Abstract

Intensification in cropping systems with limited natural resources has necessitated to determination of agroecosystems sustainability in terms of both environmental and economic aspects. For this aim, emergy analysis is used as a suitable tool in various ecosystems. This study was conducted to evaluate and compare sustainability and resource use efficiency of autumn and spring potato agroecosystems in Golestan province during the period 2017-2018. For this purpose, 120 and 60 farms were selected for autumn and spring potato, respectively. Sample size was determined by Cochran formula and farmers were selected by stratified random sampling. Then, emergy graph was drawn and spatial and temporal boundaries were defined, and resources were also divided into four categories: renewable environmental resources, nonrenewable environmental resources, purchased renewable resources, and purchased nonrenewable resources. After drawing the emergy table, emergy indices were calculated and compared by t-test between autumn and spring agroecosystems. In the end, spatial distribution of emergy indexes was done by GIS software. According to results, total emergy inputs for the autumn and spring potato production were estimated as 1.71E+16 and 1.76E+16 sej ha^{-1} yr^{-1}, respectively. In autumn potato production systems, dependence on purchased inputs was higher than environmental inputs, while in spring potato production systems, the dependence of environmental inputs was higher than purchased inputs. Results showed that groundwater emergy was the largest emergy inputs of the total in both autumn and spring potato production systems with share of 23.92% and 45.28%, respectively. In autumn and spring potato production systems, transformation rates were calculated as 1.50E+05 and 2.54E+05 sej j^{-1}; specific emergy indices were 5.41E+08 and 9.12E+08 sej g^{-1}; emergy yield ratios were 1.44 and 2.06; standard emergy investment ratios were 2.29 and 0.94; modified emergy investment ratios were 20.95 and 15.04; emergy renewability were 22.85% and 12.78%; emergy density indices were 1.71E+16 and 1.76E+16 sej ha^{-1}; standard environmental loading ratios were 29.10 and 30.02; modified environmental loading ratios were 3.38 and 6.84; standard emergy sustainability indices were 0.05 and 0.07; modified emergy sustainability indices were 0.43 and 0.30; emergy self-support ratios were 0.30 and 0.52 and product safety indices based on emergy were -0.15 and -0.21, respectively. There was a significant difference between the emergy indices of the autumn and spring potato production systems. Despite the higher contribution of environmental resources in the spring potato production system, the high consumption of groundwater as a non-renewable input led to an increase in environmental pressure. The use of new irrigation methods will improve water consumption and, as a result, reduce environmental pressure on ecosystems. Spatial analysis showed that the highest emergy density related to the autumn agroecosystem was in North Astarabad village. In final, the autumn production system was more favorable in terms of yield and resources use efficiency, renewability and environmental sustainability than spring production system in Golestan province. The economic sustainability of autumn potato production system was slightly lower than the spring potato production system, due to the unreasonable use of purchased inputs such as seed and fossil fuels. Thus, optimum management of inputs such as seed and fossil fuels will increase economic sustainability in the autumn potato agroecosystem.

Keywords: Ground water, Economic sustainability, Productivity, Environmental pressure

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