Mountains of our Future Earth

Perth Concert Hall
Perth, Scotland, UK, 4-8 October 2015

Feminization, Agricultural Transition, and rural Employment: Case studies of Champasak and Salavan Provinces ,Lao PDR
Saithong Phommavong, Dexanoulath Seandouangdeth, Kabmanivanh Phouxay, Maliphone Douangphachanh, Keophouthone Hathalong, Sisavath Sengphachanh, Bounath Keopanhya

Mountain farming systems efficiency and sustainability
Jaime Pires, Margarida Arrobas, Carlos Aguiar, Isabel Ferreira, João Azevedo

Assessing the potential of the High Asia Refined Analysis to support hydrological modelling in the Upper Indus Basin
David Pritchard, Hayley Fowler, Andras Bardossy, Greg O'Donnell, Nathan Forsythe

Promoting Sustainable Mountain Development for Global Change (SMD4GC)
Nadine Salzmann, Christian Huggel, Samuel Nussbaumer, Thomas Kohler, André Wehrli, Eric Nanchen

From regional to local scale: assessing the degradation of mountain permafrost by 2D and 3D digital photogrammetry in the Southern Swiss Alps
Cristian Scapozza, Christian Ambrosi

Microtopography affects the relationship between soil, plant distribution and decomposition rates in a subalpine grassland
Emanuele Pintaldi, Consolata Siniscalco, Luisella Celi, Gianluca Filippa, Michele Freppaz, Edoardo Cremonese, Elena Barni, Marta Galvagno, Michele D'Amico, Umberto Morra di Cella

Topography driven isolation, speciation and endemism
Manuel Steinbauer

Monitoring temperature and snow presence across topographic aspects in semi-arid woodlands: implications for tree growth response at the upper and lower treelines.
Scotty Strachan, Constance Millar

Shifting perspectives on natural ecosystems in the high Andes
Steven Paul Sylvester, Mitsy D.P.V. Sylvester, Felix Heitkamp, Hermann Jungkunst, Johanna Toivonen, Carlos Gonzales Inca, Michael Kessler

Resilience of mountain grassland ecosystem service provision
Marina Kohler, Caroline Devaux, Karl Grigulis, Georg Leitinger, Sandra Lavorel, Ulrike Tappeiner

Arctic and alpine tundra vegetation change has no net impact on tundra litter decomposition rates
Haydn Thomas, Anne Bjorkman, Isla Myers-Smith, Sarah Elmendorf, Hans Cornelissen, Daan Blok, Jens Kattge, Martin Hallinger, Gabriela Schaepman-Strub, Ken Tape, Martin Wilmking, sTUNDRA Working Group

Dynamics of the treeline ecotones of Central Altay: past and present.
Elena Timoshok, Elena Filimonova, Evgenii Timoshok

Temperature, precipitation and biotic interactions as determinants of tree seedling recruitment across the tree line ecotone
Lise Tingstad, Siri Lie Olsen, Kari Klanderud, Vigdis Vandvik, Mikael Ohlson

Mountain farming systems efficiency and sustainability

Jaime Pires, Margarida Arrobas, Carlos Aguiar, Isabel Ferreira, João Azevedo

Instituto Politécnico de Bragança - Mountain Research Centre (CIMO), Bragança, Portugal

Introduction

Like other economic sectors, agriculture requires the efficient use of resources and farming inputs, considered as a key factor for sustainability. On the other hand, the ecological limitations of the productivity in mountains make the study of efficiency in agricultural systems in these areas even more crucial.

Material and methods

Based on these assumptions, we present in this study the preliminary results of efficiency analysis in four farms representative of farming systems, in mountain regions in Portugal: a) Douro vineyards (60ha), b) olive grove (15ha), c) mixed-farming (36ha), and d) chestnut orchards (10ha).

These are rainfed agriculture systems in small/medium-sized farms, consisting of several blocks, with the exception of the in Douro vineyard, which has a single block.

The dominant soils are antrosols in Douro and leptosols and cambisols in the other systems. Granite is the dominant bedrock in the mixed-farming site while schist is dominant in the remaining sites. Soils are acidic to slightly acidic, with low OM contents, low levels of phosphorus and medium levels of potassium. Given the altitude and annual rainfall, the farm of mixed-farming systems presents the most acidic soils and with the highest organic matter contents (≥ 70-80g $\cdot kg^{-1}$). Long-term mean annual rainfall and mean annual temperature are, 763mm and 16.1ºC, 501mm and 15°C, 1455mm and 10°C, and 12°C and 809mm, for sites following systems a, b, c, and d, respectively. The growing season varies from 122 days (b) and 243 days (a).

The Mixed-Farming system (c) is presented in detail in Núñez-Fernández *et al* (2013). Data considered for the remaining systems results are annual means for three consecutive years for external inputs at each farm (fertilizers, pesticides, fuel and hand labor) and the total annual production of farm outputs (port and table wine (a), olive (b) and chestnut (d)).

Input and output data were later converted into: i) monetary units (€), using the prices of the national agriculture statistics in 2014 as reference; and ii) energy units, applying the values in Dessane (2003) for chemical fertilizers and olives, Bayliss-Smith (1982) for fuels and machinery (including maintenance), Pimentel and Pimentel (2008) for the remaining inputs and INSRJ (2015) for the remaining outputs. These data allow us to address and discuss energy and economic efficiency (output/input ratios), as well as the different monetary values per unit of energy.

Results and discussion

Excluding Douro vineyard, energy efficiency was between 0.12, in the mixed-farming system (Fernández-Núñez *et al* 2013), and 1.76 in olive grove, while economic efficiency varied between 1.41 in olive grove and 8.48 in chestnut orchard. The total energy input was from 2320 $MJ\cdot ha^{-1}$ in the mixed-farming to 10572 $MJ\cdot ha^{-1}$ in chestnut orchard, while the energy output was from 279 to 15502 $MJ\cdot ha^{-1}$ for the mixed-farming and olive grove systems, respectively. These values are much lower than those reported in other studied systems, such as Dessane (2003) and Pimentel and Pimentel (2008).

As verified by other authors, fuel represents the largest share of energy in inputs (53-80%), keeping the same relative positioning in terms of costs per hectare, except in olive grove where the hand labor has the largest share (61%).

The Douro vineyard, the only system considered as an entrepreneurial, presents the highest energy inputs, similar to those referred for other systems and other authors.

The prices of energy inputs ranged from € 0.017 $\cdot MJ^{-1}$ (fuels) and € 0.17 $\cdot MJ^{-1}$ (seeds in mixed-farming), except for hand labor that presented the highest and very different value, € 2.38 $\cdot MJ^{-1}$. The prices of energy outputs ranged from € 0.048 $\cdot MJ^{-1}$ for olives and € 0.808 $\cdot MJ^{-1}$ for table wine (Douro vineyards).

The energy consumption in all systems but Douro vineyards were low, which allows them to be considered tendentiously sustainable. However it is necessary to further improve their efficiency. Regarding the prices of energy consumed and produced as inputs and outputs, the replacement of fuels by other energy sources, should be based on renewable sources. The price of the output energy is crucial for the economic efficiency and sustainability of the systems.

References

Bayliss-Smith, T. P. 1982. The ecology of agricultural systems. Cambridge: Cambridge University Press.

Dessane, Damien. 2003. "Energy efficiency and Life Cycle Analysis of Organic and Conventional olive groves in the Messara Valley, Crete, Greece." MSc diss., Wageningen University.

Fernández-Núñez, Esther, Moreira, N.; Cabanas, J.; Pires, J. C.; Aguiar, C.; Bernardo, A.; Rodrigues, M. A. and Jaime M. Pires (2013). "Farming systems in mountain regions of NE Portugal: conversion from conventional production to organic production." Grassland Science in Europe 18: 93-95.

INSRJ. 2015. "Table of food composition." Accessed January 10. http://www.insa.pt/sites/INSA/Portugues/AreasCientificas/AlimentNutricao/AplicacoesOnline/TabelaAlimentos/Paginas/TabelaAlimentos.aspx

Pimentel, David and Marcia H. Pimentel. 2008. Food, Energy and society. Boca Raton: CRC Press.