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A Comparative Cost – Effectiveness Analysis in Different Tested Aquaponic Systems

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Abstract

One of the main global priorities nowadays is finding sustainable methods of increasing food production. However, profit maximization remains the primary purpose of every economic activity. The integration of aquaculture recirculating systems with different aquaponics techniques comes as a respond to both requirements that were mentioned above. The aim of present research is to make a comparative cost effectiveness analysis in two integrated aquaponics systems, where both deep water culture (DWC) and light expanded clay aggregate (LECA) substrate aquaponic techniques were applied. Four combinations of fish and plants species were used as follows: rainbow trout (*Oncorhynchus mykiss*) – spinach (*Spinacia oleracea*), stellate sturgeon (*Acipenser stellatus*) – spinach (*Spinacia oleracea*), stellate sturgeon (*Acipenser stellatus*) – mint (*Mentha piperita*) and stellate sturgeon (*Acipenser stellatus*) – tarragon (*Artemisa dracunculus L.*). Three production scales were used for the first two mentioned fish to plants combinations, as follows: 59crops/m^2; 48crops/m^2 and 39crops/m^2. For each experiment, the cost analysis includes capital costs and operational costs. As main conclusions, we can point out that LECA substrate aquaponics technique requires a higher investment cost, comparing with DWC technique, but also had generated higher incomes, which led in the end to better economic indicators. The combination of fish to plants stellate sturgeon (*Acipenser stellatus*) – spinach (*Spinacia oleracea*), produced by applying LECA substrate aquaponics technique, had proved to be the most economic feasible, from all tested variants. It is recommended that alternative variants for power to be implemented, in order to minimize the electricity operational costs and therefore, to improve the profitability of tested facilities.

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1. Introduction

One of the most significant worldwide problems is related to assuring that total world food production can cover the needs of each individual, at a certain time and context. Thus, in these circumstances, the agricultural sector gains a considerable attention, given its social and economic implication. In many cases, the growth of agricultural productivity is related with a negative impact on the environment. Therefore, a sustainable development of this production sector is necessary to be made. As Kurtoglu et. al (2010) mentioned, sustainable development is the management and conservation of the natural resource base and the orientation of technological and institutional changes in such a manner as to ensure the attainment and continued satisfaction of human needs for present and future generations. Also, in the same scientific paper (Kurtoglu et. al, 2010) it is mentioned that sustainable development conserves land, water, plant and animal genetic resources, and is environmentally no degrading, technically appropriate, economically viable and socially acceptable (GESAMP Report, 2001). Three types of sustainability are identified: social, economic and environmental sustainability (Phillips et al, 2001).

Integrating aquaculture recirculating production systems with hydroponics resulted as aquaponics integrated systems, having a double purpose, as follows: obtaining dual production of both fish and plants and assuring a water treatment process by using the phytoremediation capacity of each one of the cultured plant species. Several studies were made during the last decade, in order to evaluate especially the production performances, phytoremediation capacity and economical sustainability of those systems (Petrea et. al, 2013, 2014; Petrea et. al, 2013-A, 2014 –A; Engle et. al 2010; Palm et. al 2014, 2015). Tyson et. al (2011) conclude that aquaponics can be a sustainable agricultural production system.

Love et. al. (2014) mentioned that aquaponic operations vary in size and type of production system and there is a high adoption rate among respondents towards environmentally sustainable methods of production. This fact is reiterated also by Tyson et. al (2011), who underlined the positive impact of aquaponics systems on the market due to public concerns over energy and water use in agriculture.

Water, energy and fish feed are the three largest physical inputs for aquaponic systems (Love et. al. 2014), while the outputs are represented by both fish and plants production.

Several studies (Sotorrio, 2002; Tokunaga et. al, 2014; Palm et. al, 2014; Palm et. al, 2015) had demonstrated that the integration of an aquaponic system into an already existing recirculating aquaculture system represents a good method to increase profitability of the economic activity. Thus, when aquaponics starts to be an economic activity, it implies keeping close eye on costs and production efficiencies throughout the production process. The level of risk in case of aquaponics an integrated system requires the manager ability to make adjustments when negative outcomes occurs, fact that will lead to a successful business (Engle, 2010).

Economic sustainability of aquaponics, the combination of aquaculture and hydroponics, depends on a variety of factors, including system and feed design, animal welfare or parasite and pathogen control (Palm et. al, 2015).

Starting from two already productive recirculating aquaculture systems, the aim of present research is to make a comparative cost effectiveness analysis between two integrated aquaponics systems, where both deep water culture (DWC) and light expanded clay aggregate (LECA) substrate aquaponic techniques were applied, in order to identify their economic sustainability.

2. Materials and Methods

Integrated aquaponics systems description

The present experiment took place at the pilot recirculating system stations of Aquaculture, Environmental Science and Engineering Department from Food Science Faculty, “Dunarea de Jos” University of Galati. Two already existed recirculating aquaculture systems were integrated with hydroponic units and other components that