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Evolution of Farming Systems in the Mediterranean High Mountain: The Case of the Alpujarra Alta (Spain)

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Abstract: In mountainous Mediterranean areas, even at high elevations, the landscapes are generally strongly transformed by humans. Agriculture is a key factor in this because, until very recent times, farming has been the main occupation of its inhabitants and has dominated their history and culture. This study examines the evolution of agroecosystems in the Alpujarra Alta (a set of mountain valleys and ravines, located in south-eastern Spain, within the Penibetic Range), from the Neolithic revolution and the Roman period until the present emphasizing the eight centuries under Muslim rule and the serious agrarian crisis induced by the expulsion of the Moorish from the area in the last third of the 16th century. This provoked profound transformations leading to the so-called “evolved farming system” in the early nineteenth century. This system continued until the middle of the twentieth century, when a massive rural exodus, prompted by the industrialization of the country, made farming unfeasible, triggering a phase of gradual system degradation. Finally, the current situation is discussed, resulting from the degradation of the established system as well as from new opportunities arising from the processes of endogenous local development induced in the area during the last quarter of a century.

Keywords: agrarian systems; high mountain; Alpujarra Alta; endogenous development; agrarian history; farming evolution

1. Introduction

Knowledge of the structure and possibilities of agrarian systems is key to endogenous rural development processes in general, and particularly in mountain regions. In Mediterranean mountain areas, farming systems have adapted to the recent rural exodus caused by the difficulty of mechanizing and modernizing farms, especially those on steep slopes with erosion and a harsh climate. These mountain farming systems have great territorial importance in countries such as Spain, where the harshest areas are occupied by them, these usually being the most difficult to be integrated into rural development processes. To determine their current situation and prospects is worth to analyse the history behind their current situation. This paper tries to present this evolution, examining the changes in the agrarian system of the Alpujarra Alta (High Alpujarra) of southeastern Spain.

The Penibetic system includes the Sierra Nevada range, where mountain valleys on the south-eastern side face the Mediterranean Sea. This area of mountain villages is called the Alpujarra. The areas closest to the coast, with an elevation of less than 600–700 masl (metres above sea level), are known as the Alpujarra Baja (Low Alpujarra), while the Alpujarra Alta (High Alpujarra) constitutes

the zones of higher elevation. Many villages on the southern slope of the Sierra Nevada and the north face of the coastal Penibetic range (Sierras de Lujar and Contraviesa), constitute the habitat of the Alpujarra Alta. The region has elevations that reach more than 3000 masl. with the Guadalfeo river valley between them, the present study refers to the area located between 700 and 1700 masl. where the agrarian system is basically located (See Figure 1). Numerous streams and gullies flow into the Guadalfeo, which is the water axis of the region. Some 70% of the Alpujarra Alta lies within the province of Granada while the rest belongs to the province of Almería.



Figure 1. Localization of the Area of the Alpujarra.

Although research abounds on the geography and socio-demographics traits of the Alpujarra Alta, fewer studies have examined its agricultural system. Works that address this subject from different approaches include: [1–23]. Many of these works resulted from research projects made between 1979 and 2013.

The present study provides an overview of the evolution and current state of the agricultural system of the Alpujarra Alta. Global figures and statistical information have been purposely omitted in order to simplify the presentation and focus on the characterization of the historical stages in the evolution of the system. Abundant statistical details concerning the agrarian system are available in the aforementioned works, particularly in [7,12,21–23]. After describing the historical aspects of the agrarian system, some final considerations on the possibilities and perspectives of the agriculture of the area in the twenty-first century, have been presented.

2. The Beginnings of the Alpujarra Alta Agrarian System: From Neolithic Times to the Roman Period

In the Alpujarra Alta, the agricultural revolution began in the Late Neolithic, around 3000 BC [1], where an itinerant agroforestry system, with fallow periods of between 5 and 10 years. The setting was a Mediterranean-type mountain with sparse trees, often mixed with thickets. The cultivated plants were basically winter cereals.

As a consequence of the demographic pressure and, possibly, of technological innovations introduced by colonizing peoples (Iberians, Phoenicians), this initial farming system gave way to an agro-pastoral system based on annual crops with biannual rotation of cereals and legumes on irrigated terraces. Primitive irrigation networks were established by slightly deviating natural water courses. Terraces were cultivated with perennial crops, basically grape vines, fig trees, and olive trees, as well as several types of fruit trees depending on the elevation. Crops were combined with livestock, particularly goats and sheep, as well as cattle to a much lesser extent. Domesticated animals were pastured in the wooded areas near the villages for much of the autumn, winter, and spring and herded in the summer to high-altitude pastures. Forage reserves had to be stored for winter because the snowy climate limited grazing. These reserves were generally based on straw, cereals and legumes, complemented with the yield of certain trees used for wood (like oak or chestnut). In this farming system, the spreading of harvest debris and livestock manure helped to maintain soil fertility [18].

The transition of the Neolithic itinerant agroforestry system to the agro-livestock system took place at about the time the Romans took over the Iberian Peninsula, just before the beginning of the Christian era (throughout the second half of the first millennium BC). At this time, farms became larger, often operated with slave labor.

Under Visigoth domination starting in the fifth century AD, the Roman agricultural system and its structures remained practically unchanged. This system will be maintained until the Muslim conquest of the Alpujarra Alta in the eighth century.

3. The Decisive Arab Influence

With the occupation by the Arabs in the eighth century began a slow but profound transformation of the farming system, which stabilized by the end of the twelfth century. Even by the middle of the 10th century, written sources (see [24]) mention the predominance of irrigated agriculture with a great diversity of crop species. A twelfth century description in the Treaty of AL-ZUHRI (see [25]) refers to the Alpujarra Alta, stating that *“on the highest peaks of these mountains the plants hardly grow, and the animals cannot live, but their slopes are dotted with crowds of very close villages where irrigated land predominates with a great abundance of plants and fruits”*. This indicates an established agricultural system transformed with respect to the previous stage. The transformation involved the following changes:

- *Complex development of irrigation* with new water-management techniques replaced the natural location of irrigation points of the Roman period and the advent of large systems of water channels, whose layout to some extent still exists today.
- *New settlers*, mostly of Berber and some of Arab origin, not only brought institutional changes in cultural patterns, social relations and administration, but also provided new farming skills and cultivation techniques.
- *The introduction of new crops*, particularly horticultural ones, included more than 30 different species that have been documented in the area, some preexisting in the zone, or other zones of Al-Andalus, and others introduced by the new settlers. Crops included vegetables, pear, apple, peach and pomegranate. [26] posited that most of the irrigated plants brought by the Arabs from the East had already been adapted to Al-Andalus by the tenth century. In fact, crops such as eggplant, watermelon, certain types of cucumber, banana, orange, lemon, rice, sugar cane and cotton are mentioned as early as the ninth century.

- *The emergence of the silk industry* introduced mulberry trees and the development of a local industry. [24], based on the information of the Habices Books of the Alpujarra municipalities (The books of habices were books that recorded the goods (usually lands, houses and plantations but also mills, ovens, stables, etc.) that the Muslim faithful donated, in property or in usufruct, to the mosques in the towns of Muslim Spain. In Arabic, these goods and rights were called waqf (plural awqaf) and in Maghreb Berber they were called habis, giving the Spanish name of habices. The books of habices began with a description of the zone, its cultures, and its agrarian and agroindustrial infrastructures. After the Christian conquest, in 1506, these funds were distributed among the Christian churches. Subsequently, in 1572 the habices, along with other properties expropriated or purchased from the Moors who left the country, were described in the so-called Books of Apeos. Both the Book of Habits and the later Books of Apeos that have been preserved are often a valuable source of information concerning fifteenth and sixteenth century agriculture of this area), estimated that 75% of the trees in the area at the end of the fifteenth century were mulberry for silkworm rearing, reflecting the importance of this industry during the Moorish period. The Almerian agronomist Ibn Luyun at the beginning of the fourteenth century claimed, perhaps with exaggeration, that the Alpujarra was the region that produced the most silk in the world and therefore was called *land of twisted silk (Tierra del sirgo)* [27].
- *Increase in the surface area cultivated* resulted from the development of irrigation. Not only were old dry lands from the Roman era transformed by irrigation, but new lands not previously cultivated, often by crossing hillsides, sometimes with steep slopes, were farmed.
- *Increase in the distance of transhumance* boosted the development of livestock, particularly sheep, the most abundant domestic animal at this time. Sedentary family livestock (cattle, sheep, goats) raised on the farm (providing manure and taking advantage of forage crops), coexisted with livestock that was herded to summer pastures at high elevations. In any case, despite their importance, livestock animals were always less abundant than might be expected in such a mountainous area. The Alpujarra in the Arabs period and later depended more on cultivation than on livestock raising.

These changes led to the modification of the high-elevation agropastoralist system (800–1500 masl) characteristic of the previous period. The new system was characterized by an irrigated polyculture system without fallow periods. Crops included cereals, legumes, horticultural crops for human food and fodder, with perennial plantations generally on the edges of work plots, terraces, and a number of tree species, usually on the banks of streams torrents (The books of habices analysed in [24] mention, in addition to the mulberry tree, the olive tree (15% of the trees), chestnut, fig, cherry, almond, apricots, pear trees, apple trees, plums and grapevine).

4. The Impact That the Expulsion of the Moriscos Exerted on the Agrarian System

The agrarian system resulting from these changes remained relatively stable for almost five centuries, until 1570, when the Moriscos (The term “Morisco” refers to the Muslim population that continued to live in Spain, after the defeat, the definitive Christian victory in 1492 whether they converted to Christianity or not. The Moriscos were definitively expelled from Spain in 1610, but from some territories, such as the Alpujarra, four decades before, due to the uprisings of the Morisco population) were expelled from the Alpujarra. This started a slow change that lasted until the beginning of the nineteenth century, which marked the beginning of what we will call the *evolved system* of agricultural production in Alpujarra. The facts that define this evolution chronologically are the following:

- *The uneven land distribution among the new settlers*, coming mainly from Galicia, Andalusia, Castile and Asturias, led in some cases to farms that were too small to prosper. Only farmland was given to the new settlers because the pastures and the mountain areas of the Upper Alpujarra remained under the direct administration of the Spanish Crown. The aim was to maintain

irrigated agriculture in the Alpujarra similar to that existing in the Moorish period. For this, the Spanish administration, in exceptional cases, did not expel some Morisco families who knew how to manage the complex irrigation system and were expected to transfer this knowledge to the new settlers.

- *The decline of the silk industry*, which began to have market problems at the end of the sixteenth century, was aggravated by the expulsion of Muslim artisans and Jewish merchants. In the seventeenth and eighteenth centuries, strong competition in silk production arose in other areas such as eastern Spain (Murcia, Valencia), and Italy. However, even in the first half of the nineteenth century, some villages in the area still produced “mulberry silk”, in fact [28] (volume 2, p. 200) in a general description of agriculture of the Alpujarra still includes silk among the agro-industrial products of the area, after oil, wine, almonds, and locally cured ham.
- *New crops* such as corn and potatoes from America, grew in economic importance in the area.
- *The partial failure of the repopulation policy*, especially for establishing farming families, resulted because many new settlers soon left the land, disenchanted by the colonization conditions imposed. Thus, the number of families working the land in the Alpujarra plummeted to less than one tenth between 1565 and 1590 as a direct result of the expulsion of the Moriscos.
- *A decrease in irrigated land* followed the population decline, with the consequent abandonment of part of traditional irrigation networks. This decrease was exacerbated by a boom in the livestock farms, above all herded sheep, which were more familiar to most new settlers than were irrigated crops. With the livestock farm, dry-cereal-fallow-pasture crops developed.

5. The Evolved Agrarian System

Throughout the second half of the eighteenth century, and more clearly in the nineteenth, there is an evolution that led to what we have called the “evolved agrarian system” of the Alpujarra Alta. The fundamental force driving this transformation was the population growth that took place in these centuries, slowly returning to population levels reached prior to the expulsion of the Moriscos. This demographic increase was due to natural population growth and strong immigration. In the second half of the nineteenth century the region reached the highest population density of its history, reaching, for the overall Alpujarras, almost 60 inhabitants/km, much higher than the current density.

This robust demographic increase placed pressure on the land with the consequent expansion of the irrigated area, which included cultivation on terraces and on the large slopes on the periphery of the *vegas* traditionally under cultivation (*vega* in Spanish means the cultivated area normally near a river). This required restructuring and expansion of the networks of irrigation ditches, recovering some that had been abandoned in the previous stage. Likewise, the “high-elevation irrigation” began in summer grazing areas (above 1500 masl) apt for irrigation and with the best soils and sun exposure: barley, rye and potatoes were the most frequent crops. The potato expanded greatly after 1939, as a consequence of the hunger during the Spanish civil war and afterwards. Some of the areas of winter pastures closest to the villages were also under rainfed cultivation, sometimes cereals but also vineyards.

The crops that characterized the new agrarian system were:

- *Irrigated crops*: In the vegas and orchards: winter and summer cereals, table vegetables, legumes, potatoes and fruit trees. From the beginning of the nineteenth century, the bean was introduced into the area, which became widely associated with the cultivation of maize. High-elevation irrigation: was used generally for barley, rye and potato.
- *Rainfed crops*: Cereals (not very frequent), grapevine, fig tree and almond tree.
- *Livestock*: Livestock associated with agriculture (sheep, goats, a few cattle and family pigs) coexisted with herding, mainly sheep. Livestock became abundant, with small ruminants being the most common, although milk was never used at the industrial scale. Family cheese was made by the shepherds, some artisan types still being available up to 30 years ago.

This agrarian system, in its evolutive phase was described in 1776 by [29,30], when dealing with agriculture in the different Alpujarra municipalities. The descriptions emphasize mulberry trees for silk, and a local silk industry in crisis but still vigorous. However, the descriptions of [28] in 1846 reveal that by the mid-nineteenth century, in the Alpujarra the mulberry trees still existed but was in clear decline.

The appearance of the fungus phylloxera in 1884 almost completely destroyed grape cultivation, this being one of the crops that had developed most in the area since the seventeenth century. The crop slowly recovered with the introduction of new rootstocks resistant to the disease, and the recovery of native varieties, such as Vigeriega, which showed resistance. It took almost a century for this recovery to reach the cultivation levels of the nineteenth century.

The most curious characteristic of the evolved agrarian system was that it became more of a Mediterranean diversified agriculture than a traditional mountain agriculture [6]. This occurred under certain climatic limitations. The inhabitants of the Alpujarra, even those of its highest areas, were never mountain people, but rather Mediterranean farmers inhabiting and cultivating the mountain. As [6] pointed out, the Alpujarra has always been a “Cordillera de Campesinos” (Peasant Mountain Range).

From this system, and in some way through its degradation, agriculture was formed in the second half of the twentieth century and some of its features can still be seen today in the area.

6. The Beginning of the Degradation of the System: from the Rural Exodus until the End of the Twentieth Century

The system described above persisted, with slight changes, in the Alpujarra Alta until the rural exodus in the mid-twentieth century. At this time, the industrialization of the country caused a strong demand for labor to urban areas, degrading the system primarily due to the sharp reduction of the population and thus the workforce. The characteristics of this degradation included:

- *Abandonment of agriculture* in part of the land previously cultivated, due to lack of population.
- *Decline of the mountain livestock*: decrease of summer grazing in the areas of higher elevation and the disappearance of livestock herded by salaried herders seeking winter grazing on the coastal mountains (As an extreme example of this, the Barranco de Poqueira, one of the most representative ravines of the Alpujarra Alta, in 1975 had more than 15,000 head of sheep distributed among 14 large herds (apart from isolated animals and very small herds), while 20 years later only 3109 head were owned by 27 farmers, indicating that large flocks herded by salaried herders were replaced by small family flocks).
- *Decline of the polyculture of the Vegas and orchards*: At the beginning of the rural exodus, the average size of an irrigated farm in the Alpujarra Alta was 5 *obradas* (equivalent to 1.5 ha), a size clearly insufficient for survival. The rural exodus increased this average size, since part of the abandoned lands went to increase the farms that remained active, doubling their average surface area in 20 years. However, a technical limitation was the impossibility of mechanizing or of employing more labor, preventing the farms from further increasing their size.
- *The entry of the fragile agricultural system of the area into a market economy*: The increasingly globalized market hastened the decline of the system. The polyculture of vega associated with livestock barely covered, even with a huge workforce use, the nutritional needs of families in the first decades of the second half of the twentieth century.
- *The disappearance of activities that traditionally provided complementary income to agriculture*, such as mowing and harvesting outside the region, also contributed to the degradation of the agrarian system. The mechanization of agriculture on the extensive Spanish plains after 1950 reduced the possibilities of peasants from Alpujarra to work outside during the harvest as traditional sources of complementary income for the inhabitants of the area. Specifically, farmers from the Alpujarra Alta travelled to the basins and plateaus of the Intrabetic Trough, often to the Guadix and Baza Basins.

- *The closure of certain mines, once abundant in the area, and the completion of some hydroelectric works that had occupied a significant part of the workforce, also contributed to the rural exodus and further degradation of the system.*

All this occurred between 1950 and 1975. The special intensity of the rural exodus in the Alpujarra caused an average annual population decrease of 3.7% over the period 1960–1975 [7]. This depopulation rate, although not as acute as in areas of the Castilla-León region, for example, was the largest of all the areas of southern Spain.

However, from the start of the degradation of the “evolved agrarian system” in the Alpujarra Alta, until the beginning of the 1990s, attempts were made with variable success to alleviate the crisis. Thus, initial modernization projects of livestock and horticultural seed production taking advantage of the cold climate, were followed by later attempts such as the cultivation of saffron, the development of industrial pork from the preexisting traditional ham production, the cultivation of raspberry in the 1980s (with the introduction of the variety Zeva, adapted to the area, in small irrigated farms of Cádiz and later high-elevation villages such as Yegen, Bérchules, or Mecina Bombarón [13], semi-industrial artisan manufacture of cheeses [31], cooperative wine production [32,33] and some pioneering attempts of organic farming.

Despite these attempts, the crisis of the agrarian system threatened the very existence of the farms. The situation, in this sense, became critical. Thus, in a detailed follow-up on 83 farms of the Alpujarra Alta, of all types and dimensions (see [7] to see the different types and sizes of farms in the area in 1981, and the conformation of the sample), [19] analyzed their progress between 1981 and 1991. These authors showed that, at the beginning of the 1980s, 84.3% of these farms had a high rate of marginalization, so that they even paid the family workforce at current prices of the agricultural labor market. Not even valuing self-consumption as a product sold, one out of every four farms managed to properly remunerate family labor. This did not include benefits for amortization or reinvestment of capital, since only one farm in 10 produced surpluses to amortize their equipment. A decade later, in 1991, of the previous 83 farms, only 49 remained functioning as such, in the sense of ongoing commercial production, the rest having ceased activity, mostly by fragmentation through inheritance, or by sale with subsequent aggregation or abandonment.

It bears highlighting the relationship found in the previous study between the persistence of the farm, its larger size (scale effect in persistence), the higher earnings for family work in 1981, or starting part-time farming at any time within the period considered, with accomplishment of multiactivity, alternating agricultural tasks with non-farming activities within the family. These appear to be key factors of persistence, and of resisting the marginalization of farms at the beginning of the 1990s.

The crisis of agriculture mentioned above was manifested with different spatial patterns of farms regression within the region, particularly critical in certain places (For example, [14] described the almost total abandonment of agriculture against tourism in the Barranco de Poqueira area during the 1980s, while in other areas of the Alpujarra Alta a certain level of agrarian activity was maintained. These authors also analysed the effects of this abandonment from both socio-economic and environmental standpoints). Likewise, this crisis was reflected in the relative fall in the level of farmers’ welfare. Studies have reported that the level of well-being of full-time farmers (measured in terms of possession of certain goods and acquisition of services), in 1981, was much lower than for the active rural population working of non-agricultural activities [8]. This difference was found to be even greater a decade later, although total and exclusive dedication to farming was already rare.

The agricultural crisis also influenced both the local socio-cultural and the ecological systems. On the one hand, active agricultural heritage was considerably lost, and on the other the social valuation of agriculture has changed profoundly since the beginning of the rural exodus. That is, in 1981, professions such as a farming or shepherding were much less valued by the population itself than were others such as a construction, restaurant work, or mail service [8]. This assessment was detected again, even more acutely, 10 years later, in 1991.

With regard to the ecological system, the abandonment of cultivation also degrades the physical environment. Abandoned terraces with dense thickets increase fire risk, the moisture budget of valleys changes degrading the rustic attractiveness of the area. With all this, according to our analysis, by far the most serious impact of the abandonment of agriculture is greater water erosion mitigated for centuries by the complex system of water channels well adapted to the terrain serving the cultivation of the slopes. The effects soon became noticeable in catastrophes (e.g., landslides, massive erosion, road cuts) caused by rains, such as those at the end of 1996. The authors of [11,14–17], among others, have commented on the effects that agricultural abandonment has exerted on the environment of the Alpujarra Alta.

In 1991, the European Rural Development Program LEADER I started in the Alpujarra (The LEADER programme is an acronym in French—Liaison entre actions de développement de l'économie rurale—meaning Links between actions for the development of the rural economy. It is a European Union initiative to support rural development projects initiated at the local level in order to revitalise rural areas and create jobs). While not admitting investment projects in agricultural activities, it co-finances agro-food transformation projects. From the beginning, the LEADER had a clear bias, in the case of the Alpujarra Alta, to finance recreational activities linked to rural tourism. Although, it should be noted that in the LEADER II Program (1995–1999) 30% of public money was allocated to support agro-food processing and industrialization projects.

For the following decade (1991–2001), [34] reported that of the 49 farms that survived in 1991, 40 persisted in 2001. Whereas in the 1980s, 42% of the farms considered had stopped their activity, in the 1990s the figure was only 18%. In this period, two variables were clearly related to the persistence of farms: the practice of part-time farming (PTF), and of agrarian marketing associations. The influence of the dimensional scale effect proved less determinant in the survival of the farm than in the previous decade, which is partly to be expected because of the greater influence of PTF.

At the beginning of the twenty-first century, the abandonment of farming greatly slowed down for the following reasons:

- The farms that survived in 1991, were the most resistant, and the level of marginalization was lower.
- The area underwent the strong development of activities economically more profitable than agriculture, basically related to tourism and services in general, partly as a consequence of the performance of the LEADER Programs. This development helped to revitalize certain artisanal activities, especially textiles and ceramics, but also agro-food, and it greatly stimulated construction, but often without proper controls. This created many opportunities for part-time farming, with multiple activities in the family, which has to some extent maintained farms that otherwise might have disappeared. While the full-time farming exceeded 40% in 1991, in 2001 this figure fell by half.
- LEADER programs induced in the area institutional innovations linked with associations and social partnerships. This fact triggered a certain development of agrarian marketing associations, which prior to 1990 had been scarce in the area.

As [34] concluded, when dealing with the phenomenon of the abandonment of farming in the decade 1991–2001: The European Rural Development Programs, which are favoring above all the creation of extra-agrarian jobs, do not induce, as in principle it could be thought, a greater abandonment of the agrarian activity, but on the contrary a certain slowing down of it and a greater permanence in part-time farming. The level of diversity of activities is high and their dynamics are growing.

7. The Agrarian System in the Twenty-First Century

Currently, the Rural Development (RD) programs of the European Union have continued to operate in the Alpujarra region, supporting activities in the secondary and tertiary sectors. On the one hand, these activities are more attractive to new generations than the always hard work of local

farming, but on the other hand they bolster opportunities to combine part-time farming with multiple activities in the family setting. The agrarian system that had been in crisis in the previous era finds possibilities of change in the current situation, clearly towards greater profitability, based partly on the following:

- The greater possibilities of part-time farming discussed above.
- *The agro-food transformation and industrialization projects* partially financed by the European RD Programs have provided new opportunities for added value on certain agricultural products.
- *The increase in establishing marketing associations*, as a result of social changes and the local “institutional architecture” induced by RD processes, boosts the value of local agricultural production and its access to markets.
- *Changes in consumer demand for local artisanal and ecological foods and other local products*. This opens business opportunities for agricultural products in the area. The development of organic farming, which was already incipient in the 1990s, is now well established in the region. For about three years the Commonwealth of Municipalities of the Alpujarra of Granada province (Comunidad de Municipios de La Alpujarra Granadina), together with the Alpujarra Food Association (Asociación Alimentaria de la Alpujarra), clearly support this type of agriculture.
- A large part of the Alpujarra Alta lies within the *Sierra Nevada Natural Park* an environmental protection figure established in July 1989, and later within the *Sierra Nevada National Park* (The National Park has the highest environmental protection in Spain, under the declaration of the Spanish state. There are currently 15 National Parks that cover 0.7 % of Spanish territory, the largest being the Sierra Nevada, which includes part of the Alpujarra. The Natural Park has the strongest regional environmental protection, under the declaration of the Andalusian regional government), constituted in January 1999. This situation, though involving some minor restrictions for certain forms of agriculture and livestock breeding, which could not always be compatible with environmental protection, nevertheless presents the advantage that marketing strategy can be used for local food products by using the distinction of quality and origin related to a national park. Local farmers could use the geographical name to elicit a willingness-to-pay from food consumers.
- *The increase in the local food demand*, both by the population itself and by the many tourists visiting the region, represents a niche market, practically captive, for local agricultural products.
- *The development of New Information and Communication Technologies* in the area help mitigate the distance of the markets from population centers, facilitating commercial development of local agricultural production.

In addition to all the above, in the last two decades, key policies have been enacted to foment agrarian multifunctionality. From being considered an activity of little interest for local development, fostered by the first endogenous local development programs, [35], agriculture have been valued not only for their primary productive function but also for others: ecological, aesthetic and recreational (see [36–38], for details on agrarian multifunctionality and their consideration in public policies). Thus, policies have been designed to internalize the non-commercial functions of agriculture, through specific grants and subsidies that to some extent remunerate the farmers who carry them out. This foments the possibility of maintaining the Alpujarra Alta agro-ecosystem. As examples of the importance of these functions in the area, we offer the following considerations:

- The Alpujarra Alta has been strongly altered by humans, and, despite its altitude, the agrarian system covers a large portion of its surface area. The disappearance or decline of agriculture could be ecologically catastrophic. No decisions should be made concerning agriculture considering exclusively its financial profitability, but including other functions of an environmental, territorial and sociocultural nature that must be considered.

- Related to the above, the disappearance of the irrigation in high-elevation areas, and the subsequent neglect of the channels, has caused the snowmelt water to flow through natural channels, with the consequent flooding and destruction of pathways and roads, resulting in a high cost of repairs that would have been avoided by helping to maintain this type of agriculture.
- As shown by [39,40], the landscape of polyculture irrigation in orchards or terraces is, by far, the component of the Alpujarra Alta landscape most valued by visitors to the area, in such a way that the decrease in this type of agriculture, would undoubtedly affect tourism in the area, which is currently its fastest growing economic activity. Decisions that may affect the agrarian system should take such synergy into account.
- The extremely complex network of mixed irrigation channels and drainage ditches, where the system of stepped networks of channels and reinforcement, operating for a millennium, is a rare example of culture and water management, which properly valued, could become a factor of territorial competitiveness for tourism.

In terms of production, a viable and sustainable farming system for the Alpujarra Alta should be promoted. This productive system could include, among other products, olive oil with a certain management to improve quality, including organic production (particularly in the eastern Alpujarra Alta) (The olive tree is frequently used as a border element for horticultural crops, although there are also small orchards. The current average yearly production of the region ranges around one million liters of olive oil, which exceeds local consumption and tourism demand. When the olive harvest is higher, the quality of the oil obtained decreases considerably, because the small milling capacity forces the olive to be stored before being pressed, and the olive fruit lose quality during storage. When yield is lower, the olives are milled shortly after harvest and the quality is usually excellent. In addition, the oil is from the highest-altitude olive trees in the Iberian Peninsula. A strategy aimed at shortening the time between picking and milling the olives could provide a high-quality oil every year). Horticultural crops, with priority to organic horticulture, could include the development of small fruits such as strawberry, raspberry, blueberry, and redcurrant; various stone fruit for local consumption and tourist demand; sheep and goat farming; cheese making; pig breeding; honey production; and walnut and chestnut production. The cattle of the native Pajuna breed for meat could have a certain value for its quality and many gastronomic possibilities. The fig orchards should also be encouraged given the quality of local figs and their market demand. The maintenance and expansion of vineyards and the almond trees would be advisable to produce local wines and spirits and for manufacturing sweets and artisan pastries, respectively. Forest use, maintenance, and conservation should be regulated for sustainability.

Despite these possibilities of reversing the crisis of the Alpujarra Alta agrarian system in a context of increased farm profitability and sustainability, the crisis has also led to the emergence of some agrarian activities that offer high levels of income and employment, but that can deteriorate the ecosystem. Such is the case of greenhouses under plastic or under mesh, found massively along the Mediterranean coastline but nonexistent previously in the Alpujarra. This type of agriculture has a negative impact on the environment as well as on the aesthetic value of the landscape. Although prohibited, and even under sanctions in the zone of the Natural Park, this type of superintensive system are being implemented in some areas of the region because of their high profitability.

Finally, we should comment on certain actions to be taken which are basically the responsibility of the public sector and which should complement any attempt to improve the agrarian system of the area. These include:

- Promoting the improvement of the structure of farms.
- Improving the infrastructure, particularly roads and access routes to farms.
- Promoting farmer associations.
- Acting towards the internalization, where appropriate, of the aforementioned positive externalities of the agrarian systems.

- Designing and taking specific measures for maintaining, and, where appropriate, rehabilitating and readapting the networks of old water channels, and their value for heritage and tourism.
- Implementing measures that support and promote greater added value of local products, whether based on quality, origin, sustainable production system or industrial transformation.
- Fomenting the social revaluation of agriculture and farming professions in the local cultural system.
- Implementing, at the local level, an efficient model of in situ agricultural experimentation of a systemic and participatory nature, appropriately connected with regional and national research and development centers.

A special plan for the recovery and modernization, over the medium to long term, of the Alpujarra agrarian system is now imperative to ensure the endogenous, integral and sustainable development of the area. This plan, an essential complement to other institutional actions currently under way, should be based on the elements listed above, which would encompass the different programs and projects.

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