

## SUSTAINABLE INTENSIFICATION IN FRESHWATER FISH FARMING IN HUNGARY

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### ODRŽIVA INTENZIFIKACIJA GAJENJA SLATKOVODNIH RIBA U MAĐARSKOJ

#### *Apstrakt*

Termin "održiva intenzifikacija" je relativno nov i koncept koji se razvija iz akvakulture koja je definisana kao oblik proizvodnje u kome se "prinos povećava bez nepovoljnog uticaja na životnu sredinu i bez dodatnog kultivisanja zemljišta". Kako postoje ograničenja u konvencionalnoj intenzifikaciji slatkovodnog ribarstva, povećanje proizvodnje zahteva inovativne pristupe korišćenje novih sistema i tehnologija kao što su Kombinovana intenzivno ekstenzivna (CIE) proizvodnja ili različitih recirkulacionih sistema (RAS) uključujući i RAS na otvorenom na ribnjacima i protočni sistemi.

"Jászkişéri Halas" Kft. u Mađarskoj izgrađen je i radi kao novi tip CIE sistema koji se naziva sistemom "ribnjak u ribnjaku", iako je mali intenzivni system nije jezero već plutajući tank. Intenzivna komponenta "ribnjaka u ribnjaku" se sastoji od 4 uzgojna tanka (30 m<sup>3</sup> svaki) koji su uklopljeni u plutajuću jedinicu ukupne zapremine 120 m<sup>3</sup>. Intenzivna jedinica je bila smeštena u jednom uglu od 20 ha ekstenzivnog ribnjaka u kome se praktikuje konvencionalna polikultura, a ribnjak koristi nutrijente iz intenzivne jedinice. Voda cirkuliše između intenzivne i ekstenzivne komponente sistema putem pumpi. U intenzivnoj jedinici proizvodi se hibridni prugasti grgeč u maksimalnoj gustini nasada od 40 kg/m<sup>3</sup>. Prinos u ekstenzivnom ribnjaku gde je takođe dodavana hrana dostigao je 1050 kg/ha. Još jedan tip CIE sistema nazvan "kavez u ribnjaku" koristi se u "Aranypony Zrt." Za intenzivnu proizvodnju Evropskog soma u intenzivnoj jedinici i ekstenzivnu proizvodnju šarana, belog tolstolobika, belog amura i veslonosa u konvencionalnom ribnjaku. Jedan kavez od 50 m<sup>3</sup> postavljen je u ribnjak od 1 ha površine u kome se proizvodi 500 kg evropskog soma (1350 g). Organski otpad iz jednog kaveza donosi dovoljno nutrijenata za 1 ha površine ribnjaka gde su šaran i veslonos osnovne vrste. Nema dodavanja đubriva i dodatne hrane i ekstenzivnom delu gde je prinos bio 700 kg/ha.

"Spoljašnji RAS na ribnjaku" nastao je u "Jászkişéri Halas" Kft. konvertovanjem jednog zimovnika (2000 m<sup>2</sup>) iza velikog (20 ha) ekstenzivnog ribnjaka u intenzivni bazen za proizvodnju šarana. Voda između malog intenzivnog i velikog ekstenzivnog jezera,

koje je takođe služilo kao jedinica za prečišćavanje, cirkulisala je pomoću male pumpe sa propelerom. U malom jezeru se intenzivno proizvodi šaran (7000 fish/ha) uz dodavanje peleta. Finalna prosečna telesna masa bila je 1.5 kg i bruto prinos je bio 10,000 kg/ha. U ekstenzivnom jezeru prinos je bio oko 1 t/ha uz korišćenje dodatne hrane.

"Spoljašnji RAS na pastrmskoj farmi" sagrađen je i funkcioniše u "Hoitsy and Rieger Kft." gde se proizvodi kalifornijska pastrmka, potočna i jezerska pastrmka u 18 betonskih bazena ukupne površine 3700 m<sup>2</sup>. Da bi se pastrmke proizvodile intenzivno u zaštićenoj životnoj sredini koja je i turističko područje, farma je izgradila poseban sistem za tretman vode koji uključuje RAS na otvorenom (bubanj filteri i plutajući biofilter) i veštački izgrađena močvara (sa 7 različitih vodenih biljaka). Kao rezultat upotrebe novog sistema za tretman vode farma može da održava nivo proizvodnje bez ikakvog negativnog uticaja na vodu obližnjeg potoka i okolne ekosisteme.

*Ključne reči: slatkovodna akvakultura, kombinovanje intenzivno-ekstenzivnog sistema, održivost, intenzifikacija*

*Keywords: freshwater aquaculture; combined intensive-extensive system; sustainability; intensification*

## INTRODUCTION

The term "sustainable intensification" is a relatively new and evolving concept emerged in agriculture that has been defined as a form of production wherein "yields are increased without adverse environmental impact and without the cultivation of more land". Although marine aquaculture has future potential to explore off shore areas for increasing production, freshwater aquaculture will remain an important food production sector in some regions like Central and Eastern Europe. There are limitations in conventional intensification of freshwater fish farming by increasing stocking density and applying formulated feed due to various reasons such as environmental and animal welfare regulations, social concerns and the increasing competition for freshwater resources. Therefore the increase of freshwater aquaculture production requires innovative approaches and the use of new systems and technologies such as Combined Intensive Extensive (CIE) production systems or various recirculating aquaculture systems (RAS) including open air RAS for fish ponds and flow through systems. The potential in practical application of CIE systems however, is demonstrated by some innovative farmers in Hungary that may give a boost to the wider application of such systems in Central and Eastern Europe. Although the introduction of such systems to the practice is rather slow, the positive examples of the practical use of these systems may give a boost to sustainable intensification in freshwater aquaculture.

## RESULTS AND EXPERIENCES WITH THE PRACTICAL APPLICATION OF "POND-IN-POND" AND "CAGE-IN-POND" CIE SYSTEMS

The "Jászakiséri Halas" Kft. was the first fish farm of Hungary that built and operated a new type of CIE system called "pond-in-pond" system although the small intensive unit is not a pond but a floating tank. The intensive component of the "pond-in-pond" system consists of four fish rearing tanks (30 m<sup>3</sup> each) that are arranged in a floating unit with a

total volume of 120 m<sup>3</sup>. The intensive unit was placed in one corner of a 20 ha extensive fish pond where conventional polyculture production was carried out (Figure 1.).



**Figure 1.** The intensive unit of the “Pond-in-pond” system in operation in a 20 ha extensive fish pond of the “Jazskiseri “Halas” Kft”

There was a continuous water flow through the tanks of the intensive unit that was ensured by low head high capacity air lift pumps. The air was provided by an air blower that was driven by an electric motor of 2 kW. The formulated feed was distributed to the fish rearing tank by automatic feeder. Hybrid striped bass (*Morone saxatilis* x *M. Chrysops*) was raised in the tanks intensively during the natural growing season fed with floating pellet, while the extensive pond also served as a natural treatment unit to remove the nutrients from the effluent of the floating rearing tanks. The total yield in the intensive system was 4800 kg (40 kg/m<sup>3</sup>) and the total income was 28,800 € when the fish was sold on a price of 6 €/kg. In the large (20 ha) extensive pond large size two summer old carp of 300 g was stocked with a stocking density of 1000 fish/ha. The production was based on the use of natural food and supplementary feeding by cereals. At the end of the growing season the gross yield was 1050 kg/ha (700 fish/ha with an average weight of 1.5 kg). The survival rate was only 70 % due to the massive bird predation. The net result of the extensive fish rearing was 656 €/ha.

This special type of Combined Intensive Extensive (CIE) system called “Cage in pond” system was applied at “Aranypony Zrt.” for the intensive production of European catfish (*Silurus glanis*) in the intensive unit and the extensive production of common carp (*Cyprinus carpio*), silver carp (*Hypophthalmichthys molitrix*), grass carp (*Ctenopharyngodon idella*) and paddle fish (*Polyodon spatula*) in the conventional earthen pond. One summer old European catfish was stocked into the floating cages (5x5x2m) that were placed in a fish

pond (Figure 2). Floating pellet was distributed to the cages by automatic feeder driven by solar panels. The fish meal was substituted completely by soybean meal and meat meal. The F.C.R. was 1.95 kg. When the dissolved oxygen level in the pond decreased to low level paddle wheel aerator supplied air to the water body.



**Figure 2.** Floating cages in a fish pond at the “Aranyponty Zrt.” for the intensive rearing of European catfish

The catfish reached 1350 g individual weight by the end of the growing season. No any disease problem occurred during the intensive rearing of the catfish. One cage of 50 m<sup>3</sup> was put in a one hectare pond area, in which 500 kg European catfish was produced. The organic wastes from one cage provided sufficient nutrients for one hectare pond area where common carp and paddle fish were the main species. No fertilizer and supplementary feed were applied in the extensive pond, where the yield was 700 kg/ha (500 kg/ha common carp and 200 kg/ha paddle fish). The grass carp and silver carp as complementary species contributed to the improvement of the nutrient utilization in the system.

## RESULTS AND EXPERIENCES WITH THE PRACTICAL APPLICATION OF “POND WATER RECYCLING” OR OUTDOOR RECYCLING AQUACULTURE SYSTEM (RAS)

Outdoor RAS in a pond fish farm was created in the “Jászakiséri Halas” Kft. through converting one of the wintering ponds (2000 m<sup>2</sup>) beside a large (20 ha) extensive pond into an intensive pond for carp production. The water between the small intensive pond and the large extensive pond that was also served as water treatment unit was circulated by a small head high capacity propeller pump. The view of the intensive pond equipped with automatic feeder and surface aerator is shown in Figure 3.



**Figure 3.** View of the intensive carp rearing pond as a component of a fish pond RAS in the “Jazskiseri Halas” Kft.

In the small (2000 m<sup>2</sup>) intensive pond two summer old carp of 300 g was stocked with a stocking density of 7000 fish/ha. The fish was fed on pelleted feed with an F.R.C. of 1:1.6. The gross yield was 10,000 kg/ha (6600 fish/ha with an average weight of 1.5 kg). The survival rate was 94% due to effective protection against bird predation. The net result of the intensive production was 4,293 €/ha. Main data of the extensive pond production are shown in Chapter 3.1.

Outdoor RAS in a trout farm was built and operated by “Hoitsy and Rieger Kft.” that is a leading trout farm in Hungary producing Rainbow trout (*Onchorhynchus mykiss Walbaum, 1792.*), brown trout (*Salmo trutta m. fario Linné, 1758.*), and brook trout (*Salvelinus fontinalis Mitchell 1815.*) in 18 raceways with a total area of 3700 m<sup>2</sup>. The annual production of the farm is 36-38 tons of market size fish according to the availability of the supply water. In order to produce trout intensively in a protected environment that is also a touristic area the farm built a special water treatment system that includes open air RAS and a constructed wetland. The open air RAS also contribute to decrease the dependence on the natural water supply since the flow rate of the creek is varying greatly. The water treatment system comprises the following main units: (1) drum filter; (2) biological filter; (3) constructed wetland. The water is circulated by air lift pumps. In order to ensure safe operation there are two independent (but connectable) water circles in the RAS. The effluent water from the raceways flows to the drum filters (with a mesh size of 70 µ) by gravity. The sludge from the drum filter is collected in a pit where it is mixed with sawdust and removed once a year. The biological filter is a “floating bed” biofilter with a 800m<sup>2</sup>/m<sup>3</sup> effective filter area (Figure 4.). The plastic media in the biological filter is kept floating by air that is blown into the water

through perforated pipes placed in the bottom of the filter tank. The air also provide oxygen to the nitrifying bacteria and helps the removal of harmful gases first of all CO<sub>2</sub>.



**Figure 4.** The view of the biological filter at the “Hoitsy and Rieger” intensive trout farm

The water is circulated through the fish tanks, the drum filter and the biological filter by air lift pumps with low head (max 25cm) and high capacity. The water recycling in the system is partial, therefore a part of the water is released regularly to the creek Garadna that is flowing along the farm area. However the effluent water from the farm is treated on a constructed wetland where 7 different water plants remove efficiently the N and P from the water, thus the intensive trout farm doesn't have any negative impact on the water of the creek and the surrounding ecosystem.

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