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Analyzing the sustainability of four Damask rose and olive production systems in two regions of Nehbandan using an extended exergy, emergy, energy, and economic approach

Supervisor

Dr. Ahmad Ghanbari

Advisors

Dr. Mohammad Reza Asgharipour

Dr. Enrico Sciubba

Dr. Esmaeel Seyedabadi

By

Fatemeh Nakhaii

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Abstract

One of the most important challenges facing the management of agroecosystems is energy efficiency, which has created many problems in achieving sustainability in agriculture. In order to provide suitable strategies for the development of cultivation, increasing the sustainability and productivity of olive and Damask rose production ecosystems, an operational field evaluation of four mechanized and traditional olive and Damask rose ecosystems was carried out in the years 1401-1400 in Nahbandan region using extensive exergy thermodynamic techniques (EEA), which is a new method in evaluating the sustainability of agricultural ecosystems - emergy, economic and energy analysis. Extended exergy analysis is based on the first and second laws of thermodynamics. This method is able to calculate flows such as labor, capital and environmental costs in ecosystems. The EEA analysis of these systems showed that the high consumption of inputs leads to an increase in cumulative exergy consumption (CExC) in the mechanized system of olives and Damask roses. The comparison of environmental treatment cost (EE_E) values of the studied ecosystems shows the high production of pollutants in the traditional olive and mechanized Damask rose ecosystem in relation to other ecosystems. Also, the values of extensive exergy indices such as capital conversion of material and energy inputs (K_{CAP}), capital conversion of product sales (K_{CAP}^{EEA}), extensive exergy cost index (eec) and cumulative degree of perfection index (CDP) indicate that traditional Damask rose and mechanized olive ecosystems are more economical, more economical, higher technological efficiency and closer to optimal conditions than other ecosystems in terms of input costs. Also, based on Emergy indices, environmental load ratio (ELR), Emergy renewable percentage (R), standard and modified environmental sustainability index (ESI and ESI*), the ecological sustainability of mechanized olive and traditional Damask rose ecosystems is more than other studied ecosystems. The results of the economic analysis of the studied ecosystems showed that based on the efficiency of economic performance and net income, the traditional production system of Damask rose is a more suitable choice than the mechanized production system of Damask rose. The economic efficiency of two mechanized and traditional olive systems is 0.14 and 0.01, respectively. The analysis of the economic parameters of two mechanized and traditional olive systems shows that the mechanized olive

system is more economical compared to the purchased inputs for the two systems. Compared to other ecosystems, the highest net income is allocated to the mechanized olive ecosystem. According to the findings in this research, the amount of energy input in the olive mechanized ecosystem is less than other studied ecosystems; If the amount of energy output of this ecosystem is more, this indicates the appropriate energy efficiency in the olive mechanized system. Therefore, achieving sustainable agricultural production systems requires designing new cultivation patterns, choosing the type and amount of appropriate inputs in each ecosystem, and modifying management methods that reduce the costs of environmental modification and improve thermodynamic-economic indicators.

Key Words: Agricultural ecosystem, Ecological sustainability, Input and output, Olive production, Thermodynamic indicators