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ZNAČILNOSTI KORUZNJAKA IN NJEGOVE RAZLIČICE V EVROPI

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VARIETIES OF MAIZE AERIAL DRYING SHEDS ACROSS EUROPE

izvleček

Vernakularna arhitektura je razpršena po vsej Evropi. Prepoznavnost in pomembnost takšnih objektov, med katere uvrščamo tudi koruznjake, je mnogokrat spregledana in podcenjena. Koruznjaki so bili v preteklosti ključni objekti za shranjevanje pridelka - koruze, danes pa izkazujejo pomembno vlogo pri predstavitvi identitete posameznih regij, kljub izrazitim tehnološkim spremembam v kmetijstvu. Skupne značilnosti različnih tipov koruznjakov po celotni Evropi so konstrukcija, material in oblikovne značilnosti. Še pomembnejša pa je ugotovitev, da so koruznjaki postavljeni na lokacijah s specifičnimi podnebnimi in geografskimi značilnostmi.

V tem preglednem prispevku predstavljamo značilnosti različnih tipov koruznjakov. Osredotočamo se na uporabljene materiale in sisteme konstrukcije različnih tipov koruznjakov in njihov razvoj skozi čas. Obravnavali jih bomo z vidika arhitekture, etnologije in zgodovine. Namen prispevka je večplasten. Izpostavili smo prelomno točko začetka uporabe teh brezčasnih objektov, začetek gojenja koruze v Evropi in uporabljene prilagoditve, s katerimi je zagotovljena njihova optimalna uporaba. Pri tem opozarjamo na problematiko, ki se je pojavila ob teh prilagoditvah.

ključne besede

sušilna lopa, koruza, kozolec, koruznjak, hórreo, espigueiro, identiteta, dediščina

abstract

Vernacular architecture is sprinkled all over every landscape we may see, however the importance of these constructions are not often recognized. Aerial maize drying sheds played an important role in human development and settlements and still play a vital role in some regions' identity after remarkable advances in agriculture. These constructions share not only construction, material and form features, but also the areas where they can be found have common climatic and geographic conditions despite the physical distance.

This review article intends to give a view of this vernacular type of construction. Not only will an architectural point of view be given, but also an ethnologic and historic perspective. It presents the biggest inflection point in these timeless objects, the introduction of maize [zea mays] in Europe and the adaptations required for a maximum profit as well as problems derived from that. Materials and construction systems used will also be included and their particular evolution in each studied region.

key words

drying shed, maize, kozolec, koruznjak, hórreo, espigueiro, identity, heritage

Introduction

Vernacular architecture is the work of skilled craftsmen with no technical official education but their own experience and the knowledge of craftsmen before them orally transmitted in time. It has no trends, no recipes; no dogmas further that solving a problem or meeting a one-off need. But it has rules that have been tested throughout time to ensure the result – the architectural object – is durable, functional and practical. It has a balance between available resources and technology. Aesthetics are taken care of within some boundaries, but it is never left aside the fact that it is just a cover and the essential factor is the interior of the object and its proper functioning. Construction is beautiful on its own and nothing else is needed to make it appealing.

Its value rests in the fact that despite its apparent simplicity and meaningless importance, these buildings have survived through time and they still can be found in our landscapes. They continue existing and coexist in the majority of the cases beside modern architecture. Their functionality and technology, if well maintained, haven't been compromised and can still carry out their original function. What is left from vernacular architecture nowadays is the fruit of centuries of experience. All the bad architecture was discarded long time ago and what we see is the result of a timeless heritage. No detail is left to chance in these constructions, everything has a purpose in it and nothing is 'ad hoc' without a reason. Alberti's definition of architecture becomes truly clear in vernacular architecture: "Its beauty (of architecture) consists in such accord and harmony of the parts that nothing can be added and nothing can be taken away." Therefore, it is only when studying the construction, proportions and materials of traditional architecture that we can realize the simple yet complex machines these objects are; how everything has a reason to be and nothing is superficial or meaningless in them.

Among these buildings, the aerial drying sheds have an indisputable place. While storage and drying spaces have been widely built throughout history in the shape of barns or silos, drying sheds on piles are not so spread and the environment where they are developed seems to meet certain conditions and characteristics. Along the Cantabrian and Mediterranean coasts, these objects have been evolved in very similar ways, using the same materials and similar construction systems. They have encountered the same problems and turned up to become a symbol of that lands identity after all.

We will present specific locations where aerial maize drying sheds can be found in Europe: from the North of Portugal and Spain to Slovenia. We will expose factors that have determined

their evolution in these areas, factors that have determined materials, proportions and construction found in these objects, and the reasons of the crisis of these objects in time. It will be demonstrated that they are a same group and therefore, a classification is licit. A wider area from the Atlantic Sea to the Black Sea will be proved to be a potential area to find more examples of this study group.

Historical aspects: origin and evolution

Necessity and function

Farming is a subsistence activity, and therefore harvesting crops brings an important problem that has always needed to be solved: storage and preservation of these goods for a later use. In the past, family economy relied on subsistence agriculture. Not a big plot was worked by each family, and a minimum quantity was produced to meet their own needs. If there were leftovers, they were sold to get some profit out of it. It is for this reason that storage buildings become so important throughout History and holds the key in understanding our own evolution and social development. The harvest would be stored in these constructions and only the necessary daily amount would be taken out. Consequently, their size has to be in accordance with the volume of the harvest: wealthy people with larger fields need a larger storage room than common peasants, who would have a small plot and consequently smaller storage room for their harvest.

Specific cereals need specific conditions when being stored, and in the case of maize is not only about having a place to stay till needed for feeding. This cereal is not completely mature when harvested; instead, it has an elevated index of humidity. Dried maize grains are really stable but when still humid or stored in a room where its moisture can be increased, it is very likely to heat up, ferment and mould, becoming useless for its original purpose. This should be avoided at all costs controlling the temperature inside the storage room by cooling it down, and the humidity decreasing it by constant evaporation in its interior. Continuous ventilation is vital.

It is at this point when a specialized drying shed is needed and the maize drying shed comes to light. The corn is not threshed and the cobs are dried in cobs, making the task of storing faster and more efficient. In some cases the cobs are first hung outside in strings to be sun-dried and then taken inside of the construction to finish the process by air-drying; in others, the first step is skipped and the cobs are simply air-dried. Not separating the grain already has a positive effect in the process: it creates a spontaneous ventilation of the crop. This, together with the isolation from the ground provided by the drying shed as it is elevated on pillars and the constant aeration of the room through the numerous openings placed along it completes the new system for this crop. Aerial drying sheds will be located next to the farmers' house or in the surroundings of the living unit so it is easy to reach when needed. This is not incompatible with its last general characteristic, which is that an aerial drying shed will be located in a place where it can easily get currents of air to renovate the one inside of them and make it efficiently work. [Villes, 1985]

Aerial drying sheds have also the function of concentrating solar heat so that maize cobs can finish maturing by heating up. The roof inclination catches the maximum amount of solar radiation increasing the temperature inside of the chamber. Theorically, in this process the corn is not only being dried but also being nourished from the pith. This happens because the grains are not separated from the cob and in the process, they still get nutrients from the still attached central part. According to this theory, aerial maize drying sheds combine constant ventilation with heat drying to preserve this cereal and contribute to enhancing its nutritional value. [Pracchi, 1952]

On the other hand aerial drying sheds are built with bad heat isolation materials in their walls and roof. The exchange of heat is easily done between them and the surrounding air but it has been empirically demonstrated the zero effect of the solar radiation on the temperature inside drying sheds. It does not affect the inner temperature of the construction and consequently, the roof is only used to efficiently drain off water. The conclusion is reached by studying Spanish drying sheds built on piles with stone and wood. These buildings' main function then is to constantly and efficiently ventilate the cobs to avoid overheating and decay of the maize. No proof of heating was found. [Martínez, 1975: 46]

Later on, by studying the inclination of the roofs in the traditional Slovene aerial drying shed it was proved that roofs are intentionally built with a 45º slope. Not only it promotes a more systematic construction, but it was also proved that this angle maximizes the amount of solar radiation on the building. Since constant ventilation is the main function of these constructions and the indoor temperature is not affected by solar radiation, a new idea was developed. The solar radiation might be used to create forced ventilation inside of the construction. Kozolci are wider aerial Slovene maize drying sheds and consequently the storage chamber has a bigger chance of malfunctioning. Forced ventilation would secure well stored dried maize.

Research proved that the air trapped under the roof is heat up faster than the air surrounding the drying shed. Next to the ground, the air becomes cooler as it is in constant shadow. As the air under the roof escapes sideways outside the kozolec, it sucks the lower air into the storing space, forcing new drier air inside of the construction. And so, fresh air is continuously provided by physics and it ensures a functional drying process in all the stored goods, not only the ones in the perimeter. Form affects directly to the efficiency of ventilation, becoming a result of a given need. Aerodynamic knowledge is included in the design of the construction since the beginning and the result is an efficient functioning object. This same system could exist in narrower constructions such as hórreo, espigueiro and koruznjak, only it is less obvious due their dimensions. It is not yet proved and it would need further research. [Juvanec, 2007: 56]

Adaptation to the environment

At the beginning of the 20th century it was stated that drying sheds built on piles are simply the result of certain environmental conditions found in certain regions. These aerial sheds exist only in areas with a very high average annual rainfall and where

there is a need of isolating the crops from the floor because of humidity. Therefore, when the need for isolation disappears, so does the elevated shed and a conventional barn comes along. Enough information is collected to create a world map showing the correspondence between these two facts, but unfortunately these studies and considerations are only general and they don't go deeper in proving this matter. [Frankowski, 1918:16-27]

Some years later another research full of references to the adaptation of aerial drying sheds to the environment, opened again this subject. It claimed it is not only the climate and weather conditions that compromise these objects, but also the geology. These vernacular constructions are built with materials found in the areas where they stand and they reflect the nature of the rock present in the ground. There is a co-relation between materials and location. These studies focused on the North of Spain and claimed that ideally, a geologic map of its Northern coast could be drawn by studying in depth the materials used in hórreos and their geographical location. [López Soler, 1931: 1-66]

A study published later provided with some more light in this discussion. Despite the author's background in geology, he barely talked about the influence of the soil composition in these objects. He mentioned the co-relation between the materials used for the roofs in drying sheds built on piles and their availability in the surrounding area. He didn't go further and omitted completely the rest of the materials use. However, he finds references and data to answer the question of why these drying sheds extend to areas with a low amount of rainfall. By studying closely the Northern Iberian Peninsula, he realizes that these constructions are inevitably connected to the corn, and so, if the corn fields extend further from the maximum humidity area, the aerial drying shed will follow it. [Carlé, 1948]

It is also stated that the different supporting elements found in hórreos and their location within the region, means they were chosen to be used in one area or another according to the corresponding climate and rainfall. According to research observations, the most stable and the strongest supports correspond to the area with the highest rainfall, which would prove this hypothesis firstly stated in 1931. [Pracchi, 1952]

After a deeper research in hórreos, it could be proved that they had a geological influence in their construction materials and a climatic influence in their structure. The existing rock in the soil composition, its characteristics and quality are the key to understand why the stone is the only material used, the main one, or completely replaced by wood; why it is used in big blocks or small pieces: why it is combined with wood and why each material is used only in certain parts of the building. [Martínez, 1956: 174]

At the International Congress in Rio de Janeiro it was explained how vernacular architecture is certainly influenced not only by the climate and geological characteristics of the soil, but also socio-cultural factors. Galicia was taken as a study case. This region has an Atlantic climate, with a high amount of rainfall and lots of woods, and even though wood and stone craftsmen are the pillars of their traditional lifestyle, houses are built completely in stone. Wood is left only for certain indoor details and for accessory elements of the house and external complementary buildings like hórreo. So even though in some areas good quality stone could be extracted, wood would be still used in aerial drying sheds. Tradition and culture appears to be strongly related to these objects too. More information is provided to refute Pracchi's idea and it is suggested that the true reason has not been investigated yet and may be historical. [Martínez, 1956: 174]

Till that moment, all the adaptations to the environment of drying sheds were external to mankind: climate, rainfall, geology, composition of the soil, accessibility to materials, and suitability to plant crop. However, we cannot forget to take into account the history and the culture of the area where we are studying vernacular architecture. It will certainly help in understanding better its evolution and adaptation.

Architectural study: Elements and form

All these constructions have been built with a clear purpose: drying and storing crops for later usage, protecting them from the moisture, rodents and vermin. Regardless the geographical region or ethnical area where each drying shed has been developed and implemented, the same main parts can be identified in each one of them from bottom to top: A structure, a main body and a roof.

a) Structure

It supports the whole drying shed raising it on pillars tall enough to isolate it from vermin and moisture. The height of these pillars may vary from one region to another, but they are always driven into the ground and normally crowned with bigger stone slabs that prevent rodents to access the main body. Any structure consists of three main elements: foundations, feet, and corbels.

Foundations

Drying sheds built in stone need more carefully planned foundations than wooden ones since they are heavier, but despite this fact, they all must have a solid support. On a steep slope, a basis is needed. Sometimes it comes in a natural way, offered by the bedrock of the location. Sometimes, it has to be built creating a plinth with stone blocks filled in with dirt and covered by a horizontal stone, or pillars or masonry walls are built to absorb the height difference. When the location is practically horizontal the plinth is not needed and an individual basis is driven into the ground for each pillar or wall were the drying shed stands.

Feet

They can be built in wood or stone and shapes can vary from circular to square and rectangular. They can be conceived as pillars and appear in different numbers depending on the size of the drying shed and the style it is built in. However, these feet can also be dwarf walls set at a regular distance and parallel one to each other acting not only as supporting feet for the construction but also as beams where the floor can be directly laid. One thing is common for all types: they are divided into sections that are taken advantage from when setting their feet layout.

Corbels

Pillars and dwarf walls built to raise this construction have on top of them slabs where beams later rest on. These slabs are larger than the columns and beams they serve and it is because they prevent rodents to reach the corn. Mice and vermin can

climb upwards, but they are incapable of walking upside-down, what makes them give up and find food somewhere else. Corbels are structural elements and protection devices at the same time. The resulting void underneath such constructions isolates the storing chamber from moisture within the soil. It allows the air to flow around the object removing high levels of humidity and allowing constant air replacement. It prevents moisture to reach the storing chamber and acts as a natural barrier for rodents to access the maize. In time, this void has been also used as a storage room for tools, carriages, vehicles and often as a henhouse. All these added uses don't stop aerial drying sheds from working as designed, and turn them into more multipurpose.

b) Main body

It serves as a drying and storing room, with permeable walls that allow continuous and efficient ventilation or completely blind depending on their main function but always minimizing the direct sunlight on the stored goods.

The floor always lays on the beams set on top of the structure supports and can vary in size as well as in layout. The may be set together or may leave some space for ventilation. It depends on the material used and the type and style of drying shed. It may also be laid in a longitudinal way resting on the transversal walls of the structure, or in a transversal way on the longitudinal beams set in case the construction is set on pillars.

Walls can be curved or flat. The first case is the most primitive type and reminds of big knitted baskets in a truncated cone shape with irregular openings all around its perimeter. Its shape is so irregular that it is virtually impossible to find two identical, and creating a systematic construction with pre-establish details is unconceivable. Flat walls on the other hand, provide builders with a common ground where they could simplify the construction to improve the system as well as the details. Consequently, almost all the drying sheds found nowadays have flat walls, straight angles and regular uniform openings.

c) Roof

It protects the interior from the elements and direct sunlight and it can be either pitched or hipped depending on its size and style. At first, these roofs where movable as the main body was loaded from above. Every year straw was replaced as it didn't keep its properties longer, and the drying shed was loaded with a new crop. Later on, it became a stationary roof as straw was replaced by more endurable materials and an access on the walls was opened for loading maize.

A detached access is a barrier against snakes and vermin. Drying sheds are raised so much only a person could jump up or down that distance. When raised even more, stairs are built next to the construction as a separated object. They are never connected on the upper level and the void left corresponds to human dimensions and proportions, preventing rodents or snakes to be able to save that distance on their own. It may consist of a removable ladder stored somewhere else when not needed, or stationary isolated steps design for human body proportions.

In relation to drying sheds shape, it is crucial to understand that all this vernacular architecture is built in proportion with the human body. Craftsmen simplified measurements to those they could handle and built in accordance to them.

When studying carefully drying sheds and their measurements an interesting fact comes to light: their construction is bound to a square and its diagonal, and by extension to a 3D construction with squares, is also bound to a cube and the different diagonals contained in it. One measurement was taken as a reference for the whole structure and every element was design after it by combining squares and circles, extending those squares into rectangles and using again their diagonals. Consequently, it is almost impossible to find two drying sheds wit exactly the same measurements, while on the other hand, almost all the working drying sheds follow this proportion system.

The proportion system used in Slovene drying sheds is ingeniously simple and effective: two squares are used one of top of the other. One is parallel to the floor and it is used to create the structure, while the second one is rotated 45º and located with its diagonal on the upper edge of the lower square, creating the roofing system. Inside this one, a smaller square can be inscribed and it is exactly there where the storing room is built. It is important to highlight that all these proportions did not take as a reference the finished building with its finished materials and cladding, but the construction elements. Within this square (below and above) run other elements that use an increase and a decrease by the square root of two, so that kozolec has only two measurements: 1 and $\sqrt{2}/2$. Besides, the height is composed of the measurement of $1+\sqrt{2}$ which is a little percentage less that $\sqrt{3}$; fact that doesn't make the composition more demanding but simplifies it. The same principles can be applied to the rest of the drying sheds found in Portugal and Spain: a simple base unit exists and is used to create a simple, harmonic yet functional and complex building. [Juvanec, 2007: 61-71]

Architectural study: Materials

By studying different examples of drying sheds in Portugal, Spain and Slovenia, the materials used are stone and wood for the structure and the main body; and straw, wood or stone for the roof. The question that arises before this data is what influences the use of one material or another; is there any physical relation between the chosen materials and the climate, the geology and the flora or fauna in a region and if so, which one is the most influencing on the decision.

As explained before, some researchers such as Frankowski and Pracchi, claimed the materials used in drying sheds are related to the annual average rainfall an area has. Stone drying sheds distribution depends on how much it rains in an area, and consequently being located only in such wet regions. For the same reason, they claimed that wood is used in areas where there is a lower rainfall and wood can be preserved better; as an extension, so does the drying shed.

In Spain a coincidence exists between stone built drying shed distribution and the highest average rainfall. But the same coincidence happens with stone drying shed distribution and geological areas with high quality bedrock. This led other researchers like Martínez and López Soler to defend geological factors as the main influence when choosing materials in these

constructions. A debate is still opened around this matter and got more complex when he later suggested that tradition and culture also influences the choice despite climate and available materials. [Martínez, 1975:49-58]

In areas where there is a natural bedrock offering stone with a reasonable hardness, compactness and resistance, it will be extracted and used not only in building drying sheds but in any traditional architecture in the area. However, if the available stone is not such an easy resource to find or is barely compact, cracked and has a thick grain, ashlars will be impossible to carve and consequently this material will be avoided leaving an open window to the use of other local resources. Hard wood takes that place and is combined with stone or stand alone in the design. Soft wood is also used, not for structural elements but for cladding or flooring. This ensures no available resource is left aside and the construction is profitable and efficient. It will lower the cost and promote local economy of the area.

It is important to realize that the available materials will induce different construction systems and details. The more fine-grain sedimentary rock we can find in the area, the larger pieces of stones we can carve, meaning the bigger spans we can cover with one piece and faster and more efficient construction. The bigger grain the stones have, the smaller pieces we can carve and more masonry-like systems without mortar we find. With the wood happens the same: harder wood is reserved for structural elements as we have mentioned, having different construction details than elements of softer wood which is used to create ventilation opening, flooring and access to the building.

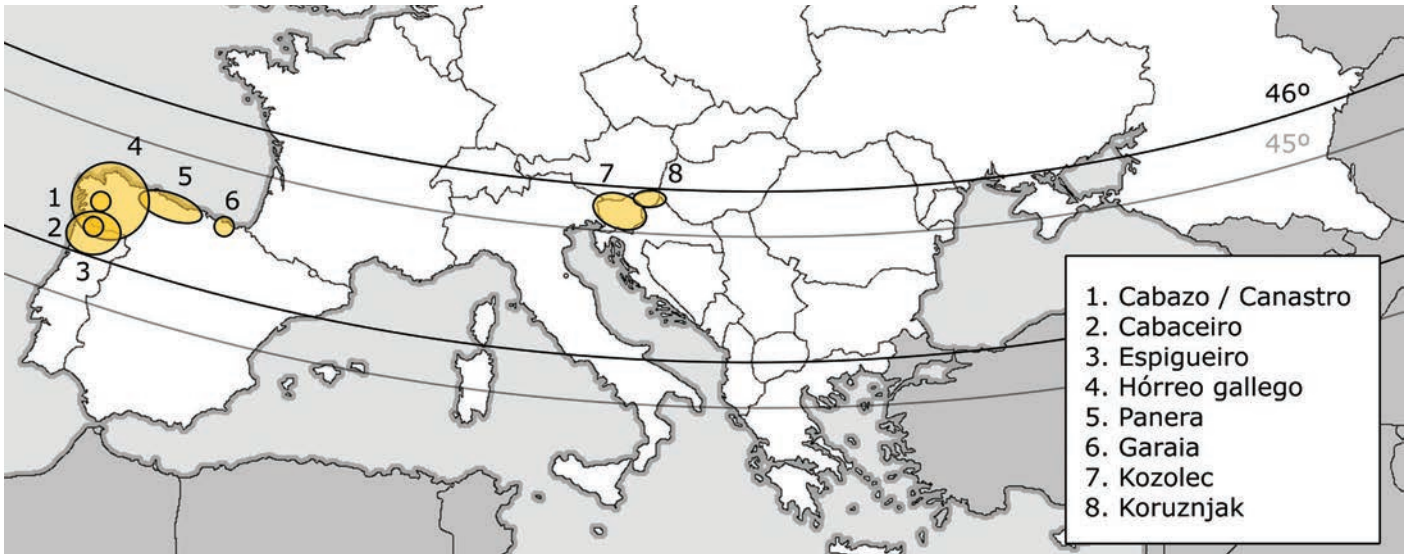
Finally, when analysing the construction methods, wooden construction details have been found in stone-made drying sheds. Not knowing the exact reason, a paralleled materialization of form happened when using wood and stone. As a consequence, specific wooden details can be found in stone built drying sheds.

Geographical distribution

The need to isolate the crops from the soil is absolutely crucial in areas with a high average rainfall. Harvested goods lose their nutritional value if left on the ground to dry and the chance of improving the quality of dried cereals for human use and animal's fodder will be taken. However, isolating the cereals and grains from the floor doesn't mean a lifted drying shed is needed. Therefore, the reason why they appear in certain areas has to be carefully studied as well as the different typologies and their specific location. Only in that way the relation between the land and the object can be understood and valued for what is worth.

This study is focused on Northern Portugal and Northern Spain, which are comprised within 41º and 43º N limiting with the Atlantic Ocean and the Cantabrian Sea on one side and mountains on the other. Due to their complex orography, it is possible to find a large number of small microclimates. A wide variety of soils, geographical accidents, and hydrographical systems create in each area a different landscape comprising the identity of the different settled groups. In Slovenia, located in between 45º and 46º N, it happens the same: even though it is a small country a wide variety of landscapes can be identified and the human settlements there have made this orography their own adapting it to their needs as well as adapting themselves to it. When looking into more Balkan countries, we find similar latitudes: Bosnia is within 42º and 45º and Serbia within 42º and 46º for example. The similar latitude of these countries and regions and the complex orography already gives us a common starting point.

Within these areas we can find three different climates: Atlantic, Continental and Alpine. Despite the different terminology, these regions are influenced by very similar conditions which create the very same frame to settle an agriculture that relates to the particular landscape and orography. All of these areas have a high average rainfall, with cold winters and warm summers, good characteristics to develop an agriculture based on two crops per year. The corn, provided a large harvest and suited perfectly the summer time conditions, the only need was developing a place where it could dry during the winter and be used throughout the year. Due to the high amount of precipitation and the continuous need of avoiding vermin indoors, elevated drying sheds were perfectly suitable and they were adapted to this new cereal's needs.



Slika 1: Izbrane lokacije koruznjakov po Evropi.

Figure 1: Selected location of aerial drying sheds in Europe.

In between these regions aerial drying sheds cannot be found. In the Mediterranean limiting French regions and the Italian northern areas around the river Po, corn wasn't such a success. Despite having similar latitudes, these regions are warmer and with a lower annual average rainfall, conditions not so suitable for corn. Consequently, maize didn't spread here and drying sheds didn't have to increase their size nor adapt to this cereal special needs.

Typology according to location

Cabazo, canastro

Canastro as it is known in Portugal, or cabazos as they are also called in Spain, are indeed the same first object developed to preserve and air-dry cereals set on the air.

It is the eldest and most rudimentary drying shed found in the North of Spain and Portugal and it is inherited from primitive gather communities settled there in the Neolithic. Although it is rare and despite its short life span, it is currently still used in areas 500 m above the sea level or higher because it is a low cost, easy to build object any farmer can make with resources at hand. In these areas maize is cultivated in small quantities due to its low profit, and which makes cabazo size perfect for its function.

This simple aerial drying shed has a circular floor plan that is rarely bigger than 1,50 m in diameter, truncated cone shape walls and a steep conic roof ended in a sharp point. The main body is made by flexible vegetable materials – thin young branches – knitted on vertical thicker sticks, reminding us of a big knitted basket. Proper ventilation is secured as these knitted walls provide enough openings all along their surface. It doesn't have an access to the interior though. On the contrary, the roof can be lifted to load or unload the maize cobs, and in some cases a temporary opening is made in the roof that is later filled in again once the action is finished. Straw is used for roofing the object, which makes this process easier and bearable. Sometimes, a small opening can be done to take cobs as needed. The object is lifted on the air by short crude wooden or stone posts and rarely also by dwarf walls. On top of them, wooden or stone lintels create a base where the basket rests.

Slika 2: Cabazo. Palas de Rei, Španija. [Martínez, 1975]
Figure 2: Cabazo. Palas de Rei, Spain. [Martínez, 1975]

Cabaceiro

It is a later implementation of cabazo. It still has knitted walls but its floor plan is no longer circular: it is rectangular with straight walls and a pitched roof originally built with straw although current examples can be found with ceramic or stone roofing. Apart from knitting tender flexible branches, a new system is introduced and coexists with it: pre-braiding vegetable fibres and later knitting them on vertical sticks along the perimeter. It is bigger than canastro or cabazo, which means that the moving roof is no longer an option due to its incremented weight and size. A door is built on one of the smaller doors and even though it is set on pillars, no steps or stairs are needed as the structure is not that high and a person can easily save that distance. Vermin and snakes are avoided while owners can access the stored goods.

Espigueiro

On the North of Portugal these aerial drying sheds can be found in greater concentrations such as in Soajo (27 objects) and Lindoso (64 objects) as well as single objects in households. With a rectangular floor plan, a pitched roof and a marked structure with protuberant lintels over the pillars where the main body stands, these objects can built in stone or mixed stone and wood.

In any case, it is surprising the large size of the ashlars used. This is mainly because the granite used for their construction is so resistant that it can be carved in pieces large enough to cover the distance between pillars and resist the weight of the drying shed without collapsing. The openings are generally made with vertical ashlars carved in a hexagonal profile so the façade and the inner surface remain flat and the air is directed to the interior making easier its ventilation. When using mixed materials, wood is used to create these openings by using vertical boards with a small separation among each other. The sun rays are therefore avoided in both types of espigueiros and the access to the chamber is granted with a wooden door. Roofing is always carried on in stone and in the most modern cases, with ceramic tiles. No stairs are required in most of the cases as the pillars' height is not so much to avoid a person to jump to the interior, though in some cases a removable step can be used to make it easier. Of course, wooden espigueiros can also be found.

Galician Hórreo

Within the Spanish territory and due to the number of remaining samples found, its geographical extension and its invariability in form through time, it is the Spanish type of aerial drying shed for excellence.

Built in stone and wood, as well as only in wood or stone, it presents a rectangular floor plan longer or shorter depending on size of the crops and the amount of corn to be dried, but with its main body being always in between 1'00m and 1.20m wide and from 1.80m to 2.00m tall. A pitched roof with short eaves covers the construction having quite often decorations like pinnacles or crosses.

Hórreos built in wood are set on dwarf walls with rectangular slabs to stop vermin to access the inside of the building. The body walls are built by vertical boards tied with one or two horizontal boards set at a middle distance, leaving uniform small spaces in

Slika 3: Cabaceiro: Libureiro. Španija. [Martinez, 1975]
Figure 3: Cabaceiro: Libureiro. Spain. [Martinez, 1975]

Slika 4: Kamniti espigueiro na stebrih. Soajo, Portugal. [José Olgon]
Figure 4: Stone espigueiro on columns. Soajo, Portugal. [José Olgon]

Slika 5: Hórreo iz lesa na več zidcih.Abegondo, Španija. [www.horreosdegalicia.com]
Figure 5: Wooden hórreo on dwarf walls. Abegondo, Spain. [www.horreosdegalicia.com]

Slika 6: Hórreo iz lesa in kamna na več zidcih. Amoeiro, Spain. [www.horreosdegalicia.com]
Figure 6: Mixed hórreo on dwarf walls. Amoeiro, Spain. [www.horreosdegalicia.com]

between them to allow natural ventilation to happen. It is widely accepted that wooden hórreos are only owned by smaller and less wealthy farmers, as well as used for lower quality variety of corn. However, despite being easy to find examples for this, it is also true that there are beautifully decorated wooden hórreos with a special attention put into details, which makes impossible to sustain this hypothesis. The stone ones are found in areas where the bedrock is such an available resource it becomes easier to carve it and build with ashlars, than cutting wood and transform it into beams and boards. It has been also related to areas with a higher average rainfall, but this is not the main reason as it has been discussed before. The structure presents a wide variety of systems again, and so does the main body: big vertical ashlars, horizontal masonry alternated with smaller stones or dry stone walls with irregular pieces to create ventilation openings; all different and adapting to the characteristics of the available stone. The walls become thicker because of the incremented weight of the construction, more stability and the way of working this material. Only when using slate thinner walls are possible.

The mixed type can be found all over the region of Galicia, which makes it very variable in measurements, structure and aesthetic. They can be built with ashlars, pillars, dwarf walls and basis, with circular or rectangular slabs as well as double ones. But they all keep the same main body structure: dry stone fronts in the shorter sides and dry stone columns in the longer sides where the wooden cladding frame is supported. The roof substructure is also stone made, and it rests in these columns to ensure stability. The difference in the stone construction details comes from the kind of stone used, which depends in great measure on the bedrock of that particular area. As we mentioned already, the finer grain the rock has, the bigger ashlars will be used in drying shed construction; the bigger grain it has, the more susceptible the rock will be to break and the smaller ashlars will be carved.

In all cases a door is always located on one of the short sides of the object and no stairs are needed to get inside due to the short height of the main body. The roof becomes stationary not being moved at all like in cabazos, and therefore, more durable materials are used such as ceramics, stone or wood.

Asturian hórreo or panera

This drying shed was originally built with a square floor plan main body supported by only four pillars. Its roof is not pitched but hipped with the catslides joint in a ridge. Some of them later adopted a slightly more rectangular shape, but not as marked as in hórreos. They are higher than their neighbouring hórreos and therefore, a removable ladder is needed to access the interior. Stone stairs are also quite normal to be built next to these buildings too, but always disconnected from the main body to physically create a barrier for vermin, snakes and rodents. A gallery is often added to the main body both for loading and unloading the stored goods, as well as to extend the drying surface in the object and use it to sundry other harvested products. While the structure can be built in stone or wood, the main body always remains in wood with a tile or slate roof.

They are mainly found in the regions of Asturias and Cantabria, on the east of Galicia.

Garaia

Found at the eastern side of the northern Spanish coast, they decay on the XV and finally disappeared on the XVI due to an extensive change of agriculture for stockbreeding, turning the cereal fields into pastures. Today, a few examples can be found but all in very bad condition as the need for a specialised maize storing room does not exist for a long time now. They had a rectangular main body, built in wood and normally divided into three rooms. Four or six pillars with lintels would support these objects, and they would have a hipped roof when being small, and pitched when growing bigger. No gallery was attached to the main body.

Koruznjak

Found only in the Northeast and Southeast of Slovenia, the koruznjak is a specialized rectangular floor plan drying shed used only for corn. The eldest types where built with a wooden structure cover in wattle knitted walls and 45º pitch roofs, reminding us of the cabacerio that once existed in the north of Spain. Later on, the wattle was replaced by wooden laths, making this construction more durable and consistent. Openings were now more regular than in the previous constructions and the walls became perfectly straight and perpendicular to each other. The roof continued to be thatched but the wooden substructure that held it turned into a more systematic one, following proportions and adding always eaves long enough to ensure rain water would not access the corn.

On one of the shorter facades a door is built to access the interior like in Portugal and Spain, but the structure that holds the main body, is however significantly shorter and; as it can be saved with just a step, no external devices are needed to access the corn. In more recent examples, the wooden angled structure has been replaced by concrete or masonry dwarf walls, raising the total height of these drying sheds, but still not enough to make necessary any attached steps.

Kozolec

It is the most extended drying shed type in Slovenia and even though it was not originally developed to dry corn, it was adapted to do so once this cereal spread across the country. Giving that the starting point of this device was a wooden vertical grid, supported by brackets and covered by a roof, where hay was hung to be dried, it is surprising how it evolved till becoming a multipurpose daily object.

Though there are many kinds of this drying shed only the one used also for corn is the so called couple-kozolec and it comprises two single kozolec – wooden vertical grids – joined with cross beams and covered by a hipped roof. Inside, an upper floor is set using these beams as a primary structure where another set of cross beams are laid perpendicularly. It is on this upper level where the corn is dried and stored. It is already protected from direct sunlight by the grid set on the longer sides of this construction, however it incorporates not only an almost opaque wooden cladding on the shorter sides, but also another wooden grid, with more or less openings depending on its use, on the upper floor. This creates a chamber well ventilated and protected that ensures corn dries in optimal conditions.

Couple kozolec are covered with a hipped roof set with a 45º slope. This ensures not only protection from the elements, but also creates a natural flow of air within the object: as the lower part receives direct sunlight and the upper one is in constant shadow, the hot air rises creating a natural ventilation around the upper level, removing high humidity levels.

Influence and changes in society

Aerial drying sheds have been used for a long time, and are constantly adapting to the different crops and cereals used in the fields as well as available resources in the area. They have been target of constant attacks since they represent the wealth of a region and their immediate future, and any conqueror would constantly burn them, tear them down or loot their content just to subjugate the local population. In some cases, it wasn't even about physical control of people, but psychological. We shouldn't forget that aerial sheds are really specific to certain areas and they are part of their identity and culture of their native population. Eliminating that identity can be achieved also by destroying their symbols and common cultural heritage, and therefore, drying sheds become a recognizable target. This is why these objects have a common spatial position within farmsteads. They need to be protected as well as easily reachable for daily needs. Therefore, they are always set next to the main house under a visual control.

Not only rivalry caused destruction of aerial drying sheds, also new discoveries and good improvements have had a collateral damage for these constructions. In fact, a new cereal created the first true inflection point in the evolution of such an ingenious construction: the corn (zea mays). Though it was introduced in Europe from America in 1515 with Sevilla as gateway– Spanish obligatory port for ships coming from and going to the new continent – it is very difficult to establish exactly when this was since the new cereal in most of the cases was designated under the same term as the main traditional cultivated cereal in each region. In the case of Portugal milho was the substituted cereal and the name given to maize in an effort for continuation in traditional agriculture; in the case of northern Spain mijo was the target for this change; and in the case of Slovenia sirk known in English as sorghum. But approximately, we can say that it did not reach the northern area of Portugal and Spain till the XVII century as well as Slovenia. [Martínez, 1975: 27]

The reason why a tropical and subtropical cereal reached such a rapid and important dissemination in Atlantic and Continental climates is because it was perfectly suitable as a summer crop: relatively hot summers with temperatures not lower than 13ºC at night and day temperatures 18ºC or higher ensured a fast growth and prevented it to slow down at nights. A constant annual rainfall made it perfect for varieties that ripe before the arrival of the autumn and the cold temperatures, making possible the harvest and later cure and drying process outside the fields, leaving the land ready for a second winter crop.

Slika 7: Panera. Asturias, Španija. [www.teyvert.com]
Figure 7: Panera. Asturias, Spain. [www.teyvert.com]

Slika 8: Garaia. País Vasco, Španija. [Indalecio Ojanguren]
Figure 8: Garaia. País Vasco, Spain. [Indalecio Ojanguren]

Slika 9: Koruznjak. Prekmurije, Slovenija. [Juvanec 2010]
Figure 9: Koruznjak. Prekmurije, Slovenia. [Juvanec 2010]

Slika 10: Kozolec. Slovenj Gradec, Slovenija. [Juvanec 2010]
Figure 10: Kozolec. Slovenj Gradec, Slovenia. [Juvanec 2010]

Thanks to it and within the Spanish territory, the hórreo reached its maximum peak in the North-Eastern Cantabrian coast, while on the other side of the northern coast the complete opposite effect happened: its downfall. Bigger productivity brought by the maize in the fields meant a need for a bigger storage. But this was developed in different ways depending on the owner of the land and the immediate effects on the drying sheds were inevitable.

In Asturias, where the Church was the main landlord, hórreo was promoted and even extended in some cases with an outdoor corridor to create a larger drying surface, making it more profitable. In Galicia and north of Portugal, where the land was owned by parishes, seminaries, religious houses and monasteries, not only they incremented the number of these constructions, but also grouped them giving birth to parish and monastic hórreos. Big private landlords followed the example given by the church and grouped their new hórreos and espigueiros keeping them close but never being an obstacle for their proper functioning and ventilation, creating an unusual picturesque image. Higher efficiency and production brought higher security and protection.

On the other hand, in Cantábria, Basquia and Navarra actions take a different turn and landowners build big stables with wide attics where they dry the cobs together with the stored cereal and grain. The drying sheds as individual objects disappear brutally form the landscape in these regions, remaining only a handful of examples.

In Slovenia maize also made a remarkable impact in agriculture and family economy. In the Pannonia plain the best conditions were found for this new crop and the need for a specialised drying shed appeared. Small objects spread across the landscape. Except in the coastal region, where this cereal had no effect at all, in the rest of the country no new construction was developed as it didn't become the main cereal. It was however included as a summer crop in farming and so, the old drying constructions used for fodder evolved and included a room where maize could dry under suitable conditions. Both koruznjak and kozolec (first and second type) are still in use and can be seen throughout the country.

Apart from this, drying sheds were also abandoned when not working properly. This could be due to inadequate used materials, construction problems, later earth moving that affected foundations, lack of training or construction knowledge or improper maintenance of the building. Transferred knowledge among generations was defected. Also, when located within the living area it could happen that later constructions around the drying sheds would stop the natural ventilation by obstructing the currents circulating around the building, and consequently making it not dry the crops and turn it into a useless object. This doomed a relevant number of aerial drying sheds after some farms became wealthier due to maize incomes.

More recently, another inflection point occurs in the history of the drying sheds. Due to technological developments, new machinery is implemented to harvest the cereals and bale them in rolls where they can directly dry and ferment without any specialised extra building or space needed. It is good news

for farmers, who can save time and energy with this useful simplification of the harvesting process as well as get a more profitable outcome; but seriously threat drying sheds. The key of survival for them is that even though a larger quantity of fodder can be obtained by new technologies, the quality of dried cereals in drying sheds is anyway higher.

Conclusions

Similarities in the outcome are visible: the studied aerial drying sheds belong to a same group and establishing a classification is licit. Besides, the similar construction details suggest this classification can be carried out following different factors: materials, construction, form or use.

The introduction of corn has played a remarkable role in these constructions' evolution and development. It should be possible to create a map of maize expansion through Europe and connect it with changes induced in aerial drying sheds: implementations in the design, expansion of the buildings and their disappearance in some regions.

There is a connection between the geographical distribution of these objects and the climatic and geological factors in these areas. It is licit to agree with Martínez and his defence of geological factors going over the climate. It may seem a bit controverted in the Iberian Peninsula, as the areas with higher amount of precipitation coincides with good quality bedrock areas. But when looking into Slovenia and the average amount of rainfall per year, we can state that it is not a matter of how much it rains but about what resources and materials are more at hand: The main accessible material along the country is wood, and only in certain parts with a better quality bedrock, stone elements can be found without a considerable difference in rainfall average. Tradition must be regarded as it influences them too.

Juvanec's theory of the usage of the 45º roof on a drying shed not to warm up the stored goods but to create forced ventilation should be proved in the whole study group. Extrapolating this system to modern materials and current construction systems seems plausible and could bring many benefits to sustainable architecture.

Drying sheds have suffered crisis throughout time, and their future is threatened by new technologies, lack of use or indifference. This vernacular architecture has to evolve and find a new position and use, but we also have to realize their cultural and social value, the identity symbol they are.

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