

# Grazing, firewood and net carbon incomes of a Holm oak dehesa ecosystem: A case study in Arroyo de la Luz, Spain

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**Keywords:** Conservation silviculture, agroforestry accounting system, environmental income.

## Background

The standard economic accounts for agriculture, livestock, forestry and fish measure harvested final goods and services which are usually sold in formal markets (European Communities, 2000). Governments have recognized the need to expand the standard system of national accounts beyond the commodities incorporating the valuation of natural resources consumption that contribute to the benefits that people obtain from ecosystems (European Commission, 2011; United Nations, 2012), and propose to develop and test novel ecosystem accounting methodologies that extend the standard national accounts including natural resources depletion and growth (United Nations *et al.*, 2014). This work presents an application of the Agroforestry Accounting System to value hardwood conservation silviculture, grazing, cork and firewood private incomes of a publicly-owned *dehesa* ecosystem in Arroyo de la Luz, Cáceres, Spain (Campos, 2015; Campos and Pulido, 2015).

## Objectives of conservation silviculture

The target of the public *Dehesa de la Luz* landowner is to improve the native Holm oak and Cork oak tree cover while maintaining livestock grazing. The economic objective of this study is to estimate private incomes from the uses of hardwood resources from an expected scenario of a long term conservation silviculture management.

## Data sources

Dehesa de la Luz farm is the source of primary data for woodland and grazing. This silvo-pastoral farm includes 909 ha of Holm oak wood pasture (including scattered Cork oak trees) and 68 ha of ponds and other non-forest land. Researchers have inventoried the trees and conservation silviculture modeling applied in 2014 and which is planned for the future (Castaño *et al.*, 2016). The measurement of grazing has required the provision of data supplied by livestock herders (Campos *et al.*, 2015).

## Concepts and methods

The ecosystem total product classifies into intermediate product and final product, and distinguishes between total product consumption and gross capital formation (cork and firewood natural growth and trees improvements).

This study reviews the concepts of conservation silviculture and non-commercial intermediate services applied in previous publications (Caparrós *et al.*, 2016). We separate products and costs of forestry activity in conservation silviculture, cork, wood and grazing (grass and acorns) and define forestry conservation works as ordinary maintenance and improvement of woodland.

The products of the conservation silviculture works are, on the one hand, the intermediate production of non-commercial services that are re-used in the production of the *dehesa* open landscape, thus conservation silviculture is regarded as a public activity; and, on the other hand, the final production investments on woodland improvements (trees plantation and thickening). The products of the conservation silviculture are valued at production cost and at producer prices.

Cork and firewood harvested products only incur on extraction and work in progress products used intermediate costs, and their products are natural growth and extractions of cork and Holm oak pruning (additionally they provide income from the revaluation of inventories of work in progress products). The grazing has ordinary tilling cost with the aim of mitigating soil compaction by livestock trampling.

We estimate the oaks carbon environmental income as the difference between the period natural growth fixation and emissions estimated from cork stripping and firewood of Holm oak pruning. The carbon service is valued at European carbon trading prices.

## Results

The forestry activity of the *Dehesa de la Luz* has conservation silviculture as its main management motivation. The *Dehesa de la Luz* ordinary silviculture works generate a non-commercial intermediate service higher than the intermediate grazing raw material (Table 1). The public owner invests in improving woodland landscape three times more than the value of the firewood extracted and about two times the value of grazing (Table 1). Silviculture contributes to 24% of forestry activity private net value added; 34% of forestry activity private total income and 50% of forestry activity labour income.

The grazing and cork products contribute, respectively, with 60% and 40% of forestry activity total environmental income.

The ecosystem services consumption contributes to 29% of forestry products consumption (total products less gross capital formation) of 85,127 euros. The environmental income contributes to 50% of the total forestry activity total income, labor income and manufactured capital income share, respectively, 29% and 21% remaining total income (Campos *et al.*, 2016a).

Environmental assets of grazing and cork contribute, respectively, 49% and 35% of the total forestry capital invested in the *Dehesa de la Luz*. The forestry current profitability rate is near 4% (Campos *et al.*, 2016a).

In addition to private forestry products concerned, we measure the environmental income of 13,587 euros in 2014 from the carbon public service of global warming mitigation (Campos *et al.*, 2016b).

## Conclusion

Conservation silviculture is based on the production of non-commercial intermediate services. The latter, given the status of being the *Dehesa de la Luz* publicly-owned, are entirely used up as input for the production of public open wood landscape.

Extremadura government has "bought" (compensation) in 2014 silviculture non-commercial services of 22,192 euros, having "donated" the municipality owner of the *Dehesa de la Luz* to public users the 13,268 euros remaining of the total 35,460 euros produced of silviculture non-commercial intermediate services (Table 1).

**Table 1:** Private economic results of forestry activity of *Dehesa de la Luz* (2014: €)

| Class                                   | Cork   | Firewood | Grazing |       |        | Conservation silviculture | Forestry       |
|---|--------|----------|---------|-------|--------|---------------------------|----------------|
|   |        |          | Grass   | Acorn | Total  |                           |                |
|   | 1      | 2        | 3.1     | 3.2   | 3      | 4                         | 5 = $\sum 1-4$ |
| 1. Total product (TP)                   | 2.199  | 21.083   | 24.875  | 3.849 | 28.724 | 86.691                    | 138.696        |
| 1.1 Intermediate product (IP)           |        | 4.108    | 24.875  | 3.849 | 28.724 | 35.460                    | 68.292         |
| Raw materials (IRM)                     |        | 4.108    | 24.875  | 3.849 | 28.724 |                           | 32.832         |
| Non-commercial services (ISSnc)         |        |          |         |       |        | 35.460                    | 35.460         |
| 1.2 Final product (FP)                  | 2.199  | 16.975   |         |       |        | 51.230                    | 70.404         |
| Sales (FPs)                             |        | 16.835   |         |       |        |                           | 16.835         |
| Gross capital formation (GCF)           | 2.199  | 140      |         |       |        | 51.230                    | 53.569         |
| 2. Total cost (TC)                      |        | 20.928   | 5.000   |       | 5.000  | 86.691                    | 112.618        |
| 2.1. Intermediate consumption (IC)      |        | 8.382    | 5.000   |       | 5.000  | 53.741                    | 67.123         |
| Raw materials (RM)                      |        | 6.744    |         |       |        | 27.587                    | 34.331         |
| Services (SS)                           |        | 1.116    | 5.000   |       | 5.000  | 26.154                    | 32.270         |
| Work in progress used (WIPu)            |        | 522      |         |       |        |                           | 522            |
| 2.2 Labour cost (LC)                    |        | 12.546   |         |       |        | 12.085                    | 24.630         |
| 2.3 Consumption of fixed capital (CFC)  |        |          |         |       |        | 20.865                    | 20.865         |
| 3. Net operating margin (NOM = TP - TC) | 2.199  | 155      | 19.875  | 3.849 | 23.724 | 0                         | 26.078         |
| 4. Net value added (NVA = LC + NOM)     | 2.199  | 12.701   | 19.875  | 3.849 | 23.724 | 12.085                    | 50.708         |
| 5. Capital gain (CG)                    | 14.700 | 57       |         | 1.511 | 1.511  | 17.999                    | 34.267         |
| 6. Ecosystem services consumption (ESc) |        | 538      | 19.875  | 3.849 | 23.724 |                           | 24.262         |
| 7. Capital income (CI)                  | 16.899 | 213      | 19.875  | 5.359 | 25.234 | 17.999                    | 60.345         |
| 7.1. Manufactured capital income (MCI)  |        |          |         |       |        | 17.999                    | 17.999         |
| 7.2. Environmental income (EI)          | 16.899 | 213      | 19.875  | 5.359 | 25.234 |                           | 42.346         |
| 8. Total income (TI = NVA + CG)         | 16.899 | 12.759   | 19.875  | 5.359 | 25.234 | 30.083                    | 84.975         |

Source: Campos *et al.* (2016a).