessary reaction as a response to the conditions of abandonment and disuse of the land, which in turn conveys the current impossibility of self-management.

Keywords: sustainable food systems, geometry, fragmentation, Huerta.

1 INTRODUCTION

Taking as a starting point the justice and fairness of the succession of property, the possibilities for the transfer of heritage from a historical analysis have evolved in many perspectives, and it is difficult in some cases to define forcefully whether they have been entirely right. Specifically, Valencia's Huerta has been physically and functionally impacted during the last 100 years, as a consequence of years of hereditary processes that partitioned and continues partitioning the land to unsustainable extremes. The relationship between the balance of the natural ecosystem and the economic operation exceeds the point of equilibrium, leading to a major problem related to the disinterest and abandonment of the land, whose problem returns to the initial situation related to the way in which humanity grows. The Castellar area is one of the few areas of Valencia's Huerta near the capital that remains highly unchanged, and therefore becomes an area of interest sampling for comparative criticism.

2 THE HUERTA IN THE VICINITY OF CASTELLAR-OLIVERAL

“To the hegemony of collective or semi collective forms of ownership – the rights of use – follows the emergence of feudal forms of property, which undoubtedly involve a step forward on the way to privatization. In this manner, as cultivated areas expand, property rights tend to prevail over those of use and, at the same time, land begins to build a more important part in noble fortunes” [1]. The land has been transformed into small portions owned by many, which speaks of a democratized agricultural space described by Giobellina [2] as an essential characteristic of the Huerta. A central theme that defines the Huerta is what has happened and what is still happening with land ownership and the size of plots. Historically, the Huerta has undergone stages of concentration and de-concentration of land ownership, but there have never been large landowners. Between the 13th century and the end of the 20th century,



property was continually subdivided, until eventually reaching the size of smallholding in which the average surface area of the plots in 1989 was 0.39 ha.

It is clear that the size of the plots has been gradually reduced in the fields, but in this case the subdivision process registers patterns that are repeated and that will tend to be repeated again and again, putting the future of this productive area in check and becoming an amalgam of plots linked with self-production. In the case of the village of Castellar-Oliveral, the portion of land located in the study area has a particular casuistry; it is one of the few unaltered areas with an exemplary cartography, a priceless map, which shows the cadastral property at the end of the 1920s, and that encompasses the area under study. This document, as well as the unaltered situation of this territory, which has been exceptionally maintained until now, makes it possible to proceed to a detailed study of the fragmentation rhythms of the Huerta plots.

3 GRAPHICAL ANALYSIS OF THE EVOLUTION OF THE FRAGMENTATION OF THE TERRITORY OF VALENCIA'S HUERTA IN THE VICINITY OF CASTELLAR

In the article “La imposible igualdad. Familia y estrategias hereditarias en la Huerta de Valencia a mediados del siglo XVIII” (The impossible equality. Family and hereditary strategies in the garden of Valencia in the mid-18th century) [3], an example is given in order to understand the distribution of land, the number of partitions related to the fifths and thirds in the inheritance of land. “We can get an idea of the territorial fragmentation (...) if we observe that the 29 *hanegada* [-24 ha] lots that the father had, split over 6 different areas, had to be divided into 10 smaller lots to cope with inheritance partition. In this case, however, it did not present too many problems since there were only two males and there was enough land to divide”.

Performing a graphical analysis aims to be able to obtain close deductions by understanding plots as a metric parameter of the evolutionary conditions of land ownership and surfaces.

3.1 Determining the mapping tools

Information within the public domain, in the case of Valencia, is a tool that magnifies the possibilities of analysis. The information, freely accessed on the part of cadaster of the administrative record of the State, is capable of providing the oldest plan of the city, dated 1928, as well as the most recent dated 2019, giving a chronological window of 91 years. Although there are other graphic representations available, for example one provided by an American flight in 1948, they do not have the quality to carry out the analysis.

3.2 Maps and portions

With the purpose of leading the research by graphic interpretation, a graphic representation system is modeled that analyzes, in a chronological way, the quantity and size of the resulting portions over time so that, finally, a story can be narrated as a result of the mathematical assumption of the surface area. A section of the eastern area of Castellar is the base sample, delimited by the urban area to the west, further delimited by the V-31 highway, and Alfafar administrative territory to the south. While to the east, the human made limit is the CV-500 road, running parallel to the coastline, and the new riverbed of the Turia, built in second half of the 20th century, provides the northern limit (Fig. 1).



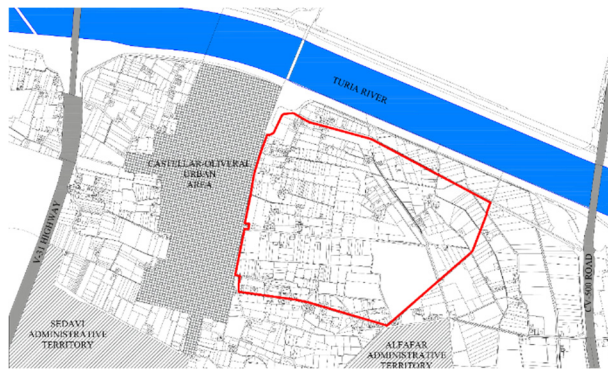


Figure 1: Castellar area site to be analyzed.



Figure 2: Plot divisions in the period 1928–1999.

3.2.1 Contrast between 1928 and 1999

Bubble map generation considering the lines that appear as a result of the division of the plots over a period of 71 years, each new line is represented by a circle whose diameter corresponds to the size of the dividing line.

The area shaded orange in Fig. 2 was converted into an industrial park during the second half of the 20th century. This had a great impact both on the functioning of the area with respect to the introduction of a new use, and because of the change in the type of ground surface and the impact on the thousand-year-old irrigation network.

3.2.2 Comparison between 1999 and 2019

Bubble map generation considering the lines that appear as a result of the division of the plots in a period of 20 years, each line is represented by a circle whose diameter is the size of the dividing line (Fig. 3).

Proportionally, in comparison with the previous map, the number of divisions that appear is substantially fewer. Due to the division of limited surfaces, as well as the partial colonization of building, since many of these divisions, particularly those that correspond to the smallest parcels, are due to the division with the purpose of building small houses on their own land, dividing the parcel.



Figure 3: Plot divisions ranging from 1999–2019.

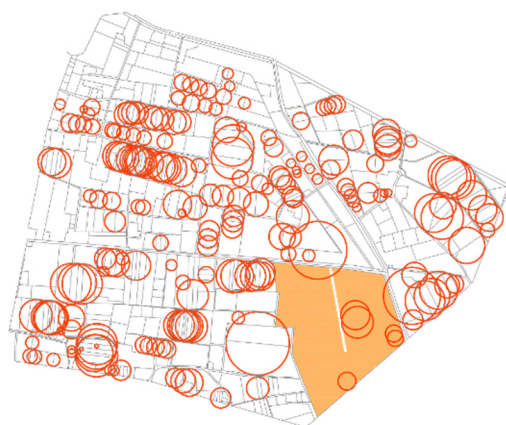


Figure 4: Cumulative divisions of plots ranging from 1928–2019.

3.2.3 Comparison between 1928 and 2019

Complete map with the accumulation of partitions in the plots over the course of almost a century – 91 years (Fig. 4).

It can be seen by combining both maps, that the fragmentation of the plots has been a generalized and constant fact over time, since it is even evident that in those areas where there were no changes during the last century, the plot sizes are already relatively small, which indicates that the land was probably divided prior to 1928. Although this fact does not exclude them from relevant observation and reflection.

3.2.4 Analysis of surfaces with regular distribution

The sizes of the plots are mapped in four ranges, with plots of less than an 831 m² (dark brown), plots of less than 3,324 m² (orange), plots between 3,324 and 6,648 m² (yellow), and then larger plots shown green, the larger areas being darker (Fig. 5).

The aim is to obtain a generalized distribution, in which the larger plots stand out.



Figure 5: Zoning by surface size in arithmetic ratio.

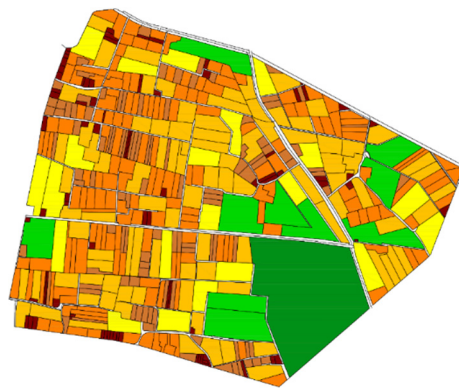


Figure 6: Zoning by surface size in geometric relationship.

3.2.5 Analysis of geometrically shaped surfaces

The previous surface area analysis highlighted the need to be able to distinguish between those plots of smaller size, since they are the ones that best illustrate the processes of fragmentation. With this objective, a new map was generated in which the distribution of surfaces follows a geometric relationship, doubling the previous surface, based on the hypothesis that fragmentation is carried out at least between two parts, together with the analysis of adjacent surfaces in which the relationship between them was mostly 1:1 or 1:2 (Fig. 6).

There is obviously some coincidence with Fig. 3, in that those areas that have been divided in the last 91 years appear with darker brown colors. However, it is also easily observed that the division into smaller plots is not only located in those areas that have been subdivided in recent years.

3.2.6 Analysis of divisions

In order to be able to determine a historically altered region, the plots that were divided, in orange, during the period 1928–2019 from those that remained unchanged during that period, in green, are represented in a contrasting way (Fig. 7).

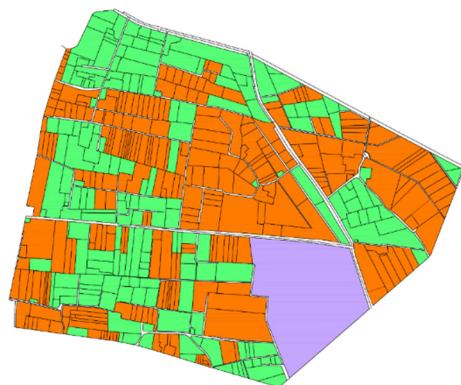


Figure 7: Identification of divided and not divided plots.

This classification shows that this fragmentation repeatedly began at least more than 200 years ago, especially when observing the level of fragmentation of some green areas, and together with the calculation of the time necessary to reach that level of subdivision. In the first decades of the 19th century [4], the extension of the Huerta amounted to approximately just over 357.33 ha distributed in about 1,600 owners. We could think of an average surface area of 2.7 hectares per owner, however, the distribution was very uneven. Of the total of the owners, 36% had less than 415 m², which represented 2.9% of the total area. If we move to the opposite extreme, 6.2% of the owners had 51.3% of arable land, which accounts for the accumulation of land by large landowners. The nobility (61 owners), the clergy (62 owners) and the bourgeoisie (549 owners) accumulated 86.1% of Valencia's Huerta with average properties that ranged between approximately 1.16 ha for the first two, and 30.74 ha in the case of the bourgeoisie. The rest, owned by the peasantry, corresponded to a total of 74.57 ha. It should be noted that the income per hectare was very similar among all social groups and ranged between 348 and 396 pounds/ha. Large plots were numerous in the case of large landowners, with plots between 1,000 and 4,000 m², in more than 50% of the cases, while in the case of the peasantry, 50% of the cases remained between 250 and 1,250 m², with plots of less than 250 m² being 20%.

3.2.7 Specific analysis of the division of plots linked to generational history

The plots with geometric division behavior are sampled to be able to translate it into historical interpretation of the partitions.

The results of a study carried out in one of the central areas of the general study area, in which the divisions suffered over time, have been traced for an area of almost 70,000 m². In this area, two parallel analyses of the evolution of fragmentation has been carried out, starting from the current state, towards the past and from the old cartography presented towards the present, identifying the points of coincidence and establishing the corresponding patterns both in the direction of the division and in the surface relationship.

The area was characterised by several aspects that are interesting for the present study. It is delimited in its long sides, north and south, by roads that include ditches, which makes the supply of water possible for irrigation by these two sides, facilitating the flexibility of subdivision. To the east, it borders the industrial estate, separated by an old road in existence prior to the industrial qualification, presenting an exact limit from which it also has its previous subdivision, which is important when presenting and understanding the previous

irrigation lines and divisions. To the west, plots border the current urban area, which, despite not showing significant growth in recent years, are modified spaces and do not respond to the general surface plot of the Huerta.

The inclusion of different non-agricultural uses in this area also positions it as one of the most endangered areas for traditional vegetable plots. These uses are, in addition to the adjacent industrial park, a service and workshop area in one of the plots with a building next to the road. As well as the use of the plots by some owners as a warehouse for trailers and transport vehicles, waste collection or even apparent abandonment of them.

Regarding the fragmentation, the objective of the study, the one found in this area also presents varieties and combinations representative of the area in general, as well as a variety of composition that ranges from very simple to more complex divisions.

It is important to define the limitation of this study, which depends directly on the available cadastral information and the definition of the years in which the divisions were created. As previously observed in Figs 5 and 6, although the rules of subdivision may be the same in different areas, this does not mean that the time in which the subdivision is made is the same. To represent evolution in this study, with this limitation and with the objective of simplifying its understanding, fragmentation scales are not presented in temporal order between the different areas. It is possible that some plots were quickly divided with respect to others and then, they remained stagnant for a while, as the others were divided, progress of division that is subordinated to several processes and factors, economic, demographic and of inheritance, among others, that are outside the scope of the present study.

Fig. 8 shows the first large division into three equal parts, although greater divisions in the surrounding areas cannot be ruled out, while Fig. 9 shows three different proportions of division. The green plot is divided into two areas of equal surface plus the area that includes the building next to the road, this area in the future will be divided and will generate the access road to the rear plot (Fig. 10).

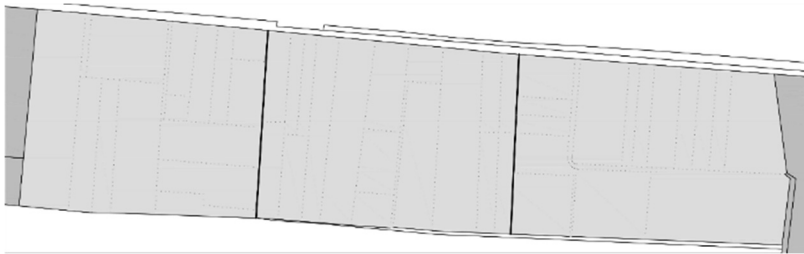


Figure 8: Zone displays with first-order partitions.

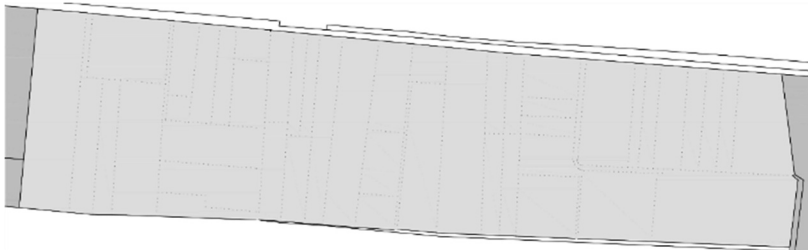


Figure 9: Analyzed zone without partitions.

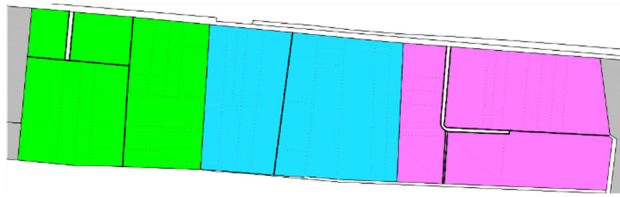


Figure 10: Zone displays with second-order partitions.

In the blue area, a second type of division appears, in fifths, “the Castilian testator divided the inheritance in five parts, four of which must necessarily be transmitted to their descendants, of them two parts must distribute them equally among children and grandchildren and the remaining part among whoever he considers appropriate: it is the so-called improvement third. The fifth part that is missing to complete the inheritance, is what we know as the free disposal fifth” [5], leaving the western part two fifths and the right part three fifths. But it is in the pink plot where the division of greater complexity is found, since between the division located in the west and the southeast appears the relation of two and three fifths respectively, while between the southeast and northeast plot the same relation of two and three fifths respectively appears again. However, the process that led to this subdivision is not known, and it also includes another interesting factor of division such as the inclusion of the east–west line to the early process of division, which corresponds to the subdivision of other plots that disappeared with the creation of the industrial park.

Fig. 11 shows new divisions in practically the entire area, except for the northwest where the first order division is intact. The most repeated divisions are in two equal parts, although there is one in three and one division in a two-to-one proportion. It is also worth noting the appearance of an access road in the horizontal division of the eastern part of the green plot.

In Fig. 12 you can see the areas that remain without further division, starting to generate the difference in areas. In this step two divisions of two and three fifths stand out, one in the second division of the blue zone and another in the southwest corner of the pink zone.

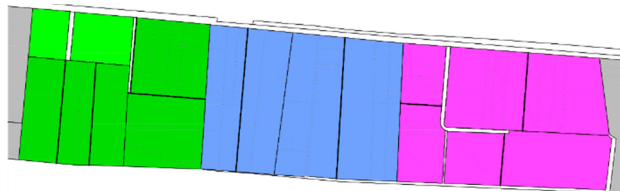


Figure 11: Zone displays with third-order partitions.

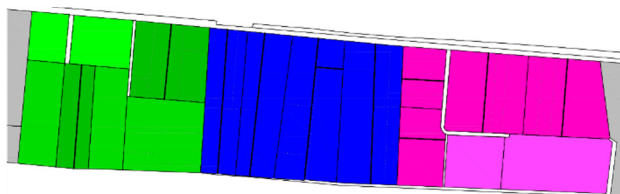


Figure 12: Area shows with fourth-order partitions.

In the divisions in Fig. 13, where a greater variety of surfaces is generated, the union to the west of the initial green plot stands out, while to the northeast of the same plot, one plot is divided into two equal parts and the other into two and three thirds, both cases with the sub-parceling of built up spaces, the squares of smaller size. In addition, apart from most divisions into two equal parts, there is a division into the same step of four parts to the east of the first order blue division, in which the proportions are 3 and 3/10 between the largest and smallest plots. In the pink area we find two subdivisions in equal parts and one in thirds.

Fig. 14 shows three new divisions in two equal parts and one third to the south center of the area corresponding to the building subplot. In this final state, we see the reduction of divisions, as well as the current variety of surfaces, in which the larger plots were generated in the third order division.

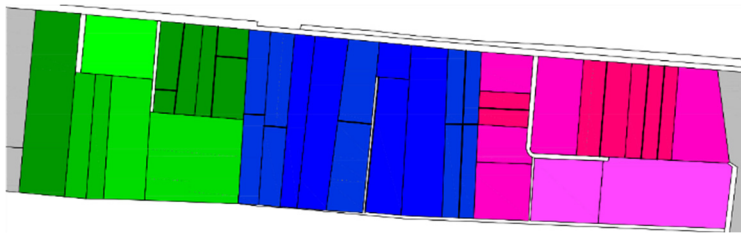


Figure 13: Zone displays with fifth-order partitions.

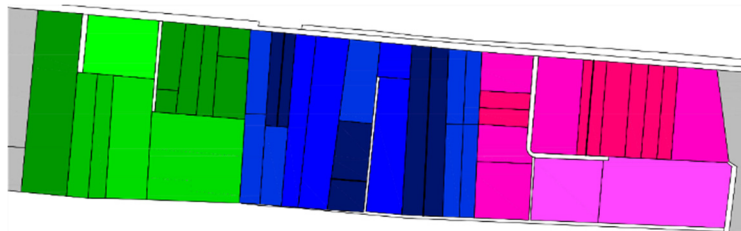


Figure 14: Zone displays with sixth-order partitions. Sexto.

4 EVALUATION OF THE CURRENT AND FUTURE SITUATION OF THE HUERTA

4.1 Critical data analysis

The fragmentation of the agricultural territory together with the plurality of owners has produced the growth in the number of plots. Having this situation effects the cost ratio maintenance – productivity – surface, becoming an uneconomic equation. This is in addition to the other problems already known around the Huerta such as aging owners and the lack of generational relief. The president of AVA-ASAJA, Cristóbal Aguado, explains that “the dramatic profitability crisis that is effecting most of the Valencian crops is created by the unprecedented aging of the agricultural population, the lack of generational support and the increasing abandonment of the fields. The alarms do not stop ringing, the numbers could not be more evident, but the government of the Botànic continues without reacting, it ignores the farmers and prefers to be in other things” [6].

4.2 Public effects of the Horta situation

Reviewing the agricultural statistics of the National Statistical Plan for the period 2009–2013, a critical aging of the population is observed, as well as a change in the trend in consumer policy that tends towards the trade of large land areas. The increase in the sale of vegetables in these establishments in the period 2003–2013 exceeded 8%, it must be remembered that these large areas are not exclusively fed by Valencian production, which unequivocally indicates a worsening of the economic situation of the farmers.

However, a review of the ages of the farmers of the Valencian garden shows that out of a total of 5,976 existing farmers in 2009, 2,456 of them, 41%, were over 65 years old, an issue that suffered a worsening in the last decade. Since in 2009, 68% of them were over 55 years old. This clearly indicates the lack of profitability that the field plots represent, given the great physical requirement that their cultivation needs that can be increasingly hard for an aging population to meet. In the same way, they emphasize an imminent subdivision with its corresponding fragmentation in the coming years as the new inheritances are incorporated into the territory.

5 RESULTS

Complementing the graphical analysis, arises the need to understand the proportions between the division of the plots and their surface area, so a statistical study was carried out with the aim of relating the area of each plot with its division process. The summary result of this study is shown in Fig. 15, in which the initial state of the graphical analysis was obviated in order to give more detail to subsequent evolution.



Figure 15: Graphs of analysis.

Fig. 15(a) highlights the descending geometric evolution for the average area of the plots, expected and corresponding to the splitting process, on the one hand, the most interesting is the change of curvature of the line of number of plots in the smaller areas, since it indicates a reduction of divisions.

On the other hand, in Fig. 15(b), the heterogeneity of the plots in terms of their surface area can be noted. This is illustrated by looking at the maximum and minimum area of the plots in each order and as the reduction of the area of the smaller plots is generated especially at the beginning of the division, generating the greatest difference between maximum and minimum plot sizes in the second order. Larger plots follow an evolution that corresponds

practically to the geometric reduction of average surface area seen in Fig. 15(a), reaching horizontality in the last three orders because there are plots that were no longer divided.

6 CONCLUSIONS

The Huerta is the closest thing to a sustainable territorial model since it has survived over the centuries. The management of water resources, the preservation of the soil and the care of the plant cover, as well as the implementation of the dispersed habitat, have addressed the limiting environmental factors. A historical landscape produced by man's perseverance in the face of nature [7].

A landscape in constant transformation, a landscape that, like all landscapes, is transformed into cycles as an expression of functionality and ecosystem health, and although its inherent biological value prevails, it is also necessary to reconcile it with its historical contribution to human development. The transition from the Huerta to an economically viable model must be aligned with a series of considerations that allow for the construction of a pragmatic legacy, a heritage of cultivation.

“The small farm can be seen as an advantage for ecological agriculture, for diversity; the Valencian case is very particular” (NGO).

“For an integrated biodynamic farm a minimum of 4.000 m² is needed. (1,000–1,500 m² of vegetables, more fruit trees, more small animals), sold locally. A three-dimensional vegetable plot” (farmer) [2].

Four fundamental actions are highlighted that can contribute to the survival of the Huerta:

1. Regulations restricting the subdivision of the Huerta by means of protective lines.
2. It will have to establish limits by area mainly by means of biological parameters and also taking into consideration the efficiency in the relation of plot size and required installations.
3. Group land management. Whether in a collaborative or cooperative manner, maintaining decision making on land management in a collective manner can be beneficial in making the use and production of the vegetable plots more efficient. In addition, committing as part of a group rather than as an individual can bring about greater shared responsibility, committing all owners or, where appropriate, tenants to be active participants in the land and not to let it fall into neglect.
4. Expansion of the Huerta. Although it might seem a drastic measure, we must not forget that the city has stolen land from the Huerta year after year, so the re-expansion of the Huerta should be no more than a necessity corresponding to the increase of biological resources in the face of population growth, not only talking about the exponential growth of the owner families but also about what the Huerta means as a food source for humanity.
5. Modification of marketing strategies. Systems that promote the reduction of costs in the delivery of the product, associated with links with marketing companies that also allow the origin of the product to be indicated “From the Huerta” could supplement the extraordinary costs that the maintenance of the Huerta in a low surface area entails. The quality seals are one of the options in other countries of the European Union, because it allows to justify a low production in relation to the high quality of the product.

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