Building Design Solutions for the Sheep and Goat Breeding in the Protected Areas of Sicily

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Abstract

This study aims to propose building solutions suitable for sheep and goat breeding within the Park of the Nebrodis (situated in North-Eastern Sicily, the largest Italian island), or within protected areas having similar characteristics. A sample of farms was studied to understand the specific demands of breeding. The data collected supports a set of useful guidelines for the organizational schemes and metadesign proposals for specific building solutions with low environmental impact.

Keywords: *sheep and goat - farm building design - protected areas*

Introduction

In the Mediterranean basin sheep and goat farming constitutes one of the main economic activities for the exploitation of its vast rural areas of low crop potential.

In Italy the majority of protected areas overlap marginal areas. The latter amount to around four million hectares, 50% of which are of medium or scarce fertility seminatives together with wooded areas of various sizes, while the rest are often abandoned natural pastures. The rural areas (those territories presenting rural characteristics of low housing density and high agricultural presence) are estimated to represent over 80% of the territory of Southern Italy. Parks and protected areas not only safeguard natural and historical/cultural heritage, but they also promote zootechnical agricultural, tourist-recreational, educational, training and research activities.

Extensive sheep and goat farming in the parks brings some delicate problems such as reasonable single flock sizes, the careful definition of transhumance routes, the areas and methods of pasture, the rational location of watering, foraging and rest points, control of the head, the implementation of the zootechnical layouts in the landscape, and the ecological, social and cultural aspects.

Preserving livestock farming inside the Parks could enhance agricultural resources and environmental safeguards. By avoiding intensive farming, the correct use of pasture preserves the land from erosion and landslip, and also simultaneously limits the quantity of invasive plants, brushwood and combustible necromass, restores fertility and improves the aesthetics of the landscape.

Thus, recent studies have shown that in marginal areas (some protected) the "pastern value" (index of goodness and efficiency of the grassy layer) increases as pastures increase, remaining between 80-90% as a maximum value and 25-35% as a minimum (Talamucci, 1996). It is therefore possible to affirm that extensive zootechnics maintains animal and vegetable biodiversity and reduces the spread of the epidemics that often occur with overcrowded breeding (Secchiari, 1996). Furthermore, the choice of autochthonous genetic types quantitatively assures satisfactory productivity levels of quality local foods.

In other words, livestock breeding in protected areas provides a multifunctional role and protects the territory. It is not aimed at the production of generic food products, but is in fact

directed at maintaining local traditional products using traditional or innovative breeding techniques which are compatible with the reclamation of nature (Fortina *et al.*, 2001).

Zootechnical activity within the Parks is linked to the modernization of farm management, though it respects tradition and local production potentials. The construction of suitable buildings to shelter the flock, which integrate with the landscape and effectively simplify its management should contribute to the aim of this project.

Main Body

In the principal Sicilian regional Parks (Etna, Nebrodi and Madonie) sheep and goat rearing has an important role (fig. 1). In the Parks of the Madonie and the Nebrodi livestock breeding methods are homogeneous. The practice of transhumance on animal farms strongly contributes to maintaining traditional physical-environmental-cultural characteristics.

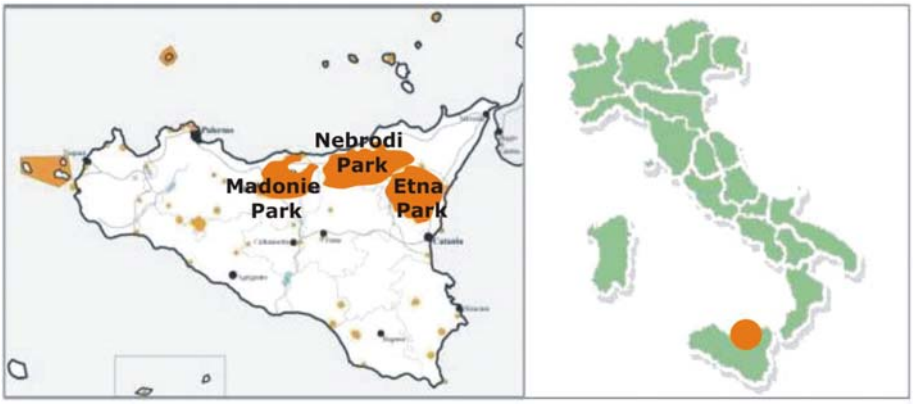

Figure 1: Location of the Sicilian natural parks

Sheep and goat breeding has a particular economic significance to farm and landscape management inside the Park of the Nebrodi where it is still carried out according to archaic methods, without the proper facilities to assure animal health, product hygiene and employee comfort. The existing animal shelters are simple sheep folds (*mànnara*), while the shepherds use small barns (*pagghjara*) annexed to the residence of the farm owner. The limitations of the current planning regulations governing new building within the parks, together with the way transhumance has been traditionally practised, never favouring the building of proper stables, are the reasons for the absence of purpose-built efficient buildings.

This research refers to the Park of the Nebrodi but its results can be extended to the other regional protected areas and also to any Mediterranean areas having similar characteristics.

Through business and territorial data analysis which shows different organizational and managerial characteristics as well as construction and typological solutions currently adopted in the area, it is possible to draw up a set of proposals for the rationalization of the spatial and functional organization of animal buildings/structures which combine managerial and environmental requirements.

Materials and Methods of Procedures

The aim of this study is to identify and propose new building schemes for extensive and transhumant sheep and goat breeding in protected environments. The sample farms are located on

territory close to the Tyrrhenian coast of Sicily which extends for about 70 km. It is mainly mountainous and it lies between the Peloritani mountains on the east slope, and the Madonie mountains on the west slope. It extends as far as the Erei mountains and Mount Etna to the South. The main elements characterizing the natural landscape are dissymetry of the slopes, varying heights of the relief (ranging from a few metres above sea level to 1847 m of altitude), thick vegetation including over 45 % of the species, subspecies and botanic varieties present in Sicily – many of which are of taxonomic and phytogeographic interest – and a variety and wealth of humid areas with many springs, high altitude lakes, streams and torrents.

The concentration of fauna is the highest in Sicily: 16 species of mammals, almost 150 species of birds both sedentary and seasonal, 11 species of reptiles, 4 species of amphibian and countless invertebrates. Of great interest are particular geologic areas which constitute the ideal habitat for particular plant and animal species. The signs of an age-old civilization add to the varied and rich natural environment: towns steeped in history, art, architecture, linguistic forms, original cultural systems, lifestyles, costumes and traditions which are surprisingly well-preserved, almost uncorrupted by time, resisting the levelling force of technology and mass communication. The aim of this research will be achieved through the development of the following phases:

- acquisition of technical and bibliographical data relative to the rational organization of the environment suitable for sheep and goat breeding and to the actual availability of eco-compatible building systems and construction materials;
- knowledge of the territorial and business characteristics acquired by carrying out direct and indirect investigations. To achieve such aims the survey studies the organizational and managerial characteristics and the construction typologies adopted by 30 farms where sheep and goats are reared to the wild and in transhumance which represent the zootechnical situation of the district of the Park of the Nebrodi. Survey forms, sketches of buildings and photographic documentation were used. The following criteria were adopted in the choice of farms: extensive transhumant breeding; at least one base of the farm within the park; uniformity of distribution over the whole territory of the Park; prevailing presence of sheep and goats (generally in the same farm bovines, pigs and equines are reared); number of heads reared ranging from 150 to 900; presence of shelters or other stable systems;
- analysis of the needs specific to the type of breeding under discussion, in relation to environmental and managerial context (cycle of the daily activities), in order to define a "business model" based on the results of research for which it was possible to outline an appropriate building system.

Consequently, taking into account the business model, the cycle of hypothesized management and the phases of the flock management, by using consolidated methods in the field of metadesign, it was possible to define homogeneous areas, characterized by environmental and technological requisites and performance. Such areas have been correlated through matrices and organized in metadesign layouts, conditions necessary to study the specific design solutions with low environmental impact.

Results and Discussion

Analysis of the farms

The majority of animal farms located within the Park practise transhumance, sometimes using remarkably distant pastures, which rarely belong to the shepherd. In the year 2001-2002, 5297 hectares of state-owned land were used, equal to 28.74% of all pasture. 4762 hectares were used for summer pasture (June 1 to November 30) and 565 hectares for winter pasture (November 1 to May 30).

Sheep and goat breeding is primarily done on dairyfarms where the milk is extracted in inadequate buildings, where the equipment rarely complies with the correct standards (EEC Directives 92/46 and 92/47, in Italy D.P.R. n° 54/97, C.M. n° 16/97). 'Heavy lambs' are also bred (the animal is obtained from a cross between part of the flock and *Barbaresca* rams). Ovine and bovine breeding are frequently associated for the mixed purposes of meat and milk. Occasionally, pig and equine farming can be found.

The animals bred are mainly sheep of endemic breeds such as the *Comisana*, the *Pinzirita*, and the *Sarda*, and goats such as the *Girgentana*, the *Argentata dell'Etna* and the *Nebrodi* goats, and some *Maltese*. They all have these characteristics in common: small-to-medium size, rusticity, longevity, fertility, vitality, resistance to pathologies and in conclusion they add a genetic patrimony of remarkable scientific interest.

The sample farms have several bases which are often quite distant to each other, confirming transhumant-wild type breeding. In 86% of cases, seasonal transhumance is practised in a traditional way, without motorized transport. At least one of the business bases is situated within the Park, mainly the one operating in the summer period.

The farm bases are located at an altitude of between 350 m and 1300 m and the land area ranges from 60 to 700 hectares, distributed between the winter and summer bases. The largest group, 34%, covers an area ranging from 150 to 250 hectares, while a few farms, (6%), extend between 550 and 700 hectares. A significant 23% use land ranging from 50 and 150 hectares.

Most land is leased (47%) or in civic use (29%), while only 24% of land is owned by the breeders which limits building investment and explains the precariousness of the structures.

There are few farms with more than 750 heads, while the prevailing number ranges from between 450 to 550, followed by smaller farms that possess an average of 200 heads.

Almost none of the sample farms comply with the building regulations for dairying which are applied to other farms or to dairy.

The sample farms are mainly directly managed or family run, which is in line with the general trend of local enterprise and aims at a maximum income and a minimum expenditure.

The data confirm the trend recognized throughout the livestock breeding community of the island: there is fragmentation of the zootechnical situation and poor product specialisation.

The lack of permanent breeding sites is accompanied by the absence of suitable buildings and by the extreme simplicity of the existing ones, both at the principal base (used in winter) and the secondary one (used in summer). In both bases, night stalling is primarily done in sheep folds (88.4%). At the principal base, roofing is rare (2.7%). Only in a few cases in the summer season, are the animals continuously put to pasture (8.9%). In 93.6% of farms, milking is carried out in the open in simple enclosures, the remainder is done under the shelter of roofs, primarily found at the winter bases. The areas where the flock are gathered before milking or stalling, and those for health checks, are always sheep folds. The materials used for the enclosures are local stone, wood, metal net, bushes and often salvaged materials (corrugated sheeting, wooden panels, etc.). For roofing, corrugated sheeting, fibro-cement, clay tiles, etc, are used. The enclosures (*badili*) of the milking area are metal net and wooden posts, and are rarely of stone or brickwork. Sheep folds and milking areas, though simple, are functional for tending the flock.

The daily routine runs in a traditional way and varies slightly according to the seasons. After the first milking, the animals are generally led to the pastures. Back in the sheepfold, where they may be health checked, the flock is conducted to an area where they wait for the second milking and subsequently led to the night stalling area. If necessary, supplementary food is given in

different places and at various times in the daily cycle; for example on the way back to the farm or during the milking or in the roofed stalling area if there is one.

In summer, the cycle is particularly demanding as the flock have to be led back to the pasture in the evening hours, after the second milking, to make up for the scarce availability of grass due to the arid ground (fig. 2).

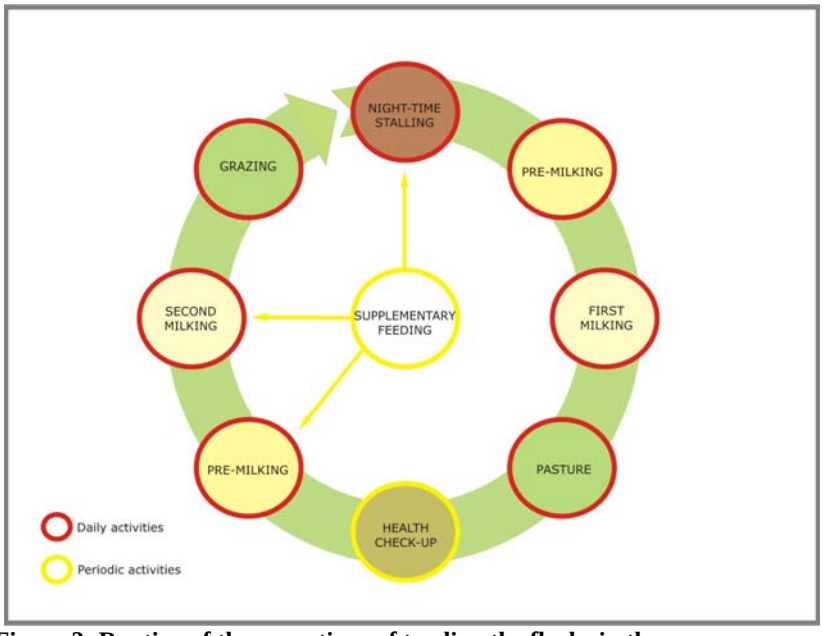

Figure 2: Routine of the operations of tending the flocks in the summer season

However in winter, because of the adverse climatic conditions, especially on clay plains, an occasional daytime stalling in roofed paddocks may be necessary (fig. 3).

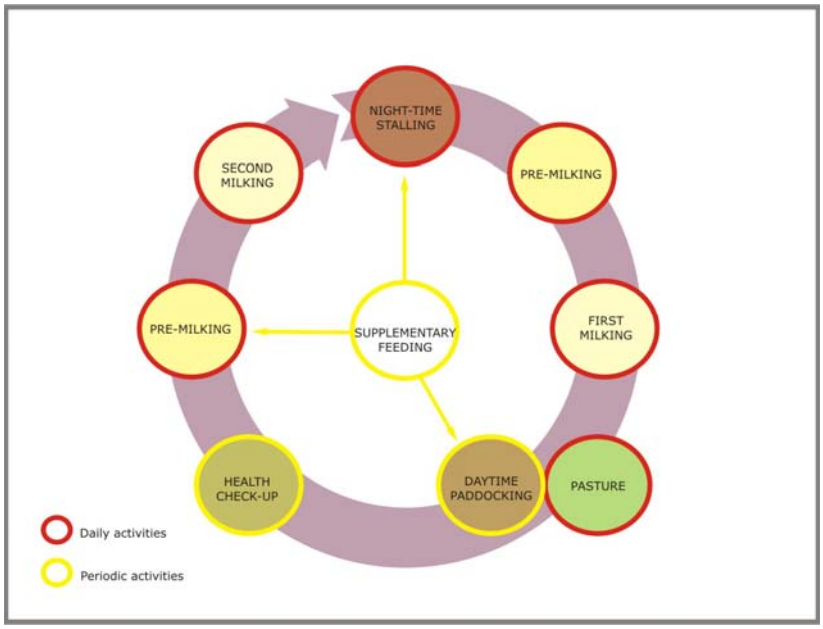

Figure 3: Routine of the operations of tending the flocks in the winter season

The analysis of the tending activities and the use of the farm areas define six different schemes which represent the "organizational typologies" recurrent within the sample (fig. 4).

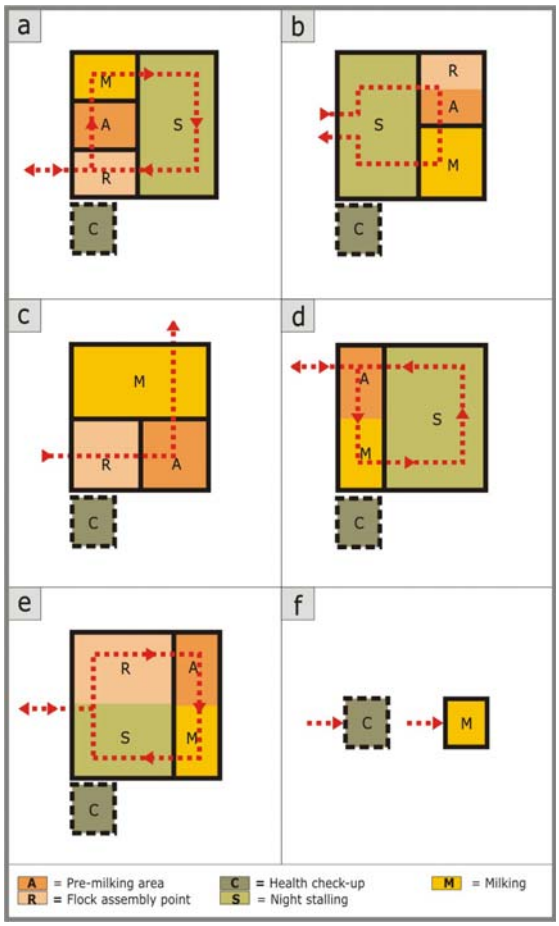

Figure 4: Typologic schemes of the farms investigated

- Typology '**a**', found in 13.33% of cases, shows separate areas for the different activities and is therefore more efficient, however it incurs higher building costs. The average surface area for night-stalling is 0.75 m^2/head.
- Typology '**b**' is the most common (40% of cases): in which the flock are gathered and wait pre-milking in one area situated near the milking and stalling areas. In this last area the average surface area is 0.77 m^2/head.
- Typology '**c**', represents only 6.7% of cases, and is mainly used in the summer bases. It is characterized by gathering, waiting and milking areas and the absence of night stalling areas.
- Typology '**d**', found in 20% of the bases, the gathering and waiting areas coincide so they are not separate from milking, while the night-stalling area is well defined, and the average surface area is 0.90 m^2/head. Such a layout is only found in farms with small flocks and it has extremely basic constructions.
- Typology '**e**' is adopted in 10% of the cases. The farm has two spaces, one for gathering and night-stalling, the other for the pre-milking wait and the milking itself. The surface area for night stalling is generally around 0.62 m^2/head.

- Typology '**f**', very infrequently found (3.33% of the cases), has a single area destined only for milking. It represents those cases in which animals find their own pasture, and is used especially in summer.

Metadesign Indications

The rather homogeneous information resulting from data, a business model representing the studied situation was defined, which can be used to propose suitable design projects.

In order to maintain and develop the zootechnical business to obtain local and organic food products which possibly have a registered mark, and considering the different nature of cattle breeding, the only breeding considered here is that of sheep and goat of autochthonous breeds.

Considering these factors, the hypothesized "type" of farm is extensive, transhumant, family run, with an average-sized flock of around 400 milk heads. The hypothesized farm land, considering both the winter and the summer base, is around 150 and 250 hectares.

Furthermore, we refer to the phases of tending the flocks during a typical day per every season.

The operations carried out in the summer base are particularly arduous as the animals have to be led to the pastures in the evening after the second milking. In accordance with the findings, the summer base would be situated within the park.

The environmental and typological system

It is possible to define homogeneous spaces, characterized by precise requirements and specific environmental and technological performances (table 1), taking into consideration the business model and flock management, including animal and employee needs, by applying consolidated methods in the field of metadesign.

Table 1: Environmental and space requirements for breeding areas

Area	Animals	Employees
Night - stalling	- Protection from atmospheric agents - Cleaning practicality - Mangers and troughs availability - Surface area appropriate to the flock size (0.80 m^2/head min roofed area) - Comfort	- Ease of access for cleaning and feeding
Pre-milking	- Cleaning practicality - Plan suitable for assembly - Surface area appropriate to the flock size (0.25 m^2head min roofed area)	- Ease of intervention in animal transferring and regulation
Milking	- Protection from atmospheric agents - Cleaning practicality - Mangers availability - Surface area appropriate to the flock size - Special equipment animal restraint and milking	- Comfort and practicality for milking
Grazing	- Surface appropriate to feeding needs - Roofing or trees to guarantee sun and wind shelter and protection - Sufficient supply of troughs	- Solar radiation protection
Health check-up	- Surface area appropriate to the flock size - Plan suitable for assembly - Cleaning practicality	- Ease of intervention in animal transferring and regulation
Feed stuff store	- Surface appropriate to feeding needs - Closing elements for protection from atmospheric agents and rodents and parasites	- Ease of movement for the employees
Tool shed	- Surface appropriate to operatives' needs - Closing elements for protection from atmospheric agents and rodents and parasites	- Ease of movement for the employees
Milk store	- Size appropriate to the flock size and the kind of milking - Protections suitable to stop insect or pests - Floors easy to clean and non-slip with inclination towards the drain water well	- Ease of movement for the employees

In the winter or principal base, the area for *night-stalling* is used as a shelter for the animals and possibly to give supplementary food in unfavourable climatic conditions. The presence of the flock during the coldest hours requires protected areas where the animals can find a shelter and conditions suitable to their comfort. The animals are gathered in the *pre-milking* area twice a day; the rather brief stay that requires small areas. The milking space shows particular organizational aspects. The dispensation of current regulations for wild breeding, only applies to the organization of the routes for the flocks, emplacement of employees for milking, and to the provision of shelter from adverse weather conditions. The *grazing* area is characterized by the quality and quantity of natural food, by surface area extension, by possible presence of shelter from strong winds or intense sun. The *health check-up* area provides for occasional animal requiring medical care or special treatment (washing or shearing). The *milk store* requires an indoor space to store the special containers for a certain period. Also the *food store* requires suitable measures to protect it from atmospheric agents.

In the summer or secondary base the *stalling* area has suitable facilities for sheltering the flocks only in the night-time hours. The *pre-milking, the milking, the pasture and the health check-up* areas all have the same characteristics aforementioned for the main base. There is no *milk store* or *food store* since milk is momentarily collected in milking space and transported to the main base or elsewhere for dairying while feed stuff is not essential as it is rarely used.

A part from the few managerial differences, it is clear that breeding operations in the two bases are similar; consequently the functional interrelations are similar. In both cases the nucleus is identical - and it is constituted by night-stalling, milking, grazing, pre-milking and health check-up areas - organized with respect to the relationships (of contiguity, of proximity and of distance) necessary for good management.

The night-stalling and the milking areas are close to each other and together constitute the most important part of the stalling plant in terms of technology and investment, as it is necessary to build roofs. In fact, unlike what observed in the local situation, the night-stalling is divided in the two spaces: the roofed is designed for greater comfort and protection of the animals, the unroofed to allow movement of the flock during long stays.

The pre-milking area does not require roofing and it is adjacent to the milking area, connected to the pasture.

Like the other areas of the farm, also the pasture is functionally characterized. It is a space which needs "to be planned" keeping in mind the rationalization of the routes and the necessity to implement specific equipment (roofs, drinking troughs, mangers, etc.). From the pasture the animals enter, systematically, the pre-milking area and only rarely the *night-stalling;* occasionally single animals or groups are led to the *health check-up*, which is near the stalling area, but preferably not directly connected to it, so as to guarantee isolation of the sick animals. However, it is advisable to locate it in a position where it can be reached by the animals returning from the pasture.

Different functional relationships among the described areas were identified, based on the research carried out, and are specified in the matrices of figure 5.

The animal and the employee routes which run between the different spaces aid in the definition of organizational layouts, that together with the indications on the technological system, constitute useful references for the proposal of specific building solutions, which respond to the prerequisites of environmental sustainability and economy; that is limiting both the initial investment and the running costs.

Three different organizational layouts for the summer base and three for the winter one are proposed in the present study.

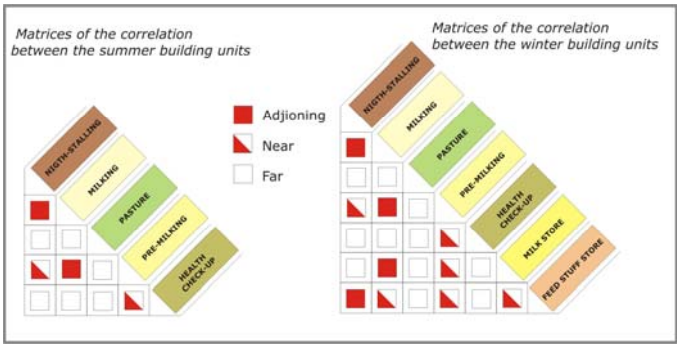

Figure 5: Matrices of correlation among the buildings in the summer and winter bases

The E_1 layout in figure 6, represents a solution for buildings with reduced visual impact. In fact, the fragmented building is an aspect which contributes to its integration in the landscape; articulated shapes both on a horizontal and vertical plane, responding to different functional areas inside the building, are usually less visible at a distance and more adaptable to the natural appearance of the land than compact shapes (Di Fazio, 1988) and (Di Fazio and Fichera, 1989). Furthermore, fragmentation of the building in several parts can mitigate the visual impact through the use of green areas in the interposed spaces (Piano, 1987).

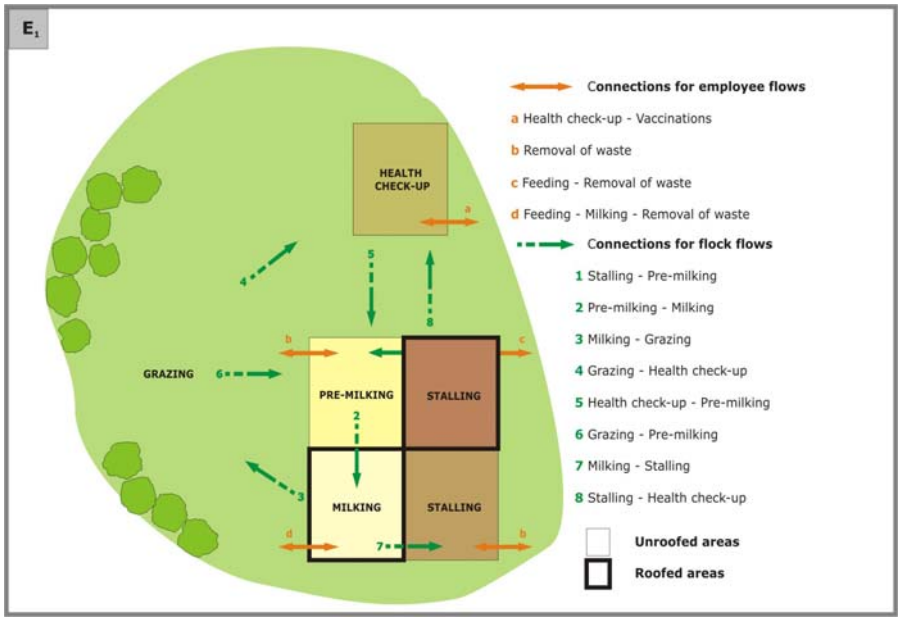

Figure 6: Summer base layout

Other factors contributing to a greater or smaller visual impact and a better environmental integration, such as materials, colours, height, position, structure, presence of trees etc., must be considered at the planning stage. The E_1 layout is characterized by the staggering of the roofed buildings and by the direct connection between the milking and the unroofed night-stalling area. Such a solution is particularly suitable for the summer climate.

The E_2 scheme (fig. 7) is characterized by the grouping of the roofed areas. It can be referred to as the construction of economical and easily assembled structures. The proximity of the unroofed stalling and the pre-milking areas allows the modification of the respective dimensions according to needs, using suitable panels.

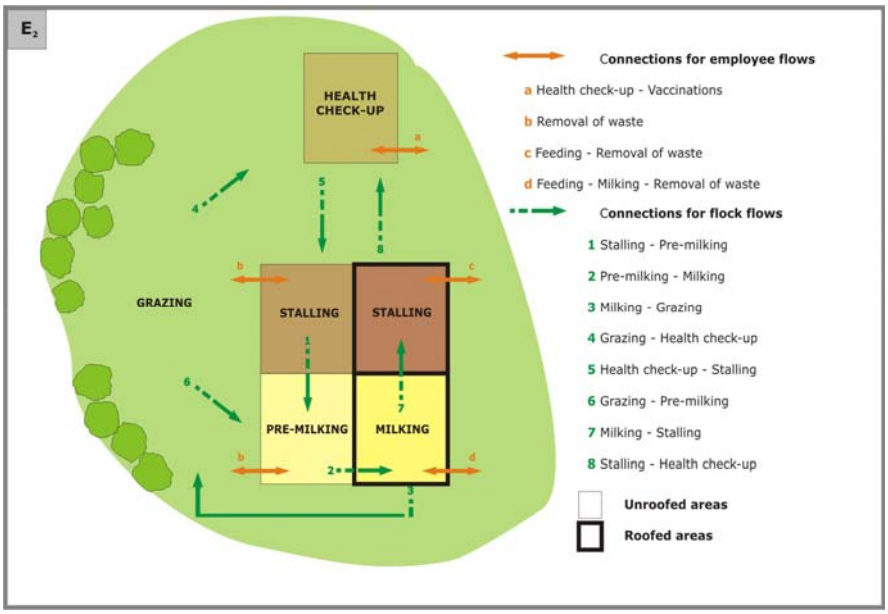

Figure 7: Summer base layout

The E_3 layout in figure 8 is the most compact; it has the health check-up area between the unroofed stalling and the pre-milking area; it is suitable for farms that have limited space for the construction of buildings.

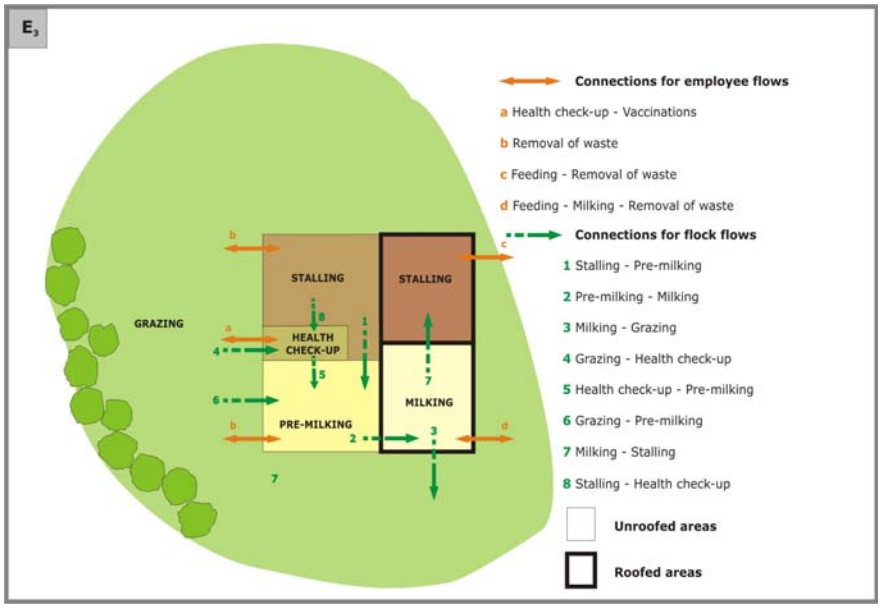

Figure 8: Summer base layout

In the winter base the flocks require greater protection from the elements, and therefore spend more time under cover. The employees have more tasks to perform related to the biological and reproductive cycles of the animals (oestrus in autumn and births in spring). The proposed functional schemes, though simplified according to the transhumant and extensive typology of the

breeding and to the standards set by the Park, is more complex in comparison to those of the summer base.

The I_1 layout (fig. 9) suggests the separation of the roofed areas to mitigate the visual impact and to allow the passage from the milking to the unroofed stalling area, guaranteeing good shelter.

The I_2 graph in figure 10 shows the grouping of all the roofed areas. The design reference requires accurate orientation to offer maximum shelter from the dominant winds, particularly annoying and harmful for the animals in the cold season.

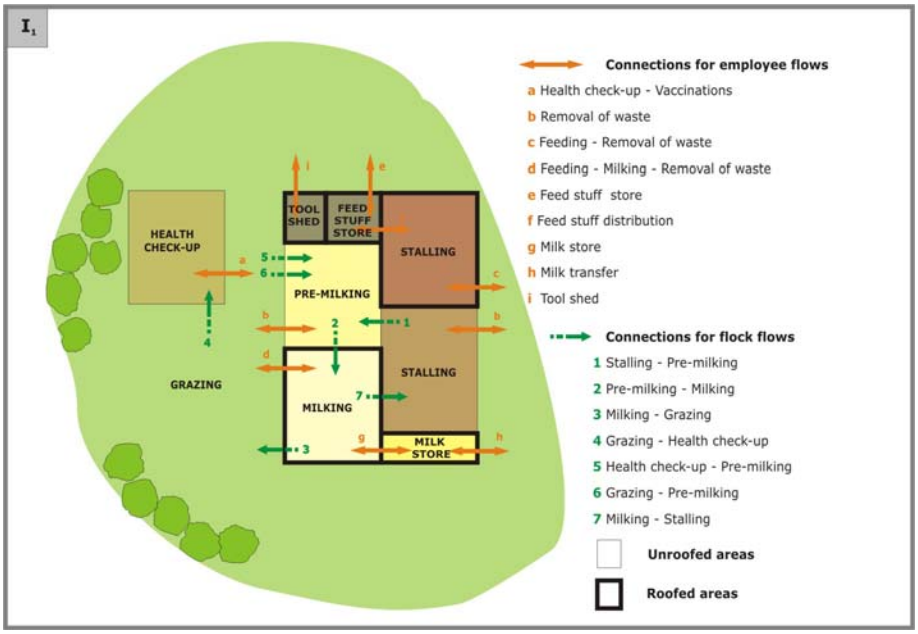

Figure 9: Winter base layout

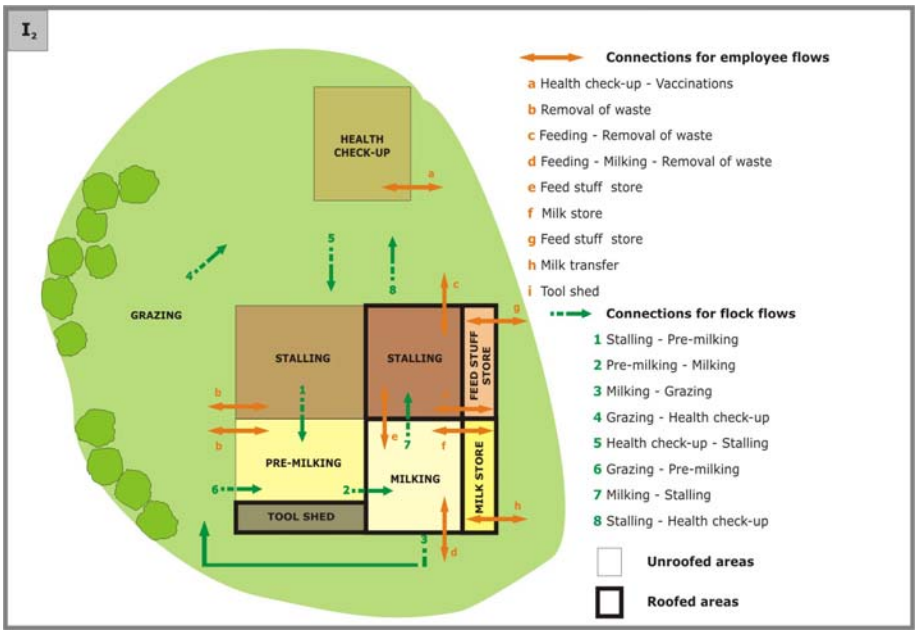

Figure 10: Winter base layout

In the I_3 layout (fig. 11) the roofed stalling and milking areas are annexed to those used as milk, tool and feedstuff stores. The health check-up area lies between the unroofed stalling and pre-milking areas. This scheme is valid because of the possibility to minimize the flock and employees' routes.

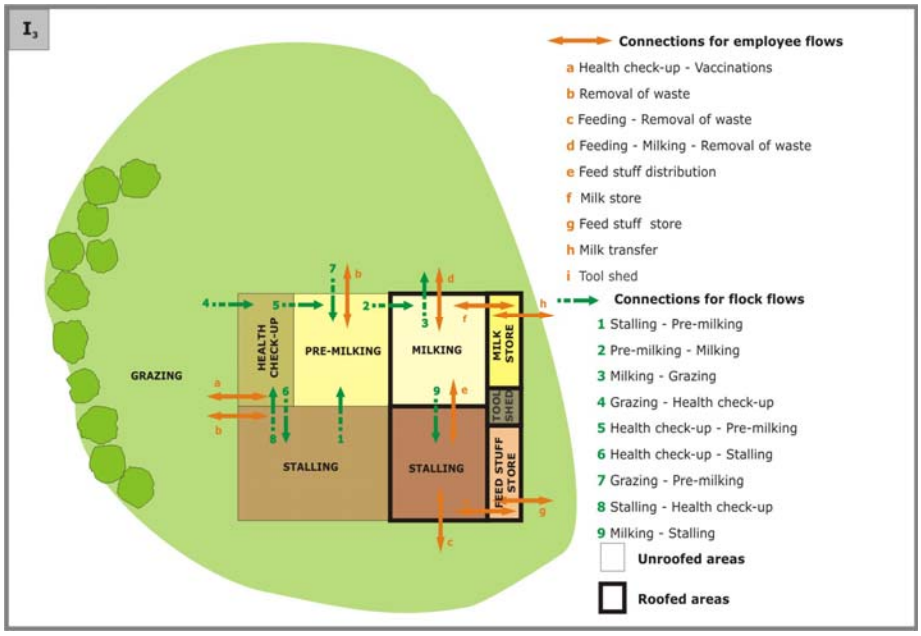

Figure 11: Winter base layout

Table 2: Identification of technical elements

Area		Horizontal elements	Vertical elements	Equipment
NIGHT-STALLING	roofed	Floors Roofing structures Horizontal partitions	Load-bearing structures Vertical partitions	Enclosures Mangers, racks
	unroofed	Floors	- - - - -	Enclosures Access systems Troughs
PRE-MILKING	unroofed	Floors in unroofed areas	- - - - -	Enclosures Access systems
MILKING	roofed	Floors Roofing structures Horizontal partitions	Load-bearing structures Vertical partitions	Access and retraint system Milking equipment Mangers
GRAZING	roofed	Roofing structures Horizontal partitions	Load-bearing structures	- - - - -
	unroofed	- - - - -	- - - - -	Enclosures Access systems Troughs
HEALTH CHECK-UP	unroofed	Floors in unroofed areas	- - - - -	Enclosures Access systems Washing ponds

Technological system

The technological elements necessary to create breeding farms complying with the defined environmental system are characterized by the need to minimize the impact of the buildings, to encourage the use of local materials and to employ the business manpower for their construction.

In table 2, the essential technical elements are specified, relative to each identified area, to guarantee the required environmental and functional conditions.

In particular, some structural elements and some partitions are necessary in the roofed areas (vertical and roof bearing structures, vertical and horizontal closing panels), while for all the areas it is advisable to have some restraining and connecting systems (enclosures, gates, etc.). It is useful to pay attention to floor systems which have to be simple but diversified in relationship to their function. The equipment is that essential to facilitate the feeding, the watering and the milking of the flocks.

Table 3 shows the minimum performances required to every technical element.

Table 3: Minimum performances of technical elements

	Elements	Performances
Structures and partitions	Vertical load-bearing structures	Resistance of all elements to permanent, accidental and seismic loads and wind actions Presence of connecting elements on the ground and between existing structures to facilitate assembly minimum height for employees and equipments Use of materials with low environmental impact
	Horizontal load-bearing structures	Resistance of all elements to permanent, accidental and seismic loads, wind and snow actions Presence of connecting elements between existing structures to facilitate implementation Use of materials and shapes with low environmental impact
	Vertical partitions	Closing elements protecting from atmospheric agents and wild animals - Presence of ventilation and use openings Presence of connecting elements on the ground and between existing structures to facilitate assembly and disassembly Use of materials and shapes with low environmental impact
	Horizontal partitions	Closing elements protecting from atmospheric agents Presence of ventilation openings - Presence of connecting elements and between existing structures to facilitate assembly and disassembly Use of materials and shapes with low environmental impact
	Floors in open areas	A sufficient surface per head Made of layers necessary for drainage and cleaning Suitable inclination
	Floors in roofed areas	A sufficient surface per head Made of layers necessary for drainage and cleaning, if in rest areas bedding must be added Suitable inclination
Equipment	Enclosures	Resistance of all elements to atmospheric agents and animal impact. Presence of connecting elements on the ground and between existing structures to facilitate assembly and disassembly. Board between adjoining vertical and horizontal elements suitable for animal regulation and protection. Minimum height 1 m Use of materials with low environmental impact
	Mangers and racks	Resistance of all elements to animal strain Presence of connecting elements between existing structures to facilitate assembly and disassembly suitable shape for animal feeding Use of materials with low environmental impact Shapes and materials suitable for cleaning purposes
	Troughs	Resistance of all elements to animal strain. Presence of connecting elements to facilitate assembly. Presence of elements suitable for adduction and removal of water Shapes suitable for watering the animals Use of materials with low environmental impact Shapes and materials suitable for cleaning purposes
	Access systems	Resistance of all elements to animal strain Presence of connecting elements between existing structures to facilitate assembly and disassembly. Shape suitable to facilitate animal movement Use of materials with low environmental impact Elements suitable to facilitate employees intervention
	Restraint systems	Resistance of all elements to animal strain Presence of connecting elements between existing structures to facilitate assembly and disassembly Shape suitable to facilitate animal restraint
	Milking equipment	Dismountable elements to permit transport and cleaning Elements in direct contact with milk must be provided with suitable protection to guarantee the hygienic safety of the product
	Washing tanks	Resistance of all elements to animal strain Presence of elements suitable for adduction and removal of water Use of materials with low environmental impact Shape suitable to facilitate animal use

In general, in all the buildings the materials must have low environmental impact. By that we mean all the aspects reducing the negative effects on the environment, especially regarding low energy in their production, shapes and colours selected in accordance with the landscape, re-use of discarded parts or their re-integration.

Table 4 shows the most suitable solutions for the different areas of the summer and winter bases.

Table 4 : Building proposals according to base location

Summer base building proposals

Area	Main function	Building proposals
NIGHT-STALLING	Night-time shelter	Canes, thatched, wooden, tiled roof
PRE-MILKING	Animal assembly	Enclosures made of chestnut posts, suckering products, thorny shrubs
MILKING	Animal and employee shelter Ease of milking	Canes, thatched, wooden, tiled roof Ramps, planks or pits for milkers
GRAZING	Solar radiation protection Wind protection	Canes or thatched sheds, windscreening hedges, trees
HEALTH CHECK-UP	Animal assembly	Enclosures made of chestnut posts

Winter base building proposals

Area	Main function	Building proposals
NIGHT-STALLING	Night-time shelter	Partially open stone or wooden buildings Tiled or wooden roof
PRE-MILKING	Animal assembly	Enclosures made of chestnut posts, suckering products, thorny shrubs
MILKING	Animal and employee shelter Ease of milking	Stone or wooden buildings with raised ramps and pits for milkers
GRAZING	Wind protection	Windscreening hedges, trees
HEALTH CHECK-UP	Animal assembly	Enclosures made of chestnut posts
FEED STUFF STORE	Food protection	Stone or wooden buildings Tiled or wooden roof
TOOL SHED	Tool protection and storage	Stone or wooden buildings Tiled or wooden roof
MILK STORE	Milk storage	Stone or wooden buildings Tiled or wooden roof

Areas subject to change Non changing areas

The shape of the roofing, in particular, has to be consistent to the local typologies and at the same time it has to allow for the outflow of rain and snow, in the winter bases situated at a high altitude. The floors have to possess layers necessary for the absorption and the outflow of the liquids (waste and rain), as well as, in the roofed areas, to the welfare of the animals. The containment and feeding equipment, also made of local materials, has to resist impact due to collision with animals. The drinking troughs have to be functional, but at the same time they must be environmentally friendly. The milking equipment has above all to be portable, washable and user-friendly. The static function of the parts is related to the necessity to withstand atmospheric agents and different climatic conditions, though it must respect of building typologies in compliance with the landscape standards imposed by the protected environment. The required seismic resistance is obtained by using a suitable constructive technique. Moreover these parts must have an extremely simple construction to facilitate assemblage and the possible removal.

The choice of materials is significantly linked to the requirements for building in protected environments, often on land which is in *civic use* or temporary lease, where it is not possible to build permanent structures. This constitutes a further reason for using available local materials (stone, wood, canes, etc.) and in any case natural materials.

Insofar, the best material is wood since it possesses a series of favourable characteristics such as high resistance to weight, durability if suitably treated. It is easy to handle using simple techniques and has low costs when choosing the right variety, possibly purchased after the planned thinning out of the woods. Wood is an excellent basic material to build enclosures, vertical and roofing structures, panelling structures and mangers.

Cane, easily found in various varieties along the water courses and woven according to traditional methods (wicker frames) or used to make roll-up mats (arelle), can be used for partitions or shelters. Cane has recently been tested as a filler of sandwich panels (K.U. Schwarz *et al.*, 2001) which can be used as walls and roofing due to their qualities of lightness, elasticity and insulating capacity.

The numerous thorny plants of the local flora can also be used as sunscreen roofing and enclosures.

The rough-hewn local stone is suitable to make enclosures, drinking troughs, mangers and vertical partitions of the shelters, when they are used on owned land.

Traditional clay tiles can be used for the roofing of fixed structures in compliance with the regulations of the Park.

On the base of the aforementioned considerations regarding the environmental and technological quality to be achieved on the breeding farms, it is possible to propose specific constructive solutions conforming to the identified performance system. Figure 12 shows the correspondence between some solutions, suitable for the protection of the stalling and milking areas, and action determined by climatic conditions.

The buildings with stone perimeter walls and clay tiled roofs meet the requirements in a durable and effective way, but require notable construction costs. The elements manufactured with organic materials offer lightness, practicality of assemblage and are cost-effective, though their durability and resistance to atmospheric agents are limited. The “green roof” guarantees the minimum environmental impact, but it requires particular constructive techniques. The metal roof, easy to erect, requires reduced slope and meets static functional requirements especially if it is made of insulated panels having the shape and colour used in the most traditional systems; but, considering the natural environment of the Park, it cannot be really proposed. Similar considerations can be made for the fibro-cement roofs that, however, are more fragile than the metal ones and require a tight supporting warping.

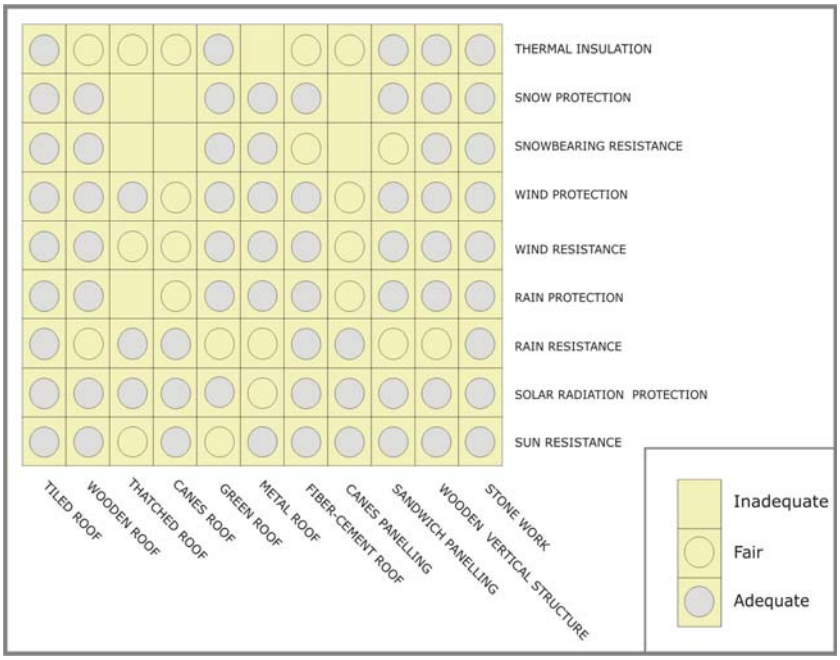

Figure 12: Relationships between constructive elements and static-functional performances

Conclusion

The analysis of the specific characteristics and the organizational and management modes of the sample farms within the Park of the Nebrodi together with the analysis of the cycle of the daily activities have identified the requirements of animals and workers and defined a business model which represents the situation studied. Thus it has been possible to elaborate reference rules for the planning of sheep and goat shelters in protected environments.

Homogeneous spaces (building units) characterized by dimensional, environmental and functional parameters, have been identified. Considering the breeding requirements in the two bases (summer and winter), such spaces have been correlated according to organizational layouts. They were considered as references for the planning favouring simplicity of layout and attention given to routes.

Six possible layouts have been illustrated, three for the summer base and three for the winter base, determining work conditions and technological characteristics. With reference to the latter, the specificity of the area and the necessity to use natural materials have been considered, proposing simple construction solutions which blend into the landscape.

The results of the research, aimed at the territory of the Park of the Nebrodi, can easily be extended to other protected areas presenting similar productive and environmental contexts.

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