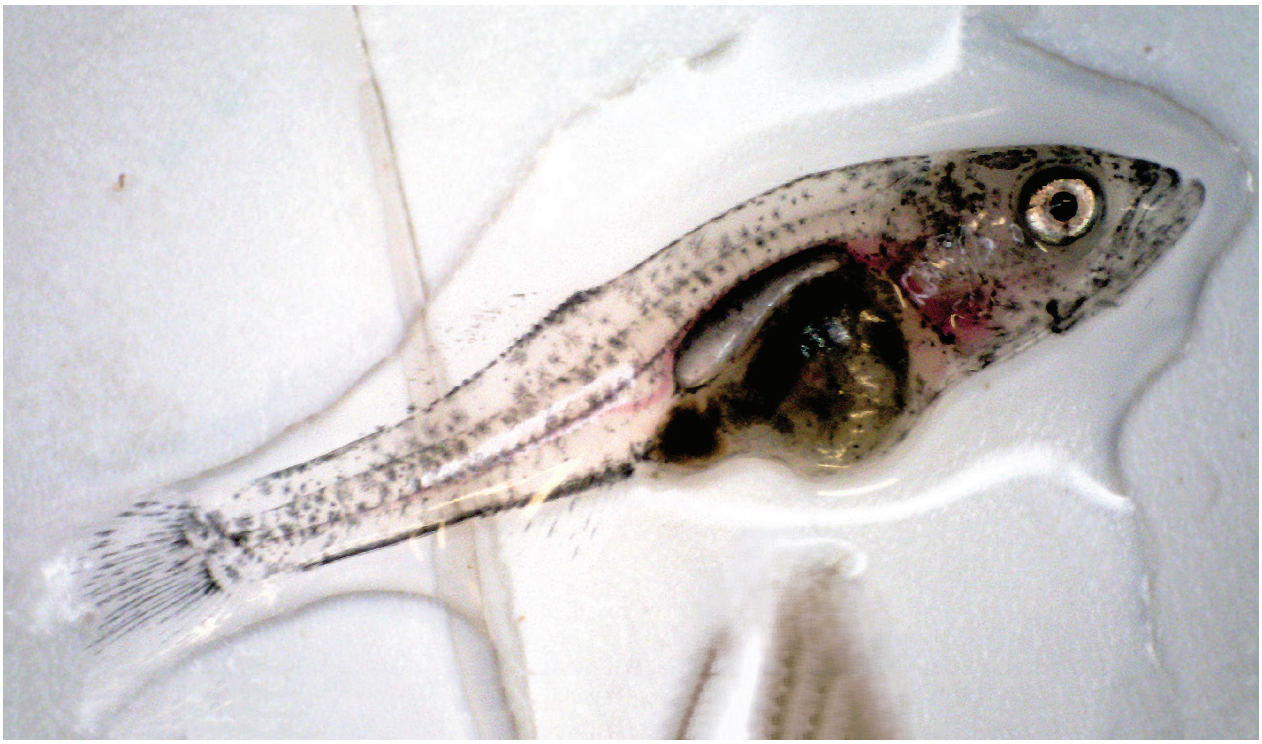
Innovations in pikeperch larviculture: Early weaning protocols in recirculating aquaculture systems (RAS)

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Over the past decade, the production of pikeperch (*Sander lucioperca*) in recirculating aquaculture systems (RAS) has significantly increased in Europe. This species thrives in RAS, which enables year-round, high-density production of high-quality fish that are well-received in the market.

Challenges in pikeperch larviculture

Despite advancements, the larviculture phase remains a major hurdle in commercial pikeperch production. This phase is influenced by various biotic and abiotic factors that affect growth and survival rates. Key challenges include the transition from yolk sac absorption to exogenous feeding and the switch from live feed to dry feed. These transitions are crucial for producing high-quality juveniles. Inappropriate weaning strategies can compromise growth, increase size variability, promote cannibalism, and cause deformities.

Early weaning in intensive pikeperch hatcheries aims to reduce reliance on Artemia, which requires significant labor and can vary in quality, affecting survival rates and larval performance. However, reliable protocols for pikeperch larval production are scarce, leading hatcheries to use diverse weaning strategies. Weaning

periods typically start between 19 and 26 days post-hatch (dph) and last from 3 to 9 days. The choice of dry feeds is often based on availability, cost, and quality rather than the specific nutritional needs of the larvae.

Importance of feed quality during weaning

The quality of dry feed during weaning is critical for the successful transition of pikeperch larvae from live feed to formulated diets. Optimal dry feeds must contain high-quality essential nutrients (proteins, lipids, vitamins, and minerals) to support larval development, metabolism, and immune function. These diets need to be highly digestible to ensure efficient nutrient absorption, leading to better growth rates and improved feed conversion ratios. High attractability and palatability are also essential for successful feed intake during weaning.

Previous studies have shown contradictory results regarding the rearing of pikeperch larvae on live food and formulated feed. These studies often used suboptimal rearing conditions, such as water temperature, larval density, and photoperiod, which may not reflect the best practices for pikeperch culture.

Developing new weaning protocols at Inagro

The aquaculture department of INAGRO, Belgium, has over 15 years of experience in pikeperch production in RAS. INAGRO has successfully closed the production cycle, growing fish to commercial size (+1kg), maintaining domesticated broodstock, and developing reliable protocols for high-quality larvae production. However, the use of live feed (Artemia nauplii) from day 4 to day 23 post-hatch makes larviculture one of the most intensive phases. Developing a successful early

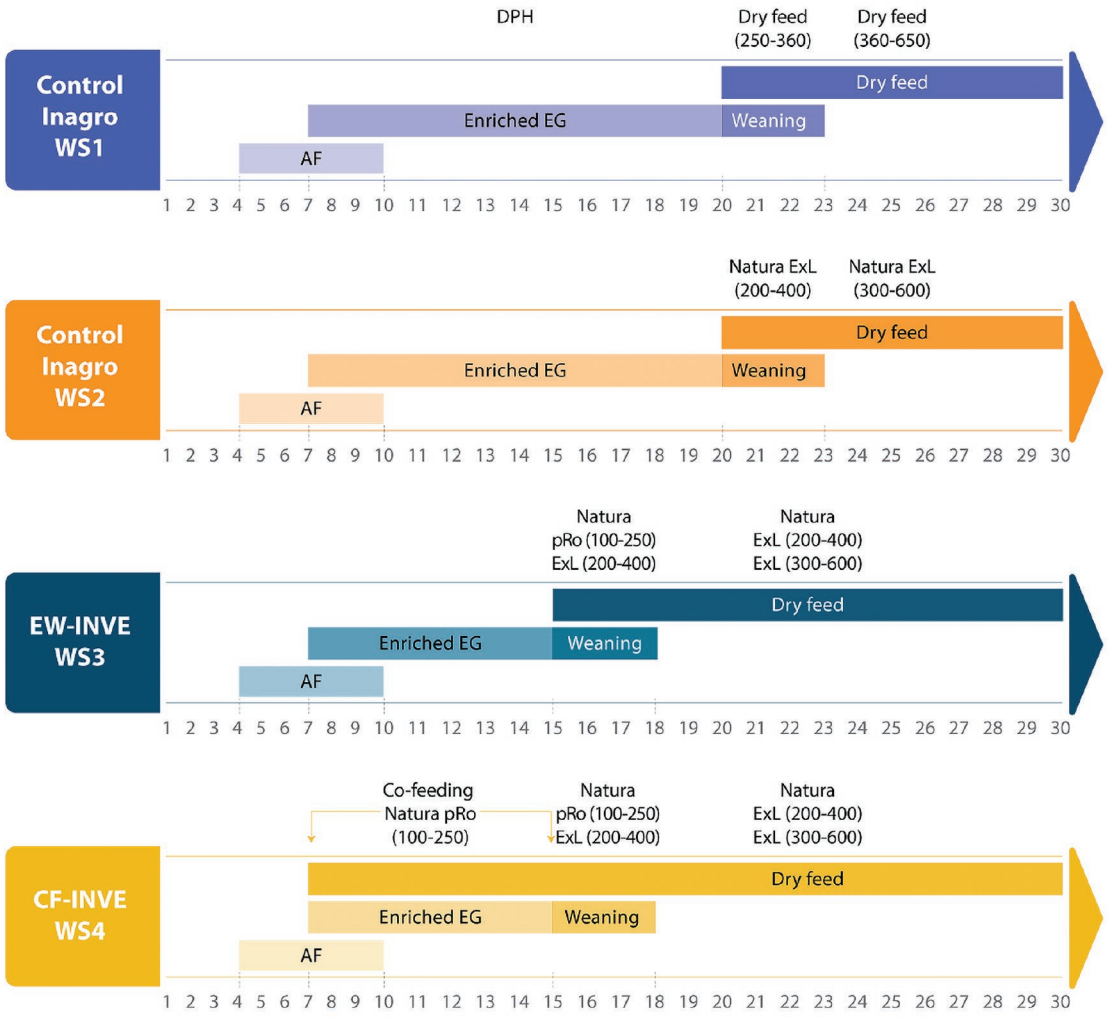


Figure 1. Feeding protocols used during the trial.

weaning protocol without compromising larvae quality can reduce workload and operational costs.

Natura Feed line for early weaning

The Natura feed line (INVE AQUACULTURE) has been successfully used in the larviculture of other fish species such as seabass, seabream, and barramundi. Building on these findings, INAGRO's research team, in partnership with INVE's R&D team, conducted a pilot-scale trial at INAGRO's facility.

The feeding trial

The trial aimed to investigate the effect of different weaning strategies using Natura dry feeds on pikeperch larvae performance under intensive conditions until they reached the juvenile stage. This study is the first of its kind in pikeperch production.

Four weaning strategies (WS) were tested (Fig. 1). The control treatment (WS1) used a commercial dry feed employed at INAGRO for the past five years. The other treatments (WS2, WS3, and WS4) used the Natura feed line. All treatments started with freshly hatched AF Artemia nauplii, followed by EG enriched Artemia (Easy DHA SELCO, INVE, Belgium). Larvae were fed *ad libitum* every 2 hours using automatic feeders. A four-day weaning period involved gradually introducing dry feed (Natura pRo 100/250 and Natura ExL, INVE, Belgium) and reducing enriched Artemia by 25% per day. Different feed sizes were used according to the weaning strategy. After the larviculture phase (30 dph), fish were moved to the juvenile system to monitor growth, malformation rate, and stress resistance.

Results showed that different weaning strategies significantly affected growth performance. Larvae in the early weaning treatment (WS3) were smaller than those in the control (WS1, WS2) and co-feeding (WS4) treatments. Interestingly, larvae in WS4, weaned six days earlier, had similar growth to the control (Fig. 2).

Co-feeding enhances larval performance beyond feeding either type of feed alone and reduces weaning time. Lower growth in WS3 larvae could be due to a short transition time and lack of high-quality feed to compensate for reduced Artemia. In WS4, dry feed was introduced earlier, and larvae were habituated to dry feed ingestion. In this treatment, dry feed was observed in the gut of the larvae from 8 dph.

Swim bladder inflation rate at 15 dph (66–69%) and larval survival rate at 30 dph (37±2.5%) were consistent with commercial hatchery results.

During the juvenile phase, survival rates after grading were higher in control INVE (WS2) and co-feeding (WS4) treatments.

Co-feeding Artemia with enriched diets reduced malformations and improved stress resistance in pikeperch larvae, without compromising growth performance, highlighting its effectiveness for early weaning in RAS systems.

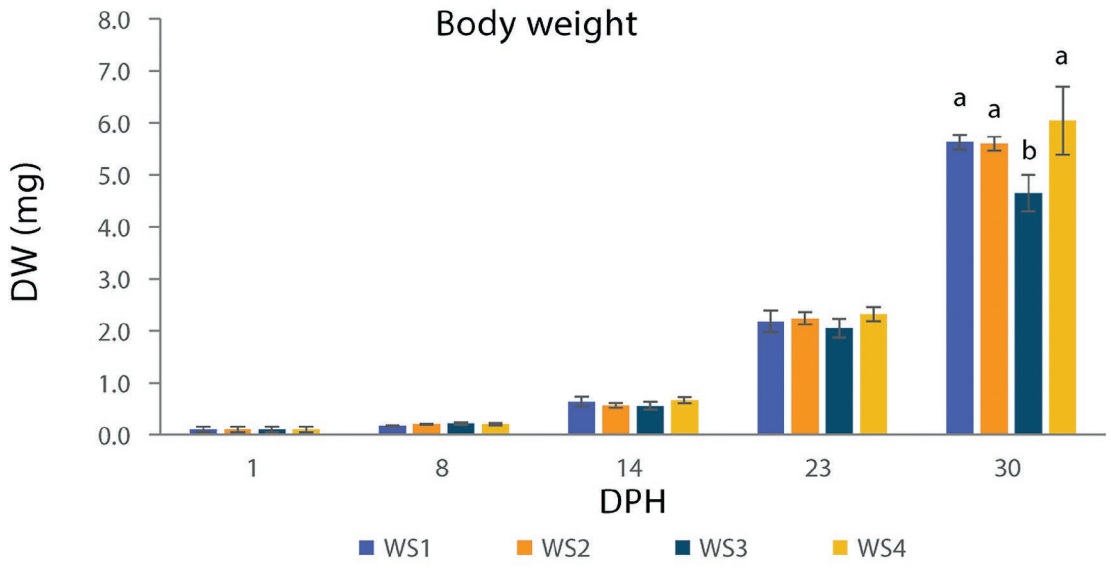


Figure 2. Body weight (DW mg) of pikeperch larvae during hatchery phase.

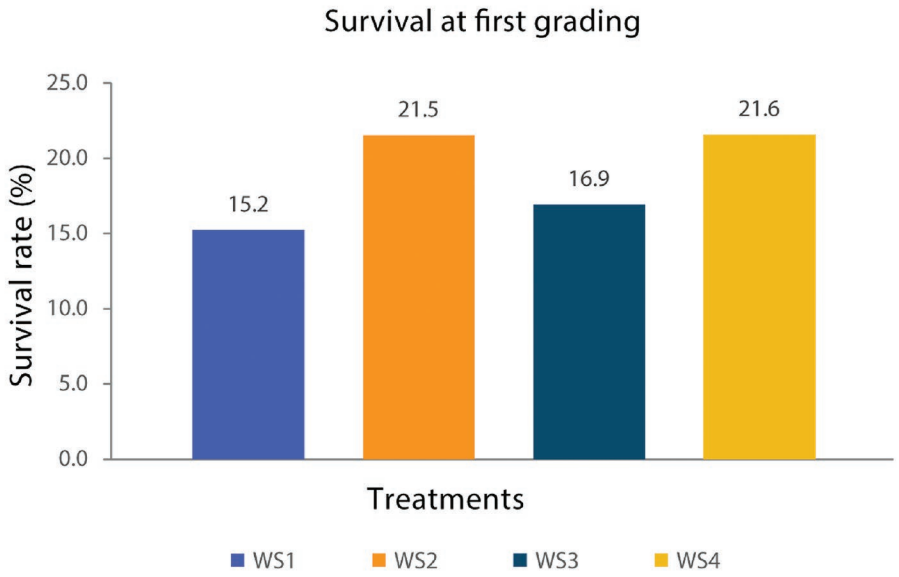


Figure 3. Survival rate (%) of pikeperch juveniles after first grading at 44 dph.

Economical impact of early weaning

An economic analysis during the hatchery phase (up to 30 dph) tracked operations related to larval feeding, including Artemia production, feeder maintenance, and feed cost. A simulation at full capacity (initial number of larvae 264,000 with a 40% survival rate at 30 dph) showed a reduction in production costs with early weaning protocols. Feed and labor costs were reduced by 23% and 45%, respectively, resulting in a total cost reduction of 32-34% compared to current protocols. The higher labor cost reduction was due to decreased live feed production.

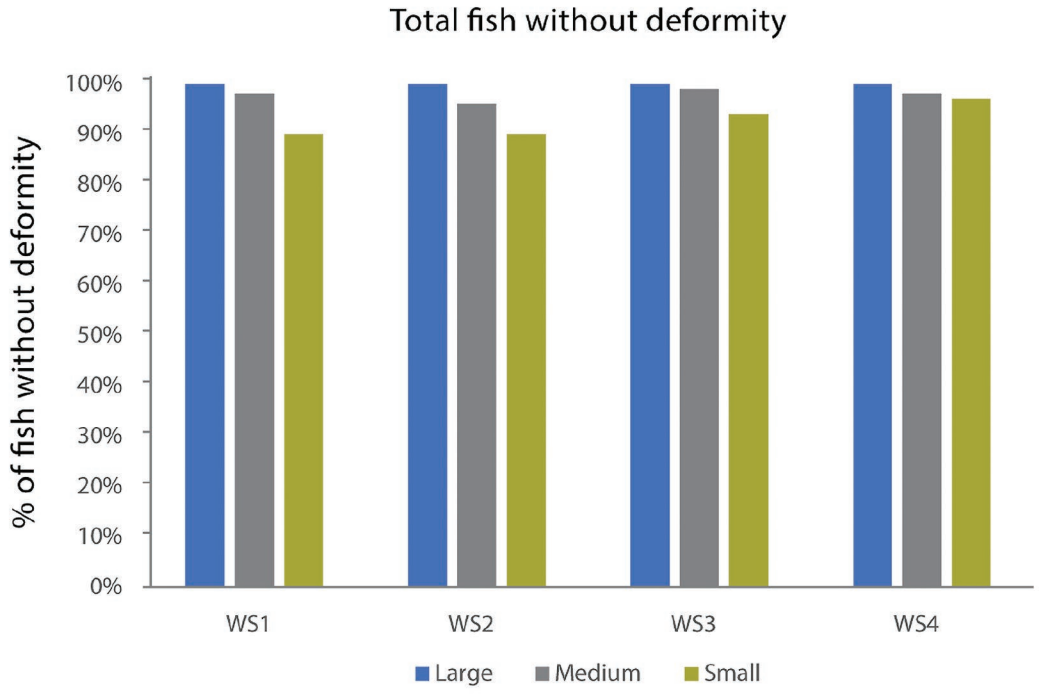


Figure 4. Total fish without deformities (%) after first grading at 44 dph. Fish are grouped into three different size classes (Large, medium and small).

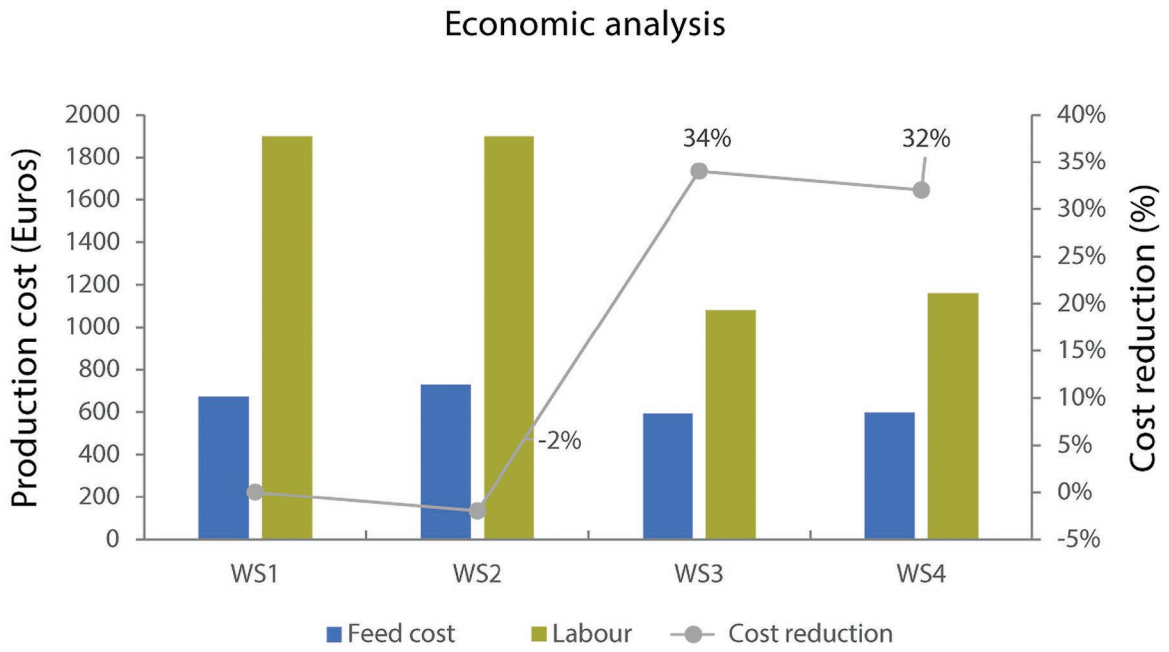
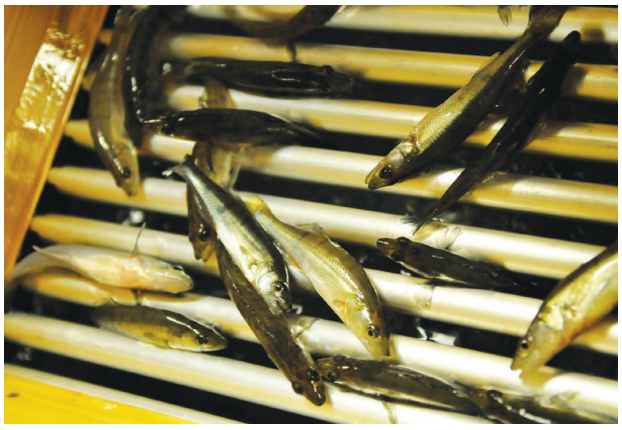


Figure 5. Economic analysis of different feeding protocols during pikeperch hatchery production up to 30 dph.



Conclusion

The study suggests that early introduction of the diet (Natura feed line) with co-feeding of Artemia is a suitable protocol for early weaning of pikeperch in RAS. The co-feeding protocol (WS4) performed as well as current protocols up to 30 dph but with reduced production costs. It also showed positive effects such as better stress resistance during grading and lower malformation rates.

Future research should evaluate the long-term effects of early weaning using the Natura line on stress resistance and growth performance during the grow-out phase until market size. This will provide comprehensive knowledge about the impact of these feeding protocols on fish performance and economic production.

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