PhD Thesis

Beyond food production: Home gardens as biocultural conservation agents.

A case study in Vall Fosca, Catalan Pyrenees, northeastern Spain

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Universitat Autònoma de Barcelona
2011

The adage goes that diversity is the spice of life. Perhaps we are beginning to learn that it is both spice and food, the food of survival

Luisa Maffi

Al Dani, la Laia i la Maria,
per entendre-ho tot des del començament

ABSTRACT

This thesis contains the results of a biocultural conservation research conducted between 2008 and 2011 in home gardens in Vall Fosca, Catalan Pyrenees, northeastern Spain. Vall Fosca is a valley where traditional agroecosystems still survive, but whose inhabitants are divided in defining the most suitable development model for the region. This dissertation examines the existence of landraces and knowledge associated with them in a rural area in an industrialized country. It shows who preserves landraces and why they do so. It also estimates the association between individual centrality in the network of seed exchange and conservation of landraces and associated knowledge. This thesis also discusses the ecosystem services provided by home gardens, as well as the differences between men and women when assessing these ecosystem services. The results establish the existence of landraces and knowledge associated with them in a rural area in an industrialized country. Specifically, my results show the existence of 39 landraces belonging to 31 species, in home gardens with a variety of 148 different species. Women, people over 65 years of age, experienced gardeners and people who grow the garden with organic techniques conserve more landraces than people without these characteristics. Also people who have a more active role in the seed exchange network and have higher levels of intermediation in the network retain more landraces and traditional knowledge than people who have a more passive role in social networks of seed exchange. Home gardens provide a wide range of services, often not very prominent in the literature on ecosystem services. Among these, cultural services are the most appreciated. In this regard, an interesting contribution of this work is that the most valued home garden ecosystem services differ significantly from the services provided by other farming systems. Another interesting contribution of this work is that women value the ecosystem services more than men. The explanation for this finding is part of the socialization theory

that assigns women roles on family care and protection. My analysis provides new data that facilitate the understanding of the relationship between pro-environmental attitudes and gender socialization. This thesis has found that home gardens and landraces are symbols of cultural identity in the valley and that both permanent residents and visitors consider that home gardens are key elements in the landscape of the valley and should be preserved as part of biocultural heritage. In addition, the ecosystem services provided by the home gardens, particularly the cultural services, can help develop relations between people, relations that might contribute to strengthening cultural identity and to create bonds of respect with the environment. The results of this thesis can contribute to make biocultural diversity visible in the valley and generate endogenous rural development models based on the sustainable exploitation of ecosystem services generated by traditional agroecosystems.

Key words: ecosystem services; landraces; rural development; socialization theory; Spain; traditional ecological knowledge.

RESUMEN

La presente tesis recoge una investigación en conservación biocultural realizada entre el 2008 y el 2011 en los huertos domésticos de la Vall Fosca en el Pirineo catalán, nordeste de España. La Vall Fosca es un valle en el que aún perviven agroecosistemas tradicionales, pero que se encuentra dividido a la hora de definir el modelo de desarrollo más deseable. Esta tesis analiza la existencia de cultivos de manejo local y el conocimiento asociado a ellos en un área rural de un país industrializado; muestra quién y por qué se conservan los cultivos de manejo local; y estima la asociación entre la centralidad individual en la red de intercambio de semillas y la conservación de los cultivos de manejo local y su conocimiento asociado. En esta tesis también se analizan los servicios ambientales proporcionados por los huertos domésticos, así como las diferencias entre hombres y mujeres en el momento de valorar estos servicios ambientales. Los resultados del análisis establecen la existencia de cultivos de manejo local y el conocimiento asociado a ellos en un área rural de un país industrializado. Específicamente mis resultados muestran la existencia de 39 cultivos de manejo local correspondientes a 31 especies, en huertos con una diversidad de 148 especies diferentes. Las mujeres, las personas de más de 65 años de edad, los hortelanos con experiencia, y la gente que cultiva el huerto con técnicas orgánicas mantienen más cultivos de manejo local que las personas sin estas características. Asimismo las personas que tienen un papel más activo en las redes de intercambio de semillas y que tienen mayores niveles de intermediación en la red, también conservan más cultivos de manejo local y tienen mayor conocimiento tradicional que las personas que tienen un papel más pasivo en las redes sociales. Los huertos domésticos proporcionan un amplio abanico de servicios, a menudo poco destacados en la literatura. Entre estos, los servicios culturales son los más apreciados. Un aporte interesante en este sentido es que los servicios de los huertos domésticos más valorados difieren significativamente de los

servicios proporcionados por otros sistemas agrícolas. Otro aporte interesante de este trabajo es que las mujeres valoran los servicios ambientales más que los hombres. La explicación a este hallazgo se enmarca en la teoría de la socialización, que asigna a las mujeres papeles de cuidado y protección. Este análisis aporta nuevos datos que facilitan el entendimiento de la relación entre actitudes pro-ambientales y la socialización de género. En esta tesis se ha podido comprobar que los huertos y los cultivos de manejo local son símbolos de identidad cultural en el valle y que tanto los habitantes permanentes como los visitantes consideran que los huertos son elementos clave en el paisaje del valle y que se deberían preservar como parte de su patrimonio biocultural. Además, los servicios ambientales proporcionados por los huertos, en particular los culturales, pueden ayudar a tejer relaciones entre las personas que contribuyan a fortalecer la identidad cultural y a crear lazos de respeto con su medio ambiente. Los resultados de esta tesis pueden contribuir a a visibilizar la diversidad biocultural del valle y generar modelos endógenos de desarrollo rural basados en la explotación sostenible de los servicios ambientales generados por los agroecosistemas tradicionales.

Palabras clave: conocimiento ecológico tradicional; cultivos de manejo local; desarrollo rural; España; servicios ambientales; teoría de la socialización; variedades locales.

SUMARIO

LISTA DE TABLAS Y FIGURAS

AGRAÏMENTS

En primer lloc vull agrair a tots els hortolans i hortolanes dels pobles de Senterada, Envall, la Pobleta de Bellveí, Cérvoles, Naens, Puigcerver, La Plana de Mont-ros, Pobellà, La Torre de Cabdella, Molinos, Espui, Cabdella, La Central de Cabdella, Mont-ros, Astell i Oveix la seva col·laboració en l'estudi. Així com a tota la gent de la vall que m'ha ajudat d'una o altra forma amb la seva predisposició i amabilitat.

Moltes gràcies a la Victoria Reyes per guiar-me en cada moment d'aquesta tesi, per ensenyar-me a pensar i escriure en llenguatge científic, per aportar contínuament tranquil·litat i bones idees, i per crear un ambient de treball igualitari, còmode i sobretot amigable. Viki moltes gràcies per ser la tutora que tots voldríem!.

A l'equip de treball del projecte dels horts; la Laura Aceituno, la Teresa Garnatje, el Juan José Lastra, la Montserrat Parada, el Manuel Pardo, la Montserrat Rigat, el Joan Vallès i la Sara Vila per l'ajuda incondicional i el magnífic ambient de treball. Vull donar les gràcies en especial a en Joan pels plecs, el català, les revisions i la seva disponibilitat.

Al José Luis Molina per la seva motivació amb aquesta tesi des dels seus inicis i per endinsar-me en el món de les xarxes, ha estat un plaer treballar amb tu.

Gràcies als amics de l'ICTA i en especial al Laboratori d'Etnoecologia. A l'Erik Gómez per les revisions de la tesi i per fer-me ser una mica més crítica. Al Francisco Zorondo per tots els favors.

A la Laura Vaqué, la Maria Calvet i el Dani Corbacho per ajudar-me en la recol·lecció de les dades.

També voldria agrair el suport tècnic per poder realitzar la tesi. A la Laia Echániz per la realització dels mapes, a la Gemma Sauret per la portada, a l'Eric Masip per les

fotografies i al Dani Corbacho per la seva inestimable ajuda informàtica. Gràcies a la Undina Mir per les revisions ortogràfiques.

Als que jo anomeno “els meus pilars intel·lectuals”; Joan Martínez-Alier, Jorge Riechmann, Emmanuel Lizcano i Eduardo Galeano, els seus llibres, classes i conferències m’han ajudat a conformar les meves idees i a criticar constructivament la realitat.

A nivell personal agraeixo el suport diari en aquest i tots els meus altres projectes a les meves amigues, amics i familiars.

PRÓLOGO

Esta tesis se ha desarrollado en el marco del proyecto "Re-valorando la cultura local. El potencial del conocimiento ecológico local al desarrollo rural y la conservación. Estudios de caso en la Península Ibérica" (2007-2010), financiado por la *Dirección General de Investigación Científica y Técnica* del MICINN (SEJ2007-60873/SOCI) y con la participación de investigadores de la Universitat Autònoma de Barcelona (UAB), Universitat de Barcelona (UB), Universidad de Oviedo (UO), Universidad Autónoma de Madrid (UAM), el Institut Botànic de Barcelona (IBB-CSIC-ICUB) y el centro de terminología TERMCAT. Como parte del proyecto y en combinación con mi propia investigación doctoral, recogí datos en la Vall Fosca (Pallars Jussà) durante tres fases de trabajo de campo: marzo-setiembre 2008, julio-setiembre 2009 y julio-setiembre 2010. Durante el trabajo de campo viví en uno de los pueblos que forman parte del estudio, Senterada, lo cual me facilitó las relaciones con la gente del valle y la integración en sus quehaceres diarios.

La presente tesis está a medio camino entre una monografía clásica y una tesis por artículos. Por ello, varios de los capítulos presentan similitudes en las secciones de descripción del área de estudio y descripción metodológica, así como algunos resultados tales como el número de cultivos de manejo local encontrados. He preferido dejar los capítulos tal y como han sido o van a ser publicados para dar coherencia interna a cada uno, aunque al incluirlos todos en el marco de una tesis, el lector hallará ciertas repeticiones. No obstante, he omitido el mapa del área de estudio en cada capítulo por ser un material gráfico redundante. Éste se halla en la introducción de la tesis.

Desde mediados del siglo XX y a nivel mundial, se ha ido produciendo una pérdida de diversidad agrícola, conocida también como erosión genética (Altieri et al. 1987, Zimmerer 1991, Altieri 1999). La principal causa de dicha erosión ha sido la difusión de una agricultura basada en los monocultivos, la mecanización, el uso de productos químicos y la excesiva especialización en el uso de variedades mejoradas y –más recientemente- transgénicas (Toledo y Barrera-Bassols 2008). La introducción de nuevas variedades mejoradas se ha traducido en la pérdida de las variedades utilizadas secularmente (Bellon 2004, Barrera-Bassols et al. 2009, Stromberg 2010). A nivel mundial se ha documentado que el 75% de la diversidad genética de cultivos se perdió durante el siglo XX (Pretty 1995). Por ejemplo, se estima que en algunas zonas de México se ha desplazado en un 90% el uso de semillas locales por semillas foráneas (Barrera-Bassols et al. 2009); durante el último siglo, en Estados Unidos se perdieron el 80% de las variedades tradicionales de tomates, el 92% de lechugas, el 90% de maíz y el 86.2% de manzanas (Kimbrell 2002). En los Países Bajos, a principios de los años 90 una sola variedad de patata ya cubría el 80% de las tierras agrícolas del país (Pimbert 1993).

La estandarización agrícola ha causado graves consecuencias ecológicas y culturales en los sistemas agrícolas tradicionales cuyas principales características son la diversidad de cultivos, el uso limitado de insumos externos, la gran intensidad de trabajo manual, y el uso de tecnologías orientadas a la conservación de los recursos locales y adaptadas a las realidades locales (Toledo y Barrera-Bassols 2008). Algunas de las consecuencias ecológicas de la estandarización agrícola son la alteración de las cadenas tróficas o la reducción del número de especies cultivadas (Altieri et al. 1987). Algunas de sus consecuencias culturales son la pérdida de información sobre las interacciones entre los cultivos y su entorno biofísico y cultural (Toledo y Barrera-Bassols 2008), o dicho de otro modo la pérdida de

conocimientos tradicionales. Por lo tanto, la estandarización agrícola ha conllevado la erosión de la diversidad biocultural (Guzmán-Casado et al. 2000, Toledo y Barrera-Bassols 2008), entendida como la interrelación de la diversidad biológica y cultural dentro de un mismo sistema (Maffi 2007).

Esta tesis se basa en el precepto de que la preservación de la agrobiodiversidad en los sistemas agrícolas tradicionales es importante para la conservación de la diversidad biocultural y los servicios ambientales que ésta genera. De dicha importancia se desprende la necesidad de estudiar modelos exitosos de conservación de la agrobiodiversidad y su conocimiento asociado. Esta necesidad se vislumbra aún más urgente en los países industrializados, como el nuestro, dónde, en las últimas décadas, los cambios en las relaciones sociales y los cambios demográficos y culturales (incluyendo la reducción en el número de fincas agrícolas, la migración hacia áreas urbanas, los incentivos agrícolas, la globalización y la simplificación de las dietas) amenazan el mantenimiento de los agroecosistemas diversificados, como por ejemplo, los huertos domésticos.

Dentro de este contexto, esta tesis analiza la conservación biocultural y la producción de servicios ambientales en los huertos domésticos de la Vall Fosca en el Pirineo catalán. Diferentes estudios sugieren que en el Pirineo ha existido un abundante conocimiento etnobotánico asociado a los huertos domésticos y que este conocimiento parece estar transformándose rápidamente (Agelet et al. 2000, Parada et al. 2009, Rigat et al. 2009, Parada et al. 2011, Rigat et al. 2011). No obstante, el estudio de la conservación biocultural en agroecosistemas tradicionales y su relación con la producción de servicios ambientales aún se encuentra en sus inicios.

La Vall Fosca representa un caso ideal para este estudio ya que es un valle donde, a pesar de mantener agroecosistemas tradicionales, recientemente se ha hallado inmerso en una dicotomía entorno al modelo de desarrollo más deseable. Los resultados y conclusiones de esta tesis pueden ayudar a visibilizar la diversidad

biocultural del valle y generar modelos alternativos de desarrollo rural basados en el mantenimiento de la diversidad biológica y cultural de la zona.

Contexto teórico

La diversidad biocultural

Diversificar es el acto de dar forma o cualidades a determinados elementos para incrementar la variedad de una cierta realidad. La diversidad exalta la variedad, la heterogeneidad y la multiplicidad y es lo opuesto a la uniformidad. En la actualidad, es posible identificar en el planeta dos tipos principales de diversidad, la biológica y la cultural, de cuyo encuentro se derivan por lo menos dos más: la diversidad agrícola y la diversidad paisajística (Toledo y Barrera-Bassols 2008).

La especie humana, como las otras especies, es una parte intrínseca del medio ambiente. Desde los inicios de la especie, los humanos han utilizado y modificado la naturaleza para responder a sus necesidades materiales y no materiales. Al mismo tiempo, las diferentes culturas se han adaptado a su medio ambiente y consecuentemente se han visto influidas y moldeadas en un proceso adaptativo (Maffi y Woodley 2010). Por lo tanto, el complejo sistema de diversidad cultural está profundamente interrelacionado con la diversidad biológica que se halla en la naturaleza (Posey 1999, Maffi 2005, Kassam 2009). La organización, vitalidad y resiliencia de los ecosistemas y las comunidades humanas que se benefician directa o indirectamente de éstos están mutuamente interrelacionados (Berkes y Folke 1998). Todos los humanos están inmersos en esta red de interdependencia, sin importar lo cerca o lejos que su vida cotidiana esté del mundo natural (Maffi y Woodley 2010). El concepto de diversidad biocultural comprende la diversidad de vida en todas sus manifestaciones biológica y cultural, las cuáles están interrelacionadas dentro de un sistema socioecológico complejo y adaptativo (Maffi 2007).

A pesar de que actualmente el incremento exponencial en ritmo y escala de las actividades humanas constituye la primera amenaza hacia el medio ambiente, la especie humana ha sido y sigue siendo un agente potenciador de la biodiversidad (Maffi y Woodley 2010). El papel de la humanidad en el aumento de la biodiversidad se evidencia, por ejemplo, en la creación y manejo de paisajes biodiversos, en la contribución de los agricultores tradicionales al stock global de variedades de plantas de cultivo, o en los comportamientos y creencias tradicionales que contribuyen directa o indirectamente a la conservación de la biodiversidad (Zent y López-Zent 2007).

Los huertos y la diversidad biocultural

Existe una amplia literatura sobre los huertos en países tropicales y comunidades indígenas, destacando la contribución de los huertos en la conservación de la biodiversidad agrícola (Alvarez-Buylla et al 1989, Caballero 1992, Albuquerque et al 2005, Das y Das 2005) y su importancia socio-económica y cultural (Lamont et al. 1999, Wezel y Bender 2003, Heckler 2004). Esta literatura también destaca la importancia del intercambio de semillas entre los hortelanos como mecanismo que contribuye a garantizar la conservación biocultural (Zimmerer 1996, Louette et al. 1997, Thiele 1999, Zimmerer 2003, Badstue et al. 2007).

Una limitación de estos estudios es que se han realizado principalmente en países donde los huertos domésticos son clave para el mantenimiento del sistema alimentario de la población, como por ejemplo Cuba (Shagarodsky 2004), Vietnam (Sunwar et al. 2006) o Perú (Perrault-Archambault y Coomes 2008). La literatura sobre la importancia biocultural de los huertos domésticos en zonas templadas y con poblaciones rurales en países industrializados es más escasa y reciente.

En Europa, la función de los huertos como suministradores de alimentos ha ido en declive desde los años 70 debido a los flujos migratorios de la población hacia zonas

urbanas y al consecuente abandono de los campos de cultivo (Naredo 2004). Este hecho explica, parcialmente, la falta de bibliografía sobre los huertos domésticos europeos contemporáneos, deficiencia que se ha empezado a subsanar solamente en la última década. Esta línea de investigación ha sido impulsada por el reconocimiento que los investigadores de la ciencias biológicas han dado a los huertos europeos como elementos clave en la conservación *in situ* de los recursos genéticos (Watson y Eyzaguirre 2002). Estudios recientes han destacado una alta diversidad biocultural en los huertos domésticos europeos (Guzmán Casado et al. 2000, Vogl y Vogl-Lukasser 2003, Acosta Naranjo y Díaz Diego 2008, Jesch 2009, Aceituno-Mata 2010). Entre otros aspectos, esta literatura –como la literatura de los huertos domésticos en los países tropicales- destaca la importancia del intercambio de semillas entre los agricultores para preservar dicha diversidad (Acosta-Naranjo y Díaz-Diego 2008, Vogly Vogl-Lukasser 2003).

También se ha puesto de relieve la importancia de los huertos en el mantenimiento de la identidad cultural en las sociedades contemporáneas industrializadas (Bhatti y Church 2001, Wagner 2002, Vogl y Vogl-Lukasser 2003, Vogl et al. 2004). Específicamente, estudios en Catalunya, sugieren que los huertos domésticos son un elemento distintivo de la vida rural social catalana (Agelet et al. 2000, Reyes-García et al. 2010). También se ha destacado que los huertos domésticos representan un espacio pequeño, pero significativo, para conservar tanto las variedades agrícolas locales (Ej. Aceituno-Mata 2010), como la seguridad alimentaria (Ej. Boulianne 2006), la calidad alimentaria, y en última instancia la salud (Ej. Clayton 2007). Por último, otros estudios sugieren que los huertos domésticos también contribuyen al mantenimiento de la diversidad cultural y la cohesión social (Brookfield et al. 2003, Nazarea 2005).

El reciente interés científico por los huertos domésticos ha ido acompañado por el nacimiento de iniciativas políticas y sociales. A nivel político, en junio de 2008 la

Comisión Europea adoptó una propuesta que permite que algunos cultivos tradicionales sean cultivados y vendidos sin necesidad de que se registren al Catálogo Común de especies hortícolas. La propuesta está orientada a reducir la erosión genética causada por las reglas y los costos asociados al registro de variedades en este catálogo, garantizando la conservación de los recursos genéticos y del conocimiento asociado a dichos cultivos. A nivel social, han surgido movimientos como el de la soberanía alimentaria, el cual explica la crisis generalizada que sufre des de hace décadas el sector agrario mundial por problemas estructurales y sistémicos del sistema agroalimentario. Este movimiento propone trasformar el sistema agrario mundial y la sociedad en su conjunto cambiando la manera de producir alimentos, y adoptando unas formas de producción que se basen en los recursos naturales y humanos locales, en la capacidad productiva de los ecosistemas locales y en su conservación (Heras 2008, Tendero 2011). Muy ligadas al movimiento de soberanía alimentaria, han surgido otras iniciativas como las cooperativas de consumo, que han revitalizado el papel de la producción hortícola a pequeña escala (López-García y López-López 2003, Galindo 2006). También se han creado bancos de semillas comunitarios que tienen el objetivo de potenciar la preservación y recuperación de algunas variedades locales que han caído en desuso pero que forman parte de la cultura hortícola y culinaria local (www.redsemillas.info), así como la creación de espacios de intercambio y reproducción de estas variedades (www.esporus.org). También se han desarrollado proyectos de huertos comunitarios y la creación de muchos huertos escolares que buscan el aprendizaje interdisciplinar a través del cultivo de pequeños huertos gestionados por estudiantes y profesores (Escutia 2009). Asimismo, algunos museos (como el Ecomuseu de les Valls d'Àneu o el Museu Industrial del Ter) promueven los huertos como parte de recuperación del patrimonio cultural.

Diversidad biocultural y servicios ambientales

Mediante la agricultura, las sociedades modifican los hábitats para crear zonas humanizadas o paisajes, es decir, áreas para la producción de bienes y servicios. Este proceso ha implicado la domesticación del espacio, creando un mosaico en el que se juntan hábitats modificados y hábitats no-modificados. Estos nuevos hábitats del Neolítico, creados hace unos 10.000-12.000 años, fueron diseñados para añadir nuevos productos a los logrados mediante la caza, pesca y recolección. El proceso para obtener estos nuevos productos se basaba en un adecuado manejo de los procesos ecológicos, geomorfológicos e hidrológicos sin afectar mayormente los ritmos y procesos naturales (Toledo y Barrera-Bassols 2008). El cúmulo de saberes, no científicos, que existen en la mente de los productores rurales en todo el mundo y que han servido durante milenios para que la especie humana se apropie de los bienes y servicios de la naturaleza sigue vigente en la actualidad adoptando una gran variedad de formas (Toledo y Barrera-Bassols 2008). Esta variedad se debe a la gran diversidad biocultural que existe en el planeta y que ha permitido a cada sociedad humana apropiarse de forma distinta de los servicios ambientales.

Los servicios ambientales se pueden definir como un conjunto de bienes y prestaciones proporcionados por los ecosistemas, modificados o naturales, que sostienen la existencia humana (Costanza yDaly 1992). Ejemplos de estos servicios son la producción de comida, el mantenimiento de la fertilidad del suelo, la conservación de los recursos genéticos y de la información cultural (Daily 1997, de Groot et al. 2002, MA 2003, Kumar 2010).

Como se ha mencionado en la sección anterior, los huertos europeos aún conservan una gran diversidad biocultural y aunque hay pocos trabajos al respecto (ver Andersson et al. 2007, Barthel et al. 2010), éstos apuntan a que, de esta diversidad, se generan varios servicios ambientales. La importancia de los servicios ambientales

para el mantenimiento de la especie humana hace necesario el estudio de sistemas socioecológicos bioculturalmente diversos, como son los huertos.

Caso de estudio: la Vall Fosca

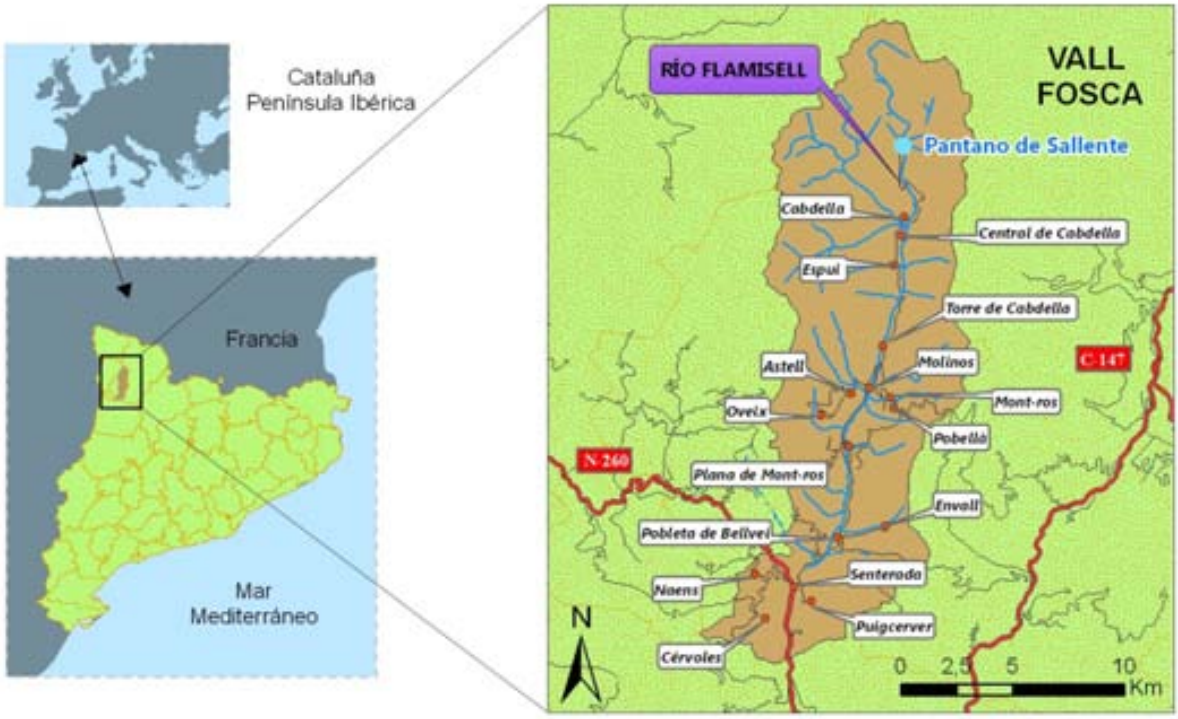
La Vall Fosca[1] es un valle pirenaico de formación glacial de 200 Km^2 y aproximadamente 1000 habitantes que discurre a lo largo del río Flamisell, al norte del Pallars Jussà (Cataluña, Península Ibérica) (Figura 1). También se la conoce como Ribera del Flamisell o Vall de Cabdella. Constituida principalmente por el término municipal de la Torre de Cabdella, incluye geográficamente una parte del municipio de Senterada que presenta las mismas condiciones ambientales que el anterior. La altitud de la región varía desde los 729 metros sobre el nivel del mar hasta casi los 3000 metros, hecho que hace que tanto el clima como la vegetación cambien dramáticamente en tan solo unos 20 Km. La precipitación anual cambia con la altitud, pero oscila entre los 800 y 1200 mm, con una temperatura media anual de aproximadamente 5ºC y con una amplitud térmica de unos 14ºC (Galanó 2008).

Las características geológicas del valle son propiamente las del Pirineo axial formado principalmente por materiales de origen paleozoico (pizarras, calizas y granitos). Asimismo, hay importantes áreas de metamorfismo (gneis, migmatitas) y profundos valles, circos y lagos formados en la erosión glaciar de la era cuaternaria. El plegamiento de los Pirineos se originó a partir de movimientos corticales durante el cretáceo inferior, separando la placa ibérica de la euroasiática y permitiendo la formación de fosas que se llenaron de sedimentos; más tarde estos sedimentos se plegaron y levantaron durante el eoceno a causa del acercamiento y subducción de las dos placas (Galanó 2008).

[1] El topónimo de Vall Fosca data de mediados años 80 cuando el municipio de la Torre de Cabdella creó una marca turística para identificarse. En esta tesis, pero, el topónimo se utiliza para designar el valle del río Flamisell.

La vegetación se distribuye siguiendo un gradiente altitudinal, desde comunidades mediterráneas hasta comunidades alpinas. La parte baja del valle está dominada por diferentes tipos de encinas y robles (*Quercus ilex* L. *subsp.ilex*, *Q. pubescens* Willd., *Q. faginea* Lam. y *Q. cerrioides* Willk. et Costa), haya (*Fagus sylvatica* L.) y pino silvestre (*Pinus sylvestris* L.) como árboles predominantes. Los puntos más altos presentan comunidades de pino negro [*Pinus mugo Turra subsp. uncinata* (Ramond ex DC. in Lam. et DC.) Domin] y prados alpinos (Ageletet al. 2000).

Figura 1: Localización de la Vall Fosca



Sociedad y economía

Para comprender las características sociales y económicas actuales de la zona hace falta hacer una breve mirada al pasado. Tradicionalmente, la Vall Fosca ha sido una zona ganadera. No obstante, a principios del siglo XX se puso en marcha la central hidroeléctrica de la Central de Cabdella y más tarde la de Molinos y por último la de la Plana de Mont-ros. La apertura de estas centrales hidroeléctricas en la zona

conllevó una mejora de la calidad de vida de muchos habitantes de la zona, ya que en pocos años se consiguieron servicios (educación, servicio médico, electricidad, etc.) que hasta entonces eran muy difíciles de obtener, y a la substitución de la actividad ganadera por la ocupación en el mantenimiento de las centrales. La situación, no obstante, ha cambiado mucho desde inicios del siglo XX hasta la actualidad, principalmente debido a las diferentes tendencias migratorias que ha sufrido la zona. Específicamente, se observan tres tendencias migratorias que han afectado la composición y las actividades económicas de la población de la Vall Fosca durante el último siglo. Primero, desde mediados del siglo XX, la zona ha sufrido una fuerte despoblación rural debida tanto a la automatización de las centrales hidroeléctricas que se habían instalado a principios de siglo en el valle, como a la crisis del sector ganadero, y a las mayores oportunidades de educación y trabajo que se encuentran fuera del valle. Segundo, desde la última década del siglo XX el valle ha experimentado un auge del turismo, mayoritariamente en verano. Aunque este es un movimiento poblacional de carácter estacional, es importante porque, de cierto modo, condiciona enormemente todas las actividades productivas de la zona. Finalmente, y de forma más reciente, el área ha experimentado un movimiento de retorno de personas que se habían ido del valle y de otras personas de la ciudad (los llamados neorurales). No obstante, este movimiento de retorno no ha sido suficiente para hacer positivo el crecimiento neto de la población del valle (Cuadro 1).

Cuadro 1: Crecimiento de la población, tasas por mil habitantes

Período, años	**Nacimientos**	**Defunciones**	**Crecimiento natural**	**Saldo migratorio**	**Crecimiento total**
1986-1991	1.89	8.63	-6.74	6.74	0
1991-1996	3.21	9.91	-6.70	-10.18	-16.88
1996-2001	3.20	9.07	-5.87	0.8	-5.07

Fuente: elaboración propia a partir de datos del Idescat.

Respecto a la distribución de la población según sectores productivos y en concordancia con lo dicho anteriormente, actualmente el sector servicios es el más importante, representado principalmente por la hostelería (Cuadro 2). La población ocupada en el sector industrial se dedica básicamente a la industria hidroeléctrica, mientras que el sector agrícola está formado principalmente por ganaderos. Cabe decir que debido a las acentuadas pendientes, la agricultura siempre ha sido una ocupación minoritaria en el valle, siendo los huertos domésticos la forma de cultivo más característica de éste. Actualmente los productos de los huertos suelen ser para consumo doméstico y no se encuentran huertas dedicadas exclusivamente al cultivo de productos para la venta.

Cuadro 2: Distribución de la población ocupada por sectores (porcentajes)

Años	Agricultura	Industria	Construcción	Servicios	Total
1996	22,7	19,4	7,3	50,7	300
2001	16,8	14,2	8,4	60,7	333

Fuente: elaboración propia a partir de datos del Idescat

.

En resumen, los datos socio-económicos sugieren que la Vall Fosca es un valle en un lento proceso de despoblamiento y con una tendencia creciente a la ocupación en el sector servicios, principalmente orientado al turismo. Sin embargo, desde el momento en que la Vall Fosca descubrió su vocación turística, hace ya casi 30 años, se halla inmersa en una dicotomía en la visión de este turismo. Por un lado, se han desarrollado varias iniciativas públicas para revitalizar el valle a través del patrocinio de las ofertas turísticas relacionadas con el patrimonio histórico y/o natural del Valle. Algunas de estas iniciativas son las visitas guiadas al museo hidroeléctrico de La Central de Cabdella, visitas a las iglesias románicas, excursiones a la zona lacustre y barranquismo. A nivel privado se ha desarrollado el turismo en casas rurales que busca una aproximación a la naturaleza y cultura del lugar.

La otra visión del turismo en la zona viene representada por la construcción de unas pistas de esquí en la zona. En 1982 el ayuntamiento de la Torre de Cabdella consiguió que, dentro del Plan de Ordenación de Estaciones de Montaña, se contemplase la construcción de una estación de esquí en el valle del Filià y más tarde, en 1995 un proyecto para construir un campo de golf en la zona. En 2006 se inició en el municipio de Espui la construcción de un espacio residencial y hotelero, llamado Vallfosca Mountain Resort, con una estación de esquí alpino con capacidad para 3500 esquiadores, un campo de golf, actividades en BTT, SPA, etc. El proyecto se encuentra parado en la actualidad ya que la constructora, Martina-Fadesa, suspendió pagos y presentó un concurso voluntario de acreedores[2] durante julio del año 2008. Actualmente el municipio es objeto de un grave impacto paisajístico ya que hay muchos edificios inacabados, herramientas de trabajo abandonadas y las torres para las pistas de esquí plantadas. Un paisaje desolador que nada tiene que ver con las esperanzas de vitalidad y prosperidad que esperaban muchos habitantes del valle entorno a dicho proyecto. Este proyecto, desde sus inicios, ocasionó una gran controversia entre los habitantes del valle, los cuales se posicionaron en dos bandos; los que creían que el proyecto de desarrollo reactivaría la economía y los que defendían que este proyecto no era más que otro de especulación urbanística y que éste no era el modelo de desarrollo que querían para el valle. En desacuerdo con estas iniciativas existen diferentes grupos como Vall Fosca Activa y el partido político Alternativa per la Vall Fosca los cuáles proponen proyectos endógenos de patrocinio del valle desde una perspectiva de desarrollo rural sostenible tanto económico, como social y ambiental.

[2]Se denomina concurso de acreedores al procedimiento legal que se origina cuando una persona física o jurídica deviene en una situación de insolvencia en la que no puede hacer frente a la totalidad de los pagos que adeuda. El concurso de acreedores abarca las situaciones de quiebra y las de suspensión de pagos.

Objetivos y estructura de la tesis

El objetivo general de esta tesis es analizar los huertos familiares de la Vall Fosca como sistemas socioecológicos, o sistemas integrados y complejos que emergen a través de las interacciones continuas entre sociedades humanas y los ecosistemas de los cuáles forman parte (Berkes y Folke 1998).

Los objetivos específicos se enmarcan en cuatro grandes temas que conforman cinco artículos, correspondientes a los cinco capítulos de esta tesis, y son los siguientes:

A) Los huertos como sistemas socio-ecológicos en transición

1) Catalogar a) la diversidad de cultivos de manejo local[3] y b) el conocimiento ecológico tradicional asociado a los cultivos de manejo local presentes en los huertos de alta montaña de la Vall Fosca (Pirineos Catalanes, Península Ibérica).

2) Estimar los cambios en los cultivos de manejo local y en el conocimiento asociado a los mismos.

El primer capítulo de esta tesis corresponde al artículo "Traditional ecological knowledge and landraces *in situ* conservation in high mountain home gardens of Vall Fosca, Catalan Pyrenees, Iberian Peninsula" publicado en el libro *Tradiciones y tranformaciones en etnobotánica* (Ed.CYTED). Este capítulo estudia la relación entre conocimiento ecológico tradicional y gestión de los huertos domésticos, centrándose en la información cultural (conocimiento y tradiciones) relacionada con la conservación *in situ* de los cultivos de manejo local. El capítulo busca establecer la existencia de cultivos de manejo local y el conocimiento asociado a los mismos en un área rural de un país industrializado.

[3] En esta tesis se utiliza el término cultivo de manejo local o *landraces* en inglés para designar lo que otros autores han denominado variedades tradicionales y/o variedades locales. Se ha evitado la utilización de variedad, ya que en este estudio no se ha discernido si los cultivos evaluados pertenecen o no a la categoría taxonómica de variedad.

B) La conservación *in situ*

3) Estimar la asociación entre las características socio-demográficas individuales de los hortelanos y la conservación *in situ* de cultivos de manejo local.

4) Explorar las razones de la conservación de los cultivos de manejo local.

En el segundo capítulo, correspondiente al artículo "Landraces *in situ* conservation: a case study in high-mountain home gardens in Vall Fosca, Catalan Pyrenees, Iberian Peninsula", publicado en *Economic Botany*, se evalúan las características socio-económicas de los hortelanos que se correlacionan con la conservación *in situ* de los cultivos de manejo local, así como las motivaciones que subyacen a dicha conservación. Es decir, quién y por qué se conservan los cultivos de manejo local y su conocimiento asociado.

C) Huertos y redes de intercambio

5) Evaluar la estructura de la red de intercambio de semillas entre los hortelanos de la Vall Fosca.

6) Estimar la asociación entre la centralidad individual en la red de intercambios de semillas y 1) la conservación de cultivos de manejo local y 2) el conocimiento asociado a los cultivos de manejo local.

En el tercer capítulo, correspondiente al artículo "Seed exchange as an agrobiodiversity conservation mechanism: A case study in Vall Fosca, Catalan Pyrenees, Iberian Peninsula" aceptado pendiente de revisiones menores en *Ecology and Society*, se analizan las redes sociales de intercambio de semillas y su papel como una herramienta básica en la conservación *in situ* de los cultivos de manejo local y su conocimiento asociado.

D) Servicios ambientales de los huertos domésticos

8) Identificar y caracterizar los servicios ambientales proporcionados por los huertos.

9) Realizar una valoración social de la importancia de los servicios ambientales de los huertos.

10) Explorar el rol del género en la valoración de los servicios ambientales de los huertos.

El cuarto capítulo pretende aclarar la importancia de los huertos domésticos como proveedores de servicios ambientales. Este capítulo, correspondiente al artículo "Beyond food production: Ecosystem services provided by home gardens. A case study in Vall Fosca, Catalan Pyrenees, northeastern Spain", aceptado pendiente de revisiones menores en *Ecological Economics*, apunta que la diversidad biocultural de los huertos domésticos es un factor clave en la provisión de servicios ambientales.

El quinto capítulo, corresponde al artículo "Gender differences in ecosystem services valuation: A case study in home gardens of the Catalan Pyrenees, northeastern Spain", en revisión en *Environment and Behavior*. En este capítulo se evalúan las diferencias entre hombres y mujeres en la valoración de los servicios ambientales proporcionados por los huertos con el fin de aportar nuevos datos que faciliten el entendimiento de la relación entre actitudes pro-ambientales y la socialización de género.

Posteriormente, en el apartado de reflexiones finales, se proponen varias estrategias para crear modelos endógenos de desarrollo rural partiendo de la conservación biocultural.

La tesis cuenta también con un anexo en el que se describen los proyectos de difusión y cooperación llevados a cabo durante la tesis doctoral con la administración y la población local de la Vall Fosca. Estos proyectos parten de una manera de ver la ciencia como algo en lo que se debe implicar la gente y facilitar a la ciudadanía una imagen de la ciencia comprensible y cercana que ayude a aportar soluciones locales a inquietudes o problemas concretos.

Finalmente, se incluye un apéndice fotográfico con imágenes de los huertos, cultivos de manejo local, poblaciones y talleres.

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CHAPTER 1

Traditional ecological knowledge and landraces *in situ* conservation in high mountain home gardens of Vall Fosca, Catalan Pyrenees, Iberian Peninsula[4]

[4] Calvet-Mir L., Calvet-Mir M. and 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: M.L. Pochettino, A.H. Ladio and P.M. Arenas (Editors), Tradiciones y tranformaciones en etnobotánica. CYTED, Argentina, pp. 457-464.

Abstract

Interest in the link between traditional knowledge and ecosystem management has grown over the last decades. In this paper we link both topics by studying the knowledge and traditions related to *in situ* conservation of landraces. We 1) assess the diversity of landraces in high-mountain home gardens of the Vall Fosca (Pyrenees), 2) catalogue the traditional ecological knowledge associated to these landraces, and 3) estimate changes in the maintenance of landraces and knowledge about them. For the analysis we use data from 60 temperate home gardens owned by 53 tenders, from 16 villages. We identified 39 landraces corresponding to 31 species, most of them with traditional ecological knowledge associated. The number of landraces cultivated in home gardens seems to have decreased since the 1960's.

Key words: Agrobiodiversity; Catalonia; cultural management; kitchen gardens; temperate areas.

Introduction

Throughout the world, indigenous and rural people continue to manage agro-ecosystems traditionally. Harvesting, gathering and other management practices are often needed for subsistence. Often, the same practices are also important social activities that contribute to define cultural identity and provide links to people's history, ancestors, land, art and environmental philosophy (Moller et al. 2004).

The last two decades have witnessed a growing interest in the traditional knowledge associated to ecosystem management. Traditional ecological knowledge (TEK) has been defined as "a cumulative body of knowledge, practice and belief, evolving by adaptative processes and handed down through generations by cultural transmission, about the relations of living beings (including humans) with one another and with their environment" (Berkes et al. 2000: 1252). Since the 1980s, a growing literature within environmental sciences, ecological anthropology, resilience theory, and agroecology has stressed the potential role of traditional knowledge in sustainable natural resource management, biodiversity conservation, and cultural empowerment (e.g. Altieri and Merrick 1987, Jarvis and Hodgkin, 1999, Berkes et al. 2001, Maffi 2002, Toledo 2002, Moller et al. 2004, Drew and Henne 2006). Traditional ecological knowledge has also entered the policy realm. For instance, the Convention on Biological Diversity (1992) recognized the inextricable link between biological and cultural diversity and the role of traditional knowledge on *in situ* biodiversity conservation (Maxted et al. 2002).

Here we contribute to research on the link between traditional knowledge and ecosystem management by focusing on cultural information (knowledge and traditions) related to *in situ* conservation of landraces. Specifically, we 1) assess the diversity of landraces maintained in high-mountain home gardens of the Vall Fosca valley (Catalan Pyrenees, Iberian Peninsula), 2) catalogue the traditional ecological

knowledge associated to these landraces, and 3) estimate changes in the maintenance of landraces and knowledge about them.

For the empirical analysis we use data from 60 temperate home gardens in Vall Fosca. We focus on home gardens because previous research has highlighted the importance of home gardens in the maintenance of crop and agroforestry genetic resources (Soemarwoto et al. 1985, Padoch and de Jong 1991, Gispert and Nuñez 1993, Rugalema et al. 1995, Millat et al. 1996, Agelet et al. 2000, Trinh et al. 2003, Khoshbakht et al. 2006, Sunwar et al. 2006, Perrault-Archambault and Coomes 2008). For example, research on *in situ* conservation within home gardens in tropical (Watson and Eyzaguirre 2002) and temperate areas (Guzmán-Casado et al. 2000, Vogl and Vogl-Lukasser 2003, Aceituno-Mata 2006, Acosta-Naranjo and Díaz-Diego 2008) suggests that home gardens serve as local gene banks, contributing to preserve biodiversity.

We use the term "home garden" to refer to small, fenced plots close to the farmers' homestead, where annual, biennial, and perennial cultivated species are grown in beds (Vogl and Vogl-Lukasser 2003). For the purpose of this paper, we use the term "landrace" to refer to annual and biennial crops that have been reproduced by farmers during more than one generation (30 years or more) in a specific geographic area, keeping the seeds continuously. For perennial crops and crops with vegetative reproduction, we use the term landrace when a specific crop has been cultivated and reproduced in the area for more than 60 years. These crops have been selected by the farmers from domesticated or wild species, adapting them to the local environmental conditions and to the local agrarian culture uses and management (Brown et al. 1978, Cleveland et al. 1994, Guzmán-Casado et al. 2000, Louette 2000).

Methods

We collected data between March and September 2008 and between July and September 2009. Data collection included garden inventories and structured interviews.

Study site

The study was conducted in Vall Fosca, a mountain valley in Northern Catalonia (northeastern Iberian Peninsula). Vall Fosca is a Pyrenean valley of glacial formation of 200 km^2 and 1000 inhabitants lying along the Flamisell River. Vall Fosca translates as "dark valley", a name that originates from the short hours of sunlight on the valley due to the marked slopes of the surrounding mountains. Annual precipitation changes with altitude, ranging from 800 to 1200 mm. The altitude in the region varies from 729 masl to nearly 3000 masl allowing for an altitudinal vegetation gradient ranging from Mediterranean to Alpine communities. The lower altitudes are dominated by different kinds of oaks (*Quercus pubescens* Willd., *Q. faginea* Lam. and *Q. cerrioides* Willk. et Costa), beech (*Fagus sylvatica* L.) and red pine (*Pinus sylvestris* L.). The high points have black pine communities [*Pinus mugo* Turra subsp. *uncinata* (Ramond ex DC. in Lam. et DC.) Domin] and alpine meadows (Agelet et al. 2000).

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. Due to high slopes, agriculture in the valley is rare. The most characteristic form of cultivation of Vall Fosca is home gardens. Due to the absence of shops and the difficult accessibility to the market town, especially in winter, traditionally home gardens in Vall Fosca had a high diversity of species and varieties. Customarily home gardens were managed by women as a part of their household activities, as men spent large shares of their time

outside the household in charge of the cattle. Nowadays these traditional features are still partially present.

In our previous work (Calvet-Mir et al., unpublished data) we found that some socio-demographic attributes of the gardener are associated with *in situ* conservation of annual and biennial landraces. Specifically, women, retired people, people who manage an organic garden, and experienced gardeners conserve a major number of annual and biennial landraces than people without those characteristics. We also found that the conservation of perennial landraces is not associated to socio-demographic attributes of the gardeners, probably because fruit trees are not intensively managed in the area nowadays. Our work suggests that landraces might be a marker of cultural identity, since local traditions and identity are still linked to agrarian activities.

Sample

Research was conducted in 16 of the 23 villages in Vall Fosca. The study villages vary notably in altitude and population size and composition. The altitude of the studied villages ranges from 729 masl to 1422 masl. The number of permanent residents ranges from 5 to 156 inhabitants, with three villages composed by one family. Only three of the 16 villages studied have a grocery shop with fresh fruits and vegetables, although all the villages are visited once a week by an itinerant trader who sells fresh fruits and vegetables. All the villages have weekly bus access to the nearest market town, La Pobla de Segur, where there are several shops and supermarkets.

Structured data collection included the inventory of 60 home gardens belonging to 53 households, almost all the home gardens in the study area.

Methods of data collection

Inventory: To capture seasonal variation, over the seven months of research in 2008, we visited all home gardens in the sample three times. On the first visit, we requested the main tender to accompany us to the home garden. We then asked the tender to identify all the edible plants present in the home garden at the moment of the visit. In the two subsequent visits we noted the presence of crops not present during previous visits. During the inventories we asked about the origin of each seed. If the seed was kept from the gardener's previous crop, we asked how long s/he had been keeping the seed continuously. The procedure allowed us to identify landraces. Photos of each variety were taken to contrast the information with vouchers from the herbariums of Universitat de Barcelona (BCN), Real Jardín Botánico, CSIC (MA) and Universidad de Oviedo (FCO). Vouchers of all identified landraces were deposited in the herbarium of the Centre de Documentació de Biodiversitat Vegetal, Universitat de Barcelona (BCN).

Structured interviews: We conducted structured interviews in 2009 to gather knowledge about landraces. We interviewed 13 landraces' custodians that we selected from our previous sample of 53 garden tenders. These interviews served us to gather information about the name's origin, plant characteristics, distribution area, specific management, recipes and sayings of each landrace maintained in the gardens. During those interviews we also asked about crops that their parents or grand parents used to plant from seeds.

Methods of data analysis

We used the inventories to identify 1) annual landraces (annual and/or biennial crops that have been reproduced by the farmers during more than 30 years in a specific geographic area, keeping the seeds continuously) and 2) perennial landraces (perennial and/or vegetative reproduction species that have been cultivated and

reproduced in a specific geographic area for more than 60 years). The inventories also allowed us to identify the major landraces' custodians. Data from structured interviews permitted us to catalogue the traditional ecological knowledge associated to the landraces and estimate changes in the maintenance of landraces and knowledge about them.

Results and discussion

Presence of landraces in home gardens

We found 39 taxa that fit in our definition of landraces. They are listed in Table 1.1 indicating species and family name, voucher number, presence in sampled gardens, and type of landrace (annual or perennial). Sixteen landraces were cultivated by one tender only, whereas six landraces were cultivated by ten or more gardeners in the sample. Most landraces belonged to the Fabaceae and Rosaceae families, with 10 landraces from each family. On average, each tender grew 3.68 landraces, 2.26 annual and 1.41 perennial. One tender had 14 landraces, but ten gardeners (or 18.87% of the sample) do not have any landrace. Although most of the species in our sample are from commercial origin, the landraces identified represent the 16.62% of the diversity of home gardens.

Comparison of the number of landraces encountered in our study with other studies is difficult for two main reasons. First, many studies in tropical regions have focused on the presence of native versus exotic species (Padoch and de Jong 1991, Azurdia and Leiva 2004) or have analyzed genetic diversity of a single crop (Shagarodsky et al. 2004, Sthapit et al. 2004, Williams 2004). The scope of our research is different, since the aim was to assess the number of landraces maintained in the area. Second, previous studies on landraces have used different definitions of the concept or different sampling methods. For example, in Vietnam, Gessler and Hodel (2004) used individual descriptions to assess the diversity of landraces in home gardens.

Sthapit et al. (2004) include seeds from companies to assess the diversity of two species in traditional farming systems of Nepal and Vietnam. Despite the difficulty of the comparison, our finding seems in the line of other studies in the Iberian Peninsula. Thus, in a study in three provinces of Andalusia (Spain) Guzmán-Casado et al. (2000) described and evaluated 52 landraces of 15 different species, Acosta-Naranjo and Díaz-Diego (2008) described 23 landraces in the district or "*comarca*" of Tentudia, Extremadura (Spain), and in a study of 92 home gardens in a village located in Sierra Norte de Madrid (Spain), Jesch (2009) described 24 landraces of 13 different taxa.

Table 1.1

List of the 39 landraces found in home gardens of Vall Fosca valley and presence in home gardens (n=60)

Vernacular name (Catalan)	Scientific name	Family	Voucher	Presence in home gardens	Type
Bleda del país	*Beta vulgaris* L. subsp. *vulgaris* var. *vulgaris*	Chenopodiaceae	BCN-S 1653	24	Annual
Col berrugada	*Brassica oleracea* L. var.*capitata* (L.) Alef.	Brassicaceae	BCN-S 1660	1	Annual
Col de lluc	*Brassica oleracea* L. var.*capitata* (L.) Alef.	Brassicaceae	BCN-S 1671	3	Annual
Col de ruc	*Brassica oleracea* L. var.*oleracea*	Brassicaceae	BCN-S 1661	16	Annual
Carbassa de rabequet	*Cucurbita maxima* Duch.	Cucurbitaceae	BCN-S 1659	6	Annual
Enciam de carxofeta de la Maria	*Lactuca sativa* L. var. *capitata* L.	Asteraceae	BCN-S 1672	3	Annual
Tomata rosa de la Paquita	*Lycopersicum esculentum* Mill.	Solanaceae	BCN-S 1666	1	Annual
Julivert	*Petroselinum crispum* (Mill.) Hill	Apiaceae	BCN-S 1654	28	Annual
Fesol afartapobres	*Phaseolus coccineus* L.	Fabaceae	BCN-S 1664	13	Annual
Fesol de mata baixa	*Phaseolus vulgaris* L. var.*nanus* (L.) Aschers	Fabaceae	BCN-S 1663	2	Annual
Mongeta grogueta de mata baixa	*Phaseolus vulgaris* L. var.*nanus* (L.) Aschers	Fabaceae	BCN-S 1658	1	Annual
Mongeta perona de mata baixa	*Phaseolus vulgaris* L. var.*nanus* (L.) Aschers	Fabaceae		1	Annual
Fesol de mata alta	*Phaseolus vulgaris* L. var.*vulgaris*	Fabaceae	BCN-S 1662	3	Annual
Fesol perona de mata alta	*Phaseolus vulgaris* L. var.*vulgaris*	Fabaceae	BCN-S 1657	14	Annual
Fesol de beina llarga verda	*Phaseolus vulgaris* L. var.*vulgaris*	Fabaceae	BCN-S 1669	1	Annual
Mongeta lila, de mantequilla	*Phaseolus vulgaris* L. var.*vulgaris*	Fabaceae	BCN-S 1670	1	Annual
Mongeta pilarica de mata alta	*Phaseolus vulgaris* L. var.*vulgaris*	Fabaceae	BCN-S 1655	1	Annual
Mongeta vermella per a tavella i gra	*Phaseolus vulgaris* L. var.*vulgaris*	Fabaceae	BCN-S 1656	1	Annual

Vernacular name (Catalan)	Scientific name	Family	Voucher	Presence in home gardens	Type
Ceba de paret/escalunya	Allium ascalonicum L.	Liliaceae	BCN 62717	11	Perennial
All	Allium sativum L.	Liliaceae	BCN 60897	3	Perennial
Espàrrecs	Asparagus officinalis L.	Liliaceae	BCN 62710	4	Perennial
Safrà	Crocus sativus L.	Iridaceae		1	Perennial
Codonyer autòcton	Cydonia oblonga Mill.	Rosaceae	BCN 62712	1	Perennial
Escarxofes	Cynara scolymus L.	Asteraceae	BCN 62702	1	Perennial
Figuera	Ficus carica L.	Moraceae	BCN 62707	2	Perennial
Maduixera	Fragaria x ananassa (Weston) Duchesne ex Rozier	Rosaceae	BCN 62708	8	Perennial
Patatera	Helianthus tuberosus L.	Asteraceae	BCN 62706	1	Perennial
Pomer autòcton	Malus domestica L.	Rosaceae	BCN 62711	10	Perennial
Menta	Mentha sp.	Lamiaceae		2	Perennial
Menta	Mentha spicata L.	Lamiaceae	BCN 62704	7	Perennial
Herbabona	Mentha x gentilis L.	Lamiaceae	BCN 62705	2	Perennial
Cirerer	Prunus avium L.	Rosaceae	BCN 62709	1	Perennial
Pruna clàudia	Prunus domestica L. subsp. domestica	Rosaceae	BCN 62713	5	Perennial
Prinyó d'agost	Prunus domestica subsp. insititia (L.) Bonnier et Layens	Rosaceae	BCN 62714	3	Perennial
Pruna roja	Prunus domestica L. subsp. domestica	Rosaceae	BCN 62718	1	Perennial
Pruna rossa	Prunus domestica L. subsp. domestica	Rosaceae		1	Perennial
Pera de la Mare de Déu d'Agost	Pyrus communis L.	Rosaceae	BCN 62716	4	Perennial
Perer	Pyrus communis L.	Rosaceae	BCN 62715	6	Perennial
Parra	*Vitis vinifera L.*	Vitaceae	BCN 62703	1	Perennial

In situ conservation and traditional ecological knowledge

Landraces in Vall Fosca have associated a large extent of traditional ecological knowledge. Evaluating the data gathered with structured interviews we realized that each landrace has particular features. As an example of those features, here we describe the landraces or group of landraces with more special characteristics. The goal of the exercise is to show the links between traditional knowledge and the maintenance of landraces, rather than catalogue the information related to each landrace. The traditional ecological knowledge linked to landraces include information on the appropriated sowing, planting, and harvesting calendar; type of manure, rotations, instructions for keeping the seeds; culinary, fodder and medicinal uses. This knowledge also includes sayings related to some ecological characteristics of the landrace.

For example, all the landraces that belong to the genus *Phaseolus* are normally sowed directly in the ground at the middle of May, concretely around Saint Isidore (May 15th). The holes have to be shallow. As the saying goes, "*El fesol vol sentir tocar missa*" ("Beans want to hear the church bells"). It is also said that the gardener must put two or three seeds in each hole, and holes should be separated by about 50 cm, or as they said "*Entre fesol i fesol s'hi ha de poder ajeure una ovella*" ("Between bean and bean a sheep should be able to sleep").

Gardeners also have traditional knowledge on cultivation and harvesting practices. For example, it is common in the area that gardeners put ashes over *Allium sativum* L. and *Allium ascalonicum* L. as manure and to avoid pests. *Col de ruc* (*Brassica oleracea* L. var. *oleracea*) is harvested for human consumption only after the first frost, although its leaves can be harvested before as fodder for the hens and pigs.

As mentioned, traditional ecological knowledge also includes information on how to use different landraces. For example, the three landraces encountered of the species

Brassica oleracea L. are used as edible, fodder, and as medicinal remedy to diminish external inflammations. *Cydonia oblonga* L. is used to do a type of sauce very appreciated "*allioli de codony*". This sauce is made with garlic, olive oil and quince, and is used to accompany meat dishes.

In addition to knowledge of specific landraces, there is a more general traditional ecological knowledge that includes the management of all landraces. For example, gardeners believe that to get a good harvesting they must sow in "*lluna ferma*", or the period that goes from full to new moon. Similarly, the harvesting of vegetables that can be storaged, such as onions, garlics, or pumpkins, should be done during the same period. Gardeners keep wild flowers and plants around the home garden to avoid pest and favour pollination. They also rotate crops from one year to the other: "*A l'hort s'han de fer rotacions si no la terra es cansa*", translated as "If you do not rotate crops, the earth gets tired".

Changes in the maintenance of landraces and knowledge about them

We tried to evaluate to what extent a decrease in the number of landraces had occurred in home gardens during the last decades. Using information from structured interviews we obtained a historic baseline for the description of changes in floristic composition, particularly landraces, and the traditional ecological knowledge associated to them. Many of our informants were over 60 years of age, so they had memories for at least 40 years. In addition some informants were older (up to 90) and could remember even further back. Information was also gathered from the informants' memories of lore passed down form their parents or grandparents. We deduced that landraces represented the majority of edible crops cultivated in the home garden before 1960. Beyond 1960 the number of landraces cultivated in home gardens declined rather steeply, due to the major accessibility to market towns, and the introduction of new crops. We estimate that half of landraces cultivated and used in the 1960s have disappeared from the home gardens or have fallen into disuse. For

instance, potatoes' landraces have disappeared from the home gardens of Vall Fosca, and *Cynara cardunculus* L., used to curdle milk, has fallen into disuse and only remains in some home gardens as a witness of a lost cultural tradition.

From the 39 landraces found in this research, 16 were only present in only one garden, probably as a remainder of a past tradition or due to the gardener like this specific landrace. For example, an 81 years old woman is the only person that still cultivates *Helianthus tuberosus* L. She explained that she likes to preserve the tubercles of this plant with vinegar and aggregate them to salads. As Agelet et al. (2000) argue in a study about the loss of diversity of useful medicinal plants in home gardens of mountain regions of Catalonia, these are examples of the acculturation to which rural communities have been subjected by the industrialization of Iberian regions and in Europe in general. A similar situation was also reported from Mayan home gardens by Rico-Gray et al. (1990) and Caballero (1992), and in a Moroccan oasis (Bellakhdar et al. 1987). Many people remember that they use to have landraces for some species, such as potatoes, and although they do not cultivate and use them anymore, they still remember the traditional management and the taste of these landraces.

We found two main reasons that could explain the decrease in landraces cultivation in home gardens. First, landraces are more labour-intensive than commercial varieties (since it is necessary to do the seed bank). Second, gardeners argue that when they grow landraces they have to wait for their harvest longer than when they use commercial varieties. This is mostly due to the fact that most gardeners do not have the technical equipment (e.g., green houses) to start the seed bank during the winter, so landraces seedlings are usually planted later than commercial varieties seedlings, and therefore their harvesting also comes later. As reported by Reyes-García et al. (2009) in a study of home gardens in three different mountain regions of the Iberian Peninsula, although some decades ago gardeners seemed to have

depended on their seeds to grow crops, during the study period (2008) as much as 61% of the propagules had a commercial origin. Second, changes in the dietary habits and the accessibility to market town also have been the cause of the marginalization of some landraces. For example, fruits are usually bought at market, because market fruits are bigger and more tasteful than local ones. The use of *Allium ascalonicum* L., has decreased dramatically because the commercial varieties of *Alliium cepa* L. are more tasteful and have the same us as *Allium ascalonicum* L. Agelet et al. (2000) also encountered in the changes of dietary habits a major reason of the disuse of some taxa as *Prunus domestica* subsp. *insititia* (L.) Bonnier & Layens. Despite of the decrease of landraces cultivated in home gardens of Vall Fosca since middle last century we found information on recent introduction of landraces into the home gardens. There are species that have been introduced in the area in the 1970s and 80s and seem to adapt well to the local environmental conditions and to the local agrarian culture uses and management. For example, three landraces of *Phaseolus vulgaris* L. var. *vulgaris* (*fesol perona de mata alta, fesol de beina llarga verda, fesol lila de mantega*). These crops seem to have displaced other older landraces of *Phaseolus vulgaris* var. *vulgaris* due to their better taste or their easier cooking.

Conclusions

In conclusion, the finding of 39 landraces Vall Fosca and the large extent of traditional ecological knowledge associated to them highlights the importance of home gardens for *in situ* conservation for two main reasons: 1) home gardens in Vall Fosca act as repositories of crop genetic diversity and cultural information, and 2) landraces and their linked knowledge are still available in a region where modern commercial varieties dominate the seeds system. Researchers and policy makers should join efforts to collaborate with local people in the maintenance of this form of cultural and biological diversity.

Acknowledgements

Research was funded by the Ministerio de Educación y Ciencia (MEC-España) (SEJ2007-60873/SOCI), the Generalitat de Catalunya (AGAUR and CPCTC). L. Calvet-Mir acknowledges finantial support from a FPU grant (MEC-España, AP-2006-01849). We thank all the tenders who collaborated in the project. We also thank L. Aceituno, M. Chaves, T. Garnatge, J.J. Lastra, M. Parada, M. Pardo, M. Rigat, J. Vallès, L. Vaqué, and S. Vila for help in the fieldwork, identification of species and comments to previous versions of this work.

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CHAPTER 2

Landraces *in situ* conservation: a case study in high-mountain home gardens in Vall Fosca, Catalan Pyrenees, Iberian Peninsula[5]

[5] Calvet-Mir L., Calvet-Mir M., Vaqué-Nuñez L. and Reyes-García V., 2011. Landraces *in situ* conservation: a case study in high-mountain home gardens in Vall Fosca, catalan Pyrenees, Iberian Peninsula. Economic Botany, 65:146-157.

Abstract

Interest in landrace conservation has grown over the last decades with much research focusing on the maintenance of on-farm crop genetic diversity in the tropics. Research on landraces is less abundant in temperate climates. In this paper we assess landraces conservation status in home gardens in Vall Fosca (Catalan Pyrenees, Iberian Peninsula). We estimate the individual socio-demographic attributes associated to *in situ* conservation of landraces and explore the reasons for their conservation. Field work was conducted in March-September 2008. We surveyed 60 home gardens, owned by 53 tenders from 16 villages. We recorded occurrence, abundance, uses, and management of plants cultivated in home gardens. We also enquired about the informants' reasons for conserving landraces. We found 148 different species. We identified 39 landraces corresponding to 31 species. Women, people over 65 years of age, experienced gardeners, and people who grow their home garden organically were more likely to conserve landraces than people without those characteristics. Although the informants express a strong preference for landraces, they mainly grow commercial varieties. Landraces seem to be displaced by less labor intensive commercial varieties.

Key words: Catalonia; commercial varieties; crop genetic diversity; cultural tradition; seeds exchange.

Introduction

Researchers and policy makers have highlighted the importance of *in situ* conservation, or conserving crop genetic resources in the environments in which they occur (Maxted et al. 2002). Researchers have emphasized the need for *in situ* conservation of crop genetic resources for three reasons. First, maintaining genetic diversity, both at the species and within species levels, is important to continue the process of crop evolution through farmers' selection. Differently from *ex situ* conservation, *in situ* conservation enhances the crop's ability to adapt to changing conditions or requirements (Altieri et al. 1987, Altieri and Merrick 1987). Second, because adapted crops have a low dependency on outside-farm inputs, *in situ* conservation is related to yield security and sustainable production (Altieri and Merrick 1987, Prescott-Allen and Prescott-Allen 1982). Last, *in situ* conservation ensures the maintenance of cultural information (knowledge and traditions) that might enhance crop productivity (Cox 2000, Maffi 2002).

At the political level, discussions concerning the *in situ* conservation of crop genetic resources first occurred in the 1992 Convention on Biological Diversity (Maxted et al. 2002) and have grown since then. For instance, over the last decade Bioversity International, one of the centers of the Consultative Group for International Agricultural Research (CGIAR), has worked on the *in situ* maintenance and use of crop genetic diversity, particularly landraces (Jarvis and Hodgkin 2008).

Previous research on *in situ* conservation of crop genetic resources has addressed ecological issues such as the maintenance of crop genetic diversity in agricultural ecosystems (Jarvis and Hodgkin 2008) particularly in home gardens (e.g. Eyzaguirre and Linares 2004), the conservation of neglected and underutilized crops (Padulosi et al. 2008), and the value of agricultural diversity as a source of nutrition and health (Frison et al. 2006). Researchers have, however, paid less attention to social aspects associated to *in situ* conservation of crop genetic resources. The scant research on

the topic has highlighted the importance of farmers' networks to preserve plant varieties, traditional practices, and cultural values in rural communities (Watson and Eyzaguirre 2002).

Here we contribute to research on *in situ* conservation of crop genetic resources by focusing on an understudied topic in an understudied region of study. Specifically, we 1) assess the diversity of species and landraces maintained in high-mountain home gardens of a region of the Catalan Pyrenees, 2) estimate the association between individual socio-demographic characteristics and landraces *in situ* conservation, and 3) explore the reasons for landrace conservation. For the empirical analysis we use data from temperate home gardens in the Vall Fosca, Catalan Pyrenees.

We focus on home gardens because previous research has highlighted the importance of home gardens in the maintenance of plant genetic resources (Agelet et al. 2000, Sunwar et al. 2006, Perrault-Archambault and Coomes 2008). We use the term "home garden" to refer to small, fenced plots close to the farmers' homestead, where annual, biennial, and/or perennial cultivated species are grown in beds (Vogl and Vogl-Lukasser 2003). We also follow Vogl and Vogl-Lukasser (2003) and use the term "crops" to refer to domesticated plants as well as to wild plants under incipient management (tolerated, encouraged, or protected) present in home gardens. Specifically, we included under our definition of crop wild plants present in home gardens when gardeners indicated some use of the plant and mentioned that they were intentionally tolerated in the garden (i.e., Fragaria vesca L.). We excluded wild plants considered weeds by gardeners. Last, we use the term "landrace" to refer to annual and biennial crops that have been continuously reproduced by farmers during more than one generation (30 years or more) in the area of study. For perennial crops and crops with vegetative reproduction, we use the term landrace when the crop has been cultivated and reproduced in the area for more than 60 years (Brown 1978,

Cleveland 1994, Guzmán-Casado et al. 2000, Louette and Smale 2000). We did not collect genetic information from landraces, so our definition of landraces refers to folk (rather than to genetically different) landraces.

Methods

This study is part of a bigger research among home gardens in three rural areas of the Iberian Peninsula conducted by a multidisciplinary team of social and natural scientists (Reyes-García et al. 2010a,b). We collected data in Vall Fosca (northern Catalonia, Iberian Peninsula) between March and September 2008. Data collection included participant and non-participant observation, garden inventories, and semi-structured and structured interviews.

Study site

Vall Fosca is a Pyrenean valley of glacial formation of 200 km^2 and 1000 inhabitants lying along the Flamisell River. At the administrative level, Vall Fosca is mainly constituted by the municipality of La Torre de Capdella and includes parts of the municipality of Senterada. Vall Fosca translates as "dark valley", a name that originates from the short hours of sunlight on the valley due to the marked slopes of the surrounding mountains. The altitude in the region varies from 729 masl to nearly 3000 masl. Annual precipitation changes with altitude, ranging from 800 to 1200 mm. In the valley there is an altitudinal vegetation gradient varying from Mediterranean to Alpine communities.

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. Due to high slopes, agriculture in the valley is rare. The most characteristic form of cultivation of Vall Fosca is home gardens. Due to the absence of shops and the difficult accessibility to the market town, especially in winter, home gardens in Vall Fosca traditionally had a

high diversity of species and varieties. Customarily, home gardens were managed by women as a part of their household activities, as men spent a large part of their time outside the household in charge of cattle. Nowadays these traditional features are still partially present although they are being modified by recent demographic changes.

Sampling

Research was conducted in 12 of the 19 villages of the municipality of Torre de Capdella and in the four villages of the municipality of Senterada that are geographically within the Vall Fosca. We excluded from the study villages without permanent residents and villages without home gardens.

The villages' altitude ranges from 729 masl to 1422 masl and the number of permanent residents ranges from five to 156. In three villages there is only one permanent household. Only three of the villages have a grocery shop, although an itinerant trader who sells fresh fruit and vegetables visits all the villages weekly. All the villages have a weekly public transport service to the nearest market town, La Pobla de Segur, although most households own a car.

Structured data collection included the inventory of 60 home gardens belonging to 53 households and a garden survey conducted with the primary garden tender. Since we surveyed almost 70% of the villages in Vall Fosca and all the available gardens in those villages, our sample captures most of the active home gardens in the valley.

Methods of data collection

Participant and non-participant observation: To achieve a better understanding of the activities realized in the home gardens, we used participant and non-participant observation. During our fieldwork we worked with farmers and observed their work. For example we helped farmers in planting and accompanied them during harvesting time. Living in the village gave us ample opportunities -other than during the formal

interviews- to interact with gardeners and to discuss the garden's progress and other matters.

Semi-structured interviews: We conducted semi-structured interviews about the management of home gardens over the last 70 years with 15 elderly men and women owning a home garden. Results from these interviews provide a temporal baseline for the description of changes in management and floristic composition, and they have been used to interpret quantitative results.

Inventory: To capture seasonal variation, we visited each home garden three times. On the first visit, we requested the main tender to accompany us to the home garden where we measured its dimensions. We then asked the tender to identify and describe the uses (i.e., edible, medicinal, ornamental) of all the cultivated plants present in the home garden. In the two subsequent visits we repeated the procedure, but only noted crops not present during previous visits. Species were determined from the vernacular name by the lead author and photos of each variety were taken to contrast the identification with botanists from the Universitat de Barcelona, Universidad Autónoma de Madrid, and Universidad de Oviedo. We took vouchers of a) species that could not be identified in the field or with the assistance of photos and b) specimens that entered in our category of landraces. We deposited vouchers in the herbarium of the Centre de Documentació de Biodiversitat Vegetal, Universitat de Barcelona (BCN), where a botanist used the vouchers to identify species that could not be identified in the field.

Survey: We administered a survey to all the main tenders of gardens in the sample. In the first part of the survey, we asked questions about garden management (i.e., fertilization, weed and pest management). In the second part, and for each crop in the garden, we enquired about the origin of the planting material (i.e., commercial, kept, gift). If the gardener had kept a seed from the previous year, we asked how long the tender had been continuously keeping the seed. We also asked about specific

management techniques of the crop. The information was subsequently used to identify landraces. In the third part of the survey, we collected information about the sociodemographic characteristics of the gardener (i.e., age, years tending a garden). In the last part of the survey, we asked tenders about the importance of landraces, their preferences regarding landraces and commercial varieties, and their reasons to maintain landraces. Specifically, we asked, "Why do you consider important the conservation of landraces?", "Do you prefer landraces or commercial varieties?", "What advantages do landraces have compared to commercial varieties?", and "What disadvantages do landraces have compared to commercial varieties?" We wrote answers *verbatim* and coded them latter.

Methods of data analysis

We used the questions on crop attributes to identify two types of landraces: annual landraces (or annual and/or biennial crops that had been continuously reproduced by the farmers over more than 30 years) and perennial landraces (or perennial species and/or species with vegetative reproduction that had been locally cultivated and reproduced for more than 60 years).

We used the questions on tenders' and gardens' attributes to create four binary variables: 1) *Male* took the value of 1 if the main tender of the garden was a man and 0 otherwise; 2) *Retired* took the value of 1 if the person was 65 years or older, the official retirement age in Spain, and 0 otherwise; 3) *Experienced* took the value of 1 if the person had continuously been gardening for 25 years or longer and 0 otherwise; and 4) *Organic* took the value of 1 if the garden was mainly fertilized with manure or organic products and received manual, organic, or non-treatment management methods to control weeds and pests. The variable *Organic* took the value 0 if the garden was mainly fertilized with chemical fertilizers or if it received agrochemical treatments to control pests and weeds.

To examine the association between the sociodemographic attributes of gardeners and the presence of landraces in home gardens, we ran a Wilcoxon rank-sum test. We also ran a set of multiple regressions with the number of landraces present in a household's home gardens as dependent variable and the sociodemographic characteristics of the tender as explanatory variables. We ran two different models, one with the number of annual landraces as dependent variable and one with the number of perennial landraces. For the statistical analysis we used STATA 9 for Windows.

We coded textual answers to the four questions on the reasons for maintaining landraces. For example, we coded positive responses to the first question "Why do you consider important the conservation of landraces?" into four categories that capture the range of reasons given by informants: a) nutrition and taste, b) tradition and food security, c) ideological reasons, and d) adaptation to the territory. We analyzed this information using descriptive statistics.

Limitations

The study has two main limitations. First, since the unit of analysis is the person and we only have 53 gardeners, our sample size is small for multivariate statistical analysis. Second, since we have not done genetic analyses, it is possible that we have over or underestimated the number of landraces. For example, it is possible that what we consider two different landraces are in fact the same. Similarly, it is possible that a single vernacular name is used to design genetically different landraces.

Results

Tenders and home gardens characteristics

Table 2.1 summarizes the sociodemographic characteristics of the sample. The mean area of home gardens in Vall Fosca was 147.25 m^2. Each tender had between one and three home gardens (mean=1.1). Across the 60 home gardens in the sample, we found 148 different species from 50 families. The most frequent species in home gardens corresponded to edible crops. Lettuce (*Lactuca sativa* L.) was present in 95.0% of the home gardens, followed by chard (*Beta vulgaris* L.) present in 86.1%, and onion (*Allium cepa* L.) encountered in 83.3% of the home gardens. The most common families found were Asteraceae (16.2% of the total number of species) and Rosaceae (9.5%). Most species grown were edible (41.9%) or ornamental (36.5%). Other uses of species grown in home gardens included medicinal, fodder, and spices. 106 species had only one use, whereas 42 had at least two potential uses.

Presence of landraces in home gardens

We found 39 taxa that fit in our definition of landrace. Table 2.2 includes the species and family name, voucher number, total number of gardeners that maintain the landrace, and type of landrace (annual or perennial) of the 39 taxa defined as landraces. Sixteen landraces were cultivated by only one tender whereas six landraces were cultivated by 10 or more tenders. Most landraces belonged to the Fabaceae and Rosaceae families, with 10 landraces each. On average, each tender grew 3.7 landraces, 2.3 annual, and 1.4 perennial. One tender had 14 landraces, but ten gardeners (18.9%) did not have any.

Table 2.1

Definition and summary statistics of variables used in statistical analysis (n=53)

	Definition	Mean	StD	Min.	Max.
Dependent variable					
Annual landrace	Annual or biannual crop continuously cultivated for more than 30 years	2.3	2.1	0	8
Perennial landrace	Perennial crop or crop with vegetative reproduction cultivated for more than 60 years	1.4	1.7	0	7
Explanatory variable		%			
Man	Dummy variable: 0=woman, 1=man	43			
Retired	Dummy variable: 0=less 65 years old; 1= 65 years old or older	43			
Experienced	Dummy variable: 0=less than 25 years managing a home garden; 1= 25 or more years managing a home garden	49			
Organic	Dummy variable: 0=non-organic home garden; 1=organic home garden	72			

Table 2.2

List of the 39 landraces found in home gardens of Vall Fosca valley and frequency of gardeners maintaining them (n=53)

Vernacular name (Catalan)	Scientific name	Family	Voucher	% of holders	Type
Bleda del país	*Beta vulgaris* L. subsp. *vulgaris* var. *vulgaris*	Chenopodiaceae	BCN-S 1653	41.5	Annual
Col berrugada	*Brassica oleracea* L. var.*capitata* (L.) Alef.	Brassicaceae	BCN-S 1660	1.9	Annual
Col de lluc	*Brassica oleracea* L. var.*capitata* (L.) Alef.	Brassicaceae	BCN-S 1671	5.7	Annual
Col de ruc	*Brassica oleracea* L. var.*oleracea*	Brassicaceae	BCN-S 1661	26.4	Annual
Carbassa de rabequet	*Cucurbita maxima* Duch.	Cucurbitaceae	BCN-S 1659	11.3	Annual
Enciam de carxofeta de la Maria	*Lactuca sativa* L. var. *capitata* L.	Asteraceae	BCN-S 1672	5.7	Annual
Tomata rosa de la Paquita	*Lycopersicum esculentum* Mill.	Solanaceae	BCN-S 1666	1.9	Annual
Julivert	*Petroselinum crispum* (Mill.) Hill	Apiaceae	BCN-S 1654	50.9	Annual
Fesol afartapobres	*Phaseolus coccineus* L.	Fabaceae	BCN-S 1664	24.5	Annual
Fesol de mata baixa	*Phaseolus vulgaris* L. var.*nanus* (L.) Aschers	Fabaceae	BCN-S 1663	3.8	Annual
Mongeta grogueta de mata baixa	*Phaseolus vulgaris* L. var.*nanus* (L.) Aschers	Fabaceae	BCN-S 1658	1.9	Annual
Mongeta perona de mata baixa	*Phaseolus vulgaris* L. var.*nanus* (L.) Aschers	Fabaceae		1.9	Annual
Fesol de mata alta	*Phaseolus vulgaris* L. var.*vulgaris*	Fabaceae	BCN-S 1662	5.7	Annual
Fesol perona de mata alta	*Phaseolus vulgaris* L. var.*vulgaris*	Fabaceae	BCN-S 1657	26.4	Annual
Fesol de beina llarga verda	*Phaseolus vulgaris* L. var.*vulgaris*	Fabaceae	BCN-S 1669	1.9	Annual
Mongeta lila, de mantequilla	*Phaseolus vulgaris* L. var.*vulgaris*	Fabaceae	BCN-S 1670	1.9	Annual
Mongeta pilarica de mata alta	*Phaseolus vulgaris* L. var.*vulgaris*	Fabaceae	BCN-S 1655	1.9	Annual
Mongeta vermella per a tavella i gra	*Phaseolus vulgaris* L. var.*vulgaris*	Fabaceae	BCN-S 1656	1.9	Annual

Vernacular name (Catalan)	Scientific name	Family	Voucher	% of holders	Type
Ceba de paret/escalunya	Allium ascalonicum L.	Liliaceae	BCN 62717	20.8	Perennial
All	Allium sativum L.	Liliaceae	BCN 60897	5.7	Perennial
Espàrrecs	Asparagus officinalis L.	Liliaceae	BCN 62710	7.6	Perennial
Safrà	Crocus sativus L.	Iridaceae		1.9	Perennial
Codonyer autòcton	Cydonia oblonga Mill.	Rosaceae	BCN 62712	1.9	Perennial
Escarxofes	Cynara scolymus L.	Asteraceae	BCN 62702	1.9	Perennial
Figuera	Ficus carica L.	Moraceae	BCN 62707	3.8	Perennial
Maduixera	Fragaria x ananassa (Weston) Duchesne ex Rozier	Rosaceae	BCN 62708	15.1	Perennial
Patatera	Helianthus tuberosus L.	Asteraceae	BCN 62706	1.9	Perennial
Pomer autòcton	Malus domestica L.	Rosaceae	BCN 62711	17.0	Perennial
Menta	Mentha sp.	Lamiaceae		3.8	Perennial
Menta	Mentha spicata L.	Lamiaceae	BCN 62704	13.2	Perennial
Herbabona	Mentha x gentilis L.	Lamiaceae	BCN 62705	3.8	Perennial
Cirerer	Prunus avium L.	Rosaceae	BCN 62709	1.9	Perennial
Pruna clàudia	Prunus domestica L. subsp. domestica	Rosaceae	BCN 62713	9.4	Perennial
Prinyó d'agost	Prunus domestica subsp. insititia (L.) Bonnier et Layens	Rosaceae	BCN 62714	5.7	Perennial
Pruna roja	Prunus domestica L. subsp. domestica	Rosaceae	BCN 62718	1.9	Perennial
Pruna rossa	Prunus domestica L. subsp. domestica	Rosaceae		1.9	Perennial
Pera de la Mare de Déu d'Agost	Pyrus communis L.	Rosaceae	BCN 62716	7.6	Perennial
Perer	Pyrus communis L.	Rosaceae	BCN 62715	11.3	Perennial
Parra	Vitis vinifera L.	Vitaceae	BCN 62703	1.9	Perennial

Who conserves landraces?

We found that several sociodemographic characteristics of informants were associated with the presence of landraces in their gardens (Table 2.3). Women in our sample conserve an average of 2.6 annual landraces whereas men conserve an average of 1.9. The difference in means was statistically significant in a Wilcoxon rank-sum test (p=0.08). Women also conserve more perennial landraces than men (1.5 versus 1.3), although the difference was not statistically significant. Retired people conserve more annual and perennial landraces than non-retired people, although the association was only significant for perennial landraces (p=0.08). People who have been managing a home garden for at least 25 years conserve a mean of 2.7 annual and 1.8 perennial landraces while less-experienced farmers conserve 1.8 annual (p=0.06) and 1.1 perennial landraces (p=0.03). Last, tenders who use organic management practices conserve an average of 2.6 annual landraces whereas tenders who do not use them conserve an average of 1.4 (p=0.04).

Table 2.3

Results of bivariate analysis (n=53)

	Annual landraces				**Perennial landraces**			
	Mean	SD	Min	Max	Mean	SD	Min	Max
Men	1.87	2.20	0	8	1.30	1.92	0	7
Women	2.57*	1.91	0	7	1.50	1.48	0	5
Retired	2.78	2.15	0	8	1.91*	1.97	0	7
Non-retired	1.86	1.90	0	7	1.03	1.29	0	4
Experienced	2.69*	1.95	0	8	1.77**	1.61	0	5
Less experienced	1.85	2.09	0	7	1.07	1.68	0	7
Organic	2.60**	2.15	0	8	1.53	1.81	0	7
Non-organic	1.40	1.50	0	5	1.13	1.25	0	4

* and ** significant at the 10% and 5% level

We ran a series of multivariate regressions to test whether results from bivariate analysis hold (Table 2.4). Since our sample size is small, we can only include three

explanatory variables at a time. The results of column [1] and [2] suggest that experienced tenders with organic gardens keep more landraces than less experienced gardeners with non-organic gardens. Women and retired respondents also conserve more annual landraces than men and non-retired respondents, but the difference is not significant in statistical terms. Results from columns [3] and [4] suggest that none of the socio-demographic variables analyzed, excluding the duration of gardening, is consistently associated with the maintenance of perennial landraces.

Table 2.4
Results of multivariate analysis (n=53)

	Annual landraces		Perennial landraces	
	[1]	[2]	[3]	[4]
Man	-0.23 (0.62)	^	0.53 (0.46)	^
Retired	^	0.43 (0.35)	^	0.64 (0.60)
Experienced	0.85 (0.39)**	0.68 (0.30)**	0.73 (0.29)**	0.38 (0.49)
Organic	1.18 (0.61)*	1.19 (0.57)**	0.45 (0.46)	0.32 (0.42)
R^2	0.12	0.13	0.06	0.08

Regressions with robust standard errors (in parenthesis). Regressions results include clusters for village of residency and a constant (not shown). For definition of variables see Table 2.1.

^ Intentionally omitted

* and ** significant at the 10% and 5% level

Reasons for landraces conservation

Responses to the question "why do you consider important the conservation of landraces?" suggest that the main reasons for landraces conservation are 1) their taste and perceived nutritional value (37.5%), 2) tradition and food security (25.0%), and 3) ideological reasons (16.7%).

When asked about advantages of landraces versus commercial varieties, 43.7% of the sample argued that landraces had a better taste and 27.1% said that landraces were

more adapted to the local climate and more resistant to pests than commercial varieties. For instance, various respondents remembered the absence of potato beetle (*Leptinotarsa decemlineata)* before the introduction of commercial varieties of potato (*Solanum tuberosum* L.). Informants, however, also mentioned some disadvantages of landraces, such as the additional work in making seedbeds (18.7%), problems with degeneration of seeds (12.5%), and the lower productivity of landraces in comparison with commercial crops (12.5%). Almost half (48%) of the sample did not find any disadvantage on growing landraces and almost 90% of the people interviewed pointed out that they preferred landraces to commercial varieties.

Discussion and conclusions

We organize the discussion around three main findings that emerge from this work.

Landraces *in situ* conservation in temperate home gardens

Home gardens in Vall Fosca constitute a repository of *in situ* conservation of crop genetic diversity. At the species level, we found a total of 148 species in the 60 gardens surveyed. The number is relatively low in comparison with other studies. For example, in a review of 29 studies, Pulido et al. (2008) found that the number of species reported in Latin American home gardens ranged from 27 to 405 species. Vogl and Vogl-Lukasser (2003) found a total of 587 species in Eastern Tyrol. In contrast, at the landraces level, we found a number of landraces larger than in previous studies in the Iberian Peninsula. For example, in a study in three provinces of Andalusia, Guzmán-Casado et al. (2000) found 52 landraces; and in a study in Tentudia, Extremadura, Acosta-Naranjo and Díaz-Diego (2008) identified 23 landraces. Considering that those studies sampled larger geographic areas than our study (i.e, provinces versus municipalities) and included orchards and crop fields, the finding of 39 landraces in home gardens in the municipality of Vall Fosca (or 16.6%

of the diversity of taxa) is comparatively higher than findings from previous research.

The comparison, however, should be taken with caution for at least two reasons. First, research suggests that the number of species encountered in an area depends on the sampling effort as much as on geographical, cultural, and economic factors (Perrault-Archambault and Coomes 2008). Since our and the reported studies do not follow the same sampling protocol, it is possible that differences are due to sampling effort. Second, previous studies reporting the presence of landraces have used different definitions of what constitutes a landrace. Before such comparisons can be made, further studies should compare whether landraces identified with information provided by informants are indeed morphologically, agronomically, or genetically distinct.

Association between gardeners' sociodemographic attributes and annual and perennial landraces *in situ* conservation

We found that women are more likely to conserve landraces than men. Women have historically been in charge of home gardens and seed management in the study area, including keeping and exchanging seeds, and preparing seedbeds. Through ethnographic means, we observed that women are in charge of seed management even in gardens where the primary tender is a man. The finding that women have an important role as seed selectors and custodians of germplasm is consonant with findings on other regions of the world, such as Nepal (Bajracharya 1994), India (Ravishankar et al. 1994), and rural areas in Eastern Tyrol (Austria) (Vogl and Vogl-Lukasser 2003), (but see Reyes-García et al. (2010b) for contrasting findings in the Iberian Peninsula).

We also found that people over 65 years of age and with more experience are more likely to keep landraces than younger people. The results meshes with previous

literature in tropical and temperate home gardens, suggesting that the age of the household head correlates with species diversity: the younger the household, the lower the diversity in the home garden (Acosta-Naranjo and Díaz-Diego 2008, Eyzaguirre and Linares 2004). Additionally, landrace conservation is a traditional practice in Vall Fosca, so it is not surprising that people who have been growing a home garden for long time also maintaining more annual landraces. Acosta-Naranjo and Díaz-Diego (2008) also highlight the fact that people who have been farmers all their lives are the custodians of landraces.

Finally, respondents who manage their gardens organically are more likely to keep landraces than respondents who do not manage their gardens organically. Possible explanations for this association relate to tradition and ideology. People who follow traditional management practices are more likely to grow gardens classified as organic, and they are also more likely to maintain landraces (Acosta-Naranjo and Díaz-Diego 2008, Vogl and Vogl-Lukasser 2003). Additionally, people who follow agroecological practices for ideological reasons might have both an organic home garden and a disposition to recover local agrobiodiversity.

Interestingly, results from multivariate analysis suggest that the sociodemographic attributes of the gardeners who are good predictors for the conservation of annual landraces do not have the same predictive power for perennial landraces. A potential explanation for this result lies in the different management techniques required by annual and perennial landraces. While the conservation of annual landraces requires the active engagement of the gardener in keeping the seeds year after year, perennial landraces (specifically fruit trees) might be just tolerated in gardens. For example, a common practice in Vall Fosca is to lend land to any person who wants to start gardening (i.e., retired men or urban migrants without previous gardening experience). We have found some perennial landraces in the home gardens of those new gardeners. The perennial landraces were in fact planted by previous owners,

and the new gardener just keeps them in the garden, although he/she buys all the other seeds in the market.

People's preference for landraces

The last finding that deserves attention is that people express a strong preference for landraces, rather than for commercial varieties, although people plant more commercial varieties than landraces in their gardens. Specifically, almost 90% of the informants in the sample said they prefer landraces to commercial varieties, but only 20.4% of their crops do not have a direct commercial origin.

The strong theoretical preference for landraces seems related to their perceived quality, to the local tradition of home gardening, and to their links to local identity. For example, informants explained that they keep landraces of chard (*Beta vulgaris* L. subsp. *vulgaris* var. *vulgaris*) because local chard tastes better than commercial chard. Some other people said that they grew landraces because the seeds had been passed to them by their parents and grandparents and they wanted to keep their heritage. Other informants explained that they grew landraces because they considered it was better for their nutrition and the environment, i.e., as an alternative to industrial agriculture. Other studies on vegetable home gardens have highlighted the importance of home gardens in achieving psychological benefits associated with the individual sense of belonging to a community and obtaining healthy food, although they have not distinguished between landraces and non-landraces (Clayton 2007, Reyes-García et al. 2010a).

One interesting question that arises from our data is: Why do people mainly grow commercial varieties despite their reported preference for landraces? We can think of two plausible explanations. First, it is possible that the accessibility to market products in the last 60 years has changed local tastes and preferences. Interviewees explained that some of the now common crops were not planted during the first

decades of the twentieth century. Such new arrivals include today's favorites zucchini (*Cucurbita pepo* L.) and tomato (*Lycopersicum esculentum* L.), both present in 80% of the home gardens, or eggplant (*Solanum melongena* L.) (23.3%). These new crops are still not completely adapted to the local agrarian culture, and gardeners do not have specific management strategies nor do they keep their seeds. Second, it is also possible that the costs associated with keeping landraces exceed their perceived benefits. Thus, problems of seed degeneration, the extra work that comes with the seed bank preparation, and the lower yields of some landraces (the main disadvantages encountered by our respondents) might stop gardeners from growing landraces.

In conclusion, the finding of 39 landraces in Vall Fosca highlights the importance of home gardens for *in situ* conservation for two main reasons: 1) home gardens in Vall Fosca act as repositories of crop genetic diversity, and 2) landraces are still available in a region where modern commercial varieties dominate the seed system. However, the finding that almost half of the identified landraces are only present in one home garden stresses the need of further studies that identify the process of acquisition, exchange, and dissemination of local seeds and knowledge associated with them.

Acknowledgements

Research was funded by the Programa de Ciencias Sociales y Humanidades del Ministerio de Educación y Ciencia (MEC-España) (SEJ2007-60873/SOCI), the Agència de Gestió d'Ajuts Universitaris i de Recerca (AGAUR) and the Centre de Promoció de la Cultura Popular i Tradicional Catalana (CPCTC) (Generalitat de Catalunya). L. Calvet-Mir acknowledges financial support from a FPU grant of the MEC-España (AP-2006-01849). We thank the tenders who collaborated in the project. We also thank Laura Aceituno, Teresa Garnatje, Juan José Lastra, Montserrat Parada, Manuel Pardo, Montserrat Rigat, Joan Vallès, and Sara Vila for help in the identification of species and comments to previous versions of this work.

Three anonymous reviewers also provided useful comments. Thanks also go to Samuel Pyke for English editing and Laia Echániz and Daniel Corbacho for help with the figures.

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CHAPTER 3

Seed exchange as an agrobiodiversity conservation mechanism: A case study in Vall Fosca, Catalan Pyrenees, Iberian Peninsula[6]

[6] Calvet-Mir L., Calvet-Mir M., Molina J.L. and Reyes-García V., 2011. Seed exchange as an agrobiodiversity conservation mechanism: A case study in Vall Fosca, Catalan Pyrenees, Iberian Peninsula. Ecology and Society: accepted, pending minor revisions.

Abstract

Interest in landraces conservation has grown in the last decades with research on the topic focusing on *in situ* conservation of agrobiodiversity in the tropics. Researchers agree that home gardens play a key role in the maintenance of *in situ* agrobiodiversity, but few studies have analyzed how farmers actually maintain agrobiodiversity in home gardens and what mechanisms they use to avoid genetic erosion. In this article, we evaluate the functioning of a network of seed exchange and explore its contribution to agrobiodiversity conservation. We focus on the exchange of seeds and seedlings among 55 home garden keepers who grow a total of 62 home gardens in Vall Fosca (Catalan Pyrenees). Fieldwork included visits to gardens and surveys to register the frequency and management of local landraces. We also asked about the farmers' network of seeds exchange. We identified 20 local landraces belonging to 17 species. People who were mentioned more often in the network of seed exchange (highest indegree) and who had a higher level of intermediation among other people in their personal network (highest egobetweenness) conserved more local landraces and had more local landrace knowledge than people less central in the network. Our findings suggest that local landrace conservation is strongly associated to individual position in the network of seed exchange.

Key words: Catalonia; home gardens; in situ conservation; local landraces; social network analysis; Spain; traditional ecological knowledge.

Introduction

Throughout the last few years, the interest has increased in possible ways to stop the loss of crop genetic diversity, or agrobiodiversity. In that effort, researchers and policy makers have pointed out the importance of *in situ* conservation, or the conservation of species in their own habitat, as a complementary strategy to *ex situ* conservation, or conservation of species in genetic banks (Oldfield and Alcorn 1987, Brush 1991). Researchers have highlighted the importance of agrobiodiversity *in situ* conservation for four main reasons. First, *in situ* conservation is a dynamic mechanism by which new genetic resources are created (Louette et al. 1997) allowing the adaptation of the crops to environmental changing conditions (Altieri et al. 1987, Altieri and Merrick 1987). Second, this conservation mechanism is tied to food safety and sustainable food production, since adapted crops have low dependence on external inputs like pesticides or fertilizers (Prescott-Allen and Prescott-Allen 1982, Altieri and Merrick 1987). Third, agrobiodiversity *in situ* conservation ensures the maintenance of cultural information (knowledge and traditions) that can affect crop's productivity (Cox 2000, Maffi 2002). Finally, agrobiodiversity *in situ* conservation allows the creation and conservation of other agroecosystem active components such as social networks (Zimmerer 2003).

During the last three decades, efforts to ensure agrobiodiversity *in situ* conservation have also reached the policy realm. The first example of political interest on the topic is found in the 1992 Biological Diversity Convention (BDC). After the agreements in the BDC, and throughout its work program on agrobiodiversity, Bioversity International, one of the centers of the Consultative Group for International Agricultural Research (CGIAR), has worked on agrobiodiversity *in situ* maintenance and usage (Jarvis and Hodgkin 2008). Another political effort in the same line can be found in the adoption by the European Commission in June 2008 of a proposal to allow cultivation and sale of some traditional crops that are not registered at the

Common Catalogue of home garden species. This proposal aims at promoting agrobiodiversity *in situ* conservation by reducing the impact on genetic diversity erosion caused by the rules and costs generated by the previous obligation to register commercial crop varieties in the Common Catalogue.

Despite the academic and political interest in the topic, few studies have analyzed how agrobiodiversity is actually maintained in farmers' fields. Research on the topic, mostly from South America and Asia, suggests a connection between the conservation of agrobiodiversity in farmers' fields and the exchange of seeds and seedlings (Zimmerer 1996, Louette et al. 1997, Thiele 1999, Zimmerer 2003, Badstue et al. 2007). For example, in a study in Peru, Ban and Coomes (2004) find that home gardens agrobiodiversity is strongly tied to the number of seedlings and seed exchanges done by the gardeners, which the authors interpret as a support to the idea that seed exchange promotes the creation and preservation of genetic diversity. Following this line of thought, some researchers have stated that markets could lead to a reduction in agrobiodiversity, since local landraces, typically exchanged, would be substituted by higher-yielding varieties, typically obtained through market transactions (Bellon 2004, Stromberg 2010).

Here we contribute to this line of research by evaluating the functioning of a seed exchange network, a type of social network. A social network is a measure of the social world based on a tie definition among a set of actors, in this case spontaneous socialization among people owning a home garden. Specifically, we 1) assess the structure of the seed exchange network and 2) estimate the association between an individual's centrality on the seed exchange network and *i*) local landrace *in situ* conservation and *ii*) local landrace knowledge. For the empirical analysis we use data from high-mountain home gardens in an understudied region: the Vall Fosca, Catalan Pyrenees. Based on previous research suggesting that the exchange of knowledge and information are crucial for the effective governance of natural resources (Bodin

and Crona 2009), we hypothesize that informal networks of seed exchange can play an important role in agrobiodiversity *in situ* conservation. Based on previous studies (Vogl and Vogl-Lukasser 2003, Acosta-Naranjo and Díaz-Diego 2008) we also assume that seed and knowledge are transmitted together. Based on previous studies (Vogl and Vogl-Lukasser 2003, Acosta-Naranjo and Díaz-Diego 2008) we also assume that seed and knowledge are transmitted together. We use the term "home garden" to refer to 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). We focus on home gardens because previous research has highlighted the importance of home gardens in the maintenance of plant genetic resources (Agelet et al. 2000, Sunwar et al. 2006, Perrault-Archambault and Coomes 2008, Calvet-Mir et al. 2011) and has underlined the link between agrobiodiversity *in situ* conservation and seed exchange in home gardens (Ban and Coomes 2004). We adapt previous definitions of "local landrace" (Brown 1978, Cleveland et al. 1994, Guzmán-Casado et al. 2000, Louette and Smale 2000) and use the term to refer to annual and biennial crops that have been continuously reproduced by gardeners during more than one generation (30 years or more) in the geographic area of study. For perennial crops and crops with vegetative reproduction, we use the term local landrace when a specific crop has been cultivated and reproduced in the area for more than 60 years. These crops have been selected by gardeners among domesticated or wild species adapting them to the local environmental conditions and to the local agrarian culture, uses, and management. Finally, we use the term "local landrace knowledge" to refer to the cumulative body of knowledge, practice, and belief related with local landraces evolving by adaptive processes and handed down through generations by cultural transmission (adapted from Berkes et al. 2000).

Methods

This study is part of a larger research on home gardens in three rural areas of the Iberian Peninsula (Aceituno-Mata 2010, Reyes-García et al. 2010, Calvet-Mir et al. 2010, Calvet-Mir et al. 2011). We collected data on the Vall Fosca (Northern Catalonia) between March and September 2008 and between July and September 2009. Data collection included participant observation, garden inventories, semi-structured, and structured interviews.

Study site

Vall Fosca is a Pyrenean valley of glacial formation of 200 km^2 and about 1000 inhabitants lying along the Flamisell River. At the administrative level, it is mainly constituted by the municipality of La Torre de Capdella and partially by the municipality of Senterada. The altitude in the region varies from 729 masl to nearly 3000 masl. Annual precipitations range from 800 to 1200 mm, depending on the altitude. The altitudinal vegetation gradient varies from Mediterranean to Alpine communities.

The valley has been mostly inhabited by peasants who worked as cattle dealers. Over the recent years, local inhabitants have started to combine traditional activities, such as cattle ranch, with tourist services, offering accommodation and food for urban visitors. High altitudes and the presence of slopes make it difficult to engage in intensive agriculture, which explains why the area lacks a strong agricultural sector. Furthermore, the most characteristic form of agriculture in the area is home gardens. Home garden products are mainly grown for household needs and normally are not sold. As part of their household activities, women customarily managed home gardens, as men spent much of their time outside the house in charge of cattle. Otherwise, nowadays, retired men manage home gardens as hobby. Because of the absence of shops and the difficult accessibility to the market town, especially in

winter, traditionally home gardens had a wide diversity of species and varieties. For the same reason, most seeds were kept or exchanged. According to our informants, before the 1970s, when the accessibility to market town improved, seed storage and exchange were the most common ways to acquire seeds. Differently, previous studies show that nowadays as much as 80% of plants in the studied gardens have a commercial origin (Calvet-Mir et al. 2011). However, local landraces are out of the market and can only be acquired via exchange. We have also found that women, retired people, people who manage an organic garden, and experienced gardeners conserve more local landraces than people without those characteristics (Calvet-Mir et al. 2011). Additionally, in an effort to strengthen *in situ* agrobiodiversity conservation, in 2005, a local seed bank was established in the area with the goal to conserve local landraces of two neighboring valleys with the participation of local gardeners. Gardeners are provided local landraces to sow them in their gardens and are asked to return part of the seeds to the local seed bank. However, less than 10% of the gardeners in Vall Fosca are active collaborators of the local seed bank, mainly, due to accessibility issues for people who are too old to drive a car.

Sampling

Research was conducted in 16 of the 23 villages that are geographically within the Vall Fosca. We excluded villages without permanent residents or without home gardens. Villages on the sample vary in altitude, population size, and composition. Altitude ranges from 729 masl to 1422 masl and the number of permanent residents ranges from five to 156. In three villages there is only one permanent household. Only three of the villages have a grocery shop, although an itinerant trader who sells fruits and vegetables visits all the villages once a week. Most households own a car and all the villages have a weekly public transport service to the nearest market town, La Pobla de Segur.

Structured data collection included the inventory of 62 home gardens belonging to 55 households and a survey conducted with primary garden keepers (55). Since we surveyed almost 70% of the villages in Vall Fosca and all the available gardens in those villages, our sample captures almost all the potential gardeners in the area.

Methods of data collection

Participant observation: We used participant observation to achieve a better understanding of home gardening in the area. During fieldwork, we worked with garden keepers and observed their work. For example, we helped them when planting and accompanied them during harvest time. Living in the village gave us ample opportunities -other than during the formal interviews- to interact with gardeners and to discuss garden's progress and many other issues.

Semi-structured interviews: We conducted semi-structured interviews with a sample of 28 elderly men and women owning a home garden. We asked about the management of home gardens and the presence and management of local landraces over the last 70 years.

Inventory: We visited each home garden three times. In the first visit, we requested the main keeper to accompany us to the home garden and to identify all the plants cultivated in it. In the two subsequent visits, we inquired about the presence of other plants that were not yet planted during the first visit. The lead author determined species from the vernacular name and took photos of each variety to contrast the information with botanists from Universitat de Barcelona, Universidad Autónoma de Madrid, and Universidad de Oviedo. Vouchers of all local landraces were deposited in the herbarium of the Centre de Documentació de Biodiversitat Vegetal, Universitat de Barcelona (BCN).

Survey: We carried out a questionnaire with the 55 home garden primary keepers. In Vall Fosca the primary garden tender is the person that mainly performs the activities

related to the home garden management. Other members of the family only act as secondary managers. The questionnaire was divided in five sections: 1) socioeconomic characteristics of the gardener, 2) home garden management practices, 3) seed and propagule origin and management, 4) seed exchange network, and 5) local landrace knowledge. In the first section we compiled information about the socioeconomic characteristics of the main home garden keeper including age, gender, and number of years gardening. In the second section, we asked about fertilization and pest management techniques used in the home garden. In the third section, we asked about the origin of the seeds and propagules of all the plants in each garden. We also asked about the number of years that a crop had been grown from seeds kept from previous years. In the fourth section, we asked keepers about their seed exchange network. Specifically, we asked, "Could you please list the name of all the people to whom you have ever given seeds or any other type of propagule?" Once the person stopped listing names, we asked, "Could you please list the name of all the people who had ever given you seeds or any other type of propagule?" After all the names were listed, we asked informants the sex, age, and place of residence of all the people listed. To proxy gardeners' local landrace knowledge, in the last section, we asked them to identify seeds and pictures of local landraces and to respond to questions about their management and usage (Calvet-Mir et al. 2010). The questionnaire included six questions on three local landraces (6*3=18 questions): one of the landraces was well known in the valley, one quite known, and one rare. The six questions for each local landrace were similar and included a) the identification of the seed by its local name, b) the presence of the local landrace in the informant's garden at the time of the interview, c) and during previous years, d) having the local landrace in storage, e) a question on landrace management, and f) a question on landrace use.

Methods of data analysis

Social network analysis: We used information on section four of the survey 1) to explore the network of seed exchange and 2) to calculate two individual centrality network measures (*indegree* and *egobetweenness)*. Information was treated with the program UCInet6-Netdraw for Windows (Borgatti et al. 2010).

To explore the structure of the seed exchange network, we added information on nominations as seed giver and seed receiver with the "Union" tool from UCInet6. By joining information from the two networks we reduced the number of missing ties that occurred as a consequence of recall bias (Brewer 2000, Scott and William 2002). In addition, the values of nominations from both name generators are kept in the new matrix. When the nominations are reciprocal values are summed up. When nominations are not reciprocal, the new values from one of the name generators are added to new cells, indicating ties previously not identified. The resulting matrix represents more accurately the actual network of seed exchange in the valley. Based on Borgatti et al. (2010), we then calculated four network measures: 1) *Size*, or number of actors in the network; we differentiate between actors living within and outside the studied villages; 2) *Number of components,* or the number of connected subgraphs in which all actors are directly or indirectly in contact; 3) *Density,* or the number of links in the network, expressed as a proportion (from 0 to 1) of the maximum possible number of links; and 4) *Network centralization index,* or the tendency for a few actors in the network to have many links (expressed in percentage).

Using the sum of responses to the two name generating questions, we also calculated two individual centrality measures (Borgatti et al. 2010): 1) *Indegree* refers to the number of nominations that a person received on other people's lists. For example, if nine people mentioned one informant when asked to list the name of seed givers or receivers, then the informant would have an *indegree* of nine; 2) *Egobetweenness*

measures how many alters are connected one to each other through the person (Ego), and it indicates the importance of each person connecting his/her personal network. It is a measure of the proportion of times that ego lies in the shortest path between each pair of alters.

Generation of outcome and control variables: We used answers to survey questions to generate additional variables for statistical analysis. Outcome variables include *local landrace conservation* and *local landrace knowledge.* We used the questions on seed and propagule origin and management to identify local landraces and generated a variable, local landrace conservation, which captures the number of local landraces kept by each gardener. We also generated a variable that proxies for individual knowledge of local landraces, local landrace knowledge, by adding responses to all the knowledge questions related to local landraces. Since questions on local landraces were coded as correct (1) or incorrect (0), the score of local landrace knowledge ranges from 0 to 18 (18=3 local landraces*6 questions).

Finally, we created four binary variables to be used as control in multivariate regression models. *Male* was coded as 1 if the main keeper of the garden was a man and 0 otherwise. *Retired* was coded as 1 if the person was 65 years or older, since 65 is the usual age of retirement in Spain and 0 otherwise. *Experienced* was coded as 1 if the person had continuously been gardening for 25 years or longer and 0 otherwise. We used information on garden management techniques to classify gardens as organic or non-organic. A garden was classified as organic if the gardener reported the use of manure or organic products as main fertilization management technique and the use of manual, organic, or not-treatment methods as main management techniques to control weeds and pests. We coded the variable organic as 0 if the gardener used chemical fertilizers or agrochemical pests and weed control as primary management methods.

Statistical analysis: We ran Spearman correlations and a set of multiple regressions to examine the association between the person's centrality in the seed exchange network (explanatory variables) and 1) local landrace conservation and 2) local landrace knowledge (outcome variables) while using the variables that proxy for the sociodemographic characteristics of the person as control. Regression models were Poisson with clustering by village of residency. For the statistical analysis we used STATA 9 for Windows.

Results

Descriptive analysis

We found 20 taxa from 17 species that fitted with our definition of local landrace and that are still managed (Table 3.1). On average each gardener kept 2.6 local landraces (S.D.=2.4) (Table 3.2). One gardener had 8 local landraces, but 14 gardeners (25.45%) did not have any. From a range from 0 to 18, the average score of local landrace knowledge was 8.0 (S.D.=4.5). Two gardeners obtained the maximum score, while four gardeners (7.27%) scored 0. About half (45.5%) of people in the sample were men; half (50.9%) were experienced gardeners, and 52.7% were retired people. Organic home gardens represented the 74.6% of the sample. On average each gardener nominated 2.03 people as seed givers or receivers (S.D.=1.6).

Table 3.1

Local landraces in Vall Fosca home gardens

Vernacular name (Catalan)	Scientific name	Family	Voucher	Life cycle	Type of reproduction
Bleda del país	*Beta vulgaris* L. subsp. *vulgaris* var. *vulgaris*	Chenopodiaceae	BCN-S 1653	Annual/ Biennial	Sexual
Col berrugada	*Brassica oleracea* L. var.*capitata* (L.) Alef.	Brassicaceae	BCN-S 1660	Biennial	Sexual
Col de lluc	*Brassica oleracea* L. var.*capitata* (L.) Alef.	Brassicaceae	BCN-S 1671	Biennial	Sexual
Col de ruc	*Brassica oleracea* L. var.*oleracea*	Brassicaceae	BCN-S 1661	Biennial	Sexual
Carbassa de rabequet	*Cucurbita maxima* Duch.	Cucurbitaceae	BCN-S 1659	Annual	Sexual
Carbassa de cabell d'àngel	*Cucurbita ficifolia* C.D. Bouché	Cucurbitaceae	BCN-S 1665	Annual	Sexual
Enciam de carxofeta de la Maria	*Lactuca sativa* L. var. *capitata* L.	Asteraceae	BCN-S 1672	Annual	Sexual
Tomata rosa de la Paquita	*Lycopersicum esculentum* Mill.	Solanaceae	BCN-S 1666	Annual	Sexual
Julivert	*Petroselinum crispum* (Mill.) Hill	Apiaceae	BCN-S 1654	Biennial	Sexual
Fesol afartapobres	*Phaseolus coccineus* L.	Fabaceae	BCN-S 1664	Annual	Sexual
Fesol perona de mata alta	*Phaseolus vulgaris* L. var.*vulgaris*	Fabaceae	BCN-S 1657	Annual	Sexual
Ceba de paret/escalunya	*Allium ascalonicum* L.	Liliaceae	BCN 62717	Biennial	Vegetative
All	*Allium sativum* L.	Liliaceae	BCN 60897	Biennial	Vegetative
Espàrrecs	*Asparagus officinalis* L.	Liliaceae	BCN 62710	Perennial	Vegetative
Safrà	*Crocus sativus* L.	Iridaceae		Perennial	Vegetative
Codonyer	*Cydonia oblonga* Mill.	Rosaceae	BCN 62712	Perennial	Vegetative
Maduixera	*Fragaria* x *ananassa* (Weston) Duchesne ex Rozier	Rosaceae	BCN 62708	Perennial	Vegetative
Patatera	*Helianthus tuberosus* L.	Asteraceae	BCN 62706	Perennial	Vegetative
Prinyoner d'agost	*Prunus domestica* subsp. *insititia* (L.) Bonnier et Layens	Rosaceae	BCN 62714	Perennial	Vegetative
Herbacol	*Cynara cardunculus* L.	Asteraceae		Perennial	Vegetative

Gardeners had an average indegree of 2.5 (S.D.=1.9) and an average egobetweenness of 3.8 (S.D.=5.5) (Table 3.2). Analysis (not shown) suggest that both measures are collinear, and that on average, women had a higher indegree (3.1) than men (1.8; p=0.01). Women also have a higher egobetweenness than men (5.1 versus 2.2; p=0.04), although the two centrality measures do not vary according to the other control variables analyzed.

Table 3.2

Definition and descriptive statistics of the variables used (n=55)

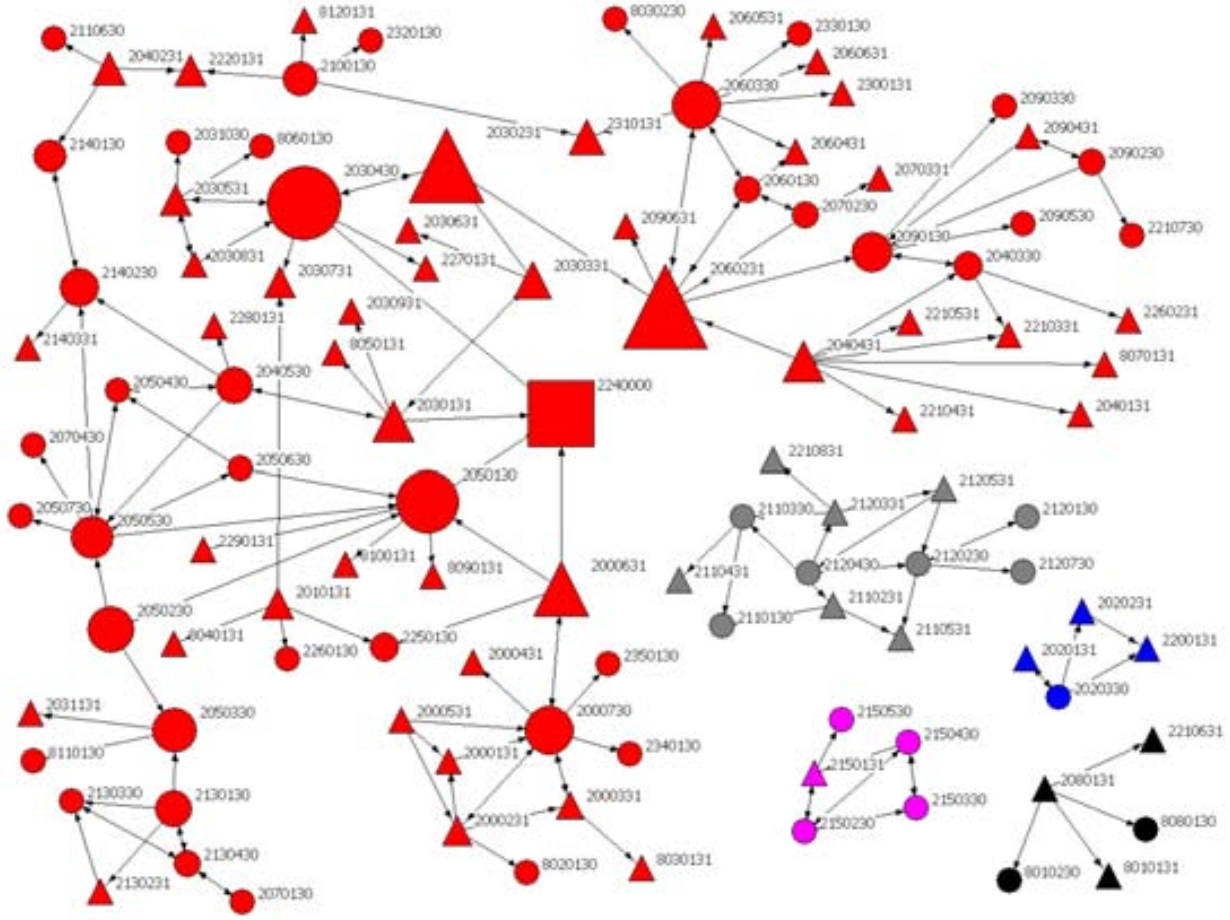
	Definition	Mean	StD	Min.	Max.
Dependent variables					
Local landrace conservation	Number of species continuously cultivated by the gardener for more that 30 (sexual reproduction) or 60 years (vegetative or perennial reproduction).	2.6	2.4	0	8
Local landrace knowledge	Score in the local landrace knowledge test.	8.0	4.5	0	18
Explanatory variables					
Indegree	Number of nominations in the seeds exchange network.	2.5	1.9	0	7
Egobetweenness	Grade of intermediation among people with which each person is directly connected.	3.8	5.5	0	26.5
Control variables			**%**		
Male	Dummy: 0=woman, 1=man.		45.5		
Retired	Dummy: 0=less than 65 years; 1= 65 years or more.		52.7		
Experimented	Dummy: 0=less than 25 years gardening; 1= 25 years or more gardening.		50.9		
Organic	Dummy: 0=non-organic gardener; 1= organic gardener.		74.6		

Network of seed exchange in Vall Fosca

The network of seed exchange in Vall Fosca is composed of 111 actors, or people nominated by the 55 local gardeners when asked about seed exchanges. Those actors include 76 gardeners in Vall Fosca and 35 living outside the research area. The 21 gardeners within the Vall Fosca that were not part of our study population were mainly people who had recently given up to manage a home garden due to their advanced age.

The network has a centralization index of 4.91%. The measure is low relative to that of a pure star network that will have a centralization index of 100%, indicating that the degree of concentration in the distribution of degree centralities among the actors is fairly low. The network has five independent components (Figure 3.1). That is, gardeners who could potentially be connected were in fact organized in five disconnected networks. The largest component includes 76.6% of the actors, the second largest includes 10.8%, and each of the other three components includes less than 5% of the actors. The analyzed network had a low density (0.018) indicating that there are few ties even between the actors that belong to the same component.

Figure 3.1
Seed exchange network in Vall Fosca (Catalan Pyrenees)



Note: Nodes (111 gardeners who participated in seed exchanges) are sized by grade of intermediation of the person (betweenness), shaped by the sex of the node (triangle for men, circle for women, and a square for a local seed bank), and coloured to indicate different network components. The number next to the node corresponds to the identification number of the primary garden tender (the first three numbers for village of residency). Edges arrow represents the direction of the nomination.

Centrality and local landrace conservation and knowledge

The bivariate and multivariate analyses of the relation between centrality and local landrace conservation and knowledge was conducted with the subset of actors from which we had complete information on the outcome variables (n=55). In Spearman correlation analysis, we found a positive association between our two measures of an individual's centrality in the network of seed exchange and local landrace

conservation and local landrace knowledge (Table 3.3). Specifically, people with a higher indegree (i.e., mentioned more often) conserved more local landraces (p=0.006) and had more knowledge (p=0.03) than people with lower indegree. Figure 3.2 provides a visual representation of the association between a gardener's indegree (size of the node) and local landrace conservation (color of the node). We also found that people with higher egobetweenness (i.e., with more brokerage in her/his personal network) also conserved more local landraces (p=0.004) and had higher knowledge (p=0.07) than people with lower egobetweenness (Table 3.3).

Table 3.3

Spearman correlations between individual centrality measures (indegree and egobetweenness) and local landrace conservation and knowledge (n=55)

	Local landrace conservation	Local landrace knowledge
Indegree	0.37***	0.30**
Egobetwenness	0.38***	0.24*

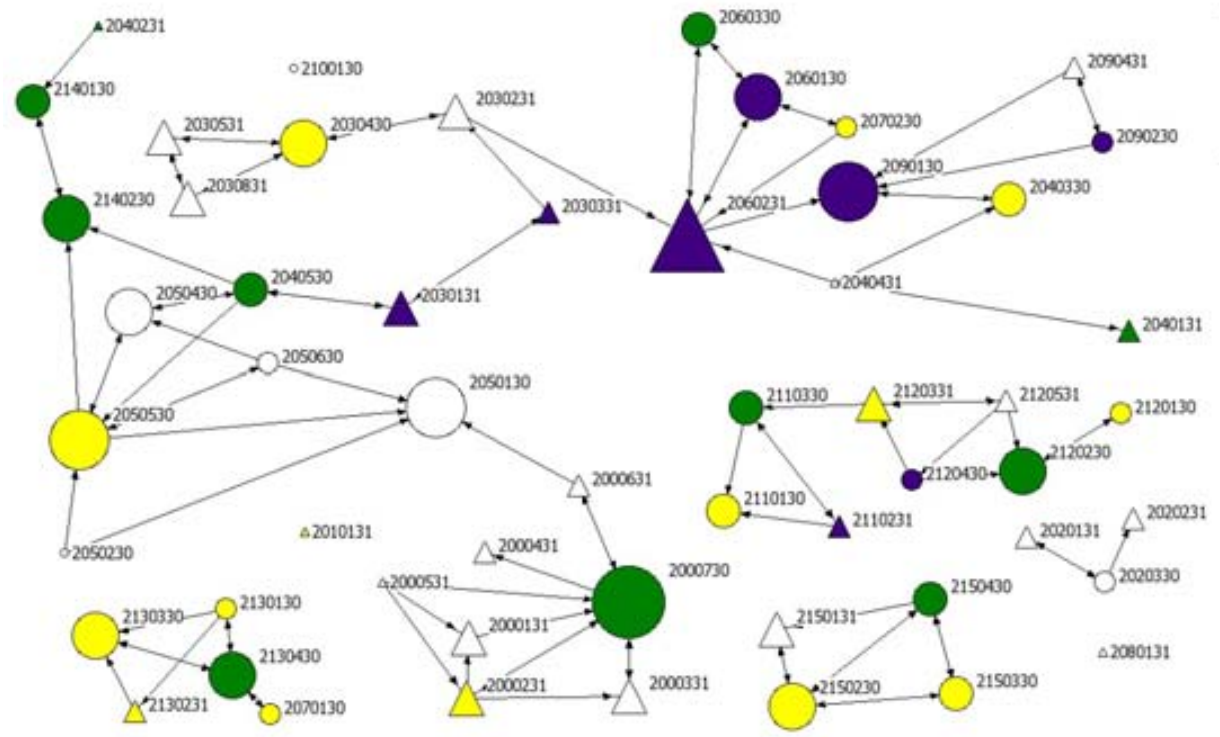
* Significant at ≤10%

** Significant at ≤ 5%

*** Significant at ≤ 1%

For definition of variables see Table 3.2.

Figure 3.2
Local landrace conservation in relation to the number of seed exchanges



Note: Nodes (55 gardeners who where surveyed) are sized by the number of nominations that a person received on other's people's list (indegree), shaped by the sex of the node (triangle for men, circle for women), and coloured to indicate the number of landraces kept by each gardener. The number next to the node corresponds to the identification number of the primary garden tender (the first three numbers for village of residency). Edges arrow represents the direction of the nomination.

We tested the associations using multivariate analysis. Table 3.4, columns [1] and [2], shows the results of a set of Poisson multivariate regressions of local landrace conservation (outcome variable) against our two measures of centrality in the network of seed exchange. We found that gardeners with high indegree (column [1] p=0.002) or high egobetwenneess (column [2] p=0.007) are more likely to conserve local landraces than less central gardeners. We conducted a similar analysis using local landrace knowledge as outcome variable (columns [3] and [4]). We found that people with higher indegree have more local landrace knowledge (p=0.01) than

people with lower indegree (column [3]). Likewise, people with higher egobetweenness (column [4]) have more local landrace knowledge than people with lower egobetweeness (p=0.003).

Table 3.4

Poisson multivariable regressions between individual centrality in the network of seed exchange (indegree and egobetweenness) and local landrace conservation and knowledge (outcome) (n=55)

	Local landrace conservation		Local landrace knowledge	
	[1]	[2]	[3]	[4]
Indegree	0.14 (0.00)***	^	0.06 (0.01)***	^
Egobetwenness	^	0.04 (0.01)***	^	0.02 (0.00)***
Male	-0.19 (0.48)	-0.26 (0.36)	-0.21 (0.04)**	-0.23 (0.02)**
Experienced	0.53 (0.01)***	0.62 (0.00)***	0.42 (0.00)***	0.47 (0.00)***

The regressions are Poisson with the standard error (in brackets). Regressions include clusters depending of the village of residence and constant (not shown). For definition of variables see Table 3.2.

^ Variable omitted on purpose

* Significant at ≤10%

** Significant at ≤ 5%

*** Significant at ≤ 1%

In additional analysis (not shown), we tested the robustness of the results in two different ways. First, we changed the control variables that we include in the model (including retired and organic, and different combinations of the control variables). We include them in separate models since our sample size is small and we cannot include many control variables in our model. Second, we ran the regressions using the variables indegree and egobetweeness with the information on nominations as seed giver and seed receiver separately. Results from our robustness models do not significantly vary from results in Table 3.4.

Discussion and conclusion

Two main findings emerge from our work: 1) the seed exchange network in Vall Fosca is active but fragmented, decentralized, and has a low density of exchanges, and 2) centrality on the network of seed exchange is associated with local landrace conservation and knowledge.

The structure of Vall Fosca seed exchange network

Several studies have suggested that seed exchange is not the main mechanism for seed acquisition, since gardeners exchange seeds only occasionally (Badstue et al. 2007, Stromberg et al. 2010). Our own previous research suggests that as much as 80% of plants in the studied gardens have a commercial origin (Calvet-Mir et al. 2011). In that context, it is not surprising the finding that, although active, the Vall fosca network of seed exchange is fragmented, decentralized, and has a low density of exchanges.

We found that the network is fragmented in five small networks that mostly correspond to subgroups of seed exchanges within people from the same or neighboring villages. Three of the smallest networks correspond to exchanges among people from the most geographically isolated villages, who mainly exchange seeds among themselves. In one of these villages, elders told us that they do not exchange seeds with people from other villages because due to their age they rarely visit those other villages and it is easier for them to ask their relatives or friends to bring to them seeds or seedlings from the market town. The smallest network corresponds to one person who only exchanged seeds with people from outside the valley. The network is not only fragmented, but also fragile, as some of the persons within the groups are only connected by one tie. Fragmentation constitutes a clear limitation on seed exchange networks as an effective mechanism for the conservation of agrobiodiversity and its associated knowledge at the local level since it hampers the

possibility of an individual to access all the local landraces and knowledge within the network. As in other situations (Borgatti and Foster 2003), fragmentation might undermine the development of trust between people, further affecting the exchange of seeds and knowledge. Bodin et al. (2006) have also suggested that fragmentation reduces the social memory and the learning and adaptive capacities of the network. Our results provide an example of how those processes might occur. Elders mentioned that in the past, when there were no markets for seeds, everybody had many seeds and there were many exchanges. Since the apparition of a seed market in the area, most people prefer to buy seeds and seedlings to avoid problems of seed degeneration and evade the extra work that comes with the seed bank preparation. As a consequence the number of seed exchanges and associated social interactions between gardeners has decreased.

We also found that the network is decentralized, meaning there is not a tendency for a few actors to have many links. Surprisingly, not even the local seed bank, that was created to improve the circulation of information on local landraces, has a central role in the network. Centralization can play a double role in the conservation of agrobiodiversity and its associated knowledge. On the one side, a low degree of centralization can increase the opportunities of learning because it increases the access of individual actors to multiple sources of information (Abrahamson and Rosenkopf 1997). For example, an informant that actively collaborates with the local seed bank pointed out that maintaining links with gardeners outside his village increased their access to several local landraces that they did not know. On the other side, a low degree of centralization can hamper the process of solving simple problems, such as seed degeneration, because relevant information cannot be relayed and synthesized to a few actors who can make a decision and take action (Leavitt 1951, quoted in Bodin et al. 2006).

Last, we found that the network had a low density of exchanges. As decentralization, low network density might also have unclear effects on agrobiodiversity conservation. On the one side, a low level of density can provide a multiple set of experiences and knowledge (Bodin and Norberg 2005) that can be useful to maintain the maximum number of local landraces and knowledge. On the other side, low density may debilitate the trust between individuals and groups and consequently increase the risk and cost of collaborating with others (Ostrom 1990), a prerequisite for maintaining the seed exchange network.

In sum, our results also suggest that, although fragmented and with a low density, the informal network of seed exchange is still alive in the area and, like in other contexts (Thiele 1999, Bodin and Crona 2009), this informal network represents a more important mechanism of seed exchanges than the local seed bank. In a sense, in the studied context, our results can help conceptualize social networks as human biologic corridors that facilitate the conservation of agrobiodiversity by social interactions between actors.

Centrality, local landrace conservation, and knowledge

Based on previous studies (Vogl and Vogl-Lukasser 2003, Acosta-Naranjo and Díaz-Diego 2008), in this work, we have considered conservation of local landraces and associated knowledge as parts of agrobiodiversity conservation. Our results suggest that, indeed, at the individual level, measures of network centrality are associated to those two aspects of agrobiodiversity conservation. The finding that centrality in the seed exchange network is associated to local landrace conservation and knowledge reinforces previous findings on the importance of seed exchanges to ensure the maintenance of local agrobiodiversity (Thiele 1999, Zeven 1999). Farmers have traditionally used informal networks to acquire seeds (Vogl and Vogl-Lukasser 2003, Acosta-Naranjo and Díaz-Diego 2008), especially those only locally available (Ban and Coomes 2004, Badstue et al. 2007, Stromberg et al. 2010).

A potential explanation of why individual centrality on the network of seed exchange is associated with local landrace conservation and knowledge is the role of seed exchange as agrobiodiversity conservation mechanism. As suggested for other regions (Thiele 1999, Ban and Coomes 2004, Badstue et al. 2007, Stromberg et al. 2010), it is likely that in Vall Fosca the exchange of seeds favors local landrace conservation, since local landraces are out of the market in a context where the main way of propagules acquisition is the market (Calvet-Mir et al. 2011).

It is also worthy to notice that the exchange of local landraces might be a marker of cultural identity. As Stromberg et al. (2010) note, the significance of gifts as a source of seeds, although rare, indicates the social significance of varietal exchange as a contributor to maintaining agrobiodiversity. For example, we observed that gardeners in Vall Fosca plant large seed banks with local landraces so they can offer seeds to friends and relatives. Gifts of local landraces are locally highly appreciated.

Finally, social network analysis shows how gardeners mingle with each other and allows identifying their role in the network. As other authors have pointed out (Prell et al. 2007), social network analysis, combined with other tools as stakeholder analysis, could be used to select stakeholders for participation in natural resource management initiatives. Results from our analysis could therefore be used to strengthen seed exchange networks by practitioners aiming at strengthening the networks of seed exchange. For example, after identifying the different roles in a network, practitioners could put in touch the main intermediaries in the network with the main local landraces and local landrace knowledge keepers in order to spread the seed and knowledge throughout the network.

In conclusion the study presented here suggests that social network analysis can provide many insights in the analysis of networks of seed exchanges, and could support projects for agrobiodiversity conservation.

Limitations

Results from this study, however, should be taken with caution due to some methodological limitations. First, since we have not conducted genetic analyses of local landraces, it is possible that we have over or underestimated the number of the total local landraces. Second, our measure of local landrace knowledge might be biased since we only asked about three local landraces, and those might only capture a reduced spectrum of all local landrace knowledge within the valley. Third, our sample size (n=55) is small for multivariate statistical analysis that would allow us to estimate the relative weight of the different variables. Fourth, we assume that seed and knowledge are transmitted together; however it is possible that people engage in knowledge exchange without exchanging seeds, or vice versa. Last, we had to rely on gardeners' information to construct the network of seed exchange. Previous authors have noticed that seed exchanges are difficult to record because gardeners do not remember them well (Badstue et al. 2007). Report of interaction can also be affected by a number of other factors (i.e., informant's recall capacity, frequency of the interaction, time since last interaction, and the like), so relying on report data might bias our results in unknown magnitude and direction.

Acknowledgements

Research was funded by the Programa de Ciencias Sociales y Humanidades del Ministerio de Educación y Ciencia (MEC-España, SEJ2007-60873/SOCI), the Agència de Gestió d'Ajuts Universitaris i de Recerca (AGAUR) and the Centre de Promoció de la Cultura Popular i Tradicional Catalana (CPCTC) (Generalitat de Catalunya). L. Calvet-Mir acknowledges financial support from a FPU grant (MEC-España, AP-2006-01849). We thank all the tenders who collaborated in the project. We also thank Laura Aceituno, Teresa Garnatje, Juan José Lastra, Montserrat Parada, Manuel Pardo, Montserrat Rigat, Joan Vallès, and Sara Vila for help in the identification of species and comments to previous versions of this work. Thanks

also go to Neus Costa-Llesuy for editorial help and to Daniel Corbacho-Monné and Laia Echániz-Pou for help in the field work and in the elaboration of the figure.

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CHAPTER 4

Beyond food production: Ecosystem services provided by home gardens. A case study in Vall Fosca, Catalan Pyrenees, northeastern Spain [7]

[7] Calvet-Mir L., Gómez-Baggethun E. and Reyes-García V., 2011. Beyond food production: Ecosystem services provided by home gardens. A case study in Vall Fosca, Catalan Pyrenees, northeastern Spain. Ecological Economics: accepted, pending minor revisions.

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.

Key words: agroecosystems; Europe; kitchen gardens; socio-cultural valuation; Spain.

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, MA 2003, Kumar 2010). 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 (MA 2003, Kumar 2010, Power 2010).

Ecosystem service research suggests that the social benefits that agroecosystems provide generally transcend those related to production services (Turner et al. 2004, Perrings et al. 2006, Jackson et al. 2007a, Pascual and Perrings 2007, Porter et al. 2009, Sandhu et al. 2010a). 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 (Swinton et al. 2007, Zhang et al. 2007, Sandhu et al. 2010b).

Research suggests that agroecosystems' capacity to deliver ecosystem services depends on the intensity of use and on the diversity of crop lands. 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, Jackson et al. 2007b); thereby combining agricultural productivity with the 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, Sunwar et al. 2006, Perrault-Archambault and Coomes 2008, Calvet-Mir et al. 2011a), and some contributions claiming the importance of home gardens for ecosystems service supply (Eyzaguirre and Linares 2004, 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.

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. 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 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.

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, Reyes-García et al. 2010, Calvet-Mir et al. 2011a, Calvet-Mir et al. 2011b, Reyes-García et al. 2011). 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 garden ecosystem services to serve as a cross-checking tool against which we could compare the values perceived by stakeholders.

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 4.1).

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 4.1).

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/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.

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.

Results

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 4.1).

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 garden 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.

Table 4.1

Ecosystem functions and services provided by home gardens in Vall Fosca

Function	Ecosystem processes and components	Goods and services from home gardens	Source of identification		
			Lit.	Obs.	Interv.
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	•		

Function	Ecosystem processes and components	Goods and services from home gardens	Source of identification		
			Lit.	Obs.	Interv.
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		•	

Function	Ecosystem processes and components	Goods and services from home gardens	Source of identification		
			Lit.	Obs.	Interv.
Cultural	***Provision of opportunities for cognitive development***				
Aesthetic information	Attractive landscape features	Enjoyment of home garden 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		•	

Valuation of home garden ecosystem services

Table 4.2 presents the average value given to each ecosystem service by stakeholders (Column A) and the scientific panel (Column B).

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 4.2 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 garden 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.

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 4.2, 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).

Table 4.2

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 garden 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, $p< 0.01$

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.

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 garden 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.

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, Swinton et al. 2007, Zhang et al. 2007, Sandhu et al. 2010a,b). 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 (Vogl and Vogl-Lukasser 2003, Reyes-García et al. 2011).

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 (Eyzaguirre and Linares 2004, Aceituno-Mata 2010), 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.

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 (Kaltenborn 1998,

Cantrill and Senecah 2001). 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.

Acknowledgements

Research was funded by the Programa de Ciencias Sociales y Humanidades del Ministerio de Educación y Ciencia (MEC-España) (SEJ2007-60873/SOCI), the Agència de Gestió d'Ajuts Universitaris i de Recerca (AGAUR) and the Centre de Promoció de la Cultura Popular i Tradicional Catalana (CPCTC) (Generalitat de Catalunya). L. Calvet-Mir acknowledges financial support from a FPU grant of the MEC-España (AP-2006-01849). We thank all the tenders who collaborated in the project. We also thank Maria Calvet-Mir, Daniel Corbacho-Monné and Laia Echániz-Pou for help in the field work and in the elaboration of the figures. We finally thank the colleagues of ICTA that engaged in the scientific evaluation panel and two anonymous reviewers for providing useful comments to improve the article.

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CHAPTER 5

Gender differences in ecosystem services valuation: A case study in home gardens of the Catalan Pyrenees, northeastern Spain[8]

[8] Calvet-Mir L., Corbacho-Monné D., Gómez-Baggethun E. and Reyes-García V., 2011. Gender differences in ecosystem services valuation: A case study in home gardens of the Catalan Pyrenees, northeastern Spain. Environment and Behavior: under review.

Abstract

The study of gender differences in environmental attitudes and behaviors and nature valuation has been an active field of research since the 1980s. But the extent to which a person's gender affects his or her attitudes towards the environment is still a subject of debate. In this paper, we aim at advancing the understanding on the relation between gender and environmental attitudes and behaviors through the analysis of values assigned to ecosystem services supplied by high-mountain home gardens. For the empirical analysis we use home gardens in Vall Fosca (Catalan Pyrenees, northeastern Spain). We assess the role of gender in the valuation of ecosystem services provided by home gardens and explore the factors that explain the gender's role in the valuation of ecosystem services provided by home gardens. Methods used in this research included participant observation, a survey, and a workshop. We found that women are more likely to value all ecosystem services higher than men. Using a score constructed with the overall punctuation given to the entire ecosystem services we fount that women give 7.55 % higher valuation than men. In interpreting our results, we argue that gender socialization is a major factor influencing human relationship within the environment, and specifically in our case study with home gardens.

Key words: agroecosystems; Europe; kitchen gardens; socialization theory; socio-cultural valuation

Introduction

The study of gender differences in environmental attitudes and behaviors and nature valuation has been an active field of research since the 1980s (González-García 2008). But whether a person's gender affects his or her attitudes towards the environment is still a subject of debate.

On the one side of the debate, some research suggests that women have stronger environmental attitudes than men. For example, a review of research on gender differences in environmental attitudes and behaviors conducted between 1988 and 1998 found that women consistently report stronger environmental attitudes and behaviors than men, as measured by Zelezny et al. (2000). In a recent replication of this research, Nurse et al. (2010) found that women scored higher than men on ecocentrism (a value orientation based on the fundamental belief that nature has inherent or intrinsic value). The same authors also found that women scored higher than men on the need to seek out and enjoy nature-related experiences through the senses, but that women scored lower on environmental apathy than men. Similarly, in a study in the US on gender differences on climate change knowledge and concern, McCright (2010) found that women exhibit slightly higher levels of climate change knowledge and concern than their male counterparts. Attempting to explain the social and cultural bases for differences in environmental concern, this group of authors has mainly explained specific gender differences in environmentalism by altruism and pro-social models historically attributed to women. This perspective maintains that early childhood socialization renders women more sensitive to the feelings and needs of others and thus more willing to take on caring and nurturing roles (Chodorow 1974, Gilligan 1982). For example, Zelezny et al. (2000) argue that the women's role of caring for "others" similarly engages the idea of caring for the environment. By contrast, early childhood socialization leads men to control their

emotions and more greatly value independence and achievement (Chodorow 1974, Gilligan 1982).

On the other side of the debate, research by some other authors does not find evidence of gender differences on environmental attitudes and behaviors. For example, results of a study drawing on nationally representative survey data from six developed countries suggest that there is no difference between men and women in terms of their concern about the environment (Hayes 2001). In another research conducted in the US, Blocker and Eckberg (1997) found that while there appear to be some differences in environmental orientations between men and women, these were neither strong nor consistent, and furthermore they did not extend to actions. Similar results were found in Spain in a study analyzing the relation between gender and environmental attitudes (Aragonés and Amérigo 1991).

A third group of authors still hold a different position and argue that differences or similarities between women and men's attitudes toward the environment depend on the sphere of analysis. Thus, according to some research, in the private sphere (e.g., recycling) women demonstrate greater internalization of environmental behaviors than men, but there are no clear gendered patterns in the public sphere (e.g., environmental organization donations) (Hunter et al. 2004, Xiao and Hong 2010). For example, in a study across 22 nations, Hunter et al. (2004) found that women undertake substantially more environmentally oriented behaviors in the private sphere than men, but this statement tend to be more consistent within nations at the upper end of wealth distribution rankings.

Here we aim at advancing the understanding on the relation between gender and environmental attitudes and behaviors through the analysis of values assigned to ecosystem services. Our research is based on a case study on valuation of ecosystem services supplied by high-mountain home gardens in a valley in the Catalan Pyrenees, in the northeastern Iberian Peninsula, Vall Fosca. The valuation is based

on surveys addressing the perception of women and men about the importance of ecosystem services provided by home gardens for their well-being. The specific goals of the paper are 1) to assess the role of gender in the valuation of ecosystem services provided by home gardens and 2) to explore the factors that explain the gender's role in the valuation of ecosystem services provided by home gardens.

We focus on home garden ecosystem services for three main reasons. First, the ecosystem services approach provides a useful framework for capturing specific social values people hold towards the environment (Bryan et al. 2010), so the approach should also be appropriated for the study of gendered differences in environmental valuation. Second, besides natural ecosystems, cultivated farmlands, or agroecosystems such as home gardens, have already been recognized as distinct kinds of ecosystem service-providers by international initiatives endorsing the ecosystem services approach (MA 2003, Kumar 2010, Power 2010). Previous research has highlighted the importance of home gardens in the delivery of ecosystem services (Andersson et al. 2007, Barthel et al. 2010, Calvet-Mir et al. 2011a), but none has addressed gendered differences in this valuation. And third, home gardens are modified natural spaces where men and women play different contextual roles (Howard 2003, Howard 2006, Reyes-García et al. 2010). Because of the implication of both men and women in managing fore home gardens, those ecosystems represent an ideal place to analyze gender differences in environment valuation.

We use the term "home garden" to refer to small, fenced plots close to the farmers' homestead, where annual, biennial, and/or perennial cultivated species are grown in beds (Vogl and Vogl-Lukasser 2003). The term "ecosystem services" refers to the flows of benefits for human well-being provided by natural ecosystems (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, MA 2003, Kumar 2010).

Vall Fosca and its home gardens

Vall Fosca is a Pyrenean valley of glacial formation of 200 km^2 and about 1000 inhabitants lying along the Flamisell River (Figure 1). At the administrative level, Vall Fosca is mainly constituted by the municipality of La Torre de Capdella and includes parts of the municipality of Senterada. Vall Fosca translates as "dark valley", a name that refers to the few hours of sunlight on the valley due to the marked slopes of the surrounding mountains. The altitude in the region varies from 729 masl to nearly 3000 masl. Annual precipitations depend on the altitude, ranging from 800 to 1200 mm. In the valley there is an altitudinal vegetation gradient varying from Mediterranean to Alpine communities (Calvet-Mir et al. 2011b).

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. Visitors are mainly from Spain and generally stay at rural guesthouses or camping accommodations. Activity is more intense on summer season, when tourists visit the valley attracted by the beauty of the alpine landscape and engage in trekking activities that they can perform in the periphery and inside Aigüestortes and Estany de Sant Maurici National Park, one of the 14 National Parks declared in Spain. Visitors also come to the valley attracted by cultural values and engage on the local festivals the different villages within the valley offer during the summer.

In our previous research on the study area, we have analyzed a) home garden characteristics (Calvet-Mir et al. 2011b) and b) home garden ecosystem services (Calvet-Mir et al. 2011a). So, here we summarize our previous findings before moving to the specific analysis of this work.

Home garden characteristics

High altitudes and the presence of slopes make it difficult for people in the area to engage in intensive agriculture, which explains why the area lacks a strong agricultural sector. Furthermore, the most characteristic form of agriculture in the area is home gardens.

Because of the absence of shops and the limited accessibility to the market town, especially in winter, home gardens in Vall Fosca have traditionally played an important role as a complement for food supply, hosting a wide diversity of species and varieties for household consumption (Calvet-Mir et al. 2011b). Customarily, women were in charge of home gardens as part of their household activities, as men spent much of their time outside the household in charge of cattle. However this traditional division of work has been recently reversed. Thus we found that men manage 43.4% of the home gardens studied; whereas women manage 37.7% and 18.9% are managed by both men and women. These characteristics fit with the findings reported by Reyes-García et al. (2010) for the Catalan Pyrenees and can be attributed to the deeper integration in the market economy and the crises of traditional socio-economic activities in the countryside during the 1960s that force many men to shift towards non-agricultural occupations, such as the service and the housing sector (Naredo 2004). Despite these changes in socio-economic structures and lifestyles, many households continued to maintain home gardens. Because agricultural tasks were considered men's domain, it seems likely that men who shifted to non-agricultural occupations took a more prominent role in gardening (Reyes-García et al. 2010). Our own ethnographic data also attributes these changes to the fact that currently retired men from non-agricultural sectors use to manage a home garden as hobby.

The average area of home gardens in Vall Fosca is 147.25 m^2 (Calvet-Mir et al. 2011b). Despite their relatively small size, home gardens in the area contain 148

different species from 50 families. Most species grown in home gardens in the area are edible (41.9%) or ornamental (36.5%). Other uses of species grown in home gardens included medicinal, fodder, and spices. We found 39 different local landraces in the studied home gardens. We have also found that women, retired people, people who manage an organic garden, and experienced gardeners conserve more local landraces than people without those characteristics (Calvet-Mir et al. 2011b).

Home garden ecosystem services

Based on a review of the scientific literature, documentation on the ecology, economy and culture of Vall Fosca, fieldwork observations, and interviews with local gardeners, in previous research Calvet-Mir et al. (2011a) identified and characterized 19 ecosystem services provided by home gardens in Vall Fosca. Those 19 ecosystem services, which constitute the basis of the work on gendered differences presented here, are organized in four main categories: five regulating services, two habitat services, five production services, and seven cultural services (Table 5.1). We found that home gardens provide a large set of often overlooked ecosystem services; cultural services being the category most valued by both stakeholders and scientists. The same study suggests 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. Furthermore, this previous research also found that stakeholders in the area felt that home gardens were a key element of Vall Fosca's landscapes, and stated that home gardens had to be preserved as an important component of cultural heritage (Calvet-Mir et al. 2011a).

Table 5.1

Average punctuation of ecosystem services provided by home gardens in Vall Fosca (n= 151 informants)

Ecosystem services from home gardens	**Average punctuation of ecosystem services from home gardens**		
	Range of each service (0-5)		
	A	**B**	**C**
	Male (n=81)	**Female (n=70)**	**Overall (n=151)**
	Mean	**Mean**	**Mean**
Regulating services			
Flood prevention (when gardens are located near rivers)	1.61	2.13**	1.85
Maintenance of natural, productive soils	4.36	4.60	4.47
Enhanced crop production	3.46	3.81	3.62
Enhanced water quality	2.01	2.56**	2.26
Prevention / buffering of pests and diseases	1.88	2.36**	2.10
Average punctuation of regulating services. Range 0 to 25	13.31	15.46***	14.30
Habitat services			
Living space for wild plants and animals	3.48	3.86**	3.66
Maintenance of landraces	4.58	4.70**	4.64
Average punctuation of habitat services. Range 0 to 10	8.06	8.56**	8.29
Production services			
Provision of quality food	4.90	4.91	4.91
Provision of fodder and green manure	3.99	4.66***	4.30
Crop improvement and material for medicinal proposes	3.88	3.97	3.92
Provision of medicinal plants	4.06	4.50***	4.26
Provision of resources for worship and decoration	3.56	4.46***	3.97
Average punctuation of production services. Range (0-25)	20.38	22.50***	21.36

Ecosystem services from home gardens	Average punctuation of ecosystem services from home gardens Range of each service (0-5)		
	A	B	C
	Male (n=81) Mean	Female (n=70) Mean	Overall (n=151) Mean
Cultural services			
Enjoyment of home garden aesthetic features	4.35	4.73***	4.52
Hobby	4.62	4.79*	4.70
Use in folklore, art and design	3.20	3.87***	3.51
Connection with spiritual feelings	4.06	4.47**	4.25
Place to carry out environmental education and scientific research	4.40	4.63*	4.50
Heritage value of home gardens and associated traditional ecological knowledge	4.57	4.73**	4.64
Place for creating and enhancing social networks	4.12	4.60***	4.34
Average punctuation of cultural services. Range (0-35)	29.31	31.81***	30.47
Average punctuation of all services. Range (0-95)	71.06	78.33***	74.43

Wilcoxon rank-sum test
* Significant at ≤10%
** Significant at ≤ 5%
*** Significant at ≤ 1%

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, Reyes-García et al. 2010, Calvet-Mir et al. 2011a, Calvet-Mir et al. 2011b, Calvet-Mir et al. 2011c, Reyes-García et al. 2011). We collected data in Vall Fosca (northern Catalonia, Iberian Peninsula) between July and November 2010. Data collection included participant observation, 151 surveys, and a workshop.

Methods of data collection

Participant observation. During our fieldwork we engaged on informal talks and open-ended interviews with individuals or groups of stakeholders to achieve a better understanding of gender roles in the valley, and particularly in the division of labor related to home gardens. For example, we talked with different stakeholders about their relation with home gardens, which sometimes ended in explanations about the importance of growing ornamental plants for decoration or worship purposes. Women normally reported that they liked to see flowers in their home gardens, and although some of them did not manage the home garden, they reported asking to their husbands to plant ornamental plants. Those conversations gave us a wider understanding of people's perception of home garden ecosystem services, since those services may be difficult to capture with highly structured methods or closed questionnaires.

Survey. During July-September 2010 we conducted a survey to 151 stakeholders, defined here as any adult benefiting directly or indirectly from 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, and also between visitors and local inhabitants.

In the first part of the survey, we collected information about the socio-demographic characteristics of the stakeholders (e.g., age, whether the person cultivated a garden and consumed organic products). The second part of the survey consisted of a questionnaire to assess stakeholders' agreement on statements about the importance of home garden ecosystem services for human well-being. For that part of the survey, we used a Likert scale design (Bernard 2005). Specifically, we read to stakeholders statements referring to each of the 19 different ecosystem services provided by home gardens in Vall Fosca (as identified by Calvet-Mir et al. (2011a), Table 5.1) and asked them to tell us how much did they agree with each statement. To enhance respondents understanding of our statements, each question was presented orally but accompanied with visual means, using pictures from local ecosystems (when available). For example, we read to participants the following sentence "Home gardens are important because they provide resources for worship and decoration" and showed the stakeholder an ornamental plant in a local home garden. Or we read "Home gardens are important because they are a hobby" and showed the stakeholder a picture of people working 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".

Workshop. On November 2010, we organized a participatory workshop (Steiner 1999): (1) to communicate the findings from the survey to stakeholders and (2) to validate the results obtained in the surveys by identifying stakeholders' main discourses in relation to our results. The council of the valley circulated a call inviting to the workshop all stakeholders (locals and visitors) willing to participate. The number of participants attending the workshop was 20, and the workshop lasted two hours. Members of the research team explained the findings of the research, facilitated the discussion and recorded and analyzed the participants' comments during the workshop.

Methods of data analysis

Generation of variables: We used the answers to the survey questions to generate outcome, explanatory, and control variables for statistical analysis. To generate the outcome variables we used responses to the Likert scale. We first tested whether all the questions in the Likert scale measured the same construct. The results from factor reliability analysis using Chronbach alpha suggests that there is internal consistency in the scale used to assess the perception of home gardens ecosystem services, as all the items in our Likert scale where positively associated one to each other (alpha=0.88). Because of this internal consistency, we decided to aggregate answers to different questions to create five outcome variables: *total*, *regulating*, *habitat*, *production* and *cultural*. *Total* refers to the sum of the individual punctuations given to each ecosystem service. The other four outcome variables are the sum of the individual punctuation given to each ecosystem service of a given category (Table 5.1).

We used answers to the questions included in the first part of the surveys to generate explanatory and control variables. Our main explanatory variable, *Male,* was coded as 1 if the person answering the survey was a man and 0 otherwise. Control variables included five binary, one categorical, and one continuous variable. *Visitor* was coded as 1 if the person did not reside in Vall Fosca and 0 otherwise. The variable o*rganic product was* coded as 1 if the person reported to consume organic products and 0 otherwise. *ES was* coded as 1 if the person knew the term "ecosystem services" and 0 otherwise. *Conservation* was coded as 1 if the person considered that home gardens should be preserved as cultural heritage and 0 otherwise. *Education* was coded as 1 if the person reported to have from secondary to university education and 0 otherwise. *Garden type* was coded as 0 if the person reported to not manage a home garden, 1 if the person reported to manage a home garden and to use chemical fertilizers or agrochemical pests and weed control techniques for its management (non-organic

garden), and 2 if the person reported to manage a home garden and to use manure or organic products as main fertilization management technique and the use of manual or organic methods as main management techniques to control weeds and pests (organic garden). Finally, the variable *age*, measured in years, was treated as continuous.

Statistical analysis: To examine the association between gender and the average punctuation stakeholders assigned to home garden ecosystem services, we first ran a Wilcoxon rank-sum test of the average punctuation of each ecosystem service given by men and women. We then ran ordinary least square multiple regressions to examine the relation between the overall valuation of ecosystem services (*total*), as well as the valuation of the specific categories of services (*regulating, habitat, production,* and *cultural* services) and the person's sex. In regressions we used the individual score of ecosystem services as outcome variable, the sex as explanatory variable, and seven control variables. For the statistical analysis we used STATA 9 for Windows.

Results

Valuation of home garden ecosystem services by gender

Since we used a stratified sampling strategy, our sample was similarly distributed between men (54%) and women (46%), and also between visitors (59%) and local inhabitants (41%). Other socio-demographic characteristics of people in our sample are described in Table 5.2.

Descriptive and bivariate analysis: Table 5.1 presents the average punctuation given to each ecosystem service by men (Column A), women (Column B), and the whole sample (Column C). For every single ecosystem service the average punctuation of women was higher than the average punctuation of men. The difference in means was statistically significant in a Wilcoxon rank-sum for all the ecosystem services except four. The four services where the difference was not statistically significant include two regulating services ("maintenance of natural, productive soils" and "enhanced crop production") and two production services ("provision of quality food" and "crop improvement and material for medicinal proposes"). For example, in the ecosystem service "provision of quality food" the difference on the average punctuation between men and women was 0.01 points (p=0.50). The largest differences in men and women's valuation of ecosystem services were found in two production services ("provision of resources for worship and decoration" and "provision of fodder and green manure") and one cultural service ("use in folklore, art, and design"). For example, in the ecosystem service that present the largest differences in valuation ("provision of resources for worship and decoration"), the variance on the average punctuation between men and women was 0.90 points (p=0.00) (Table 5.1). When it comes to aggregated categories, the average punctuation of women was also higher than the average punctuation of men for the four categories of ecosystem services studied. In most aggregated categories, women's average value was two points higher than men's. The difference was

smaller for habitat services, which were valued similarly by men and women, although –on average-women still valued those services 0.50 points higher than men. Bivariate analysis shows that the difference was statistically significant for all the aggregated categories (Table 5.1).

Table 5.2: Definition and summary statistics of explanatory and control variables used in statistical analysis (n=151)

	Definition			Total	Male	Female
Explanatory variable				%	%	%
Man	Dummy variable: 0=woman, 1=man			53.64		
Control variables						
Visitor	Dummy variable: 0=resident in Vall Fosca; 1=visitor			58.94	62.96	54.29
Organic products	Dummy variable: 0=never buy organic food; 1= buy organic food			68.21	67.90	68.57
ES	Dummy variable: 0=do not know the term "ecosystem services"; 1= otherwise			13.91	13.58	14.29
Conservation	Dummy variable: 0=home gardens should not be preserved as cultural heritage; 1=otherwise			94.70	93.83	95.71
Education	Dummy variable: 0=less than secondary education; 1= from secondary to university education			64.90	72.84	55.71
Garden type	Garden type	0	No garden	49.01	41.98	57.14
		1	Non-organic garden	19.87	20.99	18.57
		2	Organic garden	31.13	37.04	24.29
				Mean (StD)	**Mean (StD)**	**Mean (StD)**
Age	Respondent's age in years			52.21 (19.63)	48.59 (19.77)	56.39 (18.74)

Multivariate regression: Results from multivariate analysis (Table 5.3) corroborate that women are more likely to give a higher punctuation to ecosystem services than men. Thus, results using the score constructed with the overall punctuation given to all the ecosystem services (column *Total*) suggest that, on average, women value ecosystem services 7.17 points higher than men (p=0.000). Since the variable *Total* ranges from 0 to 95 points, a difference of 7.17 points represents a 7.55 % higher valuation by women.

When considering specific categories of ecosystem services, we found that the larger valuation differences were in cultural and regulating services. On average women valuated home garden production services 2.43 points higher than men (0.003) and regulating services 2.38 points higher (0.004). The smaller difference was found in habitat services, where women valuated those ecosystem services 0.38 points higher than men. Furthermore, the difference was not statistically significant at the conventional 90% interval of confidence level (p=0.284).

None of our control variables was consistently associated across our five models. However the stakeholders who reported that gardens should be preserved as cultural heritage (variable *conservation*) valuated ecosystem services significantly higher than the ones who did not; except for the production category, where the association was not statistically significant.

Table 5.3

Ordinary least square multiple regressions results (n=151)

	Total	**Regulating**	**Habitat**	**Production**	**Cultural**
	Coefficient (Std Error)	Coefficient (Std Error)	Coefficient (Std Error)	Coefficient (Std Error)	Coefficient (Std Error)
Explanatory variable					
Man	-7.17*** (1.98)	-2.38*** (0.81)	-0.38 (0.35)	-1.97*** (0.60)	-2.43*** (0.80)
Control variables					
Visitor	4.80* (2.46)	2.43** (1.01)	0.43 (0.43)	0.86 (0.75)	1.07 (0.99)
Organic products	3.72* (2.11)	1.42 (0.86)	0.50 (0.37)	0.95 (0.64)	0.84 (0.85)
ES	-6.54** (2.85)	-2.92** (1.16)	0.44 (0.50)	-1.28 (0.86)	-2.78** (1.14)
Conservation	9.87** (4.16)	3.48** (1.70)	1.99*** (0.73)	1.48 (1.26)	2.89* (1.66)
Education	0.08 (2.76)	0.94 (1.12)	-0.07 (0.49)	-0-20 (0.84)	-0.60 (1.10)
Garden type (Excluded category: non-organic garden)					
No garden	5.24* (2.84)	1.28 (1.16)	0.55 (0.50)	1.07 (0.86)	2.33** (1.14)
Organic garden	5.25* (2.78)	1.66 (1.14)	0.88* (0.49)	0.94 (0.84)	1.77 (1.11)
Age	0.03 (0.06)	0.01 (0.03)	0.02 (0.01)	0.01 (0.02)	-0.01 (0.02)

Regressions results include a constant (not shown). For definition of variables see Table 5.2.

* Significant at ≤10%

** Significant at ≤ 5%

*** Significant at ≤ 1%

Stakeholders' perception of valuation of home garden ecosystem services by gender

Workshop: Twenty stakeholders, nine men and 11 women between 23 and 85 years old joined the workshop. Five participants were visitors in the valley and twelve participants managed a home garden (including two visitors). At the onset of the workshop we presented participants with results from Table 5.1. After our presentation, we asked them why they thought this difference exists. When discussing about possible explanations of why women value home garden ecosystem services more than men, participants in our workshop reached a consensus in three main points: (1) In Vall Fosca, women have traditionally been in charge of managing home gardens. Traditionally those home gardens were oriented to household consumption, and thus contributed to enhance family well-being. Because of this traditional role of women's home garden management, and even if today many men manage a home garden as hobby, women still value home gardens more than men, because they associate home gardens with household wellbeing. (2) Because of the traditional division of labor in the society and the gender roles assigned to women (i.e., taking care of the family and cooking) women relate home gardens with the domestic sphere and associate family well-being with home garden, although they do not manage a home garden, since they use home garden' products to cook, so they give higher punctuation to home garden ecosystem services than men. (3) Men consume less home garden products than women, and then men perceive home gardens not as important for their nutrition as women do. During the workshop the statement arose that men did not like the "green", referring to men reluctance to consume vegetables as compared to meat.

Discussion and conclusions

Two important findings emerge from this work. First, men and women equally value the ecosystem service of "provision of quality food." And second, when considering the many other ecosystem services provided by home gardens, women value then more than men.

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. Both men and women equally value this service as there are not significant differences between the sets of valuations provided by women and men. The finding is not surprising in itself, but it is surprising in the context of the gender analysis conducted here, as women give a statistically significant higher value than men to most (76%) of ecosystem services provided by home gardens. We argue that the vocational role of home gardens in food production (Calvet-Mir et al. 2011a) is the main reason explaining the lack of differences between men and women valuation.

Our second finding, then, relates to the differences in valuing the rest of ecosystem services provided by home gardens. We interpret our second result in the context of socialization theory, thus attributing to gender socialization the differences between women and men in the valuation of home garden ecosystem services. Socialization theory (Walker 1992) posits that individual behavior is predicted by the process of socialization, whereby individuals are shaped by gender expectations within the context of cultural norms. On the one hand, and because of their role in reproduction, women across cultures are socialized to hold roles of caregivers and nurturers (Blocker and Eckberg 1989, Mohai 1992, Zelezny et al. 2000); and probably because of those culturally defined roles, they also report higher levels of altruism (e.g., Dietz et al. 2002) and are more likely to be cooperative and compassionate (Beutel and Marini 1995) than men. On the other hand, men are socialized to be more

independent and competitive (Chodorow 1974, Gilligan 1982, Keller and Goldhaber 1987) than women. Thus, we explain the differences found in the valuation of ecosystem services of home gardens in Vall Fosca in relation to the gender roles culturally assigned to men and women in the society. For example, the difference in valuing the ecosystem service "provision of resources for worship and decoration", the one showing the highest contrast between men and women responses, can be arguably linked to cultural roles assigned to women. During informal interviews, women explained that they plant chrysanthemums (*Chrysanthemum indicum* L.), not only for aesthetic reasons, but also to bring them to the grave yard on All Saints Day (November 1st), a role that is not culturally assigned to men. Similar results are reported by Reyes-García et al. (2010) in a study covering four mountain regions in the Iberian Peninsula, including Vall Fosca. In the same line, women in Vall Fosca have traditionally been in charge of taking care of domestic animals (e.g. hens, rabbits) and feeding them. This could explain the dissimilarities between men and women when it comes to value the ecosystem service of "provision of fodder and green manure", the one ranking second in difference between both sexes. Via informal talks and open ended interviews women from outside the study area also reported that bringing flowers to the grave or feed animals is normally a women task, as part of the their household activities.

Results of the workshop are also consistent with socialization theory. As results of the workshop suggest, and as reported by Calvet-Mir et al. (2011b), women in Vall Fosca have traditionally held the role of managing home gardens, and women associate family well-being with the home garden. Then, the cultural roles assigned to women (Zelezny et al. 2000), women's responsibility for social needs (Eisler et al. 2003) and their reportedly higher levels of altruism (Dietz et al. 2002) are likely to be important factors explaining gender differences in home gardens ecosystem services valuation.

Our finding is in line with previous research on the topic that has shown that women exhibit more pro-environmental attitudes and behaviors than men (Zelezny et al. 2000, Smith 2001, Dietz et al. 2002, Nurse et al. 2010, Xiao and Hong 2010). As valuation based on subjective preferences on ecosystem services is widely acknowledged to be a suitable tool for capturing many of the social values people attribute to the environment (Bryan et al. 2010), our results suggest that gender is an important variable that helps explain people's different attitudes towards the environment. The pro-social attitudes normally attributed to women could lead to pro-environmental attitudes. Then, the traditional roles culturally assigned to women as caregivers and nurturers, and the higher levels of altruism of women compared to men, should be shared by the whole society. As MacGregor (2004) states we must construct a citizenship that demands the public recognition of care as a politic ideal, avoiding women to be the mainly responsible of caregiving. We propose that environmental education in schools via home gardens management can be a good instrument to achieve this politic society ideal of constructing an egalitarian and ecologist citizenship. Home gardens could permit sharing tasks between men and women in the same environment, and could promote pro-social and pro-environmental attitudes.

As González-García (2008) states in a revision on gender and natural spaces, it is interesting to note, however, that the category "women" is not homogenous and that paying attention to the diversity of women is a crucial requirement for both an adequate understanding of the factors influencing human relationship with the environment and for the identification of intervention areas and strategies. Moreover as Kollmuss and Agyeman (2002) highlight, although altruism and pro-social models can explain specific gender differences in environmentalism, there are also non gendered external (i.e. economic, cultural) and internal (i.e. motivation, values, attitudes) factors that influence pro-environmental attitudes. Further research ought

to address different categories of “women” and “men”, and analyze the internal and external factors influencing them in order to contribute to the future understanding of the relation between gender and values towards the environment.

Acknowledgements

Research was funded by the Programa de Ciencias Sociales y Humanidades del Ministerio de Educación y Ciencia (MEC-España) (SEJ2007-60873/SOCI), the Agència de Gestió d’Ajuts Universitaris i de Recerca (AGAUR) and the Centre de Promoció de la Cultura Popular i Tradicional Catalana (CPCTC) (Generalitat de Catalunya). L. Calvet-Mir acknowledges financial support from a FPU grant of the MEC-España (AP-2006-01849). We thank all the tenders who collaborated in the project. We also thank Maria Calvet-Mir and Laia Echániz-Pou for help in the fieldwork and in the elaboration of the figures.

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REFLEXIONES FINALES

La defensa de los maíces nativos frente a los transgénicos dramatiza la tensión entre la tecnociencia y la etnociencia; entre lo sincrónico y lo diacrónico; entre la amnesia y la memoria

Narciso Barrera-Bassols

En esta tesis se ha comprobado que la diversidad biocultural aún pervive en sociedades industrializadas. Los resultados contribuyen a fortalecer una creciente literatura que sugiere que el conocimiento ecológico tradicional subsiste en sociedades rurales (Gómez-Baggethun et al. 2010, Pieroni et al. 2004, Olsson y Folke 2001) y urbanas (Andersson et al. 2007, Pieroni et al. 2007) de los países desarrollados; y que éste tiene un gran valor potencial para la gestión sostenible de los ecosistemas y la conservación de la biodiversidad (Gómez-Baggethun et al. 2010). Esta diversidad y conocimientos conforman lo que Toledo y Barrera-Bassols (2008) han llamado la memoria biocultural. Dicha memoria biocultural está siendo erosionada por toda una serie de factores que incluyen la aceleración de los cambios de usos del suelo, aculturación y pérdida de dialectos locales, políticas de conservación estricta que restringen el acceso a recursos tradicionales, y de forma más amplia, el proceso generalizado de industrialización, urbanización y mercantilización de las sociedades modernas (Turner y Turner 2008, Toledo 2009, Gómez-Baggethun et al. 2010).

En las últimas décadas y especialmente en los últimos años, han surgido voces desde los ámbitos académicos del mundo que conscientes del valor de las diversidades reconocidas por la ciencia, han buscado su mantenimiento y protección mediante mecanismos externos, centralizadores y verticales (Toledo y Barrera-Bassols 2008). Ejemplos de ello son la conservación de la variedad de germoplasma por medio de

bancos de semillas fuera de los sistemas de producción y los contextos culturales y ecológicos donde se realizaron y perfeccionaron (conservación *ex-situ*) o la documentación detallada y exhaustiva de las sabidurías locales o tradicionales mediante su almacenamiento y manejo en bancos de información (Toledo y Barrera-Bassols 2008). Sin embargo la congelación de la memoria biocultural es una salida falsa y, aunque no sean excluyentes, se deberían buscar diferentes estrategias para la preservación de dicha memoria. Las estrategias para el mantenimiento de la diversidad biocultural deben ir encaradas a identificar esta memoria, revalorizarla y crear modelos sociales que permitan el mantenimiento de la diversidad biológica y cultural de cada lugar; evitando caer en la idealización romántica y cristalizada de la sociedad rural tradicional, y en una crítica indiscriminada a la tecnología (Kurin 2004, Gómez-Baggethun 2009).

En el caso de la Vall Fosca, la conservación de los huertos y la agrobiodiversidad se deberían basar en el fortalecimiento de los elementos culturales que están íntimamente ligados a ellos. En esta tesis se ha podido comprobar que los huertos y los cultivos de manejo local son símbolos de identidad cultural en el valle. Por ejemplo durante la fiesta mayor del pueblo de Senterada se organiza un concurso culinario de platos locales hechos con productos de los huertos. También se ha comprobado que tanto los habitantes permanentes como los visitantes consideran que los huertos son elementos clave en el paisaje del valle y que se deberían preservar como parte de su patrimonio biocultural. Además, los servicios ambientales proporcionados por los huertos, en particular los culturales, pueden ayudar a tejer relaciones entre las personas que contribuyan a fortalecer la identidad cultural y a crear lazos de respeto con su medio ambiente. Dentro de este contexto se pueden desarrollar proyectos de conservación *in situ* de los cultivos de manejo local promoviendo por ejemplo platos típicos de la zona con estos cultivos en alojamientos turísticos. También se podrían ofrecer visitas bioculturales a la zona

haciendo recorridos a pie por caminos antiguos del valle, visitando los pueblos y su diversidad biocultural. Estos proyectos deberían ser articulados por los investigadores, políticos y los habitantes del valle con el fin de buscar actividades económicas que permitan la conjunción de la conservación biocultural y el desarrollo rural de la Vall Fosca. No obstante, aunque estos proyectos pueden tener buenos resultados a corto plazo, a largo plazo estas estrategias deben tener en cuenta que la preservación de los saberes tradicionales y de los sistemas productivos que los sostienen están supeditados a la transformación estructural de la sociedad técnico-industrial que los han relegado a la marginalidad (Kurin 2004, Gómez-Baggethun 2009). Cambios estructurales como la eliminación de subsidios a la agricultura industrial y a las exportaciones, medidas fiscales que favorezcan la relocalización de los mercados de distribución y consumo de alimentos y apoyo institucional de la agricultura local como estrategia política de seguridad y soberanía alimentaria son necesarios para dar alcance a las propuestas locales a largo plazo.

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Ciencia con y para la gente

Durante esta investigación de doctorado (2008-2011) se iniciaron acciones de difusión de los resultados científicos y cooperación con la administración y población local. En el marco de dichos proyectos de difusión se han generado materiales para devolver a la población local la información recogida durante la investigación de doctorado, y se han llevado a cabo acciones para revalorizar la agrobiodiversidad local. Por ejemplo, en el 2009, una vez terminada la recolección de información, se elaboró un tríptico informativo de difusión de los resultados y un catálogo de cultivos de manejo local del valle. En el 2010 se elaboró una página web para difundir los resultados más allá del ámbito local (http://icta.uab.es/Etnoecologia/difusion.htm). Se repartieron trípticos y catálogos a todos los hortelanos que participaron en el estudio, así como a los ayuntamientos, escuelas y asociaciones culturales del valle y valles colindantes. La página web, dónde también se encuentra el catálogo en formato electrónico, ha permitido llegar a un público más amplio y establecer relaciones con personas interesadas en la conservación de la agrobiodiversidad y del conocimiento biocultural.

Con el objetivo de mejorar la estrategia local de conservación de semillas, durante la investigación de doctorado también se diseñó un plan de mejora del espacio de intercambio de semillas promovido desde el 2006 por el Planter de Gerri (banco de semillas local). A través de este plan se detectaron los problemas del banco local de semillas, como el déficit en el retorno de semillas por parte de sus colaboradores y una mala gestión de éstas debido a la falta de personal. Para contribuir al mantenimiento del Planter, se propuso la aplicación de medidas como la contratación de un técnico, la reducción del número de cultivos de manejo local custodiados, y la

redefinición de la lista de colaboradores del Planter. Mediante el estudio también se detectó el papel positivo de la actividad del Planter en educación ambiental y se propusieron medidas para potenciar dichas actividades. Con el objetivo de establecer contacto entre los hortelanos e idear estrategias para la mejora de la conservación de la agrobiodiversidad *in situ* (en los mismos huertos), se llevaron a cabo charlas-talleres (2010) sobre los cultivos de manejo local de la zona y sus redes de intercambio. En estas charlas-talleres se propuso, por ejemplo, realizar un día de intercambio de semillas y hacer un proyecto escolar de conservación de semillas locales. De aquí también surgió la idea de implementar un proyecto de apadrinamiento de semillas en la escuela del valle como recurso pedagógico con la finalidad de observar y estudiar diversos aspectos (naturales, sociales y culturales) de la agrobiodiversidad y promover la valoración y el respeto del patrimonio biocultural. Este proyecto se inició en marzo de 2011 y ha tenido un gran éxito por la gran involucración de investigadores, profesores, alumnos, padres y madres de alumnos y el ayuntamiento de la Vall Fosca.

Estas acciones con las comunidades han contribuido a revalorizar la agrobiodiversidad local y la gestión tradicional de los huertos en la Vall Fosca.

El hecho de que las acciones desarrolladas se basasen en una investigación científica previa contribuyó a reforzarlas y darles legitimidad institucional. Actualmente el ayuntamiento de la Vall Fosca está involucrado en el proyecto de apadrinamiento de semillas y también está trabajando con diferentes hortelanos del valle para impulsar el intercambio de semillas.

Collada de Font Sobirana

Pantano de Sallente

Vista del valle desde el pueblo de Cabdella

Naens

Pobellà

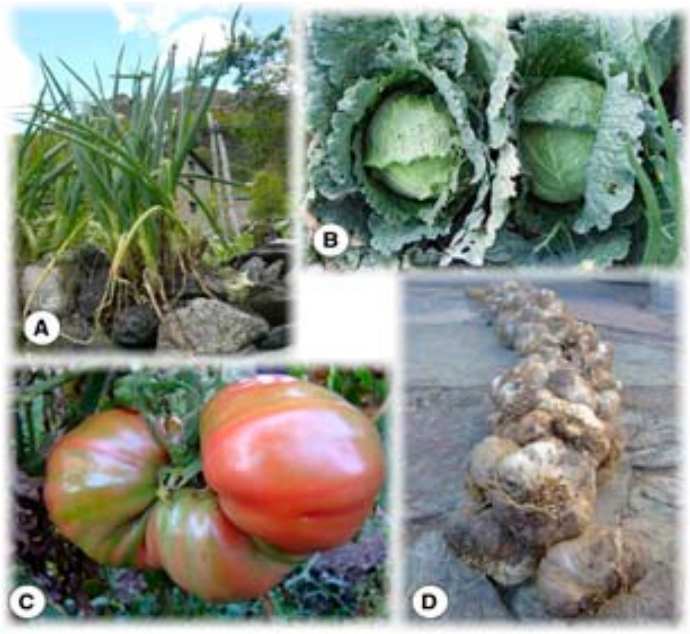
Puigcerver

Vista del pueblo de Espui desde la ermita del Fa

Cartel contra las pistas de esquí en el valle del río Filià

Huerto de Pobellà con vistas a la zona del Solà

Huerto de Espui con pared de piedra seca



Cuatro imágenes de cultivos de manejo local

A	Ceba de paret/escalunya	*Allium ascalonicum* L.
B	Col de lluc	*Brassica oleracea* L. var.*capitata* (L.) Alef.
C	Tomata rosa de la Paquita	*Lycopersicum esculentum* Mill.
D	All	*Allium sativum* L.

Saleros artesanales hechos por un hortelano de la Central de Cabdella




Taller de apadrinamiento de semillas en la escuela de la Vall Fosca

Charla-taller de devolución de información