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Is intensification a viable way for pond culture in Central and Eastern Europe?

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Abstract. Today's Central and Eastern European aquaculture is based on low production intensity pond culture dominated by traditional extensive and semi-intensive carp-based polyculture technologies, use of complete feeds in pond culture is not prevalent. Meanwhile pond culture in other parts of the World has gone through an intensification process, nowadays high-intensity monoculture technologies dominate in pond farming. Use of complete feeds and application of higher stocking rates have doubled-tripled yields compared to traditional extensive, semi-intensive farming methods. Economic analysis of Asian farms shows that intensification leads to increased profits per unit area and decreased profitability. The calculation of financial results of fish farming technologies of different intensity level show the same effect of intensification on viability in Hungary as in Asia: high feeding and stocking rate result in outstanding profit per unit area and decreased profit margin at the same time. Rising land prices (and rents), fees for usage of water, decrease in area-based subsidies can push the Central and Eastern European pond aquaculture toward intensification as high intensity fish rearing in ponds may offer good alternative for those farmers who have limited access to land (pond area) and water. However one must take the increased risks of high intensity and must have good managing abilities and farming expertise with special regard to water quality and biomass management.
Key Words: Economics of intensification, complete feeds in pond culture, intensive pond culture.

Introduction. Today's Central and Eastern European aquaculture is based on low production intensity pond culture. Traditional extensive and semi-intensive carp-based polyculture technologies are still dominating with yields under 1 tonnes/hectare. Use of complete feeds in pond culture is not prevalent yet while monoculture of higher value carnivorous or omnivorous species is also not very common. Neglecting the importance of investment in marketing and calculating with a fixed demand for locally cultured species, semi-intensive polyculture seems to be the most economically viable pond fish farming technology as feeding costs can be minimized with the use of fertilizers and supplementary cereal (0.1-0.2 EUR/kg) feeding: cyprinids (and some additional predators) can be raised with FCRs of 2.5-4.0, which results in feeding costs of 0.25-0.8 EUR/kg fish. The use of industrially manufactured complete feeds (0.7-0.8 EUR/kg) for feeding carps would probably raise the average cost of production, as FCRs in ponds are around 1.3-1.8 leading to feeding costs between 0.9-1.5 EUR/kg produced fish.

However the argument above on the one side doesn't explain the absence of monoculture for higher value predatory species while on the other side even in case of carps it contains a strict prerequisite: assuming a stagnating-decreasing demand. In the last decades pond fish farmers outside Europe (e.g. in Asia and America) chose intensification in production instead of defensive marketing behaviour of focusing on cost cutting with minimized feeding costs.

A worldwide outlook of trends in freshwater aquaculture. Recent massive increase in World aquaculture output originates in the booming of pond culture production in Asia (Fig. 1). Although mariculture (especially cage culture of salmonid and Mediterranean species) is the driving source of growth in Europe and America, the contribution of marine aquaculture to the growth of World aquaculture production is not significant. In fact intensification elements that are more and more widely used in Asian pond culture

have been the real source of booming in World aquaculture. Use of complete feeds and inorganic fertilizers, accompanied by higher stocking rates, selective breeding technologies have doubled-tripled pond yields compared to traditional extensive, semi-intensive farming methods relying on home-made feeds or supplementary feeding with local agricultural products and on-farm by-products (Edwards 2011).

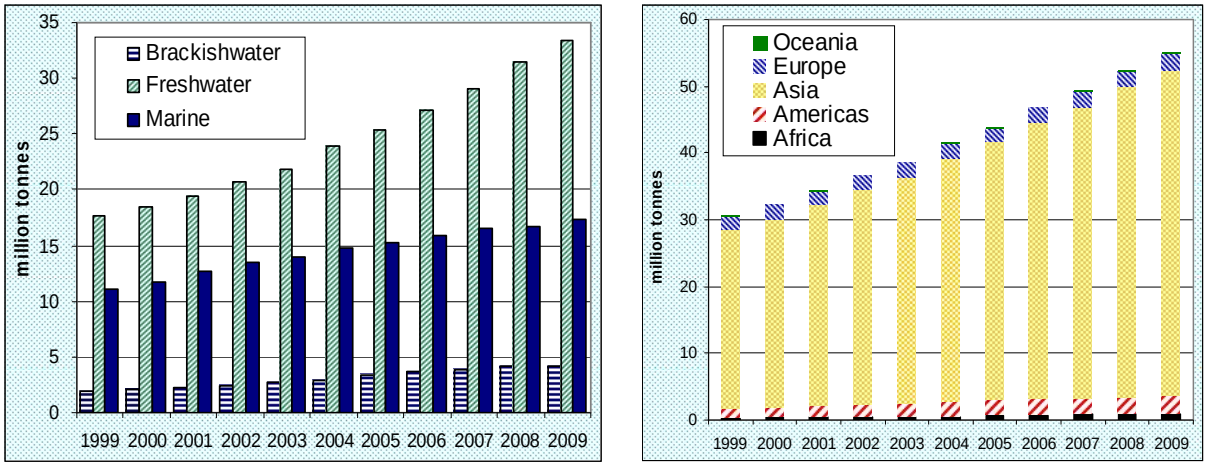

Figure 1. World aquaculture production by environment and by continents (quantity, excl. aquatic plants) (Source: FAO Fishstat Plus 2011).

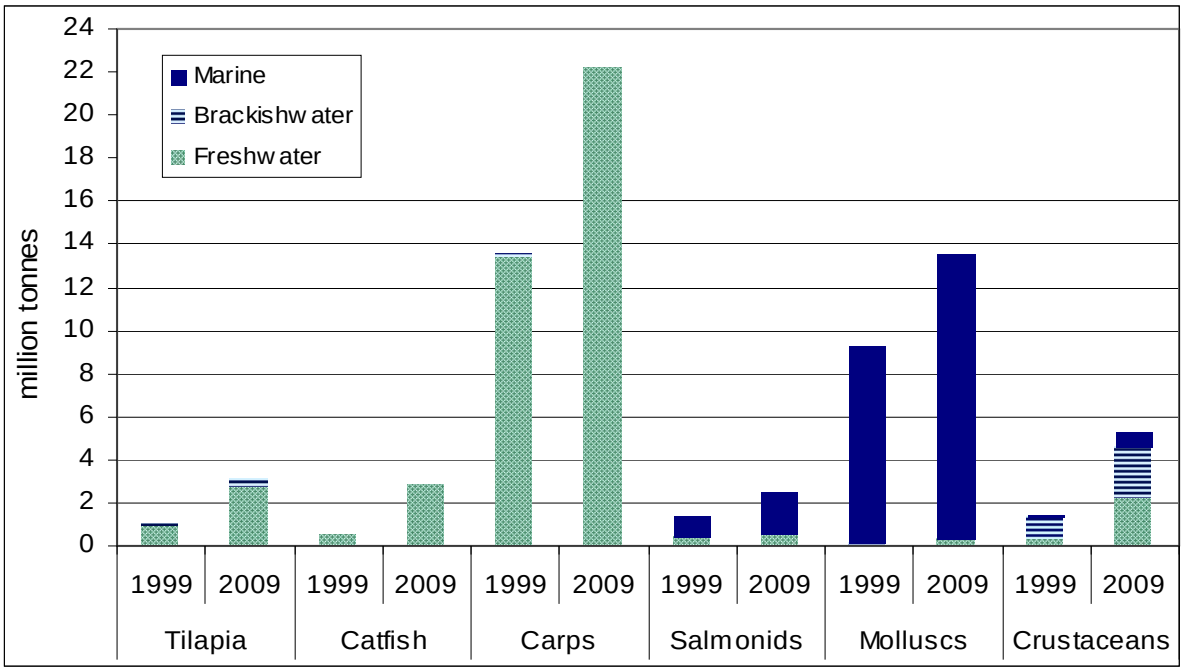

Figure 2. World aquaculture production by species (Source: FAO Fishstat Plus 2011).

Together with the ongoing intensification trend a clear direction toward specialization can be seen: monoculture farming technologies are getting dominant over traditional polyculture farming technologies and integrated (livestock–fish and rice-fish) cultures as use of manufactured complete feeds can be more easily adapted to single species systems. In addition to that feeds provide complete diets for farmed fish and there is no need for additional source of protein. Of course feeding with complete pellets led to a change in the importance of cultured aquatic species: production of carnivorous and omnivorous species increased at a higher rate than production of herbivorous species. Based on the development of intensive pond monoculture the following species have shown the most considerable growth in production in the last ten years: crustaceans

(Whiteleg shrimp, Chinese mitten crab, Red swamp crawfish, Giant river prawn etc.), catfishes (Pangasius, Channel catfish, Amur catfish, North African catfish, Striped catfish, hybrid catfishes etc.), tilapias (Nile tilapia) and some carps (Crucian carp, Black carp).

Figure 2 shows an eight-fold increase in output of freshwater crustacean culture (compared to 140 percent growth in brackishwater culture of crustaceans), five-fold increase for catfish species (order of Siluriformes) and three-fold increase in case of freshwater tilapia (Cichlidae family) farming between 1999 and 2009. At the same time quantity of farmed molluscs rose by only 46 percent, while production of salmonids and carps (herbivorous cyprinid species dominate: cultured quantity of cyprinids amounted to 22.2 million tonnes (MT), consisting of 4.2 MT Grass carp, 4.1 MT Silver carp, 3.2 MT Common carp, 2.5 MT Bighead carp, 2.4 MT Catla, 2.1 MT Crucian carp and 1.2 MT Rohu) increased by 76 and 64 percent respectively.

Economic rationale behind intensification of pond farming. As the use of manufactured complete feeds in the production of omnivorous species usually increases the production costs compared to traditional technologies that are based on natural food basis of ponds and local cheap by-products, one can wonder on the economic rationale behind the "Blue Revolution". The key to the problem of the high feeding costs is the 2-4-fold increase in yields, as complete feed diets (together with adequate stocking, fertilization and improved water management techniques) makes possible to carry a considerably increased biomass.

In farming methods where the share of fixed costs (land, rent, water, permanent labour, interests on durable capital etc.) in total cost are high, intensification can help to decrease the average production cost (cost per kg fish produced) through sharing fixed costs by increased quantity of fish produced. Obviously, with the decreasing availability of land and water resources (due to pollution, urbanization and overcrowding) the aspect of minimizing fixed cost per kg fish produced will be more and more important.

However the main economic advantage of intensification is the increased revenues and profits per unit area of land or pond. In some farming methods feeding with pellets raises the average production costs and decreases the profit margin, in turn it increases the absolute amount of profit per hectare, as 10-50 percent decrease in profit margin/kg fish combined with 50-150 percent growth in yield (kg/hectare) leads to overall increase in profit per hectare. Based on a FAO survey in Asian countries (Hasan 2007), Table 1 demonstrates two examples that intensification in pond culture may result in increased profits and decreased profit margins.

Possible implications to Central and Eastern European pond culture. Recent trends in World aquaculture show that new investments are focusing on absolute amount of profits due to resource-scarcity (land, water) and associated legal and/or economical constraints. While in communities lacking capital higher profit margins can attract investments traditional extensive, semi-intensive fish farming technologies, in a resource-constrained World profit per unit area of land can be the key factor determining the allocation of capital.

Rising land prices (and rents), fees for usage of water in Central and Eastern Europe can push the regional aquaculture toward intensification. Increase in costs which are not really flexible to production (like labour, management and other general expenses) and decrease in area-based subsidies (which function as a fixed cost-cutting item) can have a similar effect.

Based on our experience of operating experimental fishponds, financial results of fish farming technologies of different intensity level show the same effect of intensification on viability as in Asia: high feeding and stocking rate result in outstanding profit per unit area and decreased profit margin at the same time (Table 2). High yields and revenues may compensate farmers for increased risks of farming connected to the need of significant amount of credit and to the sensibility of increased biomass. Application of high feeding and stocking rate always requires high-level knowledge on water quality management.

Table 1

Economic results of pond culture sectors by intensity level in two Asian countries (computed from Hasan 2007)

	Bangladesh		*China*	
	Pangasid catfish farming in ponds		Carp farming in ponds (Polyculture of silver carp, bighead carp, grass carp, crucian carp, black carp and Wuchang bream)	
	Traditional	*Intensive*	*Extensive*	*Intensive*
	supplementary feeding with locally available feed ingredients: rice bran, wheat bran and oil cake	feeding with commercially manufactured pelleted feeds (30% protein)	supplementary feeding with locally available feed ingredients: aquatic plants, green grasses, rice bran, wheat, oil cake, waste water	feeding with commercially manufactured pelleted feeds (31% protein)
Yield (kg/ha/year)	3,380	13,945		
Market price (US$/kg)	0.615	0.615		
Gross Revenue	2,080	8,582	5,261	14,800
Variable Costs	892	4,933	3,812	10,840
Labour (hired)	*124*	*360*	*1,417*	*2,064*
Fertilizers (organic, inorganic)	*6*	*112*	*2*	*18*
Seed	*93*	*276*	*1802*	*4,243*
Feeding	*574*	*3,957*	*412*	*3,551*
Other (eletricity, drugs etc.)			*179*	*963*
Fixed Costs (US$/ha/year): *Depreciation, interest, rent, permanent labour*	89	285	27	126
Total Costs (US$/ha/year)	981	5,217	3,839	10,967
Profit (=Net Returns)	**1,099**	**3,364**	**1,422**	**3,833**
Profit margin	**112%**	**64%**	**37%**	**35%**
Average production cost	**0.29**	**0.37**		
feeding unit cost	*0.17*	*0.28*		

High-intensity fish rearing in ponds may offer good alternative for those farmers and investors of Central and Eastern Europe who have limited access to land (pond area) and water or want to pursue farming activity in a small enclosed area due to security reasons like easier control of bird-predation and theft. Table 2 demonstrates that it is possible to make subsistence for small holders from farming fish on 5-20 hectares of ponds depending on the intensity level. However one must take the increased risks of high intensity and must have good managing abilities and farming expertise with special regard to water quality and biomass management.

Table 2

Effects of intensification on economic results of fish farming in ponds in Hungary
(Calculated financial results for operation of different fish rearing technologies)

	Extensive pond culture	*Semi-intensive pond culture*	*Intensive pond culture*	*Cage in pond system*	
Brief description of technology:	Carps are raised only on natural food production of the pond	Carps are raised on natural food production of the pond and on supplementary cereal feeding	Carps are raised on commercially manufactured complete feeds. Good water quality is provided by paddlewheel aerators	Combined intensive-extensive culture: (cages are placed as intensive units in traditional pond): predators are raised on pellets in cages, whereas in the surrounding pond carps are grown on nutrients of the effluent water of the cages. Natural growth is boosted by artificial periphyton surfaces. Water exchange of cages is induced by paddlewheels aerators.	
Cultured species	Carps	Carps	Carps	African	Carps
Stocking (kg/ha/year)	200	300	750	6,400	6,000
Feeding rate (kg/ha/year):	No feeding	3,060	7,875	20,400	No feeding
FCR (natural growth increment isn't separated)	Not applicable	3.4	1.5	1.5	Not applicable
Gross yield (kg/ha/year)	500	1,200	6,000	20,000	12,000
Energy required for aeration (kWh/ha/year)	-	-	2,500	12,500	
Market price (EUR/kg)	1.8	1.8	1.8	1.8	1.8
Gross Revenue (EUR/ha/year)	900	2,160	10,800	55,600	
Feed costs (EUR/ha/year)	0	550	5,500	15,300	
Seed costs (EUR/ha/year)	400	600	1,500	24,800	
Water fees (EUR/ha/year)	100	100	150	150	
Labour costs (EUR/ha/year)	250	350	1,000	3,650	
Energy costs (for aeration) (EUR/ha/year)	0	0	400	2,000	
Interests (on short-term credit) (EUR/ha/year)	50	120	600	3,500	
Other costs (consumables, etc.) (EUR/ha/year)	150	250	1,200	6,500	
Total Costs (EUR/ha/year)	950	1,970	10,350	55,900	
Profit (=Net Returns) (EUR/ha/year)	**40**	**190**	**450**	**1,700**	
Profit margin (Net Returns/cost)	**4.2%**	**9.6%**	**4.3%**	**3.0%**	
Average production cost (EUR/kg fish)	1.73	1.64	1.72	1.75	
Feeding unit cost (EUR/kg fish)	0	0.46	0.92	0.77	

Source: Based on own calculation and results of the Sustainaqua project (Gál et al 2009).

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