Albanian Journal of Agricultural Sciences (2011), Nr.1/Vol. 10© Agricultural University of Tirana

THE SUSTAINABILITY OF AGRO-ECOSYSTEMS IN ALBANIA

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Abstract

Agricultural production is realized through a combination of natural and human factors. During this dynamic process humans interfere in the natural ecosystems to achieve pre-planned yields by cultivated plants and managed livestock. Achieving these objectives requires additional inputs beyond those provided in natural production processes. The type of inputs provided by humans might be both of renewable and non renewable resources. As a consequence of the human interference significant negative changes are becoming evident in natural and agro-ecosystems, which might threaten their long term sustainability. In this context, setting quantitative criteria for monitoring the dynamics of the overall sustainability in the agro-ecosystems remains a permanent challenge for the society. Application of the Sustainability Inequality for Albania`s agro-ecosystems showed us that agricultural production is far from being sustainable. Reorientation of the agricultural production towards sustainability trends remains one of the most important challenges in Albania. Achieving this objective requires a shift towards the use of more renewable resources, and continuous monitoring of this shifting process.

Key words: Long term sustainability, Inequity of Sustainability

1. Introduction

Since 1972 the paradigm of continuous economic growth has become questionable both by researchers and producers, and starting from 1992 there is a substantiated belief that the global economic growth has exceeded Earth`s biophysical capacities to sustain life [7]. The alarm bell for the depletion of the fossil fuels reserves as well as their negative impact on the environment by their extensive use made necessary research activities aiming at improving the sustainability of economic growth and development. In this framework several authors have conducted different studies in search of new ways for viable and long-lasting solutions, [3, 4, 6].

Food for humans and livestock is realized through different technologies of plant cultivation which are essentially based on the natural process of photosynthesis but assisted by human made inputs aiming at plant yield increase to meet growing human needs. The whole production process takes place within the land area of agro-ecosystems which are the result of combination of natural and anthropogenic influences. But the continuous growth of food production is accompanied with an increase of stress on the agro-ecosystems which may create health risks for humans and all the other living organisms on Earth.

In accordance with what is already mentioned this study follows the traces of the above mentioned authors, with the scope of providing some insight on the actual status of agro-ecosystems` level of sustainability in Albania.

2. Methods

Most of the data used in this study were found in the 2008 and 2009 Statistical Year Books prepared by Albania`s Ministry of Agriculture, Food, and Consumer Protection. Soil erosion was calculated based on average values of soil erosion in land areas with different slope gradients, presented in the erosion maps of Albania. These data made possible the identification and calculation of main energy flows that drive most of the plant production processes in the agro-ecosystem land area. These energy flows were organized in a visual form (see figure 1) in order to exclude the energy flows overlapping and minor energy flows which might not play a significant role in the development of the agro-ecosystems.

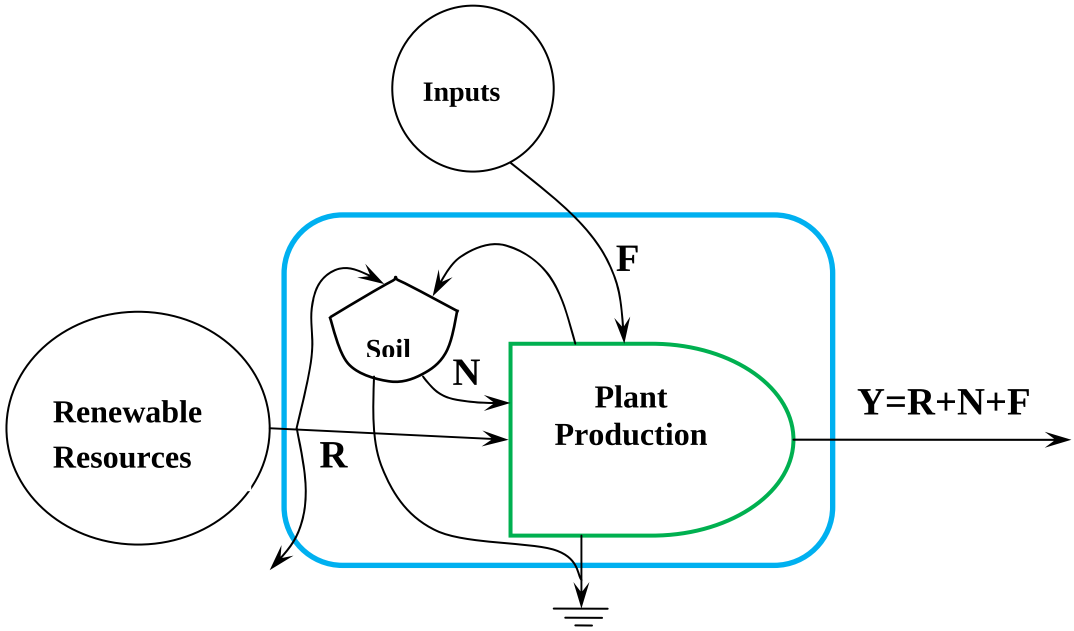

Figure 1: Main energy flows during the plant production in agro-ecosystems. R- represents renewable resources, N-non renewable resources, and F-feedback from the economy. Y-emergy yield.

All energy flows were converted in sej units by using for most of the cases the transformaties proposed by Brandt-Williams [1]. The emergy flows were organized in three groups: renewable (R), non-renewable (N) and feed-back (F) resources. Some emergy indices were calculated by using Brown & Ulgiati formula [2] which are recommended to be used in sustainability evaluation procedures. Along with these indices an additional way was used in the form of inequality for the main emergy components to shed more light in the evaluation of agro-ecosystems sustainability.

3. Results and Discussion

Main energy flows that were identified in figure 1 were converted in sej/year and are presented in table 1. Evapo-transpiration (ET) has the largest value (2.53E+20 sej/year in 2008 and 2009) among the renewable resources and it represents all the renewables (R) in order to avoid double counting. The largest component of nonrenewable resources is represented by soil erosion (9.96E+21sej/year in 2008 and 2009).

Feedback from the economy totals at 1.04E+22 sej/year for 2008 and 1.21E+22 sej/year for 2009. These two numbers represent the sum of the main emergy component that makes for the feedback: chemical fertilizers, pesticides, fuels, and electricity.

Calculation of sustainability indices is based on the values obtained for R, F, and N which are applied in the following formula:

Emergy Yield Ratio: $\mathbf{EYR} = \frac{\mathbf{R+N+F}}{\mathbf{F}}$ (1)

Environmental Loading Ratio: $\mathbf{ELR} = \frac{\mathbf{N+F}}{\mathbf{R}}$ (2)

Emergy Sustainability Index: $\mathbf{ESI} = \frac{\mathbf{EYR}}{\mathbf{ELR}}$ (3)

Sustainability Inequality: $\mathbf{R} \gg \mathbf{F} \gg \mathbf{N}$ (4)

The results obtained by the above mentioned formula are presented in table 2.

By analyzing the data presented in table 2 it becomes quite evident that Albania`s agro-ecosystems were by far not sustainable during 2008 and 2009. Given that the value of R is practically unchanged as it represents the natural resources at the disposal of plant production, high values of **F** and **N** contribute to the high level of agro-ecosystems unsustainability in a negative manner. Looking closer at these two variables reveals that **F** (feedback from the economy) is completely under humans` control as it is made of the inputs invested during plant production processes, whereas **N** (soil erosion) is partially dependent on human activities and partially on natural factors.

Table 1: Main emergy flows included in Albania`s agro-ecosystems for 2008 and 2009.

Inputs & Units		2008	2009
		sej/year	sej/year
RENEWABLES (*)			
1	Evapo-transpiration	**2.53E+20**	**2.53E+20**
NONRENEWABLES			
2	Soil erosion	**9.96E+21**	**9.96E+21**
FEEDBACK			
3	Fertilizers (gram)	4.47E+21	4.63E+21
4	Pesticides (gram)	5.81E+21	7.34E+21
5	Fuel	1.31E+20	1.30E+20
6	Electricity	3.38E+19	3.38E+19
Total FEEDBACK		**1.04E+22**	**1.21E+22**

(*) The largest component represents the renewable resources in order to avoid double counting of emergy flows.

Table 2: Emergy indices as a function of Renewables (R), Nonrenwables (N) and Feedback from the economy (F) used for agro-ecosystems` sustainability assessment.

	2008	2009		2008	2009
R	2.53E+20	2.53E+20	**EYR**	1.98	1.84
N	9.96E+21	9.96E+21	**ELR**	80.47	87.19
F	1.04E+22	1.21E+22	**ESI**	0.025	0.021
R/F	0.024	0.021			
N/F	0.958	0.823			
Sustainability Inequality					
2008			**2009**		
R << F > N			**R << F > N**		

Table 3: Simulation of emergy indices by using Renewables (R), Nonrenwables (N) and Feedback from the economy (F) as independent variables ..

	2008	2009		2008	2009
R	2.53E+20	2.53E+20	**EYR**	3.53	3.17
N	9.96E+18	9.96E+18	**ELR**	0.45	0.52
F	1.04E+20	1.21E+20	**ESI**	7.83	6.13
R/F	2.433	2.091			
N/F	0.096	0.082			
Sustainability Inequality					
2008			**2009**		
R > F >> N			**R > F >> N**		

A simulation for the main emergy indices is made by considering R, N, and F as independent variables (see table 3). By changing the values of independent variables we can obtain different values for EYR, ELR, ESI, and Sustainability inequality. **The values given to the independent variables aim at obtaining at the same time an R/F ratio of the magnitude 2 or higher, and a N/F ratio of the magnitude 1/10th or smaller** [5] as a necessary condition for a sustainable plant production.

Switching from the high values of **F** and **N** presented in table 2 to the values of indices presented in table 3 with the goal of obtaining better sustainability in Albania`s agro-ecosystems, might require radical changes in the agricultural strategies of Albania in the long run. These changes would make necessary a significant reduction of fossil fuels, pesticides, and other chemicals by replacing them with renewable resources.

Given that the soil erosion (N) is partially a natural process implies that **farmers may control it partially but significantly**, through the improvement of land management practices both in slope and flat areas, as well as by planting wherever possible suitable plant species that minimize the erosion rate.

4. Conclusions

- **Albania`s agro-ecosystems were UNSUSTAINABLE by far during 2008 and 2009**. Given that the value of **R** is practically unchanged as it represents the natural resources at the disposal of plant production, **high values of F and N contribute to the vey low level of sustainability** in the agro-ecosystems.
- Switching from high values of **F** and **N** to values that guarantee high levels of sustainability in Albania`s agro-ecosystems might require radical changes of the agricultural strategies in the long run. These changes might require a significant reduction of fossil fuels, pesticides, and other chemicals by replacing them with renewable resources.
- Replacement of non-renewable resources with renewable ones might require a profound reorientation of the research towards replacing the feedback of economy to plant production with environmentally friendly feedback of natural processes which is driven by renewable energy sources. This will become the biggest challenge of the agricultural research in Albania and the other countries in the decades to come.

5. References

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