

# AGRICULTURAL TERRACES IN THE SPANISH MOUNTAINS: AN ABANDONED LANDSCAPE AND A POTENTIAL RESOURCE

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## I. INTRODUCTION

Agricultural terraces are an essential part of the Spanish Mediterranean landscapes and of many mountain areas in the world: the Andes (Inbar & Llerena, 2000), the Himalayas (Gardner & Gerrard, 2003), the Asian monsoon region (Turkelboom *et al.*, 2008), the Near East (Ron, 1966), África (Winter-Nelson & Amegbeto, 1998) and the Mediterranean region (Rodríguez-Aizpeolea & Lasanta, 1992; Petanidou *et al.*, 2008; García-Ruiz & Lana-Renault, 2011).

In Spain, the first terraced fields dated from the second milenia B.C. (Asins, 2006); since then they have been continuously built until recently. Terraces were mostly cultivated during the XVIII and XIX centuries to compensate for the loss of incomes caused by the crisis of both the textile industry and the transhumance system (Gómez Urdañez, 1987; Arnaez *et al.*, 2011). During the XXth century, especially in the 70's, bench terraced fields were abandoned, triggering their progressive deterioration and shrub invasion with subsequent landscape homogeneity. However, terraced landscapes, which meet cultural and natural values, are a potential and interesting resource for the development of mountain areas. Within this framework the following question should be asked: what can be currently done with agricultural terraces? There are two alternatives: the first one is a non-intervention in the territory, letting

the terraces to deteriorate and, eventually, disappear; the second one is to maintain some of them. The purpose of this work is, based on bibliography, to give information about the functions that agricultural terraces had in the past and the ones they can fulfil in the future, provided they are can be maintained.

## **II. EXTENSION, LOCATION AND TYPES OF AGRICULTURAL TERRACES**

In the Mediterranean region, terraces were built to cultivate cereals and, to a lesser extent, vineyards and almond and olive trees. Their main function was to feed the great population who lived in the mountains (Rodríguez-Aizpeolea y Lasanta, 1992). Only such a reason can explain the large areas occupied by terraces, and the effort made by generations of peasants to create such an exceptional landscape. In the Sierra Tramuntana (Mallorca), terraces occupied 16.765 ha (72.3% of the cultivated area) (Grimalt & Blázquez, 1989); in the municipality of Vall d'Ebo (Alicante) they occupied 100% (705 ha) of the cultivated area (Rodríguez Aizpeolea, 1992) and in Petrer (also Alicante) they also occupied 100% of the cultivated area (Asins, 2009). A detailed research carried out in the central Pyrenees showed that in the western valleys, affected by Atlantic influence, sloping fields were dominant whereas in the eastern valleys, with a clear Mediterranean influence, bench terraces prevailed. In the central valleys (Tena and Ribera de Biescas), with a transition climate, the landscape was more complex, with the same proportion of both types of fields. Similarly, in the Iberian range, the Iregua valley (Camero Nuevo), which is in a transition area between Atlantic and Mediterranean influences, the proportion of bench terraces was much lower than in Camero Viejo (Leza, Jubera and Cidacos), without any Atlantic influence.

The typology of bench terraces depends on several factors such as the lithology, the distribution of the fields over the hillslope, the type of construction and the elements used for the management of the water (Pérez-Cueva, 1985; Asíns, 2009). Three main types of agricultural terraces can be identified. The most common type of terraced field includes a flat area delimited in the lower part by a vertical step. In the most perfect but also most expensive model such vertical step is made by a stone wall. In other models is made by a talus covered by shrubs or herbaceous vegetation or even fruit trees which help to maintain the soil. Sometimes the terraces have a slight slope gradient and are delimited by herbaceous vegetation or a wall made from stones removed from the field itself. In the central Pyrenees, Lasanta (1990, 1997) observed that terraced fields with a vegetated talus were predominant in the shady areas whereas the terraced fields delimited by stone walls were built in the sunny hillslopes. The terraces that needed more work investment were located close to the villages. The quality of the constructions decreased with the distance to the village and the quality of the soils. Finally, the wide and height of the terraces fields are related to the gradient of the hillslope. Thus, with steep slopes, terraces are narrow and with vertical step of several meters (Arnaéz et al., 1993).

## **III. IMPLICATIONS OF THE ABANDONMENT OF AGRICULTURAL TERRACES**

Many agricultural terraces have been abandoned since the middle of the XXth century. In the Iberian Range, only 5% are still cultivated, usually with almond or olive trees (Ruiz-Flaño et al., 2009). In the Maestrazgo (Castellón and Teruel) agricultural terraces represent

21% of the total area and more than 90% are nowadays abandoned (Ruecker *et al.*, 1998). In the Cárcavo basin (Murica) they occupied 39% and they are all abandoned (Lesschen *et al.*, 2008). In the Sierra Tramuntana, 28,5% of the terraced fields were already abandoned by 1979 (Grimalt & Blázquez, 1989).

When cultivation stops, new environmental dynamics occur: vegetation re-colonization on one side, and soil erosion on the other side. Nowadays most of the terraced hillslopes are affected by secondary succession with shrubs, which results in landscape homogeneity and a reduction of biodiversity (Jiménez Olivenza, 1989-90; Rodríguez Aizpeolea *et al.*, 1991; Tatoni *et al.*, 1994; Poyatos *et al.*, 2003; Gallego-Fernández *et al.*, 2004; Errea *et al.*, 2009). When the pressure of the cattle is sufficient, an herbaceous cover is well preserved. However, the decrease in the number of cows, the change from local to foreigner species, and the decrease in cattle surveillance make the animals to concentrate close the villages, resulting in the sub-utilization of the rest of the territory. In those areas, the quality of the pastures decreases and shrubs become dominant (Ascaso *et al.*, 1996; Lasanta, 2009), with the subsequent reduction of productivity, increase in forest fires (Vicente-Serrano *et al.*, 2000) and landscape degradation (Lasanta *et al.*, 2006). In most of the abandoned agricultural terraces, the main geomorphic process is wall collapse caused by small landslides, triggering important soil losses and a starting point for subsequent erosion processes (Lasanta *et al.*, 2001; Dunjó *et al.*, 2003; Arbelo *et al.*, 2006; Arnáez *et al.*, 2009). Other significant erosion processes are sheet wash erosion (Rodríguez Aizpeolea, *et al.*, 1991; Arnáez *et al.*, 1993; Cerdà, 1994), which favours stoniness, and, in the most degraded areas, incision processes such as gullies on the taluses. Soil erosion is strongly related to the modification of the topography made by the farmers. Terrace fields were built to favour infiltration and reduce soil erosion, but they required constant work for their conservation. When they are abandoned, the drainage systems loses its functionality, favouring soil saturation and natural processes which reconstruct the original profile of the slope (Lasanta *et al.*, 1996).

#### IV. POTENTIAL FUNCTIONS OF MOUNTAIN TERRACED LANDSCAPES

**Productive function.** In the past, agricultural terraces were built for food production. Despite of their abandonment, some of them are still cultivated, especially with fruit-trees orchards in Balearic Islands (Grimalt *et al.*, 1992), Levante (Asins, 2009) and Andalusian mountains (Rubio-Barquero *et al.*, 2010). Agricultural terraces can be used for high quality crops, which need manual and meticulous maintenance. They are suitable areas for ecological agriculture (Mander *et al.*, 1999) and reforestation. Research in Camero Viejo (La Rioja) showed that the enrooting and growth of reforested trees has been quite fast and has increased the heterogeneity of the landscape (Palacios-Cuesta, 2009). Agricultural terraces are also good areas for vineyards, which need deep soils for the roots to develop. Finally, agricultural terraces are an essential part of the grazing circuits of the extensive livestock; this strategy implies landscape fragmentation, with herbaceous areas associated to intensive grazing activity, and areas with shrubs, less visited by the cattle.

**Environmental function.** Agricultural terraces favour soil infiltration and control soil erosion against intense rainfalls. To achieve this, farmers divided the hillslopes in a succession of flat areas and vertical steps, changing entirely the original topography and soil distri-

bution. This system was completed by a complex superficial and subcortical drainage system (García-Ruiz y López Bermúdez, 2009) to avoid soil saturation. After the abandonment, terraces and the drainage system are not maintained anymore, favouring the development of saturated areas in the inner parts of the terraces and the occurrence of new erosion processes, which eventually leads to the loss of the most fertile soils in the mountain areas. On the other hand, the taluses between terraces which are covered by vegetation work as green veining, where animals and vegetation, depending on neighbouring agricultural practices, are preserved (Grashof-Bockan y Van Langevelde, 2004).

**Cultural function.** Moreira *et al.* (2006) include the agricultural terraces delimited by stone walls as one of the fourth most noticeable landscapes in the Mediterranean region. The cultural function of agricultural terraces is associated to the technique used for their construction. To face the hard conditions dictated by climate, altitude and slope, farmers had to develop strategies, using the available materials and natural resources. Many lessons can be withdrawn from this kind of past landscape. The objective of the stone walls was to increase infiltration and reduce soil erosion; they retain soil humidity, slight but continuous aeration, thermal inertia with temperature preservation and efficient drainage of the soils. Finally, the drainage system can inform about the technique and culture of the farmers who built them. For instance, in Camero Viejo, Pérez Carazo clearly makes a difference between the canals with an Arabic origin and those with a Christian origin.

**Aesthetic function.** The aesthetics and charm of rural landscapes made them a touristic resource (Bielza, 1999; Cánoves *et al.*, 2006). Biarge (2009) highlights the good evaluation tourists make of the terraced landscape of the Parque Nacional de Ordesa y Monte Perdido (Central Pyrenees), which becomes one of the main attractions of the park. Similarly, the agricultural terraces of Sierra Nevada (Penibetic System) are considered as one of the better evaluated landscapes due to their diversity and aesthetics (Jiménez Olivenza, 1989-90).

## V. INITIATIVES FOR THE CONSERVATION OF THE AGRICULTURAL TERRACES

The European Union included the agricultural terraced landscapes in the Rural Development Plan 2007-2013, in the Biodiversity for Agriculture Plan and in Thematic Strategy for Soils Protection. Besides, the UE supports Less Favoured Areas and Agricultural Areas with High Natural Value, which in many cases are represented by terraced fields. The priority objective of the Thematic Strategy for Soils Protection is the conservation and maintenance of terraced areas. *Mediterrinage* is a rural development UE initiative to optimize the use of agricultural terraces. Other UE initiatives are ALPTER (*Terraced Landscapes in the alpine arc*), PATTERN (to locate and describe the type and conservation state of agricultural terraces in Mallorca, Nica and Genova) and TERRISC, (to prevent natural risks associated with terraced hillslopes in Baleares, Canarias, Portugal and SW France).

Researchers agree that the maintenance of a landscape is only worthwhile if it fulfils a diversity of functions (e.g., Mathieu, 2006; Bertrand y Bertrand, 2006; Mata Olmo, 2007; Gómez-Moreno, 2008). Rural abandonment and its related consequences in terraced fields are difficult to avoid. However, we can give them one or several functions (productive, cultural, environmental...) in order to preserve them. The protection of agricultural terraces needs to involve local communities and local administrations because of the link between

landscape, tourism, agriculture and rural development (Pineda, 2007). There are already previous experiences on measures undertaken for terraced fields conservation, also and on the estimation of their costs, in Peru (Llerena *et al.*, 2004), India (Sharda y Dhyani, 2004) and the eastern part of Spain and Mallorca (Reynes, 2002). Because the measures are expensive and difficult, the public administration usually carries out the reconstruction projects. On the other hand, due to the great extension of terraced fields, those measures need to focus on specific topics and specific areas according to local interests (Romero-Martín *et al.*, 2004).

## **CONCLUSIONS**

Agricultural terraces occupy large areas in the Spanish mountains, especially in the Mediterranean region. For centuries they have kept a balance between the economy, the society and the environment. These issues are nowadays the basis for sustainable development (European Commission, 2004). Since several decades, this landscape tends, in most of the cases, to disappear. However, agricultural terraces are a “landscape-resource” with a high potential for sustainable development of many mountain areas. Because of their economic y ecological benefits, the preservation, restoration and reintegration of agricultural terraces in the mountain economy is a priority objective of public politics.

