Chapter 13
Economics of Multiple Use Cork Oak Woodlands: Two Case Studies of Agroforestry Systems

P. Campos[1]*, H. Daly-Hassen[2], P. Ovando[1], A. Chebil[2], and J.L. Oviedo[1,3]

Abstract Jerez (Spain) and Iteimia (Tunisia) cork oak agroforestry systems have close natural environments but they differ in land property rights, labour market and economic development contexts. These human induced differences result in similarities and dissimilarities on natural resources multiple use management. In this study we apply a simplified agroforestry accounting system (AAS) in two publicly owned cork oak agroforestry systems (COAS) for an average year, assuming steady state situation, without considering both environmental outputs (private and public) and government expenditures. The study objectives are to analyse the multiple Jerez and Iteimia agroforestry system activities intra-relationships taking into account intermediate outputs and to estimate a set of on-site cork oak agroforestry economic indicators related to single activity and the COAS as whole aggregated activities. In addition, in order to estimate separately the Iteimia open access grazing resource rent and the household's self-employed labour cost, we propose a simulated pricing approach trade-off as an alternative to close substitute goods pricing method. The study results show that Jerez generates a commercial capital income loss and employees receive competitive wage rate, while undertakes a significant investment on agroforestry natural resources conservation and improvements. Opposite to Jerez, Iteimia actual management offers a positive capital income and a high household self-employed labour income on hectare basis, mainly from livestock and, in a less extent, other agroforestry land uses carried out in the local subsistence-economy. The noteworthy dependence of Iteimia households on cork oak multiple use, with a current negative impact on that resources conservation, make household subsistence-economy highly sensitive to nature conservationist policies and measures.

Keywords Agroforestry accounting system, income, Jerez, Spain, Iteimia, Tunisia

[1] Institute of Public Goods and Policies of Spanish National Research Council (CSIC), Spain

[2] Tunisian Research Institute of Rural Engineering, Water and Forest (INRGREF), B.P. 10, 2080 Ariana, Tunisia

[3] FPI scholar at the centre of Forestry Research (CIFOR-INIA), Crta. La coruña km 7.5. 28040 Madrid, Spain

*Corresponding author: Albasanz, 26–28, 28037 Madrid, Spain
e-mail: pcampos@ieg.csic.es

A. Rigueiro-Rodríguez et al. (eds.), *Agroforestry in Europe: Current Status and Future Prospects*.

Introduction

Cork oak (*Quercus suber* L.) extends through the Mediterranean basin of Western Europe (Italy, France, Spain and Portugal) and North Africa (Tunisia, Algeria and Morocco), with an area of 2.3 million hectares (37% in Africa and 63% in Europe). Spanish cork oak woodlands cover almost 500×10^3 ha and most are privately owned, while Tunisia has 99×10^3 ha of cork oak forests which are publicly owned (DGF 2006).

Cork oak agroforestry system (COAS) conservation problems and economic issues can be better understood if the differences in socioeconomic development and institutional regimes across Mediterranean region are analysed. Thus, the distinction between the northern sub-region – south-western Europe – and the southern sub-region – North African countries – is useful (Scarascia-Mugnozza et al. 2000; Campos 2004).

Insufficient natural regeneration of cork oaks is commonplace in both European and African sites of the Mediterranean region (Torres and Montero 2000; Pulido and Díaz 2003; Stiti et al. 2004). As former authors state, this process might be a consequence of overgrazing, inappropriate silvicultural treatments, severe pruning, careless brush clearing and tree health problems. Grazing in European COAS is unrestricted, except in government subsidized plantations, and overgrazing has been accentuated in the last four decades by a drastic decrease in seasonal migration of herds (transhumance) and a rapid increase in cattle numbers (Campos 2004). In Maghreb COAS countries, degradation through over-pruning affects a large part of those forests (Ellatifi 2005) and overgrazing has led to “a total absence of natural regeneration of woodland” (FAO 2001).

The complex mosaic of land uses and vegetations patches of COAS reflects the ways in which human influence has shaped the natural endowment of resources. Traditionally, two of the main commercial uses of COAS have been livestock grazing and cork stripping. Cereal and pulse crops usually occupy a small share of COASs surface. Wood use for energy is still of key importance in the rural homes of the Maghreb, particularly brushwood fuel, while there are many other non-timber goods gathered by rural populations. On the northern side of COAS, there is growing importance of woodland environmental services used by private landowners (Campos and Caparrós 2006), as well as the significance of the services the oak ecosystem delivers to the public on both sides of the Mediterranean basin.

The shortcomings of the economic system whereby agriculture and forestry resources are registered nationally (Eurostat 2000; Campos et al. 2005a) and the lack of statistical data leads to incomplete estimations of commercial incomes at farm and national levels (Campos and Caparrós 2006; European Commission 2006). In the area of multiple land use, much economic data needs to be generated by the analyst for its specific purpose. These official statistical shortcomings on missing relevant agroforestry system market land outputs and costs could be offset by applying a more comprehensives agroforestry accounting system (AAS) pilot exercises. These would illustrate the operative feasibility of measuring total commercial incomes objectively from multiple land uses. In this study we apply a simplified AAS in two publicly owned cork oak agroforestry systems (COAS) for an average year, assuming a steady state situation, without considering both environmental outputs (private and public) and government expenditures.

The study objectives are to measure multiple agroforestry system activities and intra-relationships (taking into account intermediate outputs), and to estimate a set of on-site cork oak agroforestry economic indicators related to single activity and the COAS as multiple aggregated activities.

Householder free-access grazing property rights and self-employment limit the options to value single grazing resource rent and self-employed compensation costs objectively. Therefore, to estimate separately the open access grazing resource rent and the household's self-employed labour cost we propose a simulated pricing approach trade-off as an alternative to the closed substitute goods pricing method. The household steady state private total commercial income is an objective residual measurement, except for intermediate outputs, and we make use of this simulated trade-off pricing approach to measure the single incomes from forestry, animal and cropping activities.

In this study a simplified AAS is applied to two cork oak woodlands case studies located in *Jerez* (Spain) and *Iteimia* (Tunisia), which exemplify the COAS multiple land use, economic trends, similarities and dissimilarities in the northern and southern sides of the Mediterranean basin. Ignoring unique characteristics of the areas – and most COAS have some unique features – those case studies are not statistically representative. They do, however, illustrate how property rights, labour market and local socioeconomic conditions generate notable differences in respect to the type and the amount of commercial benefits produced by those ecosystems and their distribution within the economic agents that profit from COAS natural resources use.

Materials and Methods

Jerez and Iteimia Cork Oak Agroforestry System Case Studies Description

In Spain, the case study was carried out in *Montes de Propios* estate of *Jerez de la Frontera* (south-west of Spain).[1] In Tunisia, the study was conducted in *Iteimia* (north-west of Tunisia).[2] The area of the Jerez and Iteimia COASs are 7,035 and 634 ha, respectively (Campos et al. 2005b; Chebil et al. in press).

[1] Jerez COAS is located inside *Alcornocales* Natural Park (ANP). ANP has 1,677 km^2 where private landowners own 75% of the area (BOJA 2004).

[2] Iteimia COAS is located inside *Ain Snoussi* region (AS), with an area of 32.3 km^2, under public ownership regime.

Jerez and Iteimia COASs have similar natural environments, but huge dissimilarities in institutional and economic contexts. Both are mountainous areas with an altitude range between 200–650 m in Jerez and 400–642 m in Iteimia, as well as, both have a humid Mediterranean climate with an annual average rainfall of 882 mm (period 1994–2002) and 1,006 mm (period 1999–2002), respectively.

In Jerez the forest area is dominated by cork oak. Other forest species are Andalusian oak (*Quercus canariensis* Willd.) and wild olive (*Olea europaea* L. var. sylvestris Brot). Cork oak is the only forest species in Iteimia. A forest inventory of Jerez in 1976 showed a density of 149 trees per hectare of wooded land[3] with 67 cork oaks, 34 Andalusian oaks, 41 wild olive and 7 other species different from pines (Campos and Salgado 1987). In Iteimia the average cork oak trees' density increases to 583 trees per hectare on wooded land (Stiti et al. 2004). In both areas, the main brush species are the mastic tree (*Pistacia lentiscus* L.), myrtle (*Myrtus communis* L.) and strawberry tree (*Arbutus unedo* L.). Red deer (*Cervus elaphus hispanicus Erxleben* 1777) and roe deer (*Capreolus capreolus* L.) are the main species hunted for game in Jerez, and wild boar *(Sus scrofa* L.) and hare (*Lepus* sp.) in Iteimia.

More than two thirds of the total Jerez area is made up of pure and mixed stands of cork oaks and by pure stands of cork oak in Iteimia (Fig. 13.1). There is less cropland in Jerez than in Iteimia. In the latter, this consists of subsistence crops over small treeless parcels inside the forestland. In Iteimia, shrub biomass is used for fodder, firewood, charcoal and shelter. Hence, subsistence-economy in Iteimia reduces the cork oak woodland under-storey to a minimum. On the other hand, standing brush biomass is increasing in Jerez as a consequence of lower grazing pressures and lack of fuel wood uses.

Jerez is a public property which belongs to the Jerez municipality, where the owner holds the right to exclude other users from the resources of *Montes de Propios* estate, including public entry. The land ownership of Iteimia belongs to the Tunisian State, but local inhabitants have specific use rights. The Tunisian State is engaged in the forestry management operations from which it gets commercial benefits, mainly from cork, firewood, mushrooms, myrtle and hunting rent. Tunisian Forest law maintains livestock grazing among the list of usage rights that can be freely practiced by the local population (Ben-Mansoura et al. 2001). Households-subsistence economy in Iteimia generates diverse uses of woody vegetation other than cork stripping (opposite of Jerez[4]) the self-consumption of different tradable goods and services provided by the COAS being highly relevant.

The socioeconomic contexts of Jerez and Iteimia diverge substantially in the case of labour market regulation. The Jerez work force is regulated in a competitive labour market and all positions are for permanent or temporary employees. Iteimia

---

[3] Trees were counted as greater than 10 cm diameter.

[4] The ANP private landowners may incur an opportunity cost for ensuring environmental private amenities self-consumption (Campos and Caparrós 2006). However, in the case of Jerez the nature of public landownership impedes the realization of private environmental self-consumption.

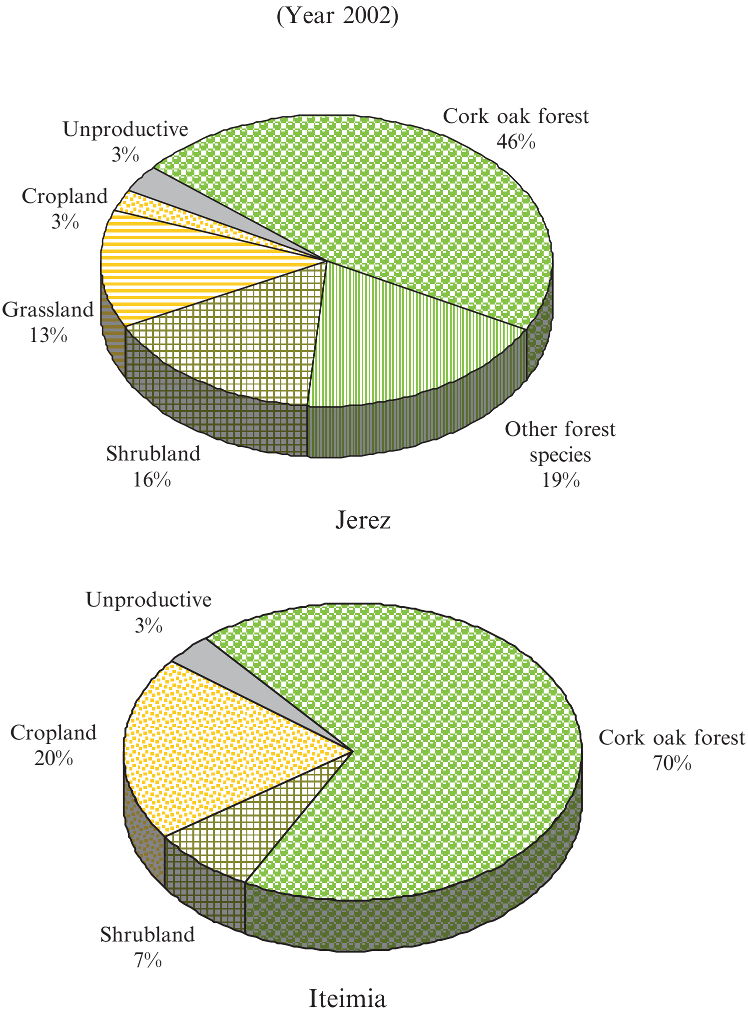

Fig. 13.1 Cork oak agroforestry land uses for Jerez and Iteimia

has weak labour market regulation and most of the operations, except cork stripping and tree thinning, are performed by family workers on their own account (self-employed). In Jerez, because the whole labour force is made up of employees, the economic risk is only borne by the Jerez Municipality. In Iteimia, the economic risk is shared by both families and the Tunisian State. Moreover, both cases differ considerably in the working time devoted to agroforestry-based activities. In Iteimia, households spent (in this case self-employed) 532 hours per hectare and year[5] in

2002 whilst in Jerez, employees worked an average of 19 hours per hectare and year between 1994 and 2002.

Management criteria in Jerez are concentrated on nature conservation and social guidance, which generates a relatively high demand for permanent and temporary employment. This management operates on the basis of financial transfers from Jerez municipality, Andalusia government, Spanish government and the European Union.

Management criteria in Iteimia are geared to avoiding negative annual cash-flow to the owner (Tunisian State) and developing subsistence-economies of local families on the basis of mitigating natural capital loss and improving livestock productivity by introducing exotic mix meat-milk cow races (*Schwitz* and *Tarentaise* races). Women and children play a major contribution to livestock rearing and crops. Households use the agroforestry natural resources with the aim of maximising the whole families' self-employed income in a context where alternative family employment opportunities in the area are low.

Income Indicators

Private Total and Capital Commercial Income

In our COASs case studies we have assumed a hypothetical forestry, livestock and crops steady state situation, which means that results do not reflect any year in particular, rather an average year at which it is supposed that the cork and crops yields, as well as herds, are in a stable situation. This steady state assumption makes it possible to estimate private single and total commercial income (TI) as the difference between a reduced number of private benefits and costs accrued from the management of those cork oak woodlands. Applying complete and simplified agroforestry accounting systems (AAS) give the same single and total incomes results (Appendix 1).

In terms of *benefits*, this study considers the intermediate outputs (IO), i.e. goods and services that are produced in the year and consumed in the same year in another activity on the estate, changes in stock (CS), sales (S) and self-consumption (SC) of both final outputs (derived from the production process) and fixed capital goods, and operating and capital subsidies net of taxes (ST). The costs that are considered for estimating total income figures are the intermediate consumption (IC) of raw materials (RM) and services (SS), and the gross investment in external fixed capital goods (FCie). This FCie matches the annual external fixed capital consumption

[5] The COAS continues to play a prominent socio-economic role for local household economy in the Iteimia area. In addition, families benefit from the employment outside the area where 25% of inhabitants are working in part-time or full-time jobs (Chebil et al. in press).

(FCC_e) in steady state if we value it at their current reposition cost (see Appendix 1). If net subsidies (ST) are included as a private benefit, total income at factor cost (TI_{fc}) is obtained. By contrast if those are omitted, total income at market prices (TI_{mp}) is assessed. Equations [1] and [2] display the benefits and costs considered in this study to measure cork oak woodlands incomes under the simplified AAS application (see Appendix 1):

$$TI_{mp} = IO + CS + S + SC - OC - FCie, \qquad [1]$$

$$TI_{fc} = TI_{mp} + ST \qquad [2]$$

If the agroforestry system activities were far from an unstable situation, equations [1] and [2] do not allow total income figures estimation. In that case, a more comprehensive complete AAS, as the one proposed by Campos et al. (2001) and Campos et al. (2008), is needed to embrace all outputs and costs derived from the agroforestry production process (see Appendix 1). It is worth mentioning that in the steady state applying the simplified AAS there is no need to consider the annual natural growth of work-in-progress since it physically equals the quantity of its extraction or consumption.[6]

In Jerez, red and roe deer herd populations are stable in numbers. However, they are not still stable in terms of the age class distribution (M. Girón, 2005, personal communication). Woodland is not in a stable situation too, since there are 62 ha recently planted growing young cork oak, carob and pines trees, which entails a yearly increase on Jerez woodland market value (Campos et al. 2001).

Considering that both hunting and forestry activities are not certainly in steady state, a residual value (called 'changes in stocks') is added to the Jerez benefits. This item captures the value differences on work-in-progress at the beginning and at the end of the accounting period.

On the other hand, we also are interested in the estimation and analysis of total income distribution among production factors. Thus, we focus on the income generation process and on the income distribution amongst woodland owners, households (in Iteimia) and employees.

Capital income (CI) indicates the income attributed to capital services as a production factor, when the owner of affected capital demands a potential benefit from capital investment. This CI indicator is significant for a private owner that uses the employee work force and puts low emphasis on household self-employment.

[6] Cork and wood growth and extraction are similar only in physical terms, but not in economic terms, since both are ongoing works that require more time than one accounting period (one year) to reach a state where they can be sold. Thus, their economic valuation is being affected by discounting issues (Campos et al. 2001). However, these omissions in steady state do not entail different results either if a complete or a simplified agroforestry accounting frameworks were to be applied.

Private capital income at factor cost (CI_{fc}) can be measured by subtracting the value of total labour costs (LC) from the private total income at factor cost (TI_{fc}):

$$CI_{fc} = TI_{fc} - LC \quad [3]$$

Total labour costs are compound by the employees' labour compensations (ELC) and the residual value estimated for household self-employed labour cost (SLC), the assessment criteria of which are detailed in the next sub-section.

Self-Employed Labour Costs Residual Value

It is controversial to assume a monetary marginal value to rural households' self-employed labour. The use of local employees wage rates for self-employed labour pricing (e.g. Mahapatra and Tewari 2005; Delang 2006) can frequently lead to a negative capital income result, which could denote – in presence of other employment opportunities – an irrational household economic behaviour. Local wage rates may not be an accurate proxy value of self-employed labour in a context where local market employment demands are extremely scarce.

Moreover, some authors suggest that farmers' subsistence economies are guided by their own rational rules for allocating their own productive factors, which are different from a capitalist firm's aim at profit maximisation (Schejtman 1980). Rural households may have diverse starting positions, opportunities and constraints as well as different objectives, ranging from meeting mere subsistence needs to accumulating wealth (Berzborn 2007).

Considering the limitations in using local marginal wage-rate as the opportunity cost of self-employed labour in a household subsistence farming rationality context, in this study we propose an alternative approach for estimating the self-employed labour costs. In the context of Iteimia, it is assumed that rural households intend to optimise the distribution of their own labour endowment among the diverse uses of their own land related activities in order to maximise their family total income. This objective implies that families seek to satisfy their own basic needs and to obtain resources for the reposition of production means consumed by the production process.

In this study, self-employed labour cost (SLC) is estimated as a residual value, which accounts for rural households' labour rewards, by using the following accounting identity (referring the H subscript to 'household agroforestry activities'):

$$SLC = IO_H + S_H + SC_H - EIC_H - OIC_H - FCie_H - ELC_H - T_G - GRR \quad [4]$$

EIC_H: households' intermediate consumption on external raw materials and services, OIC_H: the market value of intermediate consumption of own raw materials and services (except grazing resources) that are consumed in the same year by other agroforestry activities, ELC_H: employees' compensation paid by households and T_G: government taxes on products.

The grazing resource rent (GRR) reflects the estimated annual capital income value linked to the owners' right for using grazing resources for feeding controlled animals (livestock and game, the latter only in Jerez).

Valuation Criteria Applied to Jerez and Iteimia Good and Services

In Jerez, the stripped cork leaves the estate after industrial preparation (Campos et al. 2005b), being in Jerez an intermediate output. In Iteimia the cork is sold after it is stripped, and in this case is a final output.

Livestock activity in Jerez focuses on the breeding of selected herds of the pure cattle races, mainly the autochthonous red cow. Horses are also used for livestock management proposes. The grazing resource in Jerez is considered both as monte (this concept embrases the area covered by cork oak forest, shrubland and dry pastureland) and cropland intermediate outputs, attributed in proportion to the quantity of forage units that livestock and game graze at each land type. The mix pulse-cereal annual crops grown at Jerez are principally used in the form of supplementary feed (hay, straw and grains). In addition, there is a rent associated with big game, that comprises the sale of a few licences for red deer hunting (as a population control measure), venison sales and the rights for stand hunting of stags (adult male red deer) and bucks (adult male roe deer), mainly for hunting trophies (Table 13.1).

Households in Iteimia chiefly subsist on livestock rearing and the number of livestock species reared is more diverse than in Jerez, i.e. goats, cattle, sheep and

Table 13.1 Selected cork oak agroforestry commercial benefits for Jerez and Iteimia

		Jerez			*Iteimia*		
Class	Units	Quantity (ha^{-1})	Price (€ unit^{-1})	Benefits value (€ ha^{-1} year^{-1})	Quantity (ha^{-1})	Price (€ unit^{-1})	Benefits value (€ ha^{-1} year^{-1})
Cork stripping		108.1	1.0	107.6	164.9	0.4	65.2
Summer stripped cork	kg	*93.1*	*1.1*	*105.6*	*90.3*	*0.6*	*59.1*
Winter stripped cork	kg	*15.0*	*0.1*	*2.0*	*74.6*	*0.1*	*6.1*
Cork preparation		77.5	1.6	121.6			
Boiled cork	kg	*54.9*	*2.1*	*113.9*			
Raw cork	kg	*22.7*	*0.3*	*7.7*			
Firewood		41.0	0.1	2.3	688.3	0.01	7.1
From cork oak trees	kg	*31.0*	*0.1*	*1.6*	*315.0*	*0.01*	*4.3*
From shrubs	kg				*373.2*	*0.01*	*2.8*
Other firewood	kg	*9.9*	*0.1*	*0.7*			
Other forestry goods				5.2			16.3
Timber	m^3	*0.2*	*31.4*	*5.0*			
Heather bunches	Units	*0.2*	*1.2*	*0.2*			

(continued)

Table 13.1 (Continued)

		Jerez			Iteimia		
Class	Units	Quantity (ha^{-1})	Price (€ unit^{-1})	Benefits value (€ ha^{-1} year^{-1})	Quantity (ha^{-1})	Price (€ unit^{-1})	Benefits value (€ ha^{-1} year^{-1})
Charcoal	kg				*39.2*	*0.3*	*10.2*
Acorns collection	kg				*16.2*	*0.1*	*1.0*
Myrtle	T				*0.1*	*27.5*	*2.7*
Mushrooms	kg				*1.1*	*2.1*	*2.3*
Cattle				23.1			92.4
Calves sales	Units	*	*330.0*	*13.5*	*0.1*	*334.9*	*21.3*
Breeders sales and self-consumption	Units	*	*612.4*	*9.6*	*0.1*	*205.6*	*16.4*
Milk sales	l				*151.2*	*0.3*	*42.9*
Milk self-consumption	l				*36.5*	*0.3*	*10.4*
Others							*1.5*
Goats							45.3
Young goats sales	Units				*0.4*	*49.6*	*21.3*
Breeders self-consumption and sales	Units				*0.1*	*97.5*	*9.7*
Young goats self-consumption	Units				*	*49.3*	*0.4*
Milk self-consumption	l				*32.6*	*0.4*	*12.2*
Sheep							22.3
Lamb sales	Units				*0.2*	*69.6*	*12.4*
Breeders self-consumption and sales	Units				*	*113.2*	*5.4*
Milk self-consumption	l				*12.0*	*0.4*	*4.5*
Others							*0.3*
Game				2.9			0.2
Big game hunting rent	Licenses	*	*3,340.5*	*0.5*	*	*97.6*	*0.2*
Small game hunting rent	Licenses				*	*2.0*	*
Red deer meat	kg	*1.4*	*1.3*	*1.7*			
Red deer hunting	Stags	*	*775.9*	*0.1*			
Roe deer hunting	Bucks	*	*699.1*	*0.5*			
Crops				1.3			26.2
Cereals and pulse	kg	*0.3*	*1.0*	*0.3*			*12.8*
Cereal (forage)	kg				*29.4*	*0.2*	*6.2*
Hay and straw	kg	*0.16*	*6.0*	*1.0*	*112.0*	*0.1*	*7.3*

*Less or equal as 0.05

horses. The main dry crops grown in Iteimia are cereals (wheat, barley) and pulses (broad beans) for human consumption, forages and cultivated fruit tress. Cereal and pulse fallow is used as grazing fodder for livestock, forage crops are cut and stored as hay, and fruit tress are mainly olive and fruit trees for household use. It is worth noting that the list of forest commodities produced from Iteimia is larger than that accrued from COAS management in Jerez. This is the case for brush species such as myrtle or mastic tree grown at both forest areas, but only commercially extracted in Iteimia (Table 13.1).

Goods and services have been valued at 2002 average market or estimated prices[7] (without subsidies or taxes on products) that are considered to be constant. Microeconomic data on prices and quantities were collected through interviews or structured surveys applied to forest managers and local inhabitants in the case of Iteimia (Chebil et al. in press) and using primary microeconomic data from a nine-year accounting period in Jerez (Campos et al. 2005b).

Commodities such as cork, firewood, hunting licences and livestock and crop products (regardless if they are sold or self-consumed) are valued on the basis of estate gate market exchange values (price time quantities). In Jerez, grazing resources are for their own livestock and game use, and the grazing resource rent of the monte is estimated on the basis with interviews to local livestock keepers. In the case of Iteimia, the open-access right for grazing resource implies that local households have the right to use this resource without paying the imputed grazing resource rent.

In this study we propose a conditioned market simulation approach to estimate joint open-grazing resource rent and household self-employed livestock rearing labour cost in Iteimia and landowner capital income in Jerez. This approach starts with an objective measurement of livestock activity total commercial income (TI_{Lf}) that comes from assuming a zero grazing rent (GRR = 0). Thus, TI_{Lf} is estimated using the following steady-state identity (referring subscript L to livestock activity):

$$TI_{Lf} = IO_L + S_L + SC_L - EIC_L - OIC_{Lf} - FCie_L - ELC_L - T_{GL} \quad [5]$$

Note that equation [5] is similar to equation [1]. The former refers to a single activity and the latter attains to measure the COAS total income, irrespective of its distribution amongst economic agents. Equation [4] is used for estimating the self-employed total income that Iteimia households obtain from all agroforestry uses.

To estimate a positive grazing rent for Iteimia (GRR > 0) we propose to simulate a market, assuming a subjective GRR for the forage unit (FU)[8] times the number of FU extracted by animals graze. If GRR > 0, it would give us a 'conditioned' livestock total commercial income (TI_L) that, in the case of Iteimia, would allow the estimation of household-conditioned self-employed labour cost (SLC):

$$TI_L = TI_{Lf} - GRR = SLC_L \quad [6]$$

The SLC (equation [4]) equals the Iteimia households' total income from agroforestry (TI_H), except when GRR > 0. The Iteimia open-access grazing resource rent

[7] €1 = TND1.34 (Tunisian dinars), year 2002 (BCT 2003).

[8] A forage unit (FU) represents the energy contained in a kilogram of barley, at 14.1% moisture content, that is 2,723 kilocalories of metabolic energy (INRA 1978).

is entirely taken by households, therefore the self-employed income that households could obtain from livestock rearing has the upper limit of the TI_{Lf} value, that is, when GRR = 0.

In Jerez, a livestock capital income (CI_L) conditioned value can be derived from the following identity, given that employees labour cost (ELC_L) is known:

$$TI_L = TI_{Lf} - GRR = ELC_L + CI_L \qquad [7]$$

The assumed GRR does not affect the total income (TI_{Lf}) that Iteimia households obtain from livestock rearing, as well it, does not affect the capital income that a Jerez owner obtains from COAS as a whole. However, in both cases a GRR > 0 affects the total income from single livestock activity (TI_L).

Results

Animal Activity

Animal activity integrates both benefits and costs accrued from livestock and game management. The importance of livestock management operations, especially at Iteimia and, additionally of deer herds in Jerez, justifies the choice of including animal fodder consumption and costs of the supply feeding resource into the set of physical and economic indicators that best reflect the distinctive technical ways in which both COASs are run.

Grazing Resources and Supplementary Feed Consumptions

The COAS in Iteimia maintains an average livestock *instantaneous stocking rate* (ISR), measured by the number of standard livestock units (SLU)[9] per hectare of utilised agricultural land, which is three times that supported by the Jerez COAS. This implies an average of 0.33 SLU ha^{-1} in Iteimia and 0.11 SLU ha^{-1} in Jerez.[10] It is estimated that the annual total energy requirements of domestic livestock amount to 626.8

[9] Only adult females and males are considered. In case of cattle and horses, we have considered animals older than 24 months, and in case of sheep, goats, and roe and red deer older than 12 months. All standard livestock units (SLU) are presented in adult cow equivalents (Martin et al. 1987). An SLU is defined as a healthy cow with a live weight of 450 kg. An SLU is equivalent to 8.2 sheep, seven goats or 1.5 mares.

[10] Iteimia instantaneous stocking rate (ISR) is the sum of 0.14 cattle, 0.11 goats, 0.05 sheep and 0.03 equines. Jerez ISR is the sum of 0.07 cattle, 0.01 equines and 0.03 red and roe deer.

Table 13.2 Grazing resource and supplementary feed consumption for Jerez and Iteimia (FU ha^{-1})

	Jerez				*Iteimia*				
Class	Cattle	Big game	Equines	Total	Goats	Cattle	Sheep	Equines	Total
Grazing	248.2	50.7		298.9	218.1	150.0	89.7	69.9	527.8
Monte[a]	*218.7*	*50.7*		*269.4*	*218.1*	*140.5*	*89.7*	*66.8*	*515.1*
Cropland	*29.6*			*29.6*		*9.5*		*3.1*	*12.7*
Supplementary feed	55.6	8.8	11.4	75.7	5.3	80.1	7.7	6.0	99.1
Own raw materials	*26.6*	*5.0*	*2.7*	*34.2*	*5.1*	*62.5*	*6.9*	*6.0*	*80.6*
External raw materials	*29.0*	*3.8*	*8.7*	*41.6*	*0.1*	*17.5*	*0.8*		*18.5*
Total	303.8	59.5	11.4	374.7	223.4	230.1	97.4	75.9	626.8

[a] Monte includes pure and mixed cork oak forest, shrubland and grassland

forage units per hectare (FU ha^{-1}) in Iteimia. In Jerez cattle and deer herds total an annual total energy requirement of 374.7 FU ha^{-1} (Table 13.2).

One of the features that characterises the ways controlled animals are fed in both case studies is the large dependence on grazing resources extracted from the monte and cropland. Eighty percent and 84% of total controlled animals' energy requirements in Jerez and Iteimia, respectively, are met with fodder contributed by grazing resources. Under the current Jerez animal management system, cattle, horses and big game get supplementary fodder, from either their own crops or bought-in raw material (mainly mixed feed). In this way, most (89%) of total animal energy requirements are met from the farm's own feeding resources from Jerez crops and monte. In Iteimia, 97% of total energy requirements are met by their own grazing and supplementary feeding resources.

Grazing Resource and Supplementary Forage Unit Costs

The grazing resource rent (GRR) becomes a subjective value given that it is an internal intermediate output (and therefore, an intermediate consumption also). We may have overvalued it in this study. In Iteimia, a subjective GRR of €0.07 FU^{-1} is assumed. This assumption simultaneously implies a livestock keeper's self-employed residual wage-rate of €0.22 $hour^{-1}$, which is 60% of an Iteimia forestry employee's wage rate (Chebil et al. in press).

This trade-off between attributed GRR and livestock activity total conditioned income (TI_L), implies that the upper limit of GRR from Iteimia is €0.26 (Fig. 13.2). Higher GRR values would follow, according to equation [6] negative self-employed labour costs, which is rationally an unfeasible steady state result.

The same trade-off between livestock TI_L and GRR has been performed for Jerez, considering only direct livestock management costs (i.e. before imputing general management cost to livestock activity). In this case, a local market GRR of €0.09 FU^{-1} has been estimated. The interpretation of a grazing resource rent is quite different, since there is no self-employment in Jerez. It must be stressed that an imputed GRR higher than €0.11 FU^{-1} would negate the direct conditioned livestock total income (TI_L) in Jerez (Fig. 13.2).

Animal grazing and supplementary feeding have a forage unit cost that is made up of raw materials (GRR and supplementary fodder) and labour costs associated with the supply of feeding resources (Table 13.3).

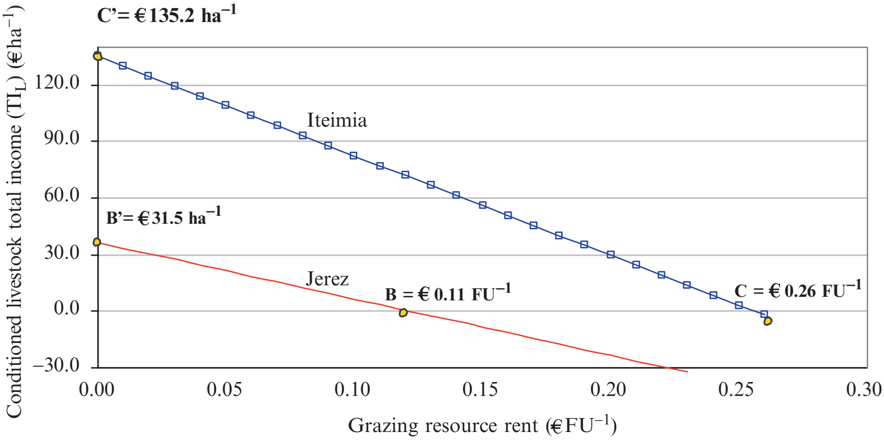

Fig. 13.2 Trade off between grazing resource rent and conditioned livestock total income for Jerez and Iteimia

Table 13.3 Forage unit cost comparison for Jerez and Iteimia (€[a]–2FU-1, year 2002)

	Jerez			Iteimia		
Class[b]	RM	LC[c]	Total	RM	LC	Total
Grazing	0.09	0.04	0.12	0.07	0.14	0.21
Monte	*0.09*	*0.04*	*0.12*	*0.07*	*0.14*	*0.21*
Cropland	*0.09*	*0.04*	*0.12*	*0.07*	*0.14*	*0.21*
Supplementary feed	0.15	0.03	0.18	0.21	0.03	0.24
Own raw materials	*0.11*	*0.03*	*0.14*	*0.18*	*0.03*	*0.21*
External raw materials	*0.19*	*0.03*	*0.22*	*0.35*	*0.03*	*0.38*
Total	0.10	0.04	0.13	0.09	0.13	0.22

[a] €1 = TND 1.34, year 2002 (BCT 2003)
[b] FU: Forage unit; RM: Own or external raw materials; LC: Labour cost
[c] Labour costs represent in case of *Jerez* cork oak woodland 95% of total direct cost related to each FU obtained by grazing and 87% of total direct costs in case FU is obtained by supplementary feeding. Additional direct costs refer to machinery and infrastructure use for cattle management and surveillance

[11] It is worth noting that an adult animal, if not fattened or grown, does not generate value added but is income for the year (Campos et al. 2005c). Under the complete agroforestry accounting system framework, breeder sales would be considered for estimating livestock fixed capital revaluations over the accounting period.

In addition to the attributed GRR, grazing operations involve labour costs of €0.04 FU^{-1} and €0.14 FU^{-1} in Jerez and Iteimia, respectively. The average cost of supplying one FU, regardless of its origin, is 0.13 €FU^{-1} in Jerez and 0.22 €FU^{-1} in Iteimia (Table 13.3).

Livestock and Big Game Total Commercial Income

Outputs derived from cattle, goats and sheep rearing that are sold or self-consumed are the main benefits in Iteimia, with a joint value of €160.0 ha^{-1} (Table 13.1). These outputs only reach a value of €23.1 ha^{-1} in Jerez (Table 13.1). Final output sales and self-consumption of breeding cattle add up to 18% and 34% of the livestock benefits in Iteimia and Jerez, respectively (Table 13.4). On the other hand, game sales generate relatively small benefits in Jerez €2.9 ha^{-1} (Table 13.1). Hunting licences generate only a negligible income of €0.2 ha^{-1} in Iteimia, which is included in the forestry activity.

Total livestock activity in Iteimia makes a positive total commercial income at factor cost (TI_{fc}) of €98.8 ha^{-1}.This is almost totally made up of self-employed labour income. In Jerez, livestock and game differ in total income figures. Livestock management generates a positive TI_{fc} of €5.2 ha^{-1} while game generates a net income loss of €€ −13.4 ha^{-1} (Table 13.4).

Labour costs related to animal activity in Iteimia are exclusively due to livestock rearing in Iteimia and account for 74% of total self-employed labour costs. In Jerez livestock and big game management have a joint labour cost of €67.3 ha^{-1}, shared out almost equally between the two animal uses (Table 13.4).

In Jerez, the aggregated livestock and game uses produce a capital loss (CI_{fc}) that is estimated to be € −75.5 ha^{-1}. Nearly two-third parts of the former capital losses are due to game activity (Table 13.4). In this context, it is worth noting that during the past two decades the Jerez owner incurred large expenditure in reducing the red deer population to benefit of both increasing roe deer population and improving natural tree regeneration. Current subsidies to livestock are €16.2 ha^{-1}, which prevents the public owner of Jerez having a higher livestock capital income loss.

Forestry Activity

Forestry Outputs

The physical amount of summer stripped cork is similar at both sites, while winter cork from silviculture improvements (dead wood, thinning, etc.) is almost five times higher in Iteimia than in Jerez. This latter winter stripped cork represents 45% and 14% of the total cork in Iteimia and Jerez, respectively (Table 13.1).

Table 13.4 Total commercial incomes, labour costs and commercial capital incomes for Jerez and Iteimia (€ ha^{-1} year 2002)

	Jerez							*Iteimia*			
		Animals									
Class	Forestry	Livestock	Big game	Crops	Cork preparation	Services	Total	Forestry	Livestock	Crops	Total
1. Benefits	140.7	28.1	7.0	10.3	193.0	9.0	388.2	123.3	179.2	34.3	336.8
1.1 Intermediate outputs	129.3	4.2		8.5			142.1	35.6	7.9	15.9	59.4
1.2 Changes in stocks	0.5		1.0		70.4		71.8				
1.3 Sales	9.6	15.9	3.6		121.6		150.7	81.5	120.3		201.8
Final output	*9.6*	*13.5*	*2.9*		*121.6*		*147.6*	*81.5*	*100.9*		*182.5*
Fixed capital		*2.3*	*0.8*				*3.1*		*19.4*		*19.4*
1.4 Self-consumption	1.3	8.0	2.4	1.8	1.1	9.0	23.7	6.2	51.0	18.4	75.6
Final output	*1.3*	*0.8*	*2.4*	*1.8*	*1.1*	*9.0*	*16.4*	*6.2*	*36.3*	*18.4*	*60.9*
Fixed capital		*7.2*					*7.2*		*14.7*		*14.7*
2. Subsidies net of taxes	33.7	16.2		–0.8	–0.2		48.9	–2.0	–2.5	–0.6	–5.2
3. Raw materials and services	12.5	38.4	19.1	5.7	185.3	1.7	262.6	8.1	76.2	9.6	93.8
3.1 Raw materials	4.6	31.7	13.3	4.0	179.2	0.6	233.4	1.2	61.9	2.4	65.6
3.2 Services	7.9	6.7	5.8	1.8	6.1	1.0	29.3	6.8	14.3	7.1	28.2
4. Gross investment on external fixed capital	2.6	0.8	1.3	1.1	1.6	0.1	7.5	0.4	1.6	2.3	4.3
5. Total commercial income (1 + 2 – 3 – 4)	159.3	5.2	–13.4	2.7	6.0	7.3	167.0	112.8	98.8	21.9	233.5
6. Labour costs	70.1	30.9	36.4	9.4	57.0	7.3	211.0	32.8	98.8	21.0	152.7
6.1 Employees compensations	70.1	30.9	36.4	9.4	57.0	7.3	211.0	19.6			19.6
6.2 Self-employed residual value								13.2	98.8	21.0	133.1
7. Commercial capital income (5–6)	89.2	–25.7	–49.8	–6.7	–51.0	0.0	–44.0	80.0	0.0	0.9	80.8

Before preparation, total stripped cork (summer and winter) has an output value at the estate gate of €107.6 ha^{-1} in Jerez and €65.2 ha^{-1} in Iteimia, respectively (Table 13.1). The stripped cork (before industrial preparation) average price at the estate gate in Iteimia is €0.40 kg^{-1} and for Jerez it has been ascribed a subjective price for fresh stripped cork at the estate gate of €1 kg^{-1} (Campos et al. 2005b). In Jerez summer stripped cork includes, before sale, the industrial preparation of stripped cork results.

Firewood in Iteimia is a major source of energy for cooking and heating for the local population. It is estimated that local households harvested 688.3 kg ha^{-1} $year^{-1}$. Brush species provide 54% of the former annual firewood of Iteimia consumption and the remaining share comes from cork oaks felled because they were unhealthy (Table 13.1).

The Iteimia and Jerez firewood output values represent 5% and 2% of their respective forestry activity benefits (Tables 13.1 and 13.4). Other forestry final outputs such as timber, mushrooms, acorns and aromatic plants represent 12% and 4% of the respective Iteimia and Jerez forestry benefits (Tables 13.1 and 13.4).

Forestry Total Commercial Income

In Iteimia and Jerez forestry activity reaches a total income at factor costs (TI_{fc}) of €112.8 ha^{-1} and €159.3 ha^{-1}, respectively (Table 13.4). This activity is the primary source of labour income in Jerez and the secondary in Iteimia. In Jerez, forestry labour accounts for 44% of the forestry total income (TI_{fc}). By contrast, in Iteimia it represents 17% of forestry TI_{fc} and 100% of employees' labour cost (Table 13.4).

Forestry subsidies and taxes are relevant in Jerez and negligible in Iteimia. In Jerez, government subsidies net of taxes on goods and services to forestry activity reach €33.7 ha^{-1}, accounting for 21% of total benefits that the public owner receives from this activity. Capital income (CI_{fc}) from forestry activity raises €89.2 ha^{-1} in Jerez and €80.0 ha^{-1} in Iteimia (Table 13.4). Forestry capital income is all retained by the Jerez owner, while in Iteimia it is shared by the State (56%) and by household livestock keepers (44%) as the owners of the cork oak woodland and the holders of grazing resources use rights, respectively (Campos et al. 2008).

Crops, Cork Preparation and Services

Crops make a significant contribution to household self-consumption and animal supplementary feeding in Iteimia. This activity generates a total commercial income of €21.9 ha^{-1} and a capital income of €0.9 ha^{-1}, corresponding to cropland GRR (Table 13.4). In Jerez crop activity is a less important source of animal feed with a total commercial income of €2.7 ha^{-1} and generates a negative capital income to its owner of €–6.7 ha^{-1} (Table 13.4).

Cork stripping is presumed to be in a stable situation in both case studies. This means that cork extraction matches cork annual growth. The changes in stock figure of €70.4 ha^{-1} in Jerez reflects cork preparation activity and refers to the value of cork that has been stripped at the time of accounting but will be prepared for sale in the next year. Cork preparation produces raw material which includes both raw cork that was stripped the year before and cork from the current stripping period (Table 13.4).

In Jerez, 72% of the stripped cork weight is the residue, after boiling the bark and other minor tasks, sold to the stopper industry for an average price of €1.6 kg^{-1} (Table 13.1). Sales of prepared cork bark totals €121.6 ha^{-1}, accounting for nearly one-third of the total private benefits in Jerez. However, cork preparation in Jerez costs more than in Itiemia (Campos et al. 2005b, for a detailed analysis), and this results in a capital income loss of € −51.0 ha^{-1} (Table 13.4).

'Service activity' is the cost to the Jerez owner cost for housing the tourist visitors of this estate. Output is valued at the cost of providing these services, so no capital income is derived from this activity, but there is a labour income of €7.3 ha^{-1} (Table 13.4).

Total Commercial Cork Oak Agroforestry Income

Jerez and Iteimia COAS generates a total private commercial income (TI_{fc}) of € 167.0 ha^{-1} and € 233.5 ha^{-1}, respectively. Agroforestry-based activities in Jerez produce a labour income of € 211.0 ha^{-1} and at the same time generate a capital loss (CI_{fc}) of € −44.0 ha^{-1} (Table 13.4). In Iteimia, labour income amounts to €152.7 ha^{-1} and is responsible for 65% of TI_{fc}. Self-employed residual labour cost and grazing resource rent that make up the Iteimia households' total income (TI_H), account for 73% of Iteimia agroforestry TI_{fc}. The Tunisian State as landowner estimates a capital income of roughly €44.4 ha^{-1}, which makes up 55% of the Iteimia capital income (CI_{fc}) and 19% of its total income (TI_{fc}). The employees labour compensation accounts for the remaining 8% of total income in Iteimia.

Capital income loss in Jerez seems to be related to nature conservation and social guidance management criteria of its public owner. This results in roe deer and autochthonous red cow race conservation and local employment generation. In Jerez, subsidies seek to partially compensate for the market capital loss of the owner set against public benefits derived from wildlife forest resources conservation. In Iteimia, however, the public owner assumes low investment on natural capital regeneration and families work to maximize self-employed labour income without expecting subsidies from the government. Thus, local households assume the risk of maintaining most of the traditional cork oak agroforestry activities.

Iteimia COAS agroforestry use generates a relevant labour income (Table 13.4), which in purchasing power parity (PPP) terms[12] is 69% higher than the labour income from Jerez on a per hectare basis.

The special issue for Iteimia households is the wage-rate (in euro per hour) obtained from COAS. In Itiemia, given both the annual working hours[13] spent by local households in agroforestry-based activities and the self-employed labour income (SLC) they obtain from those, the self-employment hourly pay, in Spanish purchasing power parity terms, is almost €0.6 hour^{-1}. This latter would be the families' hypothetical hourly pay if local families were asked to pay €0.07 FU^{-1} to the State owner for livestock grazing. Considering that the imputed value of grazing resource rent (GRR) corresponds to livestock keepers in Iteimia, the household' real livestock total commercial income ($TI_{Lf} = SLC_L + GRR$) gives an hourly pay of €0.7 hour^{-1} in purchasing parity terms, when GRR = 0. This latter hourly wage-rate amounts to 82% of forestry employees' hourly pay in Iteimia which, in 2002, came to €0.9 hour^{-1} in PPP terms (Chebil et al. in press). The average employees' wage-rate in Jerez is almost €11 hour^{-1}, 15 times higher in terms of PPP than the household's wage-rate in Iteimia and 13 times more than the employees' one.

Considering that Iteimia COAS uses about 615 ha of useful agricultural land (Campos et al. 2008) and affects 110 households (Chebil et al. in press), then the average total annual income (TI_H) from agroforestry activities is close to €948 household^{-1}. Most of the forestry workers in Iteimia are hired from the same households, which would imply that Iteimia household's TI_H from their own (self-employed) and paid (employees) work averages €1,050 household^{-1}. This latter income figure cannot be directly compared with the official average Tunisian rural household income,[14] as our measurement accounts only for just local cork oak agroforestry income.

Discussion and Conclusions

Cork oak agroforestry total commercial income in Jerez and Iteimia has been measured based on a low number of easily-collected microeconomic market data. However, this simplification restricts total income estimation to the special

[12] Given the 2002 official exchange rate of €1 = TND1.34 (BCT 2003), we have transformed Tunisian dinars (TND) into euros (€) and converted the Iteimia economic values into euros exchange values. In our case, the Jerez versus Iteimia purchasing power parity (PPP) rate shows the number of euros that in Spain have the equivalent good and services consumption power than one Tunisian euro exchange value. In 2002, the PPP rate for one Tunisian euro exchange value is 2.33 (estimated using The World Bank (2004) data). That is, we can buy the same goods with €1.00 in Iteimia or with €2.33 in Jerez. Then, to compare labour incomes in Jerez and Iteimia we calculate their values in terms of the same consumption power capacity.

[13] These estimates are performed ignoring adult working hour equivalences, given that some tasks are carried out by children.

[14] Rural income per capita in Tunisian was estimated in 2000 to be TND 864 (INS 2000). Considering the inflation rate, the euro and TND exchange rate and the average rural household size (4.67 person's family^{-1}) the average rural household income in Tunisia was near to €3,194 in 2002.

conditions of steady state case (Rodríguez et al. 2004 and Appendix 1), which is believed to be an unrealistic assumption for both case studies. From the standpoint of soil fertility and natural regeneration of woody vegetation, current managements in Jerez and Iteimia seem to be far from stable. So, our pilot exercises generate useful data on current management in COAS and should be seen as starting point for future potential real sustainable income measurement.

At both Mediterranean basin sites, cork oak stands are ageing at an uncertain rate due to the lack of recent assessment of forest seedling resource and regeneration. However, this aging of cork oaks might imply a future decline in cork growth in wooded areas in Jerez and Iteimia. For simplicity in this study it has been assumed that the cork growth will be stable, hence, the assessed total commercial incomes are presumably overvalued.[15]

Livestock and red deer restrain natural regeneration of cork oak in Iteimia and Jerez, respectively. In Jerez, red deer appears to be the main cause of damage to natural tree regeneration. Even if it seems that in Jerez there is no current widespread overgrazing, there might be localised overgrazing of seedlings and regeneration trees because of their higher palatability. In Iteimia, as in other Tunisian COASs, there are no restrictions on livestock grazing and unsuitable goat management is likely to be the main cause of the lack of natural tree regeneration (Ben-Mansoura et al. 2001).

On the other hand, the steepness of land in Iteimia and the lack of vegetation cover in some zones increase the risk of water erosion, and this is especially seen near to the villages. Neither loss of brushwood in Iteimia through overgrazing or soil erosion is considered in the estimate of total income (Chebil et al. in press).

In this study, it is clear that two similar environments can generate very different commercial results. Results from Jerez show that nature conservation and social oriented management decrease commercial capital income and increases labour income. But the apparent paradox is that a subsistence economy, as in the Iteimia case, generates both high self-employed labour and capital incomes per hectare basis. This will likely have a negative long-term impact on agroforestry system resources conservation due to overgrazing and crop erosion.

We also highlight the higher land use diversification in the Iteimia case study, in terms of extracted forest products, the livestock species and crop varieties. These may be a major strategy to minimize hazards and warranting the families' subsistence on the land. Iteimia generates more total income per hectare on a purchasing parity basis than Jerez. This greater total income figure in Iteimia is boosted by an intensive use of labour input per hectare and a higher resource extraction (e.g. grazing and shrub cutting), which shows the potential of Mediterranean cork oak agroforestry systems to support a diversified economy based on multiple animal and crop outputs from forestry. However, there is still concern over long-term sustainability of natural capital use.

---

[15] In the case of cork oak, silviculture takes into account the regeneration of the cork tree. Then, if other factors remain equal, livestock income would likely decrease in respect to what it has been estimated in the Jerez and Iteimia case studies.

In Jerez, many nature conservation activities attract a subsidy on the basis of the public environmental and employment services that it is believed the estate gives to society. In Iteimia, nature conservationist measures, which might restrict current grazing pressure, would likely decrease current household livestock commercial income (see Chebil et al. in press). Thus, local families should receive compensation for social equity and nature conservation policies. This compensation scheme should also include the value of cork oak forest conservation services provided by the livestock kept by local households. These reduce the risk of potentially catastrophic woodland fires by clearing and removing dead wood. In Jerez most fire prevention and control services are provided and paid for at an increasing rate by the government (Campos et al. 2005b).

In this work, we just focus on commercial goods and services that are controlled by different types of cork oak woodland owners (legal or actual). However, total commercial income gives an underestimate of the widespread benefits of COAS. Mediterranean *Quercus* woodlands sequester carbon, retain historically important landscapes, supply watershed services and provide refuge to high levels of biodiversity. Moreover, most migratory birds (from Central and Northern Europe to Central Africa) roost in Mediterranean cork oak woodland, and this might be endangered by current deforestation trends, especially in Northern Africa. In this context, forest services to biodiversity conservation, amongst others, could justify the creation of a specific program on cork oak agroforestry system conservation on both sides of the Mediterranean basin. Special attention will need to be paid to mitigating income loss that families might incur because of the specific land use restrictions such as temporary grazing exclusion and other measures prescribed for a sustainable cork oak agroforestry management programme.

Acknowledgments This work was funded in the frame of the research projects 'Sustainable silvo-pastoral management models in Mediterranean forests: Application on cork oak forest in Spain (Cadiz) and Tunisia (Ain Draham)' (6P/02) and 'Conservation and Restoration of European cork oak woodlands: a unique ecosystem in the balance' – CREOAK – (UE: QLRT-2001-01594). We are grateful to the Spanish Agency for the International Cooperation (AECI), to the European Commission and to the Tunisian Ministry of Research which have contributed to fund this research. We also thank to the Forest Administration and rural development office (ODESYPANO) of Ain Snoussi and to Miguel Girón and José María Martinez of Montes de Propios estate of Jerez for providing the data and their collaboration in undertaken interviews. We are grateful to an anonymous referee for their valuable comments and suggestions to the preliminary version of this study. The authors are solely responsible for the shortcomings that could remain.

References

BCT (Banque Centrale de Tunisie) (2003) Rapport Annuel 2002. BCT, Tunisia

Ben-Mansoura A, Garchi S, Daly H (2001) Analyzing forest users' destructive in Northern Tunisia. Land Use Policy 18(2):153–163

Berzborn S (2007) The household economy of pastoralists and wage-labourers in the Richtersveld, South Africa. J Arid Environ 70(4):672–685

Campos P (2004) Towards a sustainable global economy for Mediterranean agro-forestry systems. In: Schnabel S, Gonçalves A (eds.) Sustainability of Agro-silvo-pastoral Systems. Dehesas and Montados. Adv Geoecology, vol. 37. Catena Verlag, Reiskirchen, Germany, pp13–28

Campos P, Caparrós A (2006) Social and private total Hicksian incomes of multiple use forests in Spain. Ecol Econ 57(4):545–557

Campos P, Salgado JFM (1987) Informe forestal de los Montes de Propios de Jerez de la Frontera. Instituto de Economía y Geografía Aplicada, Consejo Superior de Investigaciones Científicas, Madrid

Campos P, Rodríguez Y, Caparrós A (2001) Towards the Dehesa total income accounting: theory and operative Monfragüe study cases. Invest Agrar Sist Recur for special issue 1:45–69

Campos P, Sanjurjo E, Caparrós A (2005a) Spain. In: Merlo M, Croitoru L (eds.) Valuing Mediterranean Forests: Towards Total Economic Value. CAB International, Wallingford, UK

Campos P, Oviedo P, Ovando P (2005b) La cadena de la economía del corcho en los Montes de Propios de Jerez de la Frontera. Revista Española de Estudios Agrosociales y Pesqueros 208:83–113

Campos P, Ovando P, Rodriguez Y (2005c) Comparative analysis of the EAA/EAF and AAS Agroforestry Accounting Systems: Theoretical Aspects. In: Mosquera R, Riguero A, McAdan J (eds.) Silvopastoralism and Sustainable Land Management. (ABI publishing, Wallingford, pp 324–329

Campos P, Daly H, Oviedo JL et al. (2008) Accounting for single and aggregated forest incomes: application to public cork oak forests in Jerez (Spain) and Iteimia (Tunisia). Ecol Econ 65:76–86

Chebil A, Campos P, Ovando P et al. (in press) The total commercial income from cork oak forest Agroforestry system in the region of Iteimia, Tunisia. In: Zapata-Blanco S (ed) Alcornocales e industria corchera: hoy, ayer y mañana Cork oak woodlands and cork industry: present, past and future. Museu del Suro de Palafrugell, Palafrugell, Spain. Forthcoming.

Delang CO (2006) Not just minor forest products: the economic rationale for the consumption of wild food plants by subsistence farmers. Ecol Econ 59(1):64–73

DGF (Direcção Geral das Florestas) (2006). Obtained from the Associacion Portuguesa de Cortiça (APCOR) 2007. Cork Production – Area of Cork Oak Forest. http://www.realcork.org. Cited 23 May 2007

Ellatifi M (2005) Marocco. In: Merlo M, Croitoru L (eds.) Valuing Mediterranean Forests: Towards Total Economic Value. CAB International, Wallingford, UK

European Commission (2006) Community Committee for the Farm Accountancy Data Network Farm Return Data Definitions Accounting years 2006, 2007. RI/CC 1256 rev. 4. European Communities, Brussels

Eurostat (2000) Manual on Economic Accounts for Agriculture and Forestry EAA/EAF 97 (Rev.1.1). European Communities, Brussels/Luxembourg

FAO (Food and Agriculture Organitation) (2001) North Africa. In: Global Forest Resources. Assessment 2000. Main Report. FAO, Rome

INS (Institut National de la Statistique–Tunisie) (2000) Enquête nationale sur le budget, la consommation et les niveaux de vie des ménages. INS, Tunisia

Mahapatra AK, Tewari DD (2005) Importance of non-timber forest products in the economic valuation of dry deciduous forests of India. Forest Policy Econ 7(3):455–467

Martin M, Espejo M, Plaza J, et al. (1987) Cálculo de la carga ganadera en la dehesa. In: Campos P, Martin M (eds.) Conservación y desarrollo de las dehesas portuguesa y española. Secretaria General Técnica, MAPA, Madrid, pp 239–258

Pulido F, Díaz M (2003) Dinámica de la regeneración natural del arbolado de encina y alcornoque. In: Pulido F, Campos P, Montero G (eds.) La gestión forestal de la dehesa. Junta de Extremadura/IPROCOR, Mérida, pp 39–62

Rodríguez Y, Campos P, Ovando P (2004) Commercial economy in a public Dehesa in Monfragüe Shire. In: Schnabel S, Gonçalves A (eds.) Sustainability of Agro-silvo-pastoral Systems. Dehesas and Montados. Adv in Geoecology, vol 37. Catena Verlag, Reiskirchen, Germany, pp 85–96

Scarascia-Mugnozza G, Oswald H, Piussi P et al. (2000) Forest of the Mediterranean region: gaps in knowledge and research needs. Forest Ecol Manag 132:97–109
Schejtman A (1980) Economía campesina: lógica interna, articulación y persistencia, Revista de la CEPAL 11:121–140
Stiti B, Sebei H, Khaldi A (2004) Evaluation de la régénération et analyse de la croissance du chêne liège dans la forêt de Ain Snoussi, Tunisie. Paper presented at the 4th Meeting of the IOBC/WPRS Working Group on Integrated Protection in Oak Forests, Hammamet, Tunisia, 5–8 October 2004
Torres E, Montero G (2000) Los alcornocales del macizo del Aljibe y sierras del Campo de Gibraltar. Secretaría General Técnica Ministerio de Agricultura Pesca y Alimentación, Madrid

Appendix 1 Linking Complete and Simplified Agroforestry Accounting Systems

Total income at market prices (TI_{mp}) using the complete agroforestry accounting system (AAS) (e.g. Campos et al. 2001, 2008) is estimated according to the following equation:

$$TI_{mp} = TO - IC + CG_{mp} \quad [A.1]$$

Where TO is the total output, IC the intermediate consumption and CG_{mp} the capital gains at market prices. TO and IC come from the production account, which records the outputs and the production costs of the agroforestry system during the accounting period (year); while the CG_{mp} comes from the capital balance account that records changes on asset values during the accounting period.

Total output (TO) is estimated as the sum of intermediate (IO) and final (FO) outputs:

$$TO = IO + FO \quad [A.2]$$

The final output comprises the gross internal investment (GII), the final sales (SFO), the final stock (FSO) and other final output (OFO), which accounts for the imputed value of self-consumed final goods and services:

$$FO = GII + SFO + FSO + OFO \quad [A.3]$$

Gross internal investment (GII) under steady state assumptions[1] equals to own fixed capital withdrawals net of fixed capital goods destructions (see equation [A.12]) and the fixed capital consumption of own capital goods (FCC_i). The final stock (FSO) embraces the gross natural growth (GNG) value of multi-period products (i.e. cork and firewood)[2] and the final stock value of annual products – i.e. animal and crops – (FSOo):

$$FSO = GNG + FSOo \quad [A.4]$$

On the other hand, intermediate consumption (IC) is estimated as the sum of raw materials (RM), services (SS) and the work-in-progress used (WPu) during the accounting period:

$$IC = RM + SS + WPu \quad [A.5]$$

The fixed capital consumption accounts for both internal (own) fixed capital consumption (FCC_i) and external fixed capital consumption (FCC_e):

$$FCC = FCC_i + FCC_e \quad [A.6]$$

The steady state situation implies that the cork and crop yields, as well as herds, are in a stable situation. In that case, the WPu equals to the sum of the revaluation of multi-period products' work-in-progress (WPr), the gross natural growth of multi-period products and the value of annual products used during the accounting period, which under steady state conditions (constant prices) match the final stock value of annual products (FSOo):

$$WPu = WPr + GNG + FSOo \quad [A.7]$$

The capital gains at market prices (CG_{mp}) are estimated as the sum of work-in-progress (WPr) and fixed capital (FCr) revaluations, minus the fixed capital destruction (FCd), and plus the FCC[3]:

$$CG_{mp} = WPr + FCr - FCd + FCC \quad [A.8]$$

Both the WPr and the FCr come from the capital balance account, which is broken into two accounts: the work-in-progress (WP) balance and the fixed capital (FC) balance. The WPr under steady state assumptions is estimated according to equation [A.7]. While FCr is estimated as the difference between the final (FCf) and initial (FCi) capital values and the withdrawals (FCw) and entrances (FCe) of capital:

$$WPr = GNG + FSOo - WPu \quad [A.9]$$

$$FCr = FCf + FCw - FCi - FCe \quad [A.10]$$

Fixed capital entrances are broken down into the gross investment on fixed capital goods (FCgi), that can embrace both internal (FCii) – own-produced capital goods (i.e. breeders, infrastructure) – and external (FCie) capital goods (i.e. tractors, machinery). While the fixed capital withdrawals are made of fixed capital sales (FCs), self-consumption of fixed capital (FCo) and fixed capital goods destructions (FCd). In a steady state, the initial fixed capital and final fixed capital values match, thus the FCr is estimated as:

$$FCr = FCs + FCo + FCd - FCii - FCie \quad [A.11]$$

In steady state, the gross internal investment (FCii) should offset self fixed capital withdrawals net of fixed capital destruction ($FCw_i - FCd_i$) and the internal fixed capital consumption (FCC_i):

$$GII = FCii = FCC_i + FCs_i + FCo_i \qquad [A.12]$$

Therefore, the fixed capital consumption related to own capital goods is:

$$FCC_i = FCii - FCs_i - FCo_i \qquad [A.13]$$

It is assumed that there are no sales, self-consumption or extraordinary fixed capital goods destruction of external fixed capital goods in the cases of Jerez and Itemia:

$$FCs_e = FCo_e = FCd_e = 0 \qquad [A.14]$$

Hence, the gross external investment (FCie) at reposition costs[4] is equivalent to the fixed capital consumption of external capital goods (FCC_e):

$$FCC_e = FCie \qquad [A.15]$$

By substituting equations [A.12] to [A.15] into equation [A.11], the FCr is equal to:

$$FCr = FCs_i + FCo_i + FCd_i - FCC_i - FCs_i - FCo_i - FCie \qquad [A.16]$$

$$FCr = FCd_i - FCC_i - FCie \qquad [A.17]$$

Considering the former TO, IC and CG_{mp} partial identities, the total income at market prices (TI_{mp}) is then estimated as:

$$TI_{mp} = \begin{bmatrix} (IO + FCC_i + FCs + FCo + SFO + GNG + FSOo + OFO) \\ -(RM + SS + WP_r + GNG + FSOo + FCC_i + FCC_e) \\ +WP_r + (-FCie - FCC_i + FCd) - FCd + FCC_i + FCC_e \end{bmatrix} \qquad [A.18]$$

$$TI_{mp} = [(IO + FCs + FCo + SFO + OFO) - (RM + SS + FCie)] \qquad [A.19]$$

Considering that sales (S) and self-consumption (SC) concepts in the simplified accounting structure include both final outputs (derived from the production process) and fixed capital goods, and that the intermediate consumption (IC) includes raw materials and services:

$$S = FCs + SFO \qquad [A.20]$$

$$SC = FCo + OFO \qquad [A.21]$$

$$IC = RM + SS \qquad [A.22]$$

Then, the TI_{mp} identity corresponds to equation [1] of this study:

$$TI_{mp} = IO + S + SC - IC - FCie \qquad [A.23]$$

The accounting structure we present in this work includes an additional benefit, called "changes in stock" (CS), that captures the differences on work-in-progress at the beginning and at the end of the accounting period of big game and forestry that in the Jerez case study are not under steady state conditions. Therefore, in Jerez, the TI_{mp} is measured as:

$$TI_{mp} = IO + CS + S + SC - IC - FCie \qquad [A.22]$$

Appendix Notes

[1] The steady state assumptions are: (i) Stable yields and constant prices, (ii) no extraordinary loss of capital goods; and, finally, (iii) fixed capital is perfectly divisible, so annual gross investment in amortizable fixed assets may be equalled to fixed capital consumption.

[2] Multi-period products refer to those that need more than the accounting period (a year) to reach the final form when they are sold or self-consumed.

[3] The FCC is added to the CG_{mp}, in order to correct its double counting, firstly to estimate the total cost (TC = IC + LC + FCC) and secondly to estimate the final fixed capital (FCf) value.

[4] The reposition cost of used production goods is the depreciation value of the same goods if they were bought as new production goods in the accounting year.