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DIGITAL MODELS APPLIED TO THE TYPOLOGICAL ANALYSIS OF THE OLIVE OIL MILLS WITH BEAM AND WEIGHT PRESSES IN ÉCIJA

MODELOS DIGITALES APLICADOS AL ANÁLISIS TIPOLÓGICO DE LOS MOLINOS ACEITEROS DE PRENSA DE VIGA Y QUINTAL DE ÉCIJA

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Highlights:

- The typological study of the Écija (Seville) mills with beam and weight presses reveals common patterns in these pre-industrial buildings.
- The proportional relationships between their constituent parts obtained using digital information models enabled us to determine standard structures.
- These patterns have similarly enabled us to generate a parameterised HBIM model as a standard graphical base for the historical mills in Écija.

Abstract

For centuries, mills with beam and weight presses have been the production units used in the town of Écija to obtain oil. The intensification of olive tree cultivation in the 18th century increased the proliferation of these constructions throughout the town, which at one point was home to no less than 286 mills of this type. However, the mid-20th century events surrounding the local olive groves caused many of them to fall into disuse. Nowadays, the mills present an advanced state of decay, to the extent that many of them have disappeared partly or completely. In view of the functional nature of these production units and the short space of time in which they were built, the authors decided to conduct a typological study aimed at identifying any common patterns in their design. The geometric and proportional relationships between their constituent parts, obtained using digital information models (Geographic Information System (GIS), 3D point clouds and databases), enabled us to determine standard structures based on ranges of deduced values. The repetition of these patterns suggested that it would be useful to create a graphical database using a parameterised HBIM (Historic Building Information Modelling), which in turn facilitates the introduction of attributes associated with these mills from a dynamic database; this process would therefore favour interoperability in heritage management as a response to the critical situation of the mills today. At the same time, the correspondence in the proportionality relationships between the mills analysed typologically and the model of a 16th-century mill, suggests that 18th-century mills were adapted to patterns developed in older presses.

Keywords: olive oil mills; typological analysis; digital information models; Geographic Information System (GIS); Historic Building Information Modelling (HBIM); 16th-century olive presses

Resumen:

Los molinos de prensa de viga y quintal han sido las unidades productivas del olivar encargadas secularmente de la obtención del aceite en el municipio de Écija (Sevilla). La intensificación del cultivo en el siglo XVIII hizo que estas edificaciones se multiplicaran por todo el municipio hasta llegar a un total de 286 unidades. No obstante, a mitad del siglo XX, los acontecimientos acaecidos en torno al olivar supusieron su desfuncionalización. En la actualidad, el estado de conservación de los molinos es en general de abandono, desapareciendo parcial o totalmente muchos de ellos. El carácter funcional de estas unidades productivas, así como el corto espacio de tiempo en el que fueron construidos, nos lleva a plantear la necesidad de su estudio tipológico con el fin de conocer posibles patrones comunes en su diseño. Las relaciones geométricas y de proporcionalidad entre sus elementos constituyentes obtenidas a partir de modelos digitales de información: SIG (Sistema de Información Geográfica), nube de puntos 3D y bases de datos, permiten establecer estructuras tipo a partir de rangos de valores deducidos. La repetición de estos patrones hace pertinente la creación de una base gráfica mediante un modelo parametrizado HBIM (Historical Building Information Modelling), lo cual facilita la incorporación de atributos asociados a los molinos desde una sencilla base de datos dinámica, favoreciendo la interoperabilidad en la gestión patrimonial como respuesta a la situación crítica en la que se encuentran. Además, la correspondencia en las relaciones de proporcionalidad, resultado del análisis tipológico de los molinos con el caso mostrado de un molino del siglo XVI, evidenciaría la adaptación de los molinos del siglo XVIII a patrones desarrollados en almazaras de mayor antigüedad.

Palabras clave: molinos de aceite; análisis tipológico; modelos digitales de información; Sistema de Información Geográfica (SIG); modelado de información de la construcción (HBIM); almazara s. XVI

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1. Introduction

Beam and weight presses have been the production units used for centuries in the town of Écija (Seville province) to transform olives into oil. The strong international demand for oil, the increase of domestic consumption both as a food product and as an industrial lubricant, the profitability obtained from olive groves compared with other dryland crops, and the distinction that land ownership conferred on the elite classes, all contributed to the vast expansion of the Écija olive groves that commenced in the 17th century[1] (García-Dils, Ordóñez, Sáez, Venegas & Rodríguez, 2006). This expansion not only necessitated the reconversion of crops such as vines and cereals but even exacted a cost on royal lands, pastures and barren land (García, 1981). However, the heyday of olive tree cultivation occurred in the 18th century as a result of additional factors: demographic growth, the demise of the Mesta sheep raisers guild, the diminished consumption of animal fats and the liberation of the market (Trujillo, 1995).

In the 19th century, following periods of shrinkage, the olive groves began to expand again, partly to meet the growing international demand and partly as a result of the abolition of the feudal system and the disentailment of the Church's landed property (Granados, 2009). The advent of the “oil train”, with a branch line connecting Écija to Córdoba, and improved communication routes also played a significant role in the commercialisation of olive oil (Millán, 2005).

The 20th century brought a boom in exports and consolidated the so-called golden age of the Écija olive groves. After the Spanish Civil War, the government’s protectionist measures ensured the continued cultivation of olive trees until the middle of the century, even though oil was a structurally surplus product. However, from that point on the olive sector entered a crisis as a result of the demand for labour in cities and the increase in disposable income. This latter factor not only prompted a greater demand for vegetable oils, leading to the growth of oilseed crops, but did away with the protectionism previously conferred on olive groves (Rallo, 1986). Even so, the greatest reconversion of the olive groves occurred at the beginning of the 1970s (Guzmán, Hernández, Gómez & Lora, 2020), in the wake of Decree 1.10/1072[2] (Spain, Departement of Agriculture, 1972). The measures introduced by this decree led to the virtual eradication of olive trees in the town of Écija[3] (Moya & González, 2019).

These olive groves historically occupied two clearly identified areas: the “Moorish Strip” and Valcargado[4] (Martín, 1990; García-Dils, et al., 2006; Ordóñez & García-Dils, 2006).

The vast quantity of olive trees planted naturally led to an increase in the number of olive oil mills,[5] to the extent that between the 18th century and the second half of the 20th century 286 were identified (Moya, González & Rodríguez, 2020) (Fig. 1).

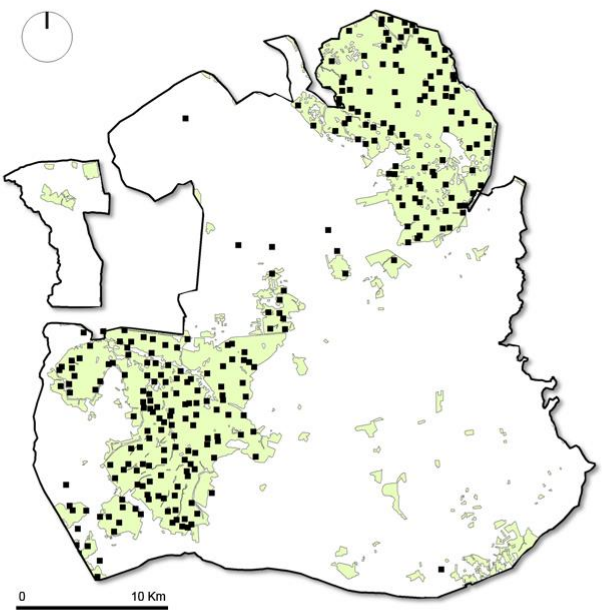


Figure 1: Site map of the Écija olive oil mills and the historical olive groves in the mid-20th century, identified using GIS. Source: The authors, based on data from the Écija Land Registry provided by Écija Town Council and the vectorisation of the olive groves using the orthophotos of the American Flight, Series A, obtained from the Spanish Geographical Institute (IGN).

According to the *General Responses* of the Ensenada Land Registry (1751), in the mid-18th century, there were 249 olive oil mills in Écija.[6] Thereafter, the number of these constructions remained relatively unchanged (some disappeared while new ones emerged) until the mid-20th century, when they fell into disuse as a result of the agricultural dynamics described above that led to the first olive growers' cooperatives. Meanwhile, the incipient modernisation of farming ushered in the use of machinery, which necessitated the provision of large spaces to house them and meant that many of the exterior and interior spaces of the mills had to undergo significant alterations (Moya, 2019), such as the reorganisation of courtyards, the creation of new openings, the vacation of the original facilities, the demolition of certain areas, etc.

[1] In earlier times, such as the Islamic period, olive tree cultivation was less important, although exports continued during the Caliphate and Emirate periods (Guzmán, 2007).

[2] Decree 1010/1972 of 13 April on the reconversion and reorganisation of oil production.

[3] In 1922 the Écija olive groves occupied 27,258 ha according to the Agricultural Department, while in the 20th century they occupied 3720 ha (Guzmán, 2004).

[4] The Écija olive groves are thought to have occupied these areas since Roman times, coexisting in the remainder of the town with other crops as a type of olive meadowland (Ordóñez & García-Dils, 2017). In his book *Ecija, sus santos, su antiguedad eclesiastica i seglar*, Father Martín Roa (1629) offers the following description: “The olive groves occupy three leagues before and just as many after the city. The ones on this side of the River Genil, on the road to Córdoba, are known as the Moorish Strip; the ones on the other side, towards Seville, are called Valcargado (“heavily laden”), because of the abundance and excellence of their fruit compared with the others.”

[5] There are records of this type of mill in Écija dating from at least the 16th century. The Seville Notarial Records list rural contracts up to the 18th century and include 31 contracts for oil press renovations and constructions. One of these contracts is accompanied by a plan which is analysed in Section 4.4 of this article.

[6] The Ensenada Land Registry (1751) lists 254 beams for the town of Écija. Bearing in mind that nine mills with double beams have been identified, we estimate the number of mills to be 249.

As another consequence of these dynamics and the rural exodus to industrial areas, a considerable number of mills were abandoned. Table 1 shows the changes in the number of mills since the 18th century.

Table 1: Écija olive oil mills.

Year	*No. of mills*	*Source*
1751	249	Ensenada Land Registry
1773	261	Diccionario Geográfico de Madoz[7]
1851	251	Breves apuntes de la ciudad de Écija
1858	249	Écija name index
1865	255	Écija manual or yearbook
1873	276	Cartographic records
1910-25	275	Topographical studies
1958	279	Topographical map
1975-77	275	Inter-ministerial orthophoto flight
1985	267	1984-85 orthophoto flight
2000	216	2000 orthophoto flight
2020	199[8]	Field trips

As shown in Table 1, olive oil mills have disappeared increasingly with the passage of time. It was precisely this vulnerable situation of the mills and other rural constructions in Écija that led the town council to provisionally amend Section 5a of the Urban Planning Regulations and By-laws of the 2009 Land Use Plan (PGOU) by inserting an inventory of singular buildings in the rural environment, including the olive oil mills. These Regulations identify 129 mills, of which, according to the PGOU, 47 were in a good state of repair, 38 in a state of neglect and 44 in a state of ruin. With regard to the architectural interest which the same PGOU attributes to these buildings, 27 were considered to be of high interest, 63 of medium interest, 25 of low interest and 14 of zero interest. Consequently, the mills considered to be of high or medium architectural interest (90) have three kinds of official protection[9] (structural, environmental and precautionary) as recorded in Volume I of the PGOU Inventory of Protected Assets.

This information sheds light on several aspects that are relevant to the consideration of the mills as heritage:

- The PGOU only identifies 129 mills in Écija, while the analysis of orthophotos and the field trips identified 199 in 2020.
- Many of the mills in Écija do not have any form of official protection even though they represent very interesting models (Fig. 2).
- The state of repair of the mills, more than a decade after the inventory was created, is naturally worse today, and many of them present advanced decay.
- The preliminary nature of the inventory, as indicated in Section 2.3 of the PGOU, *Singular Buildings in the Rural Environment*, calls for a revision of the classification and description criteria which are used to propose the different forms of protection applicable to historical olive oil mills.
- It is necessary to create agile and accessible tools to facilitate the interdisciplinary management of this important heritage.

Figure 2: El Gallego mill in Écija. This mill is assigned low architectural interest in the PGOU inventory, which means that it currently has no form of official protection.

2. Objectives and methodology

The purpose of this research project is to increase the existing knowledge about the mills and enhance public appreciation of the agricultural heritage of the Écija olive groves. The methodology is based on the assumption that the mills, as oil production units, are just one of the diverse features of the historical olive groves and therefore not the only assets that potentially merit official protection (Moya et al., 2020). However, this article focuses exclusively on the olive oil mills, specifically on the typological aspects related to their morphology and geometric proportions in the context of the spaces that define them. We, therefore, set out to demonstrate the results obtained by creating and using different digital models (GIS, 3D point clouds, databases and HBIM) as mechanisms for providing knowledge about these mills[10] and therefore tools for their heritage management.

The methodology to achieve these aims is based on the following series of sequential stages (Fig. 3):

[7] The *Diccionario Geográfico de Madoz Pascual* (1847) cites an "infinite" number of mills with 50000 *aranzadas* (unit of measurement equivalent to 3672 m^2) of olive groves, while also referring to a report presented to Écija Town Council in 1773 which specifies the number of mills and states as 42210 *aranzadas* the area occupied by olive groves.

[8] This figure refers to the number of mills that retain part of their original structures, which may be in an advanced state of decay. This aspect is explained in more detail below.

[9] The list includes the mills identified in the publication *Cortijos, haciendas y lagares: arquitectura de las grandes explotaciones agrarias de Andalucía. Provincia de Sevilla* (Granados, 2009) as well as the ones assigned medium or high interest in section 1.5 *Buildings in the Rural Environment* of Volume I of the PGOU Inventory of Protected Assets (2009.

[10] The only data the PGOU provides is a list of mills with some form of protection, accompanied by their name and geographical coordinates.

- Geolocation of the existing mills in Écija[11]
- Identification of the functional structure of the mills and their current state
- Definition of study parameters and their subsequent analysis
- Evaluation of the multiple relationships generated by the results
- Case study of the relationships focused on an Écija mill dating from the 16th century
- Generation of an HBIM model as a three-dimensional graphical base of a standard mill.

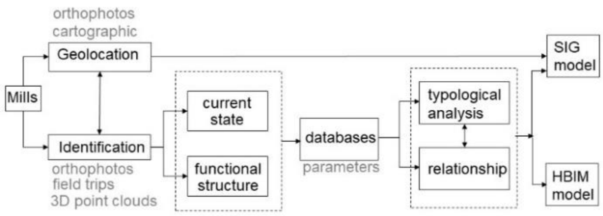


Figure 3: Flowchart of the methodology followed.

The details provided below form part of a set of results obtained within the D1 action line of the R+D+i project TUTSOSMOD.[12]

3. Beam and weight mills

3.1. Geolocation

For the geolocation of the mills, we began with a list of georeferenced mills provided by Écija Town Council in shape format, which enabled us to identify the location of the 129 mills initially identified.

As explained above, this figure differs from the real number of mills currently existing in Écija and we, therefore, used GIS to geolocate all of these buildings according to the methodology proposed by Moya & Atanasio (2020). As aids for this task, we used the list of mills in the yearbook *Anuario ecijano (D.A.G & D.M.C., 1865)*, the Cartographic Records published by the Geographical Institute in 1873 and the Topographical Land Records of the Geographical Registry Institute drawn up in Écija between 1951 and 1958. We obtained the Cartographic Records directly from the Web Map Service (WMS) of the IGN (National Geographical Institute) and the Land Records from Écija Town Council in the form of a raster file. Using these graphical bases we were able to geolocate all the olive oil mills in the town. In view of the predictably scattered nature of the Cartographic Records, we had to cross-check the location of the mills against the information from the Land Records, going through the IGN to consult the WMS orthophotos from the flights undertaken by the US ARMY (Series A 1946-47 and Series B 1956-57) and through REDIAM (Environmental Information Network of Andalusia) to consult the National Inter-ministerial Photogrammetric flight conducted in Écija in 1977[13] (Fig. 4).

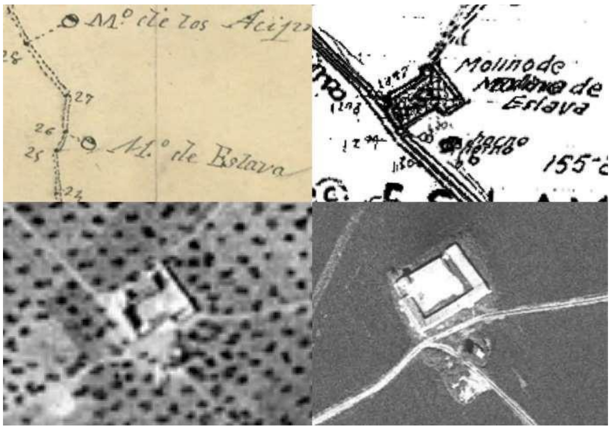


Figure 4: Geolocation of the Eslava mill using GIS and aided by the 1873 Cartographic Records, the 1951-58 Land Records and the flights undertaken in 1956-57 and 1977.
Source: IGN for a) and c), Écija Town Council for b) and REDIAM for d).

3.2. Functional description

The Écija olive oil mills were oil-producing units with a distinct functional character and the buildings, therefore, had to be structured in a manner that permitted the storage of the harvested olives,[14] their transformation into oil, and finally their storage in cellars. At the same time, there also had to be spaces for use by the people temporarily employed[15] at the mill, such as labourers' living quarters, kitchens and pantries, shelters for the draught animals, such as stables, and barns to store wheat.

The mill was also complemented by a series of external elements, such as pigpens, pigeon lofts, threshing floors, kilns, wells, cisterns, etc. The layout of the spaces at a mill is shown in Figure 5, based on the ground plan of the Charcón mill in Écija.

The oil-producing activities were conducted around a closed courtyard, accessed directly from the outside. The olives were unloaded and weighed in this space before being stored in the barns. In some cases, there was a second courtyard, often connected to the main house[16] (Table 2).

[11] The study of the olive groves and these production units must naturally be conducted at a supra-municipal level (Moya et al., 2020). However, for this article, the research is delimited by the perimeter of the town of Écija.

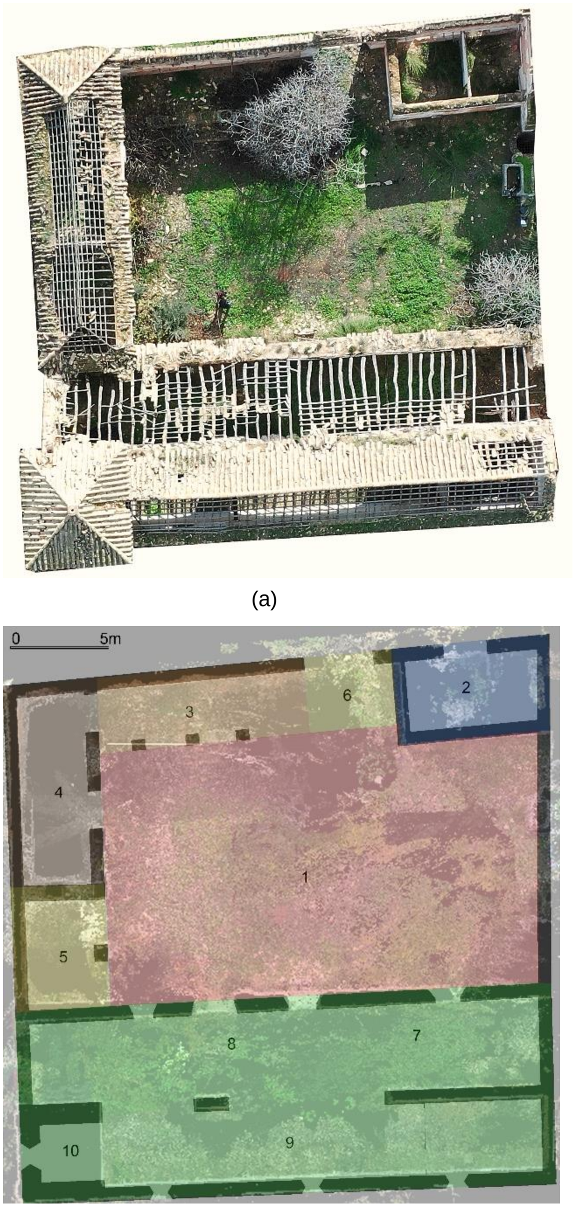
[12] Sustainable comprehensive management of cultural heritage through digital BIM and GIS models: Contribution to knowledge and social innovation social.

[13] The date of the flights conducted between 1977 and 1983 can be consulted for each area of Andalusia on the REDIAM website.

[14] The olive boom not only led to the construction of new mills but to the adaptation of many of the existing farms along the same lines to address the same needs (Infante, 2014).

[15] During the harvesting period the mills adopted the form of little settlements and in some cases even included chapels and oratories due to the labourers being unable to travel to Écija until their work had finished (Pradas & Gómez, 2005).

[16] The existence of the main house was the architectural response to the residential needs of the mill owners who wanted to oversee the pressing process from close quarters.



(a)

(b)

Figure 5: (a) Roofs and ground plan; (b) of the Charcón mill in Écija. 1: Courtyard. 2: Labourers' living quarters. 3: Porch. 4: Stables. 5: Kitchen. 6: Entrance. 7: Cellar. 8: Grinding room. 9: Beam room. 10: Counterweight tower.

Table 2: Number of courtyards at the Écija olive oil mills.

Unknown	*One*	*Two*
63	189	34

The courtyard where the olives were stored was surrounded by two or three buildings, depending on the mill. One of them, as in the case of the Charcón mill, would house the stables, adopting the form of open, narrow space for the draught animals used to turn the stone roller or transport the olives from the groves. The kitchen and pantry were adjacent to this space and led up to a second level. Situated on the other side of the courtyard were the living quarters for the olive pickers or labourers, also directly accessed from the outside, and the porch that provided shelter for the animals. The last space adjacent to this courtyard was the olive press used to produce the oil, which was divided into two connecting spaces: the beam area and the grinding area.

The olives were transported from the courtyard to the press where they were ground with a cone-shaped stone roller turned by the animals. The paste obtained from this process was then taken back to the beam area where it was loaded into esparto grass baskets, organised in a stack, ready for pressing. This was done with a large beam (13-18 m[17] judging from the length of the facilities observed), which the grinder and two foremen activated manually by turning a spindle connected to a heavy stone weight (the *quintal*) at the other end of the beam. The beam remained in this position for several hours to obtain the maximum quantity of oil.

At the end of this pressing process, the beam was raised by turning the spindle and the oil was poured into large semi-buried jars in the cellar. The new position of the beam required an additional element to compensate its mass, namely a counterweight tower. Adjacent to this structure was a hearth where water was heated and then poured onto the baskets to obtain a larger quantity of oil from a second press. This grinding process was often repeated in two shifts during the course of the 24 hours that the grinding mechanism was in operation. At the end of the process, the oil was ready for sale and distribution.[18]

The assimilation of the oil production process sheds light on the particular characteristics of the spaces inside the press, where the geometry obeys the need to accommodate certain elements (grinding stone, jars for storing the oil, beam, counterweight tower) and provide space for three people (a master grinder and two foremen) and an animal (mule or donkey) to do their work. In the case of the Écija mills, the press tends to adopt the same typology. The constant repetition of a standard type of model is the product of earlier planning that had proved its efficiency (Herrera, 2002). The press, therefore, appears to have remained unchanged until the mills fell into disuse in the mid-20th century, and as a result, they provide valuable information about the typological veracity of the Écija mills.

3.3. The current state of the mills

Before analysing the typology of the presses, we studied the current state of the mills to verify the extent to which the constituent parts have been preserved. We began by working with orthophotos, in this case, the satellite images obtained from the Landsat 8 of the US Geological Survey conducted in 2017 and 2020. These enabled us to identify the mills that had disappeared completely, the mills where only the counterweight tower had survived, the ones that still had the tower and an

[17] According to Payo (1840), the length of the beam varied between 15 and 20 *varas* (12.53 m-16.7 m). The beam at the Puntales mill was 17m long according to data obtained by López (2012).

[18] The description of the oil production process was obtained by interviewing the former grinder, the Écija resident Fidel Rodríguez Rodríguez (personal interview, 25 February 2020), who told the authors that two grinding processes per day were carried out, each of them with a weight of 10 *fanegas* (432.5 kg), a value that coincides with López (2012) but differs from the figure provided by Delgado (2012), who refers to 14-20 *fanegas* per day (600-865 kg).

odd building, the ones with only one building still standing, and the mills where all the volumes are still present (Moya et al., 2020). We traced these details by superimposing the orthophotos on the mills which we had previously geolocated with GIS.

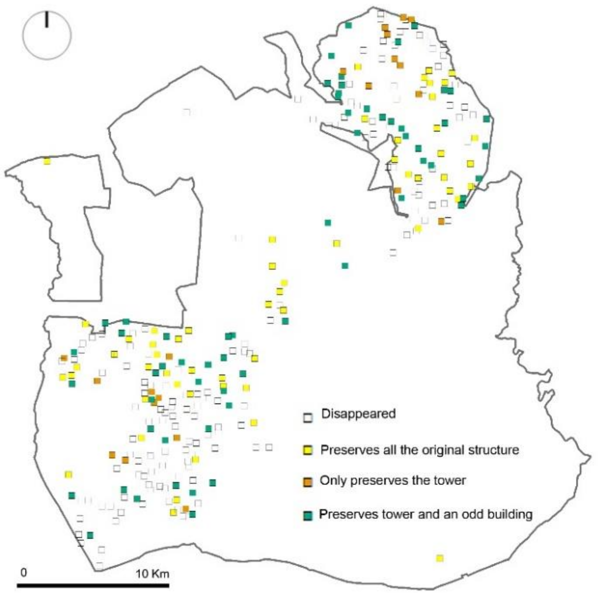


Figure 6: Site map of the mills according to their current structure.

Once we had gathered sufficient information, we organised a series of field trips to check and supplement the data obtained in the previous phase. To optimise resources and speed up this process, we divided the town into zones and created 18 different routes for visiting all the mills. The results of this phase are shown in Figure 6 and Tables 3 and 4, which clearly demonstrate the different states of repair presented by the mills today.

Table 3: Site map of the Écija olive oil mills, 2020, without considering the state of repair.

Only preserves the tower	*Preserves an odd building*	*Preserves tower and an odd building*	*Preserves all the original structure*	*Remains of an odd wall*
21	57	58	58	5

Table 4: Use of the Écija olive oil mills, 2020.

Abandoned	*In use*
69	130

4. Typological analysis

4.1. Elements and parameters studied

After analysing the mills in general and their current state of repair, we conducted a typological analysis. This focused on the formal, compositional and building elements of the press but did not include the decorative elements (cornices, mouldings, weather vanes, sundials, etc.), which clearly are also important aspects of their typological categorisation and merit further study. Based on these criteria, we divided the press into three zones: beam area, grinding area and counterweight tower.

The elements studied are defined in Figure 7 and Table 5 and are shown in Figure 8.

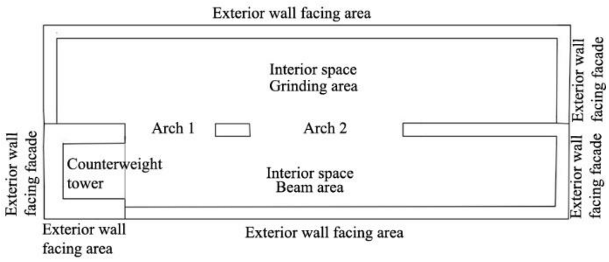
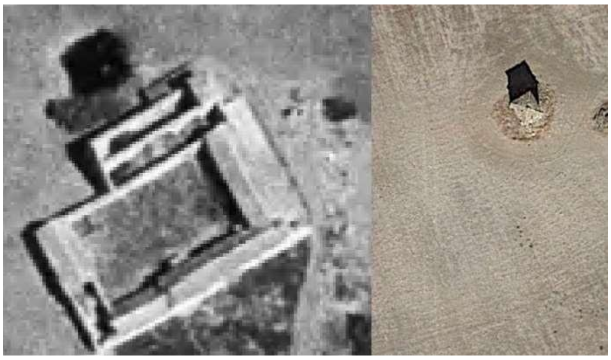


Figure 7: Location of the elements studied in the press.

(a)

(b)

Figure 8: (a) Charcon mill; (b) Gallego mill. At these, we were able to identify the beam area, grinding area and counterweight tower.



(a) (b)

Figure 9: Álamos Bajos mill in Écija. Years: (a) 1977; and (b) 2017. These images enabled us to identify the approximate dimensions of the press, its orientation, the existence of a single courtyard, and the arches between the different areas. Source: REDIAM and Google Earth.

Table 5: Elements and parameters studied in the press.

Beam area				
Element	*Parameter*			
Exterior wall facing area	Length	Height	Openings	Building system
Exterior wall facing facade	Length	Height	Openings	Building system
Interior space	Length	Width		
Roof	Height[19]			Building system
Grinding area				
Element	*Parameter*			
Exterior wall facing area	Length	Height	Openings	Building system
Exterior wall facing facade	Length	Height	Openings	Building system
Interior space	Length	Width		
Intermediate wall (Arch 1)	Span	Height of keystone from floor	Chord	Building system
Intermediate wall (Arch 2)	Span	Height of keystone from floor	Chord	Building system
Roof	Height			Building system
Counterweight tower				
Element	*Parameter*			
Exterior space	Length	Width	Height	Building system
Interior space	Length	Width		Openings

4.2. Data collection

The data were obtained from the study elements by means of orthophotos, data gathered on field trips, a series of common parameters assigned to different building systems and others extracted from historical records.

4.2.1. Orthophotos

The orthophotos were mainly used to obtain approximate dimensional values of the press, based on the assumption that we would not be able to access many of the mills due to private ownership and that it would therefore be difficult to obtain these parameters. We used GIS with the aforementioned National Inter-ministerial Photogrammetric flight undertaken in Écija in 1977 and the satellite images from Landsat 8 of the US Geological Survey conducted in 2017 and 2020.

We also determined the orientation of the press to relate the position of the building with respect to openings on the exterior walls (Fig. 9).

4.2.2. Field trips

By following the various routes scheduled for the field trips, we managed to visit all the mills where some of the constituent parts are still standing. Of the existing 199 mills, we accessed either the immediate vicinity or the interior space of 140 mills. We photographed the remainder from the closest point we were able to access.

To identify and obtain the different parameters, we used a camera, a laser distance meter, a flushometer, a tape measure and, in certain cases, a drone fitted with a camera (Fig. 10). We used graphical data sheets to record the information from the data obtained, on which we noted all the aspects defined in Table 5 before transferring them to a database.

(a) (b)

Figure 10: The Charcón mill in Écija: (a) Positioning of targets; and (b) drone flight to gather data.

4.2.3. Dimensional values of the building systems

As explained in Section 3.2, there is an evident typological uniformity in the presses at the Écija mills. This undoubtedly bears relation to the type of systems used to build them. We observed a similarity in the building solutions adopted for the various elements (types of walls, corner solutions, openings, reinforcements, etc.) and the widespread use of local materials, denoting an evident adaptation to the immediate environment. This aspect had a clear impact on the data collection, because although we were able to identify the building system it was not always possible, for a variety of reasons, to verify certain dimensional values. The uniformity of building solutions, therefore, enabled us to establish unknown measurements by examining the photographs obtained. As a reference, we also used the description of the building process for a 16th-century press found in bundle 358 in the Écija Notarial Records (APNE), which contains similar processes.

With regard to the walls around the grinding area and the beam area, these are basically made of rammed earth. In certain cases, they can be classified as simple rammed earth walls, as in most of the rammed earth constructions in Seville province (Graciani & Tabales, 2009), but the most widespread typology is rammed earth with mortar (with single, double or triple brick courses) (Moya, González & Rodríguez, 2021). As for

[19] This height refers to the ridge. The height of the roof gables is included in the height of the wall.

the height, more than half of the cases analysed were of the low module variety, with approximate dimensions of 1 *vara* (83.59 cm), while the remainder were of the high module variety[20] (Table 6).

Table 6: Heights of the rammed earth wall modules.

Rammed earth wall Height (cm)	82	83	84	87	90	92	96
Mills (34)	4	12	5	6	3	2	2

Despite the difficulty of obtaining accurate data about the real length of the rammed earth walls, we were able to define four values: three of them (163, 167 and 170 cm) are related to two Castilian *varas* (167.18 cm), corresponding to the low module variety, while the other value, 195 cm, is associated with the high module variety. Specifically, bundle 358 states that "the rammed earth walls must be one *vara* high and two *varas* long, as customary". In other words, these measurements would not only have been used in the specific mill described in the document but constituted commonly adopted values, as we were able to verify.

Of the 30 mills where we obtained the dimensions, in 29 cases the walls were 65 cm thick and 55 cm thick in one case. It is important to remember that the first measurement corresponds to the sum of two stretcher bricks (Fig. 11).

The document containing the description of the 16th-century press also refers to the wall thickness, where in relation to the mill walls the builder states that "two bricks form the walls all round".

With regard to the pillar separating the arches in the area, while the thickness corresponds to two stretcher bricks (wall thickness), the length varies according to the number of pieces of brick used, and the dimension therefore depends on the mechanical characteristics of the arches (Fig. 12). Bundle 358 at the APNE does not make reference to this dimension.

With regard to the counterweight tower, the dimensions of the exterior and interior walls vary, as explained in Section 4.3 below.

Figure 11: Detail of the rammed earth wall with mortar and a single brick course that separates the different areas at the Gallego mill in Écija. It clearly shows the thickness as two stretcher bricks.

[21]Value of the high module: (85-95 cm) (Carapallese, Canivell, Martín, Graciani, Cabrera, 2020)

They are made of sequences of mixed rammed earth walls delimited by brick buttresses at the front corners, and as a result, they did not need to conform to a specific measurement.[21] However, we were able to verify the wall thickness in 40 of the mills studied (Fig. 13). This thickness is made up of various types of brick bonds, which enabled us to identify the various thicknesses. Table 7 shows the values obtained and the bonds identified.

Figure 12: Pillar between arches at the Cipreses mill in Écija. Its dimensions are 130 x 65 cm, corresponding to the sum of two and four stretchers, respectively.

Table 7: Type of brick bond on the walls of the counterweight towers at the Écija mills.

The side wall of the tower

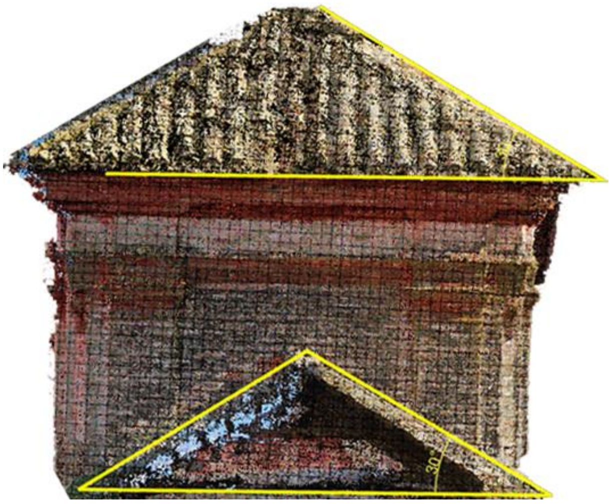
Bond type	*Dimension cm*	*Number of mills (40)*
2 stretchers	0.65	3
2 stretchers + 1 header	0.78	3
1 stretcher + 4 headers	0.88	5
2 stretchers + 2 headers	0.92	9
3 stretchers	0.96	21
3 stretchers + 1 header	1.1	8

The front wall of the tower

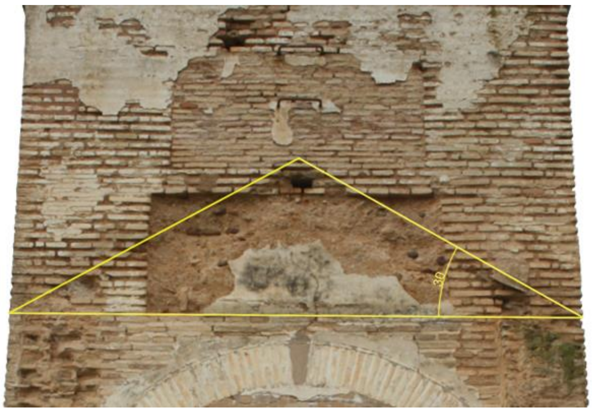
Bond type	*Dimension cm*	*Number of mills (38)*
4 headers	0.56	13
2 stretchers	0.64	4
2 stretchers + 1 header	0.78	12
1 stretcher + 4 headers	0.88	2
3 stretchers	0.96	2
3 stretchers + 1 header	1.1	3

[21] According to the text in Bundle 358, certain dimensions of the construction were decided by the promoter

Figure 13: Opening in the counterweight tower.at the Pino mill showing the wall thickness to be two stretchers.



(a)



(b)

Figure 14: (a) Collar beam roof over the press and hipped roof at the Charcón mill; (b) impressions on the tower at the Notario mill. We verified the angle of inclination as 30º for the pitches of the roofs of both the press (collar beam) and the counterweight tower (hipped roof).

Table 8: Number of mills per variety of counterweight tower roof.

Hipped roof	*Curved pitched roof*	*Flat*	*Unknown*
116	3	17	150

Lastly, at all mills, the roof over the press is a pitched structure, made of wood with a collar beam over the beam area and a mono-pitched structure as a continuation of the roof over the beam area.

Most of the counterweight towers have a hipped roof covered with ceramic tiles, and there is an odd case of a curved pitched roof and a flat roof[22] (Table 8).

For both the roof over the press and the roof over the counterweight tower we obtained the angle of inclination from the point cloud created for the Charcón mill, which we then verified at the different mills that display the same type and geometry of roof or their impressions. (Fig. 14).

We then considered the results of all these building system parameters to define the dimensions of the elements that we were unable to obtain in situ.

4.3. Results obtained

4.3.1. Non-dimensional elements

Before presenting the data set obtained as a result of our research, we must mention three aspects we identified using digital models that have repercussions for the typological definition of the mill and are not associated with dimensional values. The first one is related to the orientation of the press and the openings in this structure (Table 9). The second aspect determines the position of the counterweight tower relative to the courtyard (Table 10). Lastly, we identified the number of arches in the wall that separates the grinding areas from the adjacent beam area (Table 11).

Table 9: Orientation and windows in the press (Facade of the beam area).

Orientation	*N*	*S*	*E*	*W*	*NE*	*NW*	*SE*	*SW*
Mills (170)	16	5	8	7	37	70	14	20
Openings	0			1		2		
Mills (43)	38			1		4		

Table 10: Position of the counterweight tower relative to the courtyard.

Location of the tower relative to the courtyard	*Right*	*Left*	*Right and left*
Mills (178)	95	81	2

4.3.2. Dimensional elements

In this section, we present the results where the value is associated with numerical data. We begin with the dimensions of the press. As shown in Figure 15, the length of the press varies between approximately 14 and 34 m,[23] with ranges of different dimensions obtained as a result of the length of the beam used, as in the case of the 18 m (22 *varas*), 20 m (24 *varas*), 22 m (27 *varas*) and 24 m (29 *varas*) beams.

[22] The flat roofs have a more ornamental treatment. Herrera (2002) describes this stylistic device as a distinction of the mills from the late 18th and early 19th centuries.

[23] According to Payo (1840), the dimension of the beam area "had to be only slightly less than the nave of a small church".

Table 11: Number of arches between the beam area and grinding area.

Number of arches	0[24]	1	2	3[25]
Mills (61)	3	4	53	1

In relation to the span or width of the press, there are fewer variations since the value only fluctuates between 7.5 m and 9.75 m. This may be explained by the fact that the activity at the mill was always carried out by the same number of people, regardless of the length of the beam

In the case of the width of the interior space, we observed that the grinding area requires more space (3-4.5 m) than the beam area (2.75-3.5 m) because the latter was only accessed to activate the spindle, situated at the end of this part of the mill. The height of the press is significantly greater (5.5-7 m) than the height of the grinding area, where the scale is on a more human level (3-4 m), possibly because of the need to raise the beam.

In the case of the counterweight tower we noticed that the face of the wall that coincides with the length of the area is shorter (3-4 m) relative to the face considered to be the facade (4-5 m). There is a greater variety of dimensions (6.5-11.5 m) as regards the height, although most of the values are concentrated in the 7-5-9 m range (Fig. 16).

Lastly, we present the values related to the analysis of the arches that separate the grinding and beam areas (Fig. 17). In relation to the size of the arches, the span of the one closest to the counterweight tower is always the shortest (2.5-4 m), and we therefore consider this to be a service arch.

The second arch, which had to be large enough to allow the passage of the draught animals, presents similar measurements (6-7.5 m) because the grindstone was situated just below it (Fig. 18). The buttress on which both arches rest varies between 1.3-2 m in length and 2 stretcher bricks in width. Regarding the height from the floor to the keystone of the arch, there are significant variations in the dimensions, with this central voussoir usually being higher in the second arch. Lastly, in terms of the arch chord, the values of the first arch are distinctly smaller (1.5-2.25 m) than those of the second arch.

4.3.3. Analysis of the results

Although in some cases the results obtained allow us to define a clear typological distinction for the mills, we can establish the following dimensional relationships to determine whether the mill variables bear any mutual relationships. The set of relationships and their values are grouped in Table 12.

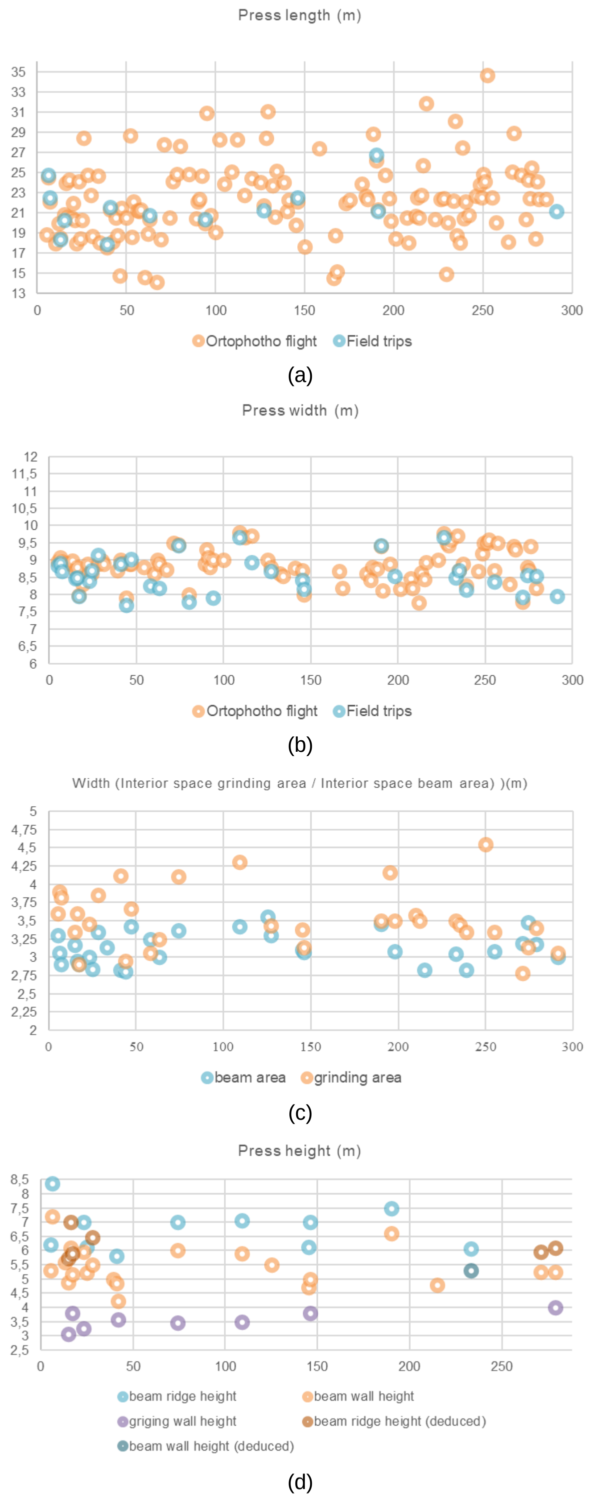


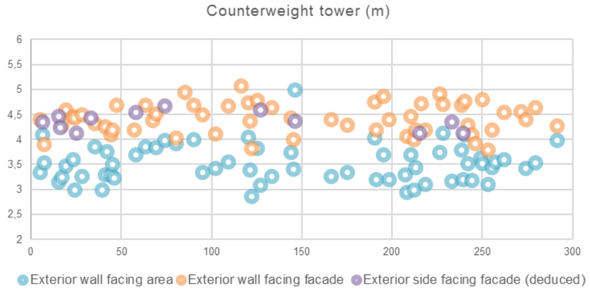
Figure 15: Dimensions of the press obtained from digital models. (a) Press length; (b) press width; (c) width; (d) press height.

4.3.4. The geographic location of results

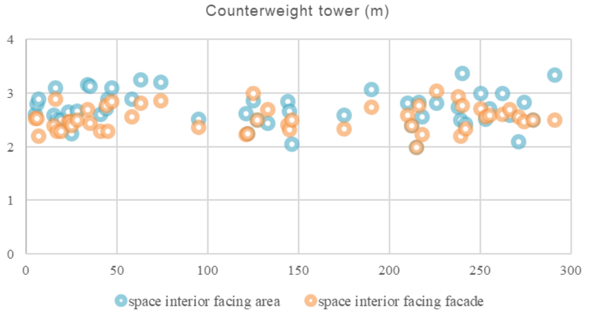
With the results obtained, we then attempted to establish the possible existence of neighbourly relations between the mills with common parameters. To do this, we created a GIS model with a preliminary selection of the mills that share the same counterweight tower height and press length within a range of 0.5 m. Having identified the mills with these shared values (38 in total),

[24] In these cases, as at the Nuño mill, there are no arches because the grinding process was carried out in an adjoining space. A pre-existing farm was probably converted into a mill, as we know to be the case at El Nuño.

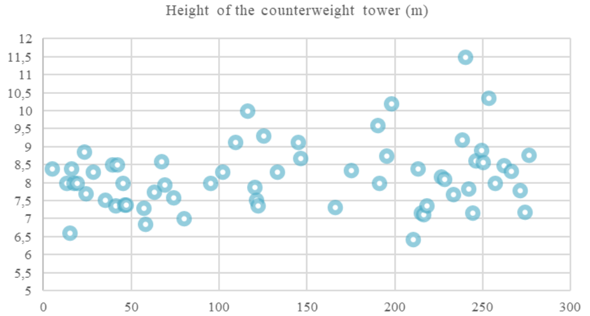
[25] Bundle 358 at the APNE specifies that if the third arch were to be blocked up, it should be with a rammed earth wall. This instruction suggests that in some cases the arches were blocked up since they were no longer of use, which explains why they do not appear in mills built at a later date



(a)

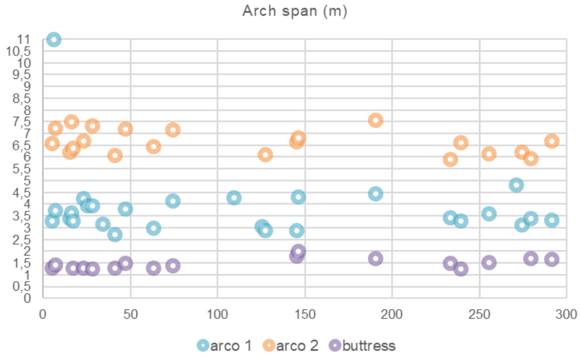


(b)

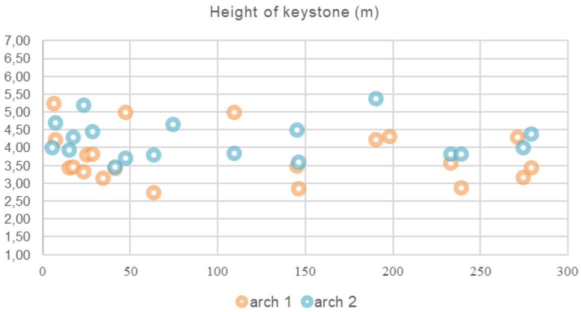


(c)

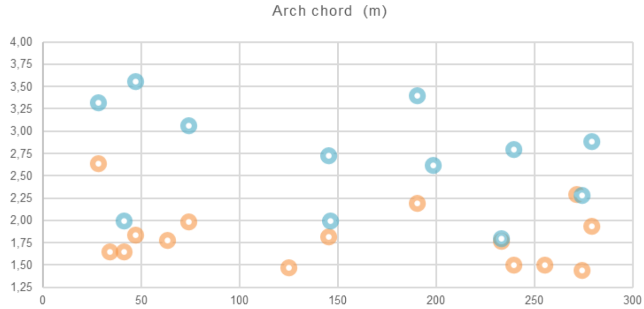
Figure 16: Dimensional values of the counterweight tower (a) and (b) counterweight tower; (c) height of the counterweight tower.



(a)



(b)



(c)

Figure 17: (a) Arch spam; (b) height of keystone; (c) arch chord. Dimensions of the arches between the grinding and beam areas.

Figure 18: Location of the grindstone below the second arch.

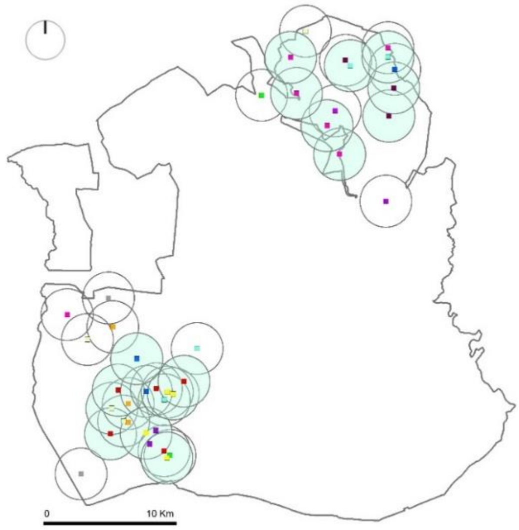
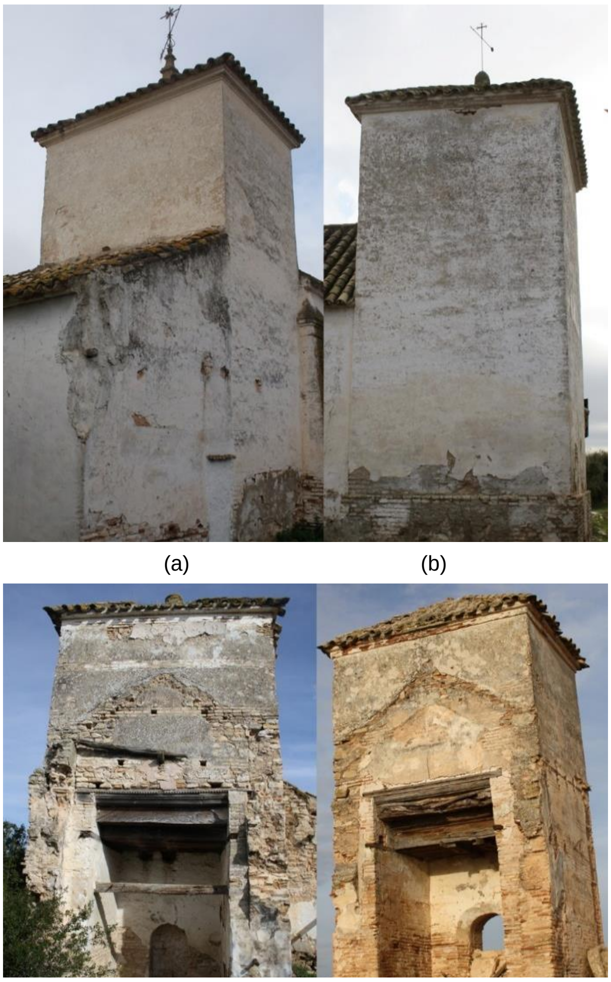


Figure 19: GIS site map of the relationship between mills with a similar counterweight tower and press length. The colours indicate mills where this is the case. The ones in blue also have neighbourly relations in a radius of less than 2 km.

Table 12: Relationship between results.

Relationship between elements	*Value*
Press length and width	1.5-3.25
Exterior press width and interior beam area	2.5-3
Exterior press width and interior beam area width	2.25-2.75
Press length and tower height	2-3.25
Tower volume and press length	4-7.5
Tower thickness facing press	1.75-2.60
Tower thickness facing facade	1.5-2
Exterior side facing facade and exterior side facing press tower	1.1-1.4
Second arch span and first arch span	1.6-2.2
Arch span and height of first arch keystone	0.7-1.2
Arch span and height of second arch keystone	1.3-1.8
Arch span and first arch chord	1.5-2.3
Arch span and second arch chord	2-2.4
First arch span and pillar between arches	1.5-3.25
Second arch span and pillar between arches	3.5-5.25
Press length and first arch span	5-8
Press length and second arch span	2.75-3.75
Tower height and press ridge height	1.1-1.5
Beam height and first arch keystone height	1.18-1.78
Beam height and second arch keystone height	1.14-1.38
Tower height and first arch span	1.80-2.6
Tower height and second arch span	1.00-1.35



(a) (b) (c) (d)

Figure 20: Mills that share press length and tower height parameters within a radius of 1 km. The formal and stylistic similarity is plain to see. (a) San José mill; (b) Patio grande mill; (c) Ciprés mill; (d) Pino mill.

MILL	LENFACAREA	LENFACFA	INTSPACEBEAM	INTSPACEGRIN	ARCH1	ARCH2	PILLAR	HEIGHTEXTWALL	HEIGHTOW	LENGTHOW	WIDTHTOW
MOLINO DE BARRIONUEVO	21,3	0	3,25	3,06	0	0	0	0	6,85	3,7	0
MOLINO DEL MARISCAL	20,36	8,8	3,48	3,14	3,12	6,21	0	0	7,2	3,43	4,4
MOLINO DE LOS HUSILLOS	21,21	0	0	0	0	0	0	0	7,3	0	4,2
MOLINO DE NAVACERRADILLA	21,32	9	2,83	4,12	2,73	6,1	1,3	4,85	7,36	3,3	4,26
MOLINO DE ALANCS DE BARRERA	21,5	8,89	3,42	3,67	3,8	7,2	1,5	0	7,38	0	0
MOLINO DE LA PICADILLA	18,07	0	0	0	0	0	0	0	7,52	3,86	4,33
MOLINO DE HERRERA SANTO TORRE A	18,43	8,6	0	0	0	0	0	0	7,7	3	4,43
MOLINO DEL NOTARIO	20,74	0	0	0	0	0	0	0	7,83	3,53	4,3
MOLINO DE ROJAS	24,45	0	0	0	0	0	0	0	7,87	4,06	4,74
MOLINO DE LOS ILAMOS ALTOS	18,35	0	0	0	0	0	0	0	7,95	3,84	4,52
MOLINO DE LAS MANTILLAS	18,56	8,98	0	0	0	0	0	5,6	8	0	0
MOLINO DE LOS CIPRESES TORRE B	20,6	7,98	2,9	2,9	3,3	6,4	1,3	5,17	8	3,25	4,3
MOLINO DEL PINO	20,5	0	0	0	0	0	0	0	8	3,47	4,6
MOLINO DE PRIMORES	22,45	9,5	0	0	0	0	0	0	8,1	4,13	4,71
MOLINO DE CERRO GORDO DE NAVALLA	24,79	8,9	3,35	3,85	3,95	7,35	1,25	5,5	8,3	3,27	4,5
MOLINO DE BADILLO	25,05	9,4	0	0	0	0	0	0	8,32	0	0
MOLINO DE CIVITA	24	8,8	2,95	3,6	3,65	7,5	0	6,1	8,4	0	0
MOLINO DE ALMENILLA ALTA	22,5	8,63	0	0	0	0	0	0	8,4	3,45	4,2
MOLINO SAN JOSE	18,14	8,9	0	0	0	0	0	4,24	8,5	3,76	0
MOLINO DEL PATIO GRANDE	17,9	8,7	0	0	0	0	0	5	8,5	3	0
MOLINO DE MESA*	22,66	8,67	0	0	0	0	0	0	8,61	0	3,93
MOLINO DEL CASTILLO	24,8	8,9	0	4,16	0	0	0	0	8,76	3,7	4,87
MOLINO GALLEGO	24,12	8,6	3	3,45	4,25	6,7	1,3	5,95	8,86	3,6	4,47
MOLINO DE CANTA LA PIEDRA	22,5	9,5	0	0	0	0	0	0	8,9	3,64	0

Figure 21: Parameters of mills located within a short distance of each other that share tower height and press length dimensions, based on the colour coding used in Figure 18.

we established a radius of 2 km around the various mills to check for typological similarities and neighbourly relations. Of the 28 studied, 24 meet the requirements of relations with up to five mills (Figs. 19, 20 and 21). However, when we checked the other parameters, we were unable to quantify the mills where all the values are similar or approximate (20).

4.4. Application of the results on a 16th-century mill

We conducted a case study to apply all the parameters analysed as a result of the data obtained. The model chosen is recorded in a document related to the construction of a press in 1574, namely the aforementioned Bundle 358 at the APNE. This document contains a description of the construction process[26] as well as a plan for the mill (Fig. 22) with dimensional values for the spaces and a graphical scale in Castilian *varas*. These aspects and the existence of notes about dimensional values for the construction works enabled us to map the mill (Table 13).

For this case study, we only defined the space corresponding to the press.

Table 13: Values obtained from the 1574 plan and transcription of the text on the construction of the press. Source: APNE.

Element	*Identification of value*
Tower relative to the courtyard	Left
Opening in press	1 door
Exterior length	24.17 m
Interior length	24 *varas* (20.06m)
Press width	7.95 m
Beam area width	3 m
Grinding area width	3.05 m
Brick stem wall	1 *vara* (0.8359m)[27]
Press walls width	2 bricks (0.64m)[28]
Beam area height	6 rammed earth modules + 1-*vara* stem wall (5.87m)[29]
Small arch span	4 *varas* (3.343m)
Large arch span	8 *varas* (6.687m)
Pillar between arches	2 *varas* (1.67m)
Exterior tower sidewall	4.04m
Exterior tower facade	4.28m
Press ridge height	7.39[30]
Counterweight tower roof	Hipped[31]

We identified numerous parameters for the mill, although we do not know the values for the height of the counterweight tower or the height of the keystones on the arches between the different areas. Table 14 shows the parameters of the elements for which we know the values, either from the plan or the transcription of the document, as well as those we obtained (in red) by deducing the tower height.

To deduce the height of the counterweight tower, we analysed the relationship between the results obtained in the previous sections, while for the height of the arches we were only able to establish a range of values between a maximum and a minimum. The relationships of the ranges used to define this criterion are shown in grey.

Table 14: Known and deduced relationships between elements in the 16th-century mill.

Elements	*Mill value 1574*	*Value according to Table 11*
Press length and tower height	2.98	2-3.25
Press length and width	3.04	1.5-3.25
Tower volume and press length		4-7.5
Exterior press width and interior beam area	2.65	2.5-3
Exterior press width and interior beam area	2.60	2.25-2.75
Tower thickness facing press	2	1.75-2.60
Tower thickness facing facade	1.89	1.5-2
Exterior side facing facade and exterior side facing tower	1.06	1.1-1.4
Second arch span and first arch span	2	1.6-2.2
First arch span and pillar between arches	2	1.5-3.25
Second arch span and pillar between arches	4	3.5-5.25
Press length and first arch span	7.23	5-8
Press length and second arch span	3.56	2.75-3.75
Tower height and press ridge height	1.09	1.1-1.5
Tower height and first arch span	2.42	1.80-2.6
Tower height and second arch span	1.21	1.00-1.35

The results obtained are shown in Figure 23.

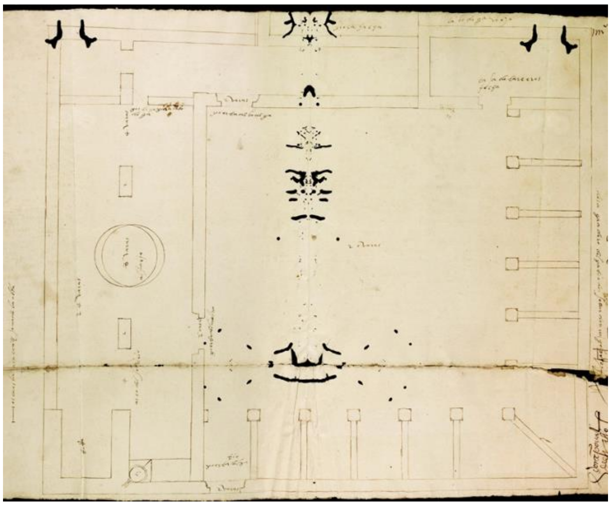


Figure 22: Map accompanying Bundle 358 related to the construction of a press in 1574. Source: APNE.

[26] These bundles were transcribed and published in *Écija Artística. Colección Documental, siglos XVI y XVII* (León & Martín, 2018).
[27] *...that raises the foundation one* vara *all round... (Bundle 358).*
[28] *…that forms walls of two bricks all round (Bundle 358).*
[29] *...with six rammed earth walls to raise the height of the beam area in the mill... (Bundle 358).*
[30] This value is obtained by assuming an angle of 30º and a collar beam roof
[31] *…the truss in the tower and cover with terracotta tiles… (Bundle 358).*

The combination with the most restricted range of values corresponds to the relationship between the ridge and the tower height. From these data, we can deduce that the tower measured between 8.12 m and 8.45 m. Meanwhile, based on the thickness of the facade side, the maximum height of the tower would be 8.08 m, so by combining these results we estimate the tower to have been 8.10 m high.

We now propose a new hypothesis for the values of the keystone height and the chord of the arches separating the different areas based on the relationships specified in Table 13. In this case, the spectrum of results is wider, with the result that the first arch would have a height of between 3.35-4.77 m and the second arch between 4.25-5.13 m. The chord for the first arch would measure between 1.45-2.20 m and for the second arch between 2.78-3.34 m (Table 15 and Fig. 24).

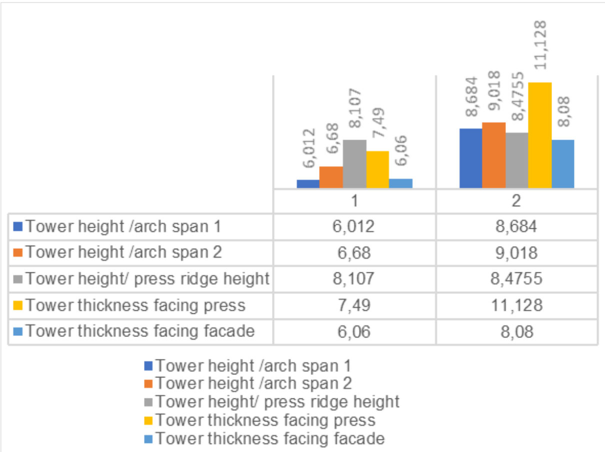


Figure 23: Ranges of values for the counterweight tower.

Table 15: Deduced values for the keystone height and chord of the arches based on relationships.

	Keystone height	
Elements	*Maximum value*	*Minimum value*
Arch span and height of first arch keystone	4.77	2.78
Arch span and height of second arch keystone	5.13	3.71
Beam area height and first arch keystone height	4.97	3.35
Beam area height and second arch keystone height	5.14	4.25
Height of keystone 1 and pillar between arches	5.01	3.01
Height of keystone 2 and pillar between arches	5.55	4.12
Arch span and first arch chord	2.22	1.45
Arch span and second arch Chord	2.78	3.34

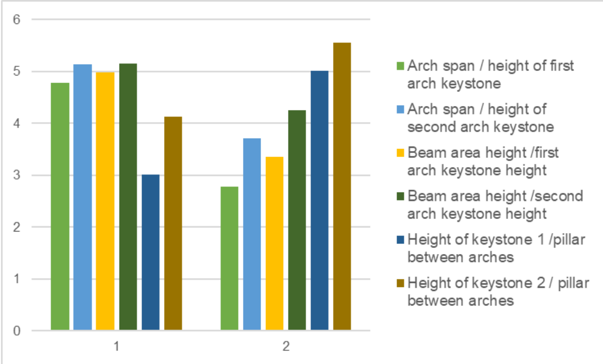


Figure 24: Ranges of values of the arches between the areas.

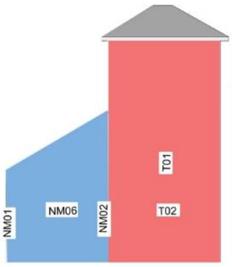
5. Standard mill HBIM

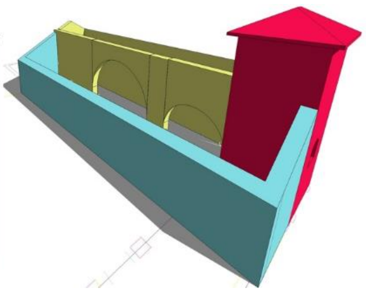
Using the results compiled and their relationships of dimensional proportionality, we generated the HBIM for a standard mill. This geometric model is based on parameterizable families defined according to the typological elements of the press associated with a set of alphanumeric records (Table 16). The initial development corresponds to a basic level of knowledge (LOK) about the mills (LOK 100), which is sufficient to differentiate them according to typological elements.

The development of the base HBIM generated for the Charcón mill is shown below. Since we have a 3D point cloud for this mill, and therefore all the values, we were able to define it completely. Having created the standard model at a development level of LOK 100 (Fig. 25), we conducted a test for this specific case up to a level of LOK 200 (Fig. 26), since this is the level that provides a graphical characterisation and sufficient information to carry out the actions related to the legal protection of the asset and its strategic planning (Castellano, 2017). Besides, the LOK 200 could be incorporated by connecting new external databases (Achile, C., Fassi, F., Mandelli, A., Perfetti, L., Rechichi, F, & Teruggi, S., 2020): materials, ornamentation, type of rammed earth, etc.

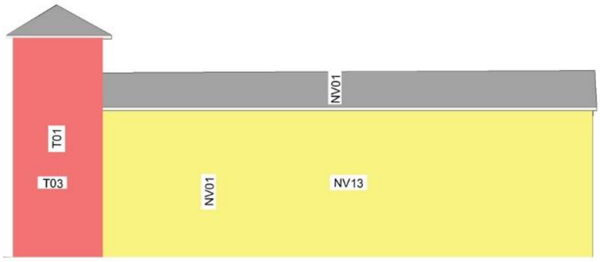
Table 16: Families that constitute the HBIM.

Zone	Code	Parameter (m)
Grinding area	NM01	Height of courtyard facade exterior wall
	NM02	Maximum height of facade side
	NM03	Length of facade side wall
	NM04	Length of area side wall
	NM05	Interior width of area
	NM06	Exterior width
Beam area	NV01	Height of exterior wall
	NV02	Height of ridge
	NV03	Length of wall preceding arches
	NV04	Arch span 1
	NV05	Arch span 2
	NV06	Height of arch keystone 1
	NV07	Height of arch keystone 2
	NV08	Arch chord 1
	NV09	Arch chord 2
	NV10	Width of pillar between arches
	NV11	Interior width of area
	NV12	Interior length of area
	NV13	Exterior length of area
Tower	T01	Height
	T02	Width of facade side
	T03	Width of area side
	T04	Interior width of tower facade
	T05	Interior width of area side

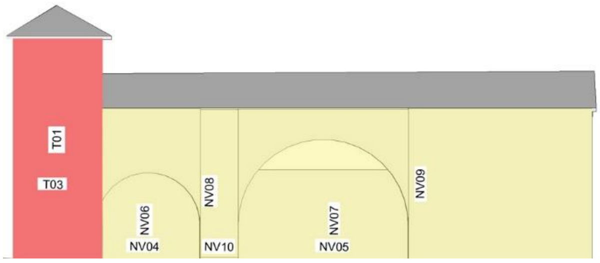




(a) (b)

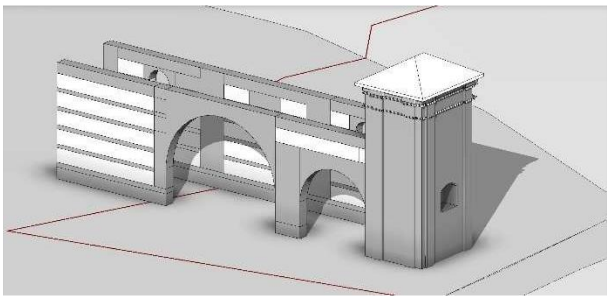


(c)

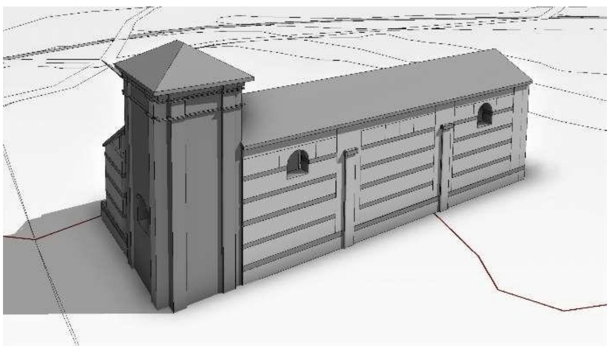


(d)

Figure 25: Volumes with parameterisable elements from the HBIM: (a) west-facing; (b) volume 3D; (c) south-facing; and (d) section of the beam area. Grinding area in blue, beam area in yellow and counterweight tower in red.



(a)



(b)

Figure 26: 3D volume of the HBIM LOK 200: (a) Interior space beam area; and (b) Exterior space beam area. These images show the building systems.

6. Discussion

To date, the most complete contribution to our knowledge of the Écija mills is the publication *Cortijos haciendas y lagares Cortijos, haciendas y lagares: arquitectura de las grandes explotaciones agrarias de Andalucía* (Granados, 2009), which contains a register of these structures (approximately half of the mills identified in this article). On this list, the mills with high interest (three mills) and some of the mills with a medium interest (12 mills) include the floor plan, whereas all the other mills are only accompanied by a brief description and a photograph. Other publications referenced here also shed important light on the Écija mills, most notably the one by García-Dils et al. (2006), which discusses the general structure and organisation of the mills and includes the original floor plan of a 19th-century mill. Equally important is López (2012)'s detailed description of the press at the Puntales mill in Écija.

Outside Écija, significant contributions have been made by more generic publications on mills (Delgado, 2012), as well as others of a more specific nature, such as the publication by García, Muñoz & Sánchez (2006) on a press in Murcia and the ones on olive haciendas in Seville (Nuñez, 2016; Infante, 2014; Recio, 2003, 2005).

Despite the importance of all these publications, there is no study of Écija mills that compares and contrasts their different scales. The methodological approach adopted in this article, based on the typological distinction of the mills according to architectural and building aspects, can therefore contribute crucial information for our knowledge of these structures in rural Écija. We also analyse the use of traditional building systems applied to constructions belonging to our agro-industrial heritage, as in the case of rammed earth walls, which have hitherto received relatively little attention compared with their use in other fields, such as military architecture, as evidenced by the research of Canivell, Rodríguez, González, & Romero (2020), Gil & Maldonado (2015), and Mileto, Vegas, & García (2013).

Besides, the use of different digital tools has demonstrated their versatility for generating heritage knowledge, a topic which has been amply explored by Angulo, (2020), Jordan, Tzortzopoulos, García-Valldecabres, & Pellicer (2018), Pocobelli, Boehm, Bryan, Still, & Grau-Bové (2018); this prevents overly reductionist approaches limited to a specific discipline. Lastly, the case study of the 16th-century mill, the existence of which was known solely by León & Martín (2018), has not only shed new light on this extraordinary document but has demonstrated, through direct application, the suitability of the proposed methodology.

7. Conclusions

The typological study of the mills reveals a unity between nearly all the cases analysed in terms of the spaces that define the press (beam area, grinding area and counterweight tower). However, the parameters corresponding to their geometry vary between mills, although there are relationships of proportionality. These relationships enable us to define ranges of dimensional values for each element, and this interrelationship makes it possible to obtain the measurements for the constituent parts of lost or unknown mills, as in the case of the mill built in the 16th-century.

The correspondence in the relationships of proportionality between the mills analysed typologically and the 16th-century mill suggests that 18th-century mills were adapted to patterns developed in older presses. The building systems determine some of the morphological aspects of the mills; for example, brick measurements and rammed earth modules determine the geometric values of the mill and therefore the typological definition.

The creation of an HBIM is useful because of the existence of a considerable number of mills where it is easy to delimit the parameterisation of the families. The creation of a standard 3D graphical base, applicable to the analysis of any mill using HBIM, represents an efficient and accessible tool for any heritage agent since it is structured on a simple database. The HBIM offers a dynamic management model because it may be used to supply the values that could not be obtained during the field trips and can incorporate new records related to a higher level of knowledge about the mills, such as their damages, alterations and pathological state.

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