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Analysis

Beyond food production: Ecosystem services provided by home gardens. A case study in Vall Fosca, Catalan Pyrenees, Northeastern Spain

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ABSTRACT

Interest in ecosystem services provided by agroecosystems has grown over the last decades with research focusing on the type of environmental, economic and social benefits delivered by agroecosystems. Researchers suggest that, besides the provisioning of food, fuel, and fiber, agroecosystems provide habitat, cultural, and regulating services. One type of agroecosystem that remains relatively unexplored from an ecosystem service perspective is home gardens. In this paper, we aim at advancing the understanding of the value of home gardens by conducting an assessment of home gardens ecosystem services. For the empirical analysis we use home gardens in Vall Fosca (Catalan Pyrenees). We identify and characterize the most important ecosystem services provided by home gardens, and conduct a valuation of the social importance of home garden ecosystem services. The methodological approach for this work included an in-depth literature review, participant observation, semi-structured interviews, a valuation questionnaire, and a scientific panel consultation. We identified and characterized 19 ecosystem functions and related services. According to our informants, home gardens provide a large set of ecosystem services, being cultural services the category most valued. We found that the most important ecosystem services provided by home gardens differ from those provided by other types of agroecosystems.

1. Introduction

The ecosystem service approach portrays natural ecosystems as stocks of natural capital that provide flows of benefits for human well-being (Costanza and Daly, 1992). Such benefits span from tangible goods like wood, clean water, or agricultural products to non-material benefits like landscapes' aesthetic features, climate regulation, and maintenance of soil fertility (Daily, 1997; de Groot et al., 2002; Kumar, 2010; MA, 2003). Besides natural ecosystems (e.g. unconverted forests and wetlands), converted ecosystems (e.g. pastures and croplands) can also play a critical role in the delivery of global ecosystem services (Bjorklund et al., 1999; Porter, 2003). Furthermore, since converted ecosystems account for 24% to 38% of the Earth's land area (Swinton et al., 2007), it is not surprising that international initiatives endorsing the ecosystem service approach, such as the Millennium Ecosystem Assessment (MA) and The Economics of Ecosystems and Biodiversity (TEEB), recognize cultivated farmlands, or agroecosystems, as a distinct kind of service-providing ecosystem (Kumar, 2010; MA, 2003; Power, 2010).

Ecosystem service research suggests that the social benefits that agroecosystems provide generally transcend those related to production services (Jackson et al., 2007a; Pascual and Perrings, 2007; Perrings et al., 2006; Porter et al., 2009; Sandhu et al., 2010a; Turner et al., 2004). According to this literature, in addition to the provisioning of food, fuel, and fiber (Swinton et al., 2007), particular types of agroecosystems provide important supporting, cultural, and regulating services, such as maintenance of soil fertility, regulation of pests and pathogens, wildlife protection, water quality supply, carbon sequestration, maintenance of rural landscapes and rural lifestyles, and maintenance of recreational areas for hunting and tourism (Sandhu et al., 2010b; Swinton et al., 2007; Zhang et al., 2007)

Research suggests that agroecosystems' capacity to deliver ecosystem services depends on the intensity of use and on the diversity of croplands. For example, Sandhu et al. (2010b) attribute a larger flow of ecosystem services to organic than to conventional agriculture, defined here as agriculture based on monoculture and intensive use of agrochemicals, fuel, and machinery. On the same line, Altieri (1999) and Jackson et al. (2007a) argue that agriculture based on traditional practices like intercropping, agroforestry, or shifting cultivation delivers more ecosystem services than conventional agriculture for various reasons. First, traditional agriculture largely relies on the maintenance of agrobiodiversity (Altieri, 1999; Jackson et al., 2007a, 2007b), thereby combining agricultural productivity with the

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delivery of the other regulating services that biodiversity provides (MA, 2005). Second, maintenance of agrobiodiversity in agricultural landscapes enhances agroecosystems' resilience (their capacity to reorganize after disturbance), thereby enhancing the likelihood of maintaining ecosystem services supply over time in the face of variability and change (Jackson et al., 2007a; Pascual et al., 2010). Third, the adaptation of traditional agriculture to site-specific biological, edaphic, and climatic conditions reduces the dependence on inputs of machinery, agrochemicals, and fuel, thereby reducing related disservices in terms of soil compaction, water pollution, and greenhouse gas emissions (Altieri, 1999).

Despite growing interest in ecosystem services provided by agroecosystems, one type of agroecosystem that remains relatively unexplored from an ecosystem service perspective is home gardens (see Andersson et al., 2007; Barthel et al., 2010, for some exceptions), or small, fenced plots relatively close to the gardener's homestead where annual, biennial, and perennial cultivated species are grown in beds (Vogl and Vogl-Lukasser, 2003). Despite previous research highlighting the importance of home gardens in the maintenance of plant agrobiodiversity (Agelet et al., 2000; Calvet-Mir et al., 2011a; Perrault-Archambault and Coomes, 2008; Sunwar et al., 2006), and some contributions claiming the importance of home gardens for ecosystems service supply (Eyzaguirre and Linares, 2004a, 2004b; Pulido et al., 2008), to our knowledge there has not been any attempt to systematically describe and valuate the ecosystem services provided by home gardens.

Here we aim at advancing the understanding of the societal value of home gardens by conducting an assessment of ecosystem services supplied by home gardens in Vall Fosca, Catalan Pyrenees, northeastern Spain. The specific goals of this paper are 1) to identify and characterize the most important ecosystem services provided by home gardens and 2) to conduct a valuation of the social importance of home garden ecosystem services.

2. Background

Research was conducted in Vall Fosca, northeastern Spain, between 2008 and 2010. Vall Fosca is a Pyrenean valley of glacial formation of about 200 km^2 and 1000 inhabitants lying along the Flamisell River. At the administrative level, it is constituted by the municipality of La Torre de Capdella and partially by the municipality of Senterada (Fig. 1). Most inhabitants in the valley have worked as cattle dealers until recent years, when they have started to combine traditional production activities with tourism services, offering accommodation and food for urban visitors. Nowadays the division of the employed population by sector shows a clear predominance of the tertiary sector, with an occupancy rate of 60.5% versus 15.8% in the primary sector or 15.5% of the secondary. The construction sector employs 8.2% of the population (IDESCAT, 2007). Due to high altitudes and marked slopes, which made it difficult to engage in intensive agriculture, home gardens have traditionally been the most characteristic form of agriculture in Vall Fosca, an area mostly devoted to pastures. Thus, the absence of shops and the limited accessibility to the town markets, especially in winter, traditionally gave home gardens in Vall Fosca an important role as a complement for food supply, hosting a wide diversity of species and varieties for household consumption. As part of their household activities, women have customarily been in charge of home gardens, as men spent much of their time outside the household in charge of cattle. Previous ethnographic interviews in the area suggest that, traditionally, seed exchange was the most common way to acquire seeds (Calvet-Mir et al., 2011a).

Despite the low predominance of the primary sector as main economic activity, our ethnographic data show that most households still manage a home garden for self-consumption. Our previous research suggest that some of the traditional features of home gardens are only partially present since, for example, currently in Vall Fosca 43.39% of the home gardens studied are managed by men, whereas 37.73% by women and 18.86% are shared home gardens. This previous research has also shown that home gardens have a mean area of 147.25 m^2 and are mainly organically managed. Specifically, it found that about 75% of the studied home gardens received manure or organic products as main fertilizers and organic or manual management methods as main practices to control weeds and pests. Some gardeners also reported that they did not use any method to control weeds and pests. Moreover, 95% of home garden tenders at the study area practiced crop rotation, a practice that consists in growing a series of dissimilar types of crops in the same area in sequential seasons for various benefits such as the replenishment of nutrients in the soil. However, only 16% of them applied crop associations; a practice that consists in growing some plants together to increase synergies

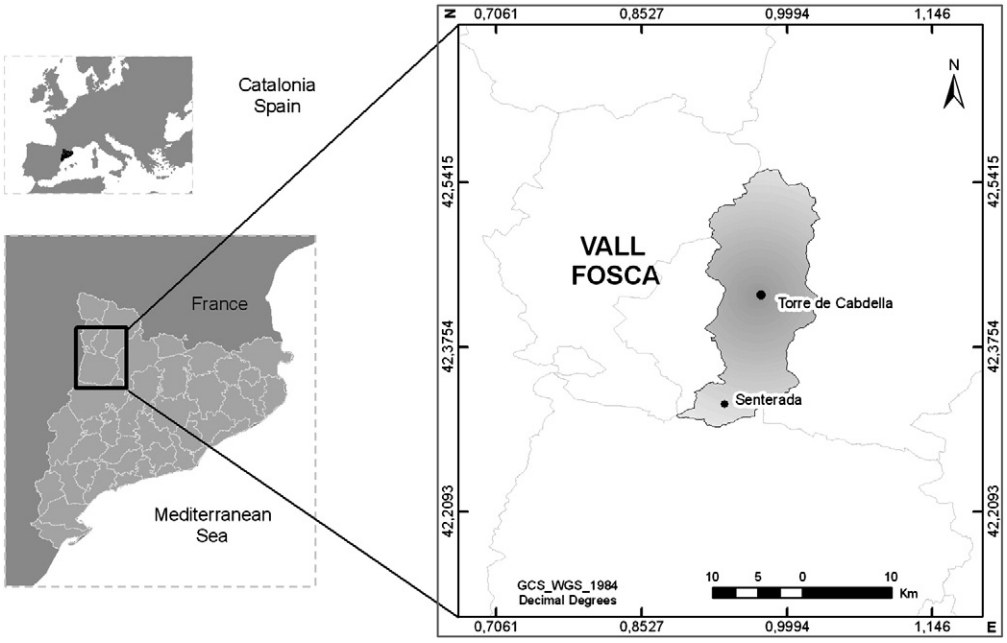

Fig. 1. Map of the study area.

that favor their development. Also, the presence of 39 landraces in Vall Fosca was recorded, highlighting the important role of home gardens for in situ agrobiodiversity conservation (Calvet-Mir et al., 2011a). Finally, this research also found that women, retired people, owners of organic gardens, and experienced gardeners were those who maintained more landraces. Women, retired people and experienced gardeners also hold more knowledge on landraces than people without those sociodemographic characteristics.

3. Methods

This study is part of a wider research on home gardens in three rural areas of the Iberian Peninsula conducted by a multidisciplinary team of social and natural scientists (Aceituno-Mata, 2010; Calvet-Mir et al., 2010, 2011a, 2011b; Reyes-García et al., 2010; Reyes-García et al., 2012). The methodological approach for this work included (1) an in-depth literature review to describe and characterize the potential range of ecosystem services provided by home gardens at large; (2) participant and non-participant observation to identify the ecosystem services provided by the home gardens under analysis; (3) semi-structured interviews (N = 55) to garden tenders to identify the reasons why people manage home gardens and related ecosystem services; (4) a valuation questionnaire (N = 151) to assess the perceived importance of the ecosystem services provided by home gardens by a variety of stakeholders; and (5) a scientific panel consultation about the importance of home gardens' ecosystem services to serve as a cross-checking tool against which we could compare the values perceived by stakeholders.

3.1. Identification and Characterization of Ecosystem Services

Identification and characterization of home garden ecosystem services was made by a triangulation of information obtained from 1) literature review, 2) participant and non-participant observation, and 3) semi-structured interviews. First, we reviewed the body of literature addressing ecosystem services provided by agroecosystems in general and by home gardens in particular. During fieldwork (March-September 2008, July-September 2009, July-September 2010), we used participant and non-participant observation techniques, typically used to establish contact with the community, the culture, and the local social organization in an active or not active way (Bessette, 2004). Through participant observation, we observed the work performed by garden keepers in order to improve our understanding of the activities related to the provision of home garden ecosystem services. We also engaged on informal talks and open-ended interviews with individual or groups of gardeners. When feasible, we also engaged in participant observation, for example, helping garden keepers when preparing their home garden for the planting season (e.g., fertilizing with organic manure), aiding during planting, and accompanying them during harvest time. Living in the village for 13 months gave us ample opportunities to interact with gardeners and observe garden's progress among other aspects. For example, for the identification and characterization of cultural services, we talked with gardeners about topics related to their sense of place or their beliefs, which sometimes ended in explanations on how home gardens gave them connection with spiritual feelings, an aspect that is difficult to capture with more structured methods. Last, to obtain information about incentives that brought people to manage a home garden, we conducted semi-structured interviews to 55 home garden tenders in Vall Fosca during spring 2008.

We followed the classification variants by de Groot et al. (2002), The Millennium Ecosystem Assessment (MA, 2003) and The Economics of Ecosystems and Biodiversity (Kumar, 2010) to divide ecosystem services in four main categories: regulating, habitat, production, and cultural services. Each ecosystem service was identified together with its underlying ecosystem functions and related key ecological processes and components following the same classification variants. Ecosystem functions refer to the ecological processes and components with the capacity to provide services whereas ecosystem services refer to the final benefits that are enjoyed or consumed by beneficiaries (Gómez-Baggethun and de Groot, 2010). As compared to ecosystem functions, ecosystems services thus require the presence of beneficiaries. For example for the ecosystem service "hobby" the underlying ecosystem function is "recreation" and its related ecological component is "variety in landscapes with (potential) recreational uses" (Table 1).

We reviewed scientific literature on agriculture-related ecosystem services and available documentation on the ecology, economy, and culture of Vall Fosca and related areas to draft a preliminary list of home garden ecosystem services. This list was then expanded with further services identified from fieldwork observations and from the interviews with local informants. Particular services mentioned in the broader agriculture-related ecosystem services literature were excluded when not suiting the biophysical features of home gardens under study. For example we excluded carbon sequestration due to the small size of home gardens and the fact that during each planting season all the vegetation is removed and the soil ploughed, which implies carbon emission. We classified sources of information as 1) "literature" when the source of identification was the literature review, 2) "observation" when the ecosystem service was identified by participant and non-participant observation, and 3) "interviews" when the source of identification was the semi-structured interviews (Table 1).

3.2. Valuation of Ecosystem Services Provided by Home Gardens

Because most ecosystem services provided by home gardens operate outside the market system and because many of them are tightly intertwined with community, tradition, and other deontological values (NRC, 2004), we adopted a non-economic valuation approach based on the socio-cultural perception on the importance of ecosystem services for human well-being. The valuation of ecosystem services was based on a survey conducted during summer 2010 with 151 stakeholders, defined as adults potentially benefiting -directly or indirectly- from any ecosystem services provided by home gardens at the study area. We used a stratified sampling strategy to obtain a sample similarly distributed between men and women, visitors and local inhabitants, and people who owned a home garden and people who did not.

For the valuation survey, we used a Likert scale design (Bernard, 2005) to assess stakeholder agreement on statements about the importance of home garden ecosystem services. Specifically, we presented to stakeholders a statement referring to each one of the 19 ecosystem services previously identified as potentially being provided by home gardens in Vall Fosca. We then asked them to tell us how much did s/he agree with each statement. To facilitate interpretation, when possible each ecosystem service was presented using pictures from local ecosystems. For example, we presented stakeholders the following sentence "Home gardens are important because they maintain landraces" and showed the stakeholder a collage of Vall Fosca landraces, or "Home gardens are important because they allow to create and maintain relations between people" and showed the stakeholder a picture of people talking in a local home garden. Then, we asked the respondent his or her level of agreement with the statement in a scale ranging from zero to five, where zero was " I completely disagree" and five was "I completely agree".

The aims of the valuation survey were to estimate 1) the average value of each ecosystem service identified, 2) the average value of each category of ecosystem services, 3) the average value of all services (summed together), and 4) the standardized relative importance of each category of ecosystem services (average value of the category/

Table 1
Ecosystem functions and services provided by home gardens in Vall Fosca, Catalan Pyrenees, North-Eastern Spain.

Function	Ecosystem processes and components	Goods and services from home gardens	Source of identification		
			Literature	Observation	Interviews
Regulating	***Maintenance of essential ecological processes and life support systems***				
Disturbance buffering	Influence of ecosystem structure on dampening environmental disturbances	Flood prevention (when gardens are located near rivers)	•		
Soil formation and maintenance of soil fertility	Weathering of rock, accumulation of organic matter that enhances fertility, maintenance of microbiota that confers structure to the soil	Maintenance of natural, productive soils	•	•	
Pollination	Role of biota in the movement of floral gametes	Enhanced crop production	•		
Waste treatment and water purification	Bioremediation. Role of vegetation and biota in removal or breakdown of xenic nutrients and compounds	Enhanced water quality	•		
Biological control	Population control through trophic-dynamic relations	Prevention / buffering of pests and diseases	•		
Habitat/Support	***Provision of habitat for wild plant and animal species and maintenance of biodiversity***				
Refugium	Suitable living space for wild plants and animals	Living space for wild plants and animals	•	•	
Maintenance of genetic diversity	Gene pool protection	Maintenance of landraces	•	•	
Production	***Provision of natural resources***				
Food	Conversion of solar energy into edible plants and animals	Provision of quality food	•	•	•
Raw materials	Variety of materials used as fiber, timber, fuel, wood, fodder, fertilizer	Provision of fodder and green manure	•	•	
Genetic resources	Genetic material and evolution in wild plants and animals	Crop improvement and material for medicinal purposes	•		
Medicinal resources	Variety in (bio)chemical substances in, and other medicinal uses of, natural biota	Provision of medicinal plants		•	
Ornamental resources	Variety of biota in natural ecosystems with (potential) ornamental use	Provision of resources for worship and decoration		•	
Cultural	***Provision of opportunities for cognitive development***				
Aesthetic information	Attractive landscape features	Enjoyment of home gardens' aesthetic features	•	•	
Recreation & tourism	Variety in landscapes with (potential) recreational uses	Hobby	•	•	•
Inspiration for culture, art and design	Variety in natural features with cultural and artistic value	Use in folklore, art and design	•	•	
Spiritual experience	Variety in natural features with spiritual value	Connection with spiritual feelings			•
Information for cognitive development	Variety in nature with (potential) scientific and educational value	Place to carry out environmental education and scientific research		•	
Maintenance of traditional ecological knowledge	Variety in natural features with traditional ecological knowledge value	Heritage value of home gardens and associated traditional ecological knowledge		•	•
Creation and maintenance of social relations	Variety in natural features with social relations value	Place for creating and enhancing social networks		•	

maximum value the category could obtain). Those estimations allowed us to identify the relative value of some categories in relation to others.

To cross-check responses, on November 2010 we followed the same procedure to conduct the valuation of home garden ecosystem services with a scientific panel. We used a purposive sample to generate the panel. The panel was integrated by seven scientists from the Institut de Ciència i Tecnologia Ambientals (ICTA) of Universitat Autònoma de Barcelona (UAB) working in the field of ecosystem services and willing to answer the survey. Each member of the panel independently valued their conformity with the 19 statements about ecosystem services provided by home gardens, using the same questionnaire than stakeholders.

Finally, we ran a power correlation analysis to examine the similarity between both sets of responses. For the statistical analysis we used STATA 9 for Windows.

3.3. Limitations

The study has some methodological limitations that should be taken into consideration for future research planning. First, by asking stakeholders to rank a service based on a pre-written positive statement we can introduce a positive bias in the score given by the stakeholders, so our results might overvalue stakeholder's valuation of home garden ecosystem services. Second, our measures are indicative since in Likert scales numbers only act as qualitative indicators of agreement to a statement. Therefore the quantitative interpretation should be taken with caution. Third, some services could be included in more than one category, for example the service "Maintenance of landraces" was included under habitat services for the role they play in maintaining genetic diversity, but it could also be embedded in the category of production services under "Provision of landraces". Since we only included each service in one category, the total score of each category should be taken as a relative measure. Fourth, the list of services was drafted by the authors based on qualitative methods. We are aware that this list does not covered all ecosystem services, e.g. "carbon sequestration", and that it is possible that we underestimated the total number of ecosystem services delivered by home gardens. Finally, the results presented here are stakeholders' and scientist perception, and the perception could be biased by a large number of factors such as the research scale, i.e. extension of the garden area, context, and the like.

4. Results

4.1. Identification and Characterization of Ecosystem Services

We identified and characterized 19 ecosystem functions and related services: five regulating services, two habitat/support services, five production services, and seven cultural services (Table 1).

About one fourth (26.32%) of the ecosystem services (most of them belonging the category of regulating services) were identified and characterized during the literature review. A slightly smaller proportion (21.05%) of the ecosystem services were exclusively identified and characterized during fieldwork, through participant and non-participant observation. These included two production services ("provision of medicinal plants" and" provision of resources for worship and decoration") and two cultural services ("home gardens' aesthetic features" and "place for creating and enhancing social

networks"). One ecosystem service (5.26%), the spiritual benefit derived from interaction with home gardens, was identified and characterized from interviews with stakeholders. Two ecosystems services (10.52%), "provision of quality food" and "hobby", were identified in the three sources; six ecosystem services (31.58%) were identified from literature and fieldwork, and one ecosystem service was identified from participant observation and fieldwork.

4.2. Valuation of Home Garden Ecosystem Services

Table 2 presents the average value given to each ecosystem service by stakeholders (Column A) and the scientific panel (Column B).

4.2.1. Valuation by Stakeholders

Our sample of stakeholders was composed by adults ranging from 18 to 91 years of age (mean = 52.2 years) similarly distributed between men (54%) and women (46%). About 35% of the sample had not completed secondary education, whereas 65% held secondary to university degrees. Visitors represented 59% of the sample. Half of the people in the sample (51%) owned a home garden (some visitors owned a home garden in their village of residency).

Within a range from zero to five, 11 (57.89%) of the home garden ecosystem services had an average value ranging from four to five, meaning that stakeholders perceived these services to be very important. Five ecosystem services (26.32%) had an average value ranging from three to four; two (10.53%) ranged between two and three, and one had an average value between one and two (Table 2 Column A).

The most valued ecosystem service was "provision of quality food", followed by "hobby", "maintenance of landraces", "heritage value of home gardens and associated traditional ecological knowledge", and "enjoyment of home gardens' aesthetic features", all of which had an average value above 4.5. Of the most highly valued ecosystem services, three were cultural services, one a production service, and one an habitat/support service. The less valued ecosystem service was "flood prevention", which had an average value of 1.85. The services "prevention/buffering of pests and diseases" and "enhanced water quality" also had a low average value (between two and three).

The relative importance of each category of ecosystem services suggests that stakeholders give a similar value to cultural (0.87), production (0.86), and habitat/support (0.83) services. However, regulating services had a much lower value (0.57), which suggests that stakeholders seem not to perceive home garden regulating services to be as important as the services from the other categories.

4.2.2. Scientific Panel Valuation

The most valued ecosystem service by the scientific panel was "provision of quality food", followed by "maintenance of landraces", "heritage value of home gardens and associated traditional ecological knowledge", and "place for creating and enhancing social networks". All those services received an average value from 4.5 to 4.67 by the scientific panel (Table 2, Column B). The first three of the above services were also the most valued services among stakeholders. The ecosystem services less valued by the scientific panel were "flood prevention" and "enhanced water quality", which obtained an average value of 1.5, followed by "prevention/buffering of pests and diseases". So, the three ecosystem services less valued by the scientific panel also correspond with the ecosystem services less valued by the stakeholders. Results of the power correlation analysis showed a great similarity (0.9987, $p<0.01$) between the stakeholders' and the scientists' sets of responses.

Results regarding the relative importance of each group of ecosystem services show that scientists, as stakeholders, confer larger value to home gardens cultural (0.78), habitat/support (0.73), and production (0.68) services than to regulating services (0.43).

5. Discussion

We structure the discussion around two topics that emerge from this work: 1) home gardens provide a large set of often neglected ecosystem services, being cultural services the category most valued by both stakeholders and scientists, 2) most important ecosystem services provided by home gardens differ significantly from those provided by other types of agroecosystems.

Table 2
Average punctuation (from a range 0–5) of ecosystem goods and services provided by home gardens in Vall Fosca according to stakeholders (Column A) and a scientific panel (Column B).

	A	B
Goods and services from home gardens	Stakeholders (n = 151)	Scientists Panel (n = 7)[a]
Maintenance of natural, productive soils	4.47	4.33
Enhanced crop production	3.62	3.33
Enhanced water quality	2.26	1.50
Prevention / buffering of pests and diseases	2.10	2.33
Flood prevention (when gardens are located near rivers)	1.85	1.50
Average punctuation of regulating services. Range 0 to 25	**14.30**	**10.67**
Maintenance of landraces	4.64	4.50
Living space for wild plants and animals	3.66	2.83
Average punctuation of habitat services. Range 0 to 10	**8.29**	**7.33**
Provision of quality food	4.91	4.67
Provision of fodder and green manure	4.30	2.50
Provision of medicinal plants	4.26	2.83
Provision of resources for worship and decoration	3.97	3.50
Crop improvement and material for medicinal purposes	3.92	3.50
Average punctuation of production services. Range 0 to 25	**21.36**	**17**
Hobby	4.70	4.00
Heritage value of home gardens and associated traditional ecological knowledge	4.64	4.50
Enjoyment of home gardens' aesthetic features	4.52	3.67
Place to carry out environmental education and scientific research	4.50	3.83
Place for creating and enhancing social networks	4.34	4.50
Connection with spiritual feelings	4.25	3.67
Use in folklore, art and design	3.51	3.17
Average punctuation of cultural services. Range 0 to 35	**30.47**	**27.33**
Average punctuation of all services. Range 0 to 95	**74.43**	**64.66**

[a] Correlation between both punctuations = 0.9987, $p<0.01$.

5.1. Home Garden Ecosystem Services

Our results suggest that home gardens provide a wide range of ecosystem services beyond the production services for which agricultural systems are fundamentally managed. As intuition would suggest, and in accordance with previous research on ecosystem services from agroecosystems (Swinton et al., 2007; Zhang et al., 2007), the most valued ecosystem service provided by home gardens is the provision of quality food. Less obviously, ecosystem services that do not belong to the production category, like the habitat service "maintenance of landraces" and the cultural services "hobby", "heritage value of home gardens and associated traditional ecological knowledge", and "enjoyment of home gardens' aesthetic features", closely follow the "quality food" service in the stakeholders' valuation scale. Thus, although the vocational and most valued role of home gardens is food production, in Vall Fosca the most valued category of ecosystem services provided by home gardens were cultural, not production services. In particular, 86% of our sample felt that home gardens were a key element of Vall Fosca's landscapes, and 95% believed that home gardens had to be preserved as an important component of cultural heritage.

Previous research in Vall Fosca and other areas provide insights to interpret these results. In relation to the high value obtained by the habitat service "maintenance of landraces", Calvet-Mir et al. (2011a) found that home gardens in Vall Fosca perform an important role as landraces custodians. Since maintenance of high biodiversity levels in specific taxonomic groups is related with the performance of ecosystem services by enhancing pest control, pollination, or soil fertility (Altieri, 1999; Jackson et al., 2007a), it is likely that the maintenance of landraces has positive synergies in terms of improving other agrobiodiversity-dependent ecosystem services. Additionally, the habitat service "maintenance of landraces" is tightly connected with important cultural services. For example landraces maintenance is connected with the cultural service "heritage value of home gardens and associated traditional ecological knowledge" since landraces in Vall Fosca have a large body of traditional ecological knowledge associated to them (Calvet-Mir et al., 2010). In previous research we have partially documented this knowledge, which includes garden management practices (i.e., soil fertilization techniques, appropriated sowing calendar and rotations) and which is often encoded in local sayings and stories. Landraces maintenance is also associated with the cultural service "place for creating and enhancing social networks" since both landraces and knowledge are partially spread throughout seed exchange networks (Calvet-Mir et al., 2011b).

Our ethnographic research in the area suggests that the benefits associated to the individual sense of belonging to a community might act as incentives to conserve landraces as a way to maintain a particular and site-specific cultural identity. This result is consistent with findings from previous research suggesting that home gardens might be a marker of cultural identity, since local culture and traditions are still deeply linked to the performance of agrarian activities in the area (Calvet-Mir et al., 2011a). For example, during summer festivals, local people organize a culinary competition consisting of the preparation of traditional dishes made with home garden products. Thus, home garden products –or some of them- are embedded in the local identity of the area.

The cultural service "hobby" is also amongst of the most valued home garden services. Specifically, respondents felt that home gardens serve as a pleasant distraction and a relaxation space.

Another eye-catching result of our study is that regulating services were not perceived to be as important as the other categories of services by both the stakeholders and the panel of scientists. We can think of three explanations for this finding. The first relates to the reduced size of home gardens as compared to most other ecosystem types. It is possible that because of their small size respondents considered that home gardens contribution to the performance of regulation services can be considered negligible. Second, in the context of the wider territorial matrix within which home gardens are embedded, the perceived contribution of home gardens to the delivery of regulating services by stakeholders and scientists may be dwarfed by that attributed to the surrounding ecosystem units in Vall Fosca, composed mainly by semi natural forest. For example, several stakeholders argued that forest of the uphill surrounded mountains were far more important in the prevention of floods in Vall Fosca than home gardens.

Finally, this result may also be related to the fact that regulating services are often taken for granted or to a lack of understanding on how these ecological processes operate. However, the fact that the evaluations by the scientists were consistent with those from the other stakeholders inclines us to think of the two first explanations as the most feasible. Only one regulating service, "maintenance of natural, productive soils", was perceived to be important. This result is consistent with previous findings showing that soil fertility in agricultural systems can be enhanced through appropriate management practices, such as conservation tillage (Swinton et al., 2007). In Vall Fosca, practices that enhance soil fertility include fertilization with organic manure (applied in all the home gardens) and crop rotation (applied in 95.2% of the home gardens). Several stakeholders argued that thanks to these management practices home gardens maintained high levels of soil fertility.

5.2. Home Garden Ecosystem Services Within the Framework of Other Agroecosystems

A relevant result from our study relates to the specificities that explain the importance of home gardens when analyzed as service providing units (Luck et al., 2003) as compared to other types of agroecosystems.

First, as already noticed, production of quality food appears as the most valued home garden ecosystem service, which parallels findings from previous research identifying provision of food, fuel, and fiber as the most important services provided by agriculture (MA, 2003; Sandhu et al., 2010a, 2010b; Swinton et al., 2007; Zhang et al., 2007). However home gardens ecosystem services also show important differences when compared with services provided by conventional agriculture. For example, 53.6% of the respondents to the semi-structured interviews argued that one of the main reasons to cultivate a home garden was the better quality (taste and nutrition) of the vegetables, and almost a half, 46.4%, of the respondents also argued that one of the main reasons to cultivate home gardens was to achieve food sovereignty and economic independence from markets. These values of home gardens ecosystem services may be analyzed in terms of the implicit role home gardens play in enhancing self-sufficiency and building resilience to external dynamics such as fluctuations in market prices of food (Rodríguez et al., 2006) or steady declines in food quality resulting from competition to produce at lower prices. This result is consistent with findings from other studies that have highlighted the perceived importance of home gardens in producing healthy food as compared to conventional agriculture (Reyes-García et al., 2012; Vogl and Vogl-Lukasser, 2003).

Second, also in contrast to previous findings from research in conventional (Swinton et al., 2007; Zhang et al., 2007) and organic (Sandhu et al., 2010b) large scale agriculture, maintenance of landraces showed to be a highly valued ecosystem service provided by home gardens. Researchers have argued that a wide range of genetic diversity is present in home gardens managed through agroecological practices like fertilization with manure, intercropping, and shifting cultivation (Aceituno-Mata, 2010; Eyzaguirre and Linares, 2004a, 2004b), conferring them a higher resilience to ecological disturbances such as insect outbreaks affecting particular species and varieties (Jackson et al., 2007a). This service seems to be more important in home gardens than in other agricultural ecosystems.

Third, in contrast with conventional agricultural systems managed solely or fundamentally for production purposes, our results suggest that the provision of cultural services plays a central role in explaining the societal importance attributed to home gardens. Cultural services are indeed the category less developed in the literature on ecosystem services provided by agriculture. Normally these services are mentioned as additional services provided by agricultural landscapes (e.g. Swinton et al., 2007), or are addressed as being embedded in the wider category of "non-marketed services" (e.g. Zhang et al., 2007). Although some studies have noted the role that agricultural systems may play in the provision of cultural services such as recreational hunting and tourism (Knoche and Lupi, 2007), the potential role of -specific types of- agroecosystems in the provision of cultural services remains, to our knowledge, largely unaddressed.

A fourth difference between ecosystem services provided by home gardens and ecosystem services provided by other types of agroecosystems relates to regulating services. According to some authors, regulating services are among the most diverse class of services provided by agriculture (Swinton et al., 2007; Zhang et al., 2007), although they debate the differences in the regulating services provided by organic and conventional agriculture (Sandhu et al., 2010b). Since home gardens in Vall Fosca are mostly organically managed (74.2% of the home gardens), one would think that they hold the potential to provide a wide range of regulating services. Nevertheless, as we mentioned in the previous section, their reduced area and the landscape around them diminish the perceived importance of Vall Fosca home gardens in the provision of regulating services. Researchers have noticed that regulating services such as pollination or pest regulation are important benefits for urban home gardens (Andersson et al., 2007; Barthel et al., 2010), but whether home gardens surrounded by forests and natural or semi natural ecosystems have an important role in the provision of regulating services is still an open question.

Finally, during our interviews stakeholders also sustained that they produced their own food as a part of the way of understanding their alimentation and their environment, which suggests that ontological dimensions are also involved in the way home gardens are perceived to be important, an issue however, that cannot be fully addressed from our data and that will need further exploration.

6. Conclusions

Due to the wide range of ecosystem services that home gardens can potentially provide and the potential role of these systems in building community resilience to fluctuations in market prices and environmental conditions, home gardens could be an important tool to restore ecosystem services in degraded zones such as marginal lands, or abandoned plots in urban areas. Future research needs to address the viability of home gardens in restoring ecosystem services in such locations, as well as, future development of research on the cultural, an other services, in urban agricultural systems could lead to deeply understand the importance and implications of these services in urban sites.

Home garden ecosystem services also can weave interactions among people through contributing to enhance cultural identity and the development of sense of place, created through firsthand interaction between humans and places (Cantrill and Senecah, 2001; Kaltenborn, 1998,). Sense of place can generate opportunities for comprehensive knowledge-building of practices that improve ecosystem services management as it has been documented in allotment gardens in Stockholm (Andersson et al., 2007; Barthel et al., 2010), enhance social networks of transmission of knowledge and agrobiodiversity as in Vall Fosca home gardens (Calvet-Mir et al., 2011b), or turn home gardens into learning places about local ecology as in rural France (Crumley, 2002). Future research should deal with how sense of place can generate opportunities for comprehensive knowledge building.

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References

Aceituno-Mata, L., 2010. Estudio etnobotánico y agroecológico de la Sierra Norte de Madrid. PhD thesis. Universidad Autónoma de Madrid, Madrid.
Agelet, A., Bonet, M.À., Vallès, J., 2000. Homegardens and their role as a main source of medicinal plants in mountain regions of Catalonia (Iberian Peninsula). Economic Botany 54, 295–309.
Altieri, M.A., 1999. The ecological role of biodiversity in agroecosystems. Agriculture, Ecosystems & Environment 74, 19–31.
Andersson, E., Barthel, S., Ahrne, K., 2007. Measuring social-ecological dynamics behind the generation of ecosystem services. Ecological Applications 17, 1267–1278.
Barthel, S., Folke, C., Colding, J., 2010. Social–ecological memory in urban gardens—Retaining the capacity for management of ecosystem services. Global Environmental Change 20, 255–265.
Bernard, H.R., 2005. Research methods in anthropology. Qualitative and quantitative approaches. Altamira Press, Walnut Creek, California.
Bessette, G., 2004. Involving the Community. A Guide to Participatory Development Comunication. International Development Research Center, Otawa, Canada.
Bjorklund, J., Limburg, K.E., Rydberg, T., 1999. Impact of production intensity on the ability of the agricultural landscape to generate ecosystem services: an example from Sweden. Ecological Economics 29, 269–291.
Calvet-Mir, L., Calvet-Mir, M., Vaqué-Nuñez, L., Reyes-García, V., 2011a. Landraces *in situ* conservation: a case study in high-mountain home gardens in Vall Fosca, Catalan Pyrenees, Iberian Peninsula. Economic Botany 65, 146–157.
Calvet-Mir, L., Calvet-Mir, M., Molina, J.L., Reyes-García, V., 2011b. Seeds exchange as an agrobiodiversity conservation mechanism: A case study in Vall Fosca, Catalan Pyrenees, Iberian Peninsula. Ecology and Society: accepted pending minor revisions.
Calvet-Mir, L., Calvet-Mir, M., Reyes-García, V., 2010. Traditional ecological knowledge and landraces *in situ* conservation in high mountain home gardens of Vall Fosca, Catalan Pyrenees, Iberian Peninsula. In: Pochettino, M.L., Ladio, A.H., Arenas, P.M. (Eds.), Tradiciones y tranformaciones en etnobotánica. CYTED, Argentina, pp. 457–464.
Cantrill, J.G., Senecah, S.L., 2001. Using the 'sense of self-in-place' construct in the context of environmental policy-making and landscape planning. Environmental Science & Policy. 4, 185–203.
Costanza, R., Daly, H., 1992. Natural capital and sustainable development. Conservation Biology 6, 37–46.
Crumley, L.C., 2002. Exploring venues of social memory. In: Climo, J.J., Cattell, M.G. (Eds.), Social Memory and History: Anthropological Perspectives. AltaMira Press, Walnut Creek, CA, USA, pp. 39–51.
Daily, G.C., 1997. Nature's Services: Societal Dependence on Natural Ecosystems. Island Press, Washington, DC.
de Groot, R.S., Wilson, M.A., Boumans, R.M.J., 2002. A typology for the classification, description and valuation of ecosystem functions, goods and services. Ecological Economics 41, 393–408.
Eyzaguirre, P.B., Linares, O.F., 2004a. Introduction. In: Eyzaguirre, P.B., Linares, O.F. (Eds.), Homegardens and agrobiodiversity. Smithsonian Books, Washington, D. C., pp. 1–28.
Eyzaguirre, P.B., Linares, O.F., 2004b. Conclusions. In: Eyzaguirre, P.B., Linares, O.F. (Eds.), Home gardens and agrobiodiversity. Smithsonian Books, Washington, DC, pp. 283–286.
Gómez-Baggethun, E., de Groot, R., 2010. Natural capital and ecosystem services: the ecological foundation of human society. In: Hester, R.E., Harrison, R.M. (Eds.), Ecosystem services: Issues in Environmental Science and Technology, 30. Royal Society of Chemistry, Cambridge, pp. 118–145.
IDESCAT, 2007. Estadística bàsica territorial: La Torre de Cabdella. Institut d'Estadística de Catalunya.
Jackson, L.E., Pascual, U., Hodgkin, T., 2007a. Utilizing and conserving agrobiodiversity in agricultural landscapes. Agriculture, Ecosystems & Environment 121, 196–210.
Jackson, L.E., Pascual, U., Brussaard, L., de Ruiter, P., Bawa, K.S., 2007b. Biodiversity in agricultural landscapes: Investing without losing interest. Agriculture, Ecosystems & Environment 121, 193–195.

Kaltenborn, B.P., 1998. Effects of sense of place on responses to environmental impacts: A study among residents in Svalbard in the Norwegian high Arctic. Applied Geography 18, 169–189.
Knoche, S., Lupi, F., 2007. Valuing deer hunting ecosystem services from farm landscapes. Ecological Economics 64, 313–320.
Kumar, P. (Ed.), 2010. The Economics of Ecosystems and Biodiversity: Ecological and Economic Foundations. : An output of TEEB: The Economics of Ecosystems and Biodiversity. Earthscan, England.
Luck, G.W., Daily, G.C., Ehrlich, P.R., 2003. Population diversity and ecosystem services. Trends in Ecology & Evolution 18, 331–336.
Millennium Ecosystem Assessment (MA), 2003. Ecosystems and Human Well-being: a Framework for Assessment.
Millennium Ecosystem Assessment (MA), 2005. Ecosystems and Human Well-being: Biodiversity Synthesis.
National Research Council (NRC), 2004. Valuing Ecosystem Services: Toward Better Environmental Decision-Making. National Academy Press, Washington, DC.
Pascual, U., Perrings, C., 2007. Developing incentives and economic mechanisms for in situ biodiversity conservation in agricultural landscapes. Agriculture, Ecosystems & Environment 121, 256–268.
Pascual, U., Muradian, R., Rodríguez, L.C., Duraiappah, A., 2010. Exploring the links between equity and efficiency in payments for environmental services: A conceptual approach. Ecological Economics 69, 1237–1244.
Perrault-Archambault, M., Coomes, O.T., 2008. Distribution of Agrobiodiversity in Home Gardens along the Corrientes River, Peruvian Amazon. Economic Botany 62, 109–126.
Perrings, C., Jackson, L., Bawa, K., Brussaard, L., Brush, S., Gavin, T., Papa, R., Pascual, U., de Ruiter, P., 2006. Biodiversity in agricultural landscapes: Saving natural capital without losing interest. Conservation Biology 20, 263–264.
Porter, J.R., Costanza, R., Sandhu, H., Sigsgaard, L., Wratten, S., 2009. The Value of Producing Food, Energy, and Ecosystem Services within an Agro-Ecosystem. AMBIO: A Journal of the Human Environment. 38, 186–193.
Porter, J.R., 2003. Ecosystem services in European agriculture: theory and practice. the Royal Swedish Academy of Agriculture and Forestry, Stockholm.
Power, A.G., 2010. Ecosystem services and agriculture: tradeoffs and synergies. Philosophical Transactions of the Royal Society B: Biological Sciences 365, 2959–2971.
Pulido, M.T., Pagaza-Calderón, E.M., Martínez-Ballesté, A., Maldonado-Almanza, B., Saynes, A., Pacheco, R.M., 2008. Home gardens as an alternative for sustainability; Challenges and perspectives in Latin America. In: Albuquerque, U.P., Alves-Ramos, M. (Eds.), Current Topics in Ethnobotany. Research Signpost, India, pp. 55–79.
Reyes-García, V., Aceituno-Mata, L., Vila, S., Calvet-Mir, L., Garnatje, T., Jesch, A., Lastra, J.J., Parada, M., Rigat, M., Vallès, J., Pardo-de-Santayana, M., 2012. Home gardens in three mountain regions of the Iberian Peninsula and their financial benefits. Journal of Sustainable Agriculture 36, 1–22.
Reyes-García, V., Aceituno-Mata, L., Vila, S., Calvet-Mir, L., Garnatje, T., Jesch, A., Lastra, J.J., Parada, M., Rigat, M., Vallès, J., Pardo-de-Santayana, M., 2010. Gendered home gardens. A study in three mountain areas of the Iberian Peninsula. Economic Botany 64, 235–247.
Rodríguez, L.C., Pascual, U., Niemeyer, H.M., 2006. Local identification and valuation of ecosystem goods and services from Opuntia scrublands of Ayacucho, Peru. Ecological Economics 57, 30–44.
Sandhu, H.S., Wratten, S.D., Cullen, R., 2010b. The role of supporting ecosystem services in conventional and organic arable farmland. Ecological Complexity 7, 302–310.
Sandhu, H.S., Wratten, S.D., Cullen, R., 2010a. Organic agriculture and ecosystem services. Environmental Science & Policy 13, 1–7.
Sunwar, S., Thornström, C.G., Subedi, A., Bystrom, M., 2006. Home gardens in Western Nepal: Opportunities and challenges for on-farm management of agrobiodiversity. Biodiversity and Conservation 15, 4211–4238.
Swinton, S.M., Lupi, F., Robertson, G.P., Hamilton, S.K., 2007. Ecosystem services and agriculture: Cultivating agricultural ecosystems for diverse benefits. Ecological Economics 64, 245–252.
Turner, R.K., Georgiu, S., Clark, R., Brouwer, R., Burke, J., 2004. Economic Valuation of water resources in agriculture. From the sectoral to a functional perspective of natural resource management. Food and Agriculture Organization of the United Nations, Rome, Italy.
Vogl, C.R., Vogl-Lukasser, B., 2003. Tradition, Dynamics and Sustainability of Plant Species Composition and Management in Homegardens on Organic and Non-Organic Small Scale Farms in Alpine Eastern Tyrol, Austria. Biological Agriculture and Horticulture 21, 349–366.
Zhang, W., Ricketts, T.H., Kremen, C., Carney, K., Swinton, S.M., 2007. Ecosystem services and dis-services to agriculture. Ecological Economics 64, 253–260.