

AquAgris
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Fish farming in Finland

Petri Jokela

Raghida Lepistö

Tampere University of Technology
Environmental Engineering and Biotechnology
Finland

EUROPE



Food fish cultivation in 2006

- Total amount 12.9 million kg
 - Finfish:
 - 12.0 million kg of rainbow trout
 - 0.8 million kg of white fish
 - 203 farms in food fish production
 - total of 498 farms

- **80 % of the production in the coastal areas**
- **Net cages**
- **Also ponds (raceways) in inland**
- **Shallow farming sites**
- **Water environment susceptible to eutrophication**

Farming licences

- licence must be obtained from an environmental permit authority
- if annual production is less than 2 000 kg, permit is not needed
- statement given by regional environmental centre
- principal aspect: nutrient load to the environment
- decision based on local conditions, governmental guidelines
- individual decisions
- licence valid 7 years on the average

- **Specific nutrient discharges:**

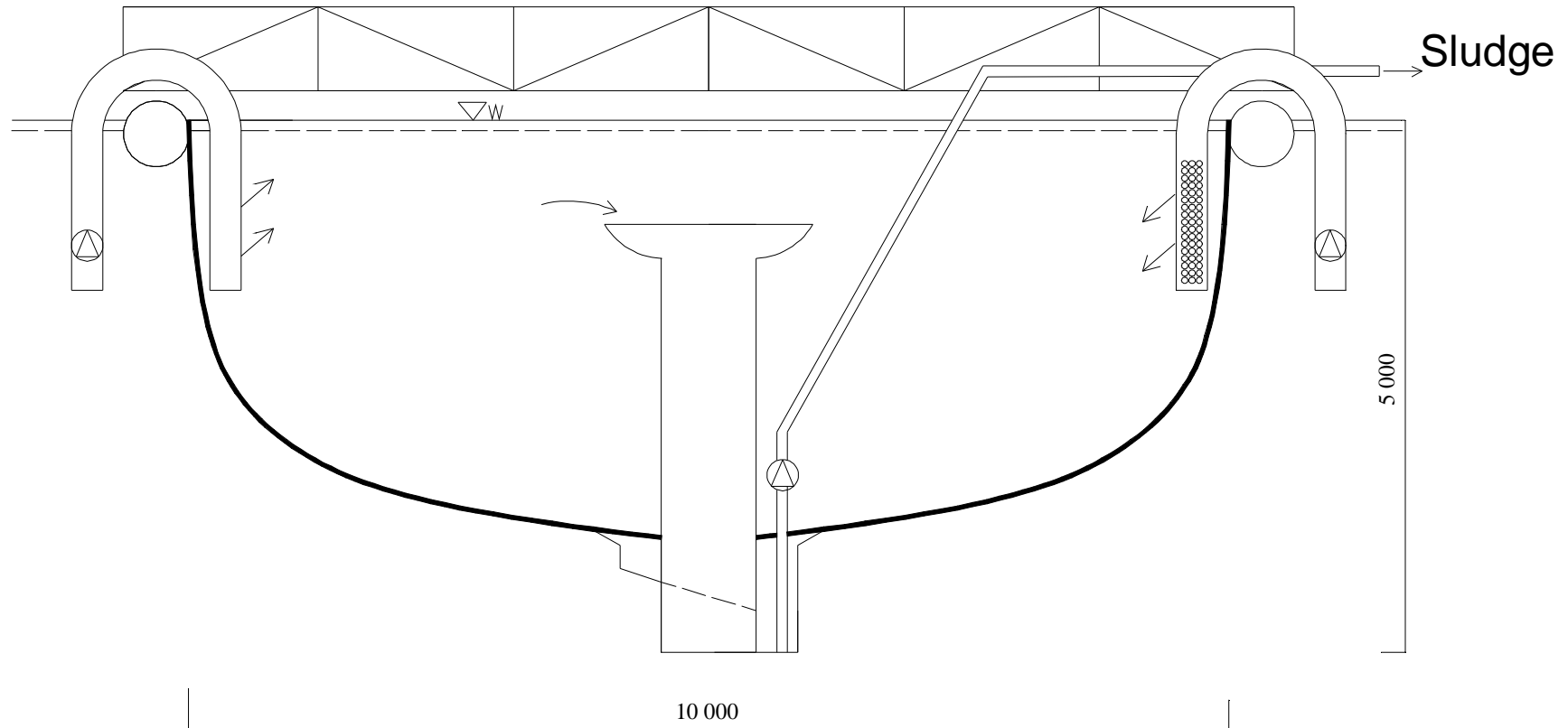
- in 2003: ca. 9 gP/kg fish, 65 gN/kg fish
- target 2005: 7 gP/kg fish, 44 gN/kg fish

- **Environmental load has decreased:**

- better feed
- more professional husbandry: larger farms
- number of farms decreased due to market changes

Bag Pen Farming

- Reduction of nutrient discharges
- Removal of nutrients bound to particles



- Swirl inside the pen collects the solids
- The solids (sludge) are removed from the bottom of the pen by pumping frequently





MATERIALS AND METHODS

- Fish: 2 years old rainbow trout females
vaccinated
weight at start-up 850 g
- Rearing August – October (87 d)
- Stocking density at start-up 23 kg/m³
- Reference group in a net cage
(stocking density at start-up 8 kg/m³)

HYDRAULIC CHARACTERISTICS

Influent (m ³ /h)	Detention time (min.)	Hydraulic surface load (m ³ /[m ² *h])
630	19	8.1
800	15	10.3

SLUDGE REMOVAL

Sludge pumping	Sludge flow (m ³ /h)	Sludge flow/ Influent flow %
periodical, 5 times/h	1.3	0.16 - 0.21

RESULTS

		Bag pen	Reference (net cage)
Final fish weight	g	1730	1660
Daily growth rate	%	0.81	0.76
Feed conversion ratio	kg/kg	1.0	1.4
Final stocking density	kg/m ³	46*	15
Mortality	%	1.7	1.8

* During high stock density, pure O₂ was added intermittently to determine its requirement and its effect on the economics of the process

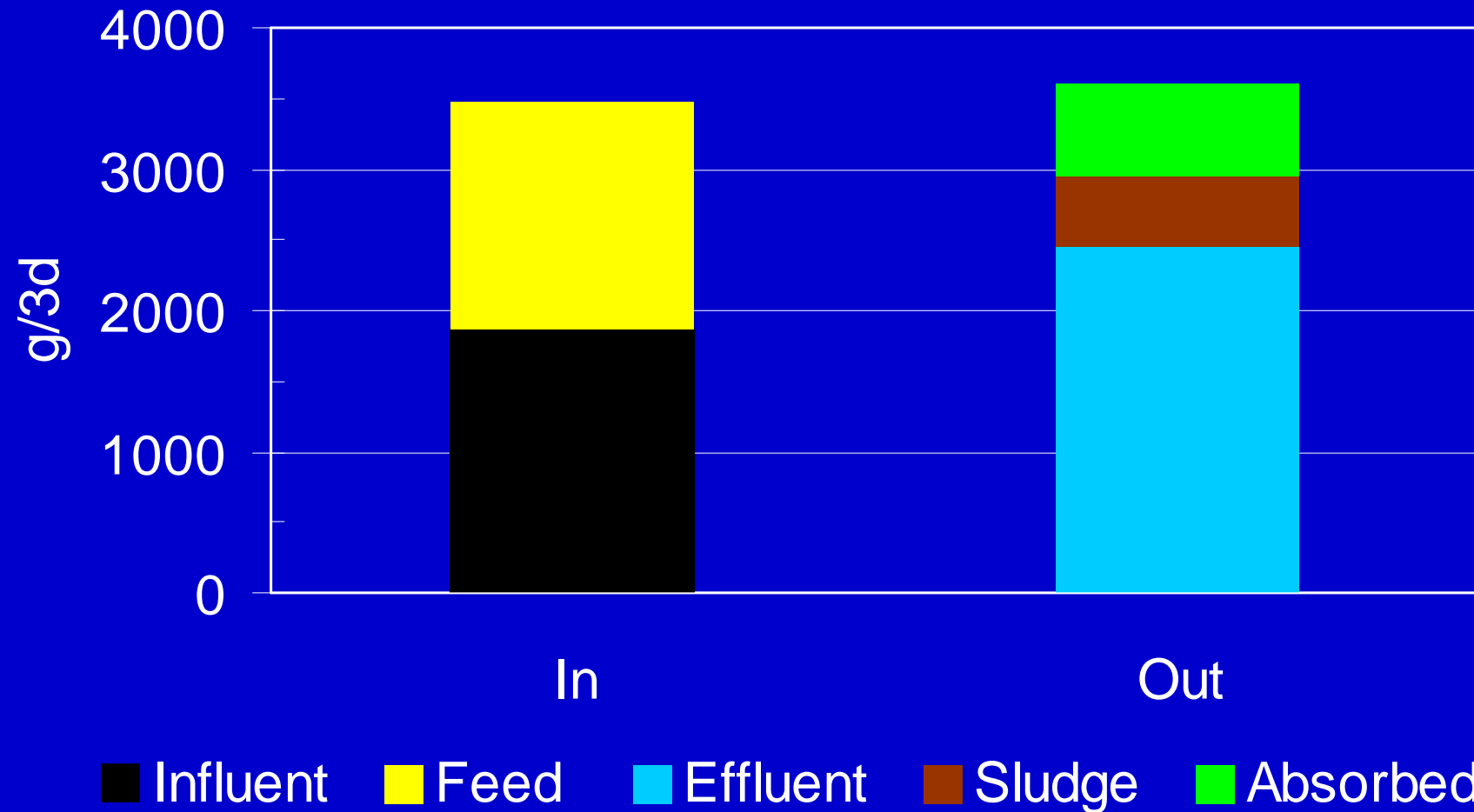
WATER AND SLUDGE QUALITIES

		n	SS (mg/l)	P ($\mu\text{g/l}$)	Psol/P %	N ($\mu\text{g/l}$)	Nsol/N %
Influent	day	12	5.7 ± 1.1	35 ± 8	87	340 ± 70	91
	night	6	5.2 ± 1.6	37 ± 4	89	410 ± 60	85
Effluent	day	12	5.9 ± 1.6	48 ± 7	80	460 ± 60	89
	night	6	5.7 ± 0.6	48 ± 2	85	470 ± 100	98
Sludge	day	12	180 ± 190	6000 ± 5900	18	5500 ± 4400	31
	night	6	130 ± 100	4900 ± 4100	18	4300 ± 3200	33

NUTRIENT BALANCE

Phosphorus, average

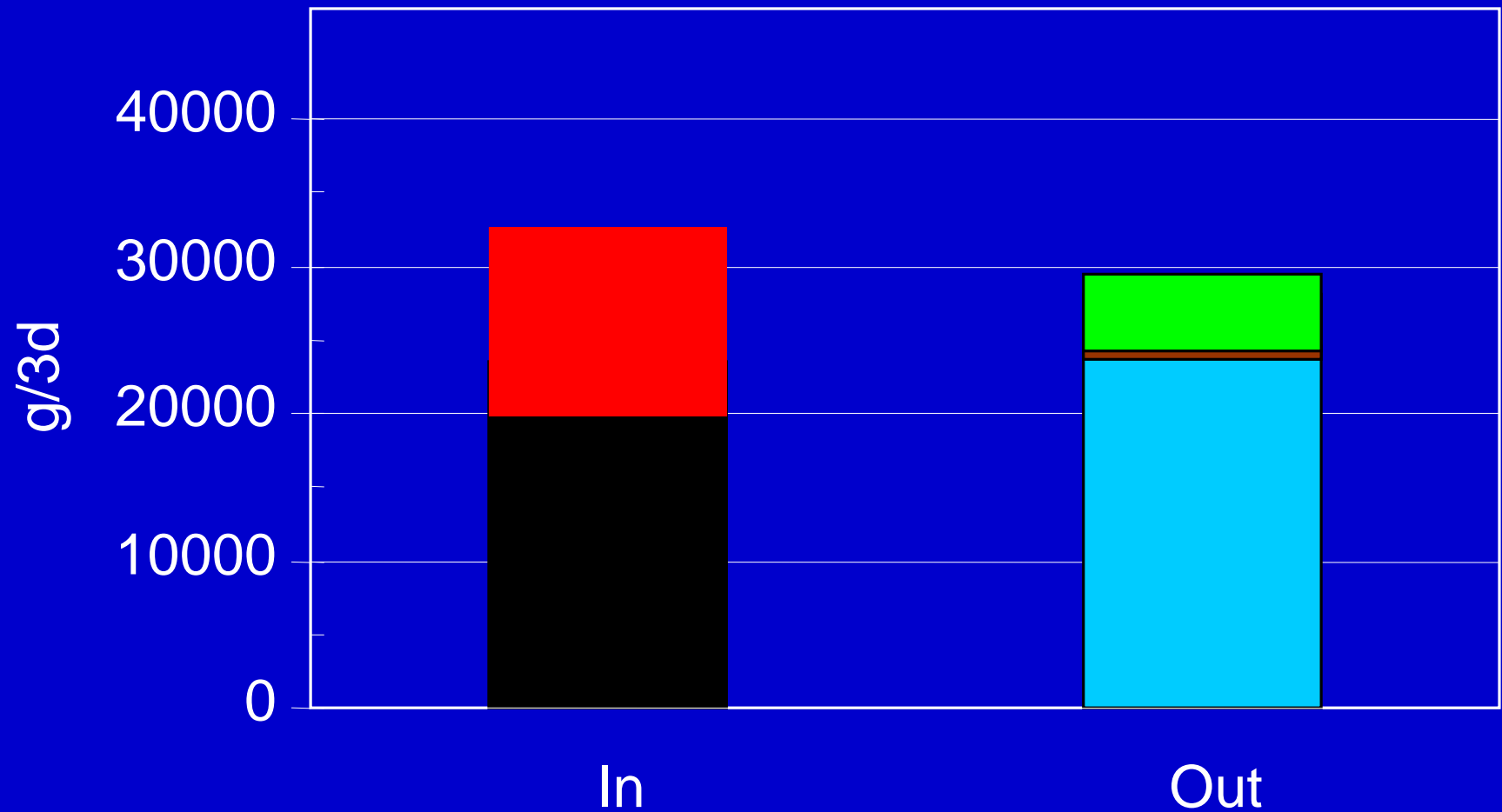
(absorbed amount assumed: 3.7 gP/kg)



NUTRIENT BALANCE

Nitrogen, average

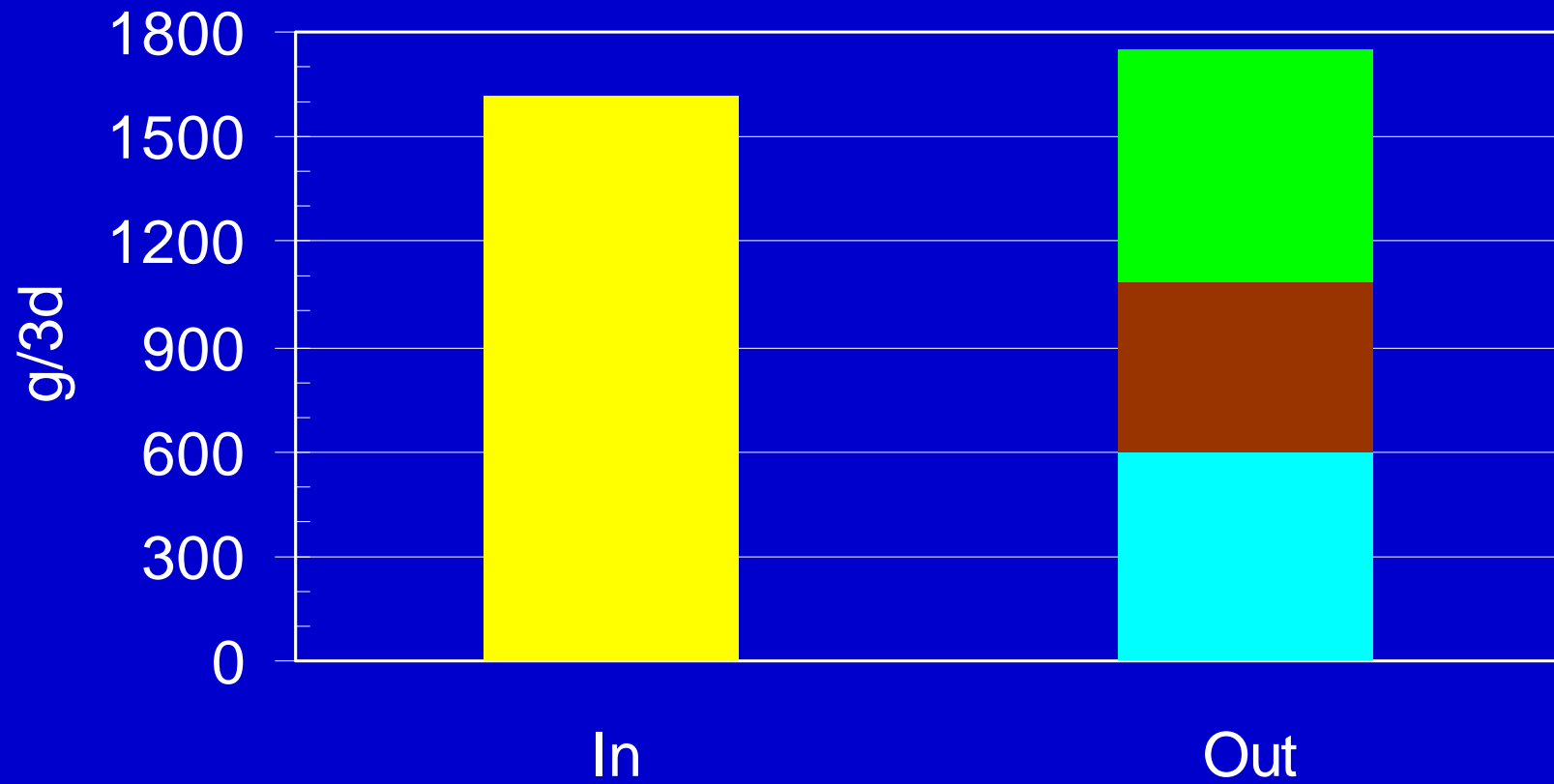
(absorbed amount assumed 25.4 gN/kg)



■ Influent ■ Feed ■ Effluent ■ Sludge ■ Absorbed

NUTRIENT BALANCE

Background (seawater) excluded
Phosphorus, average



■ Feed

■ Effluent

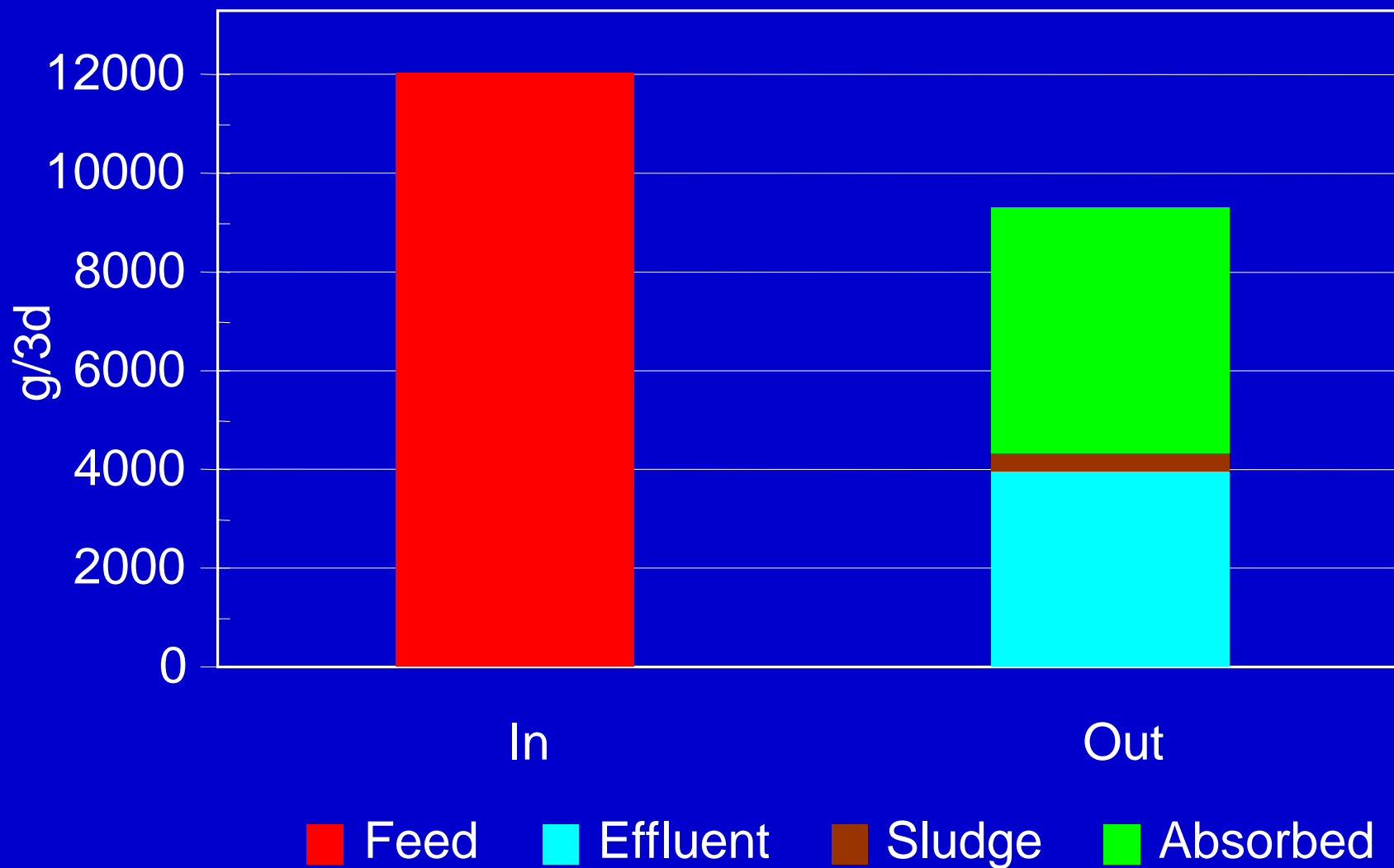
■ Sludge

■ Absorbed

NUTRIENT BALANCE

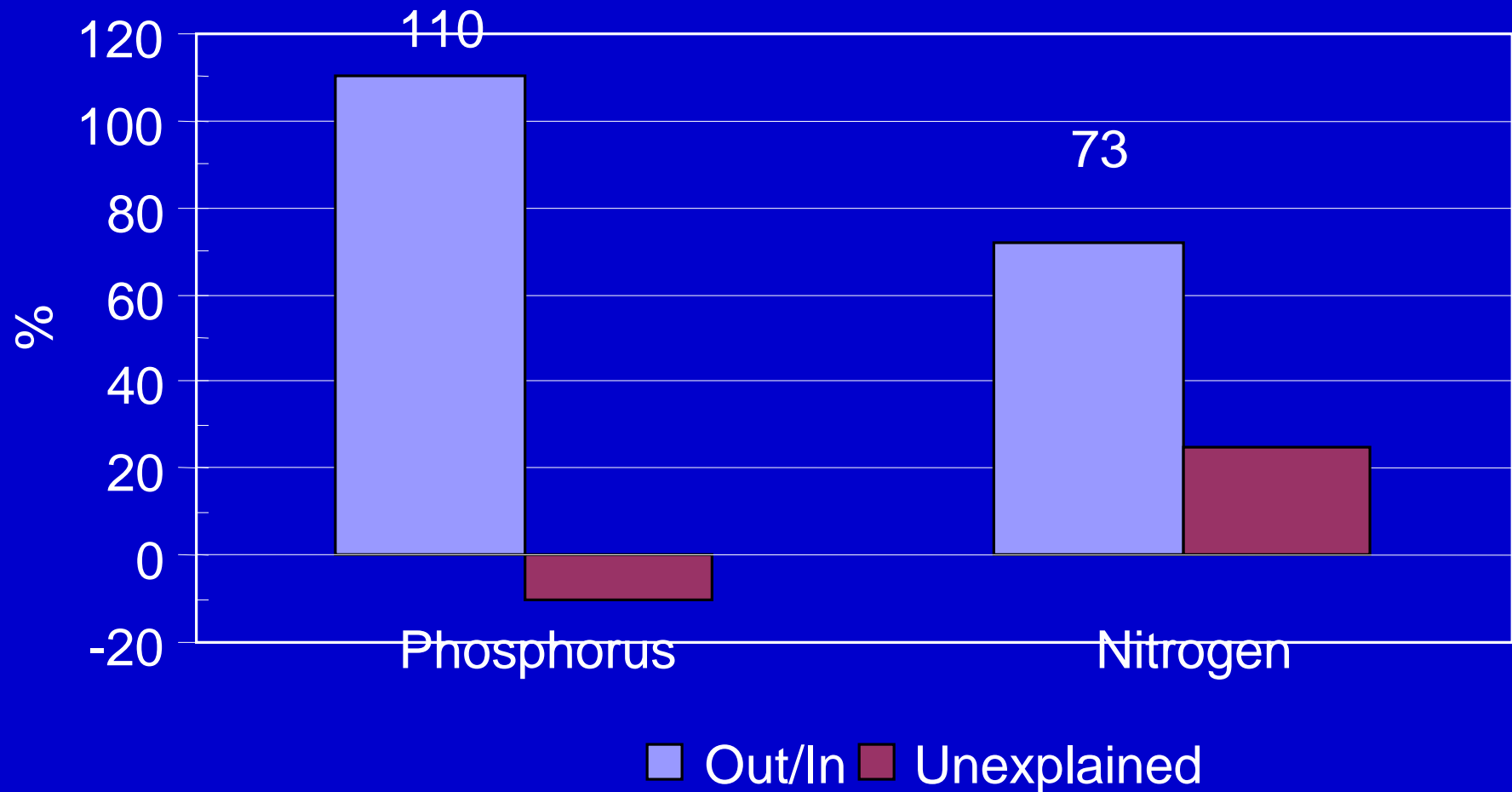
Background (seawater) excluded

Nitrogen, average



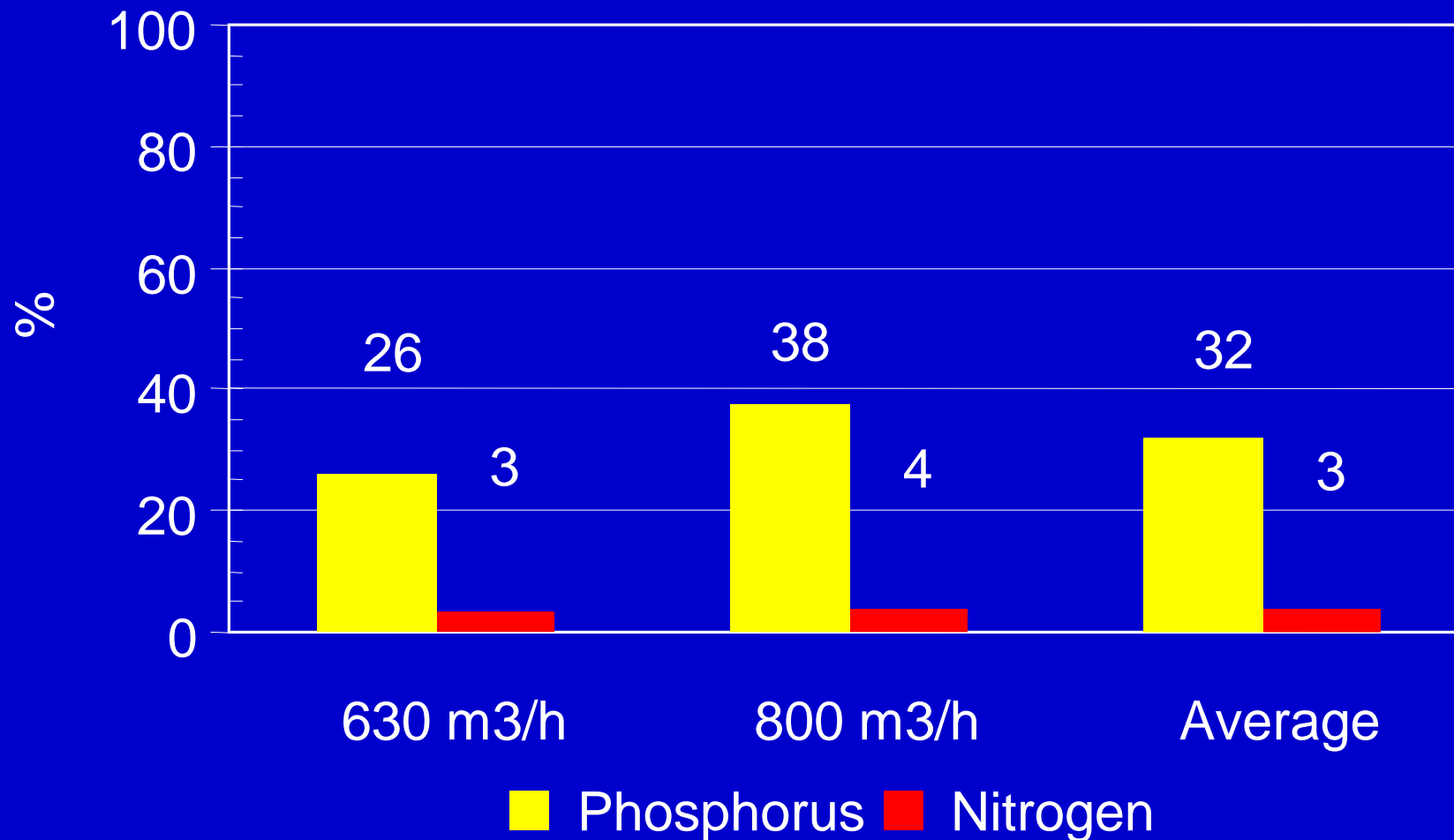
NUTRIENT BALANCE

Background (seawater) excluded



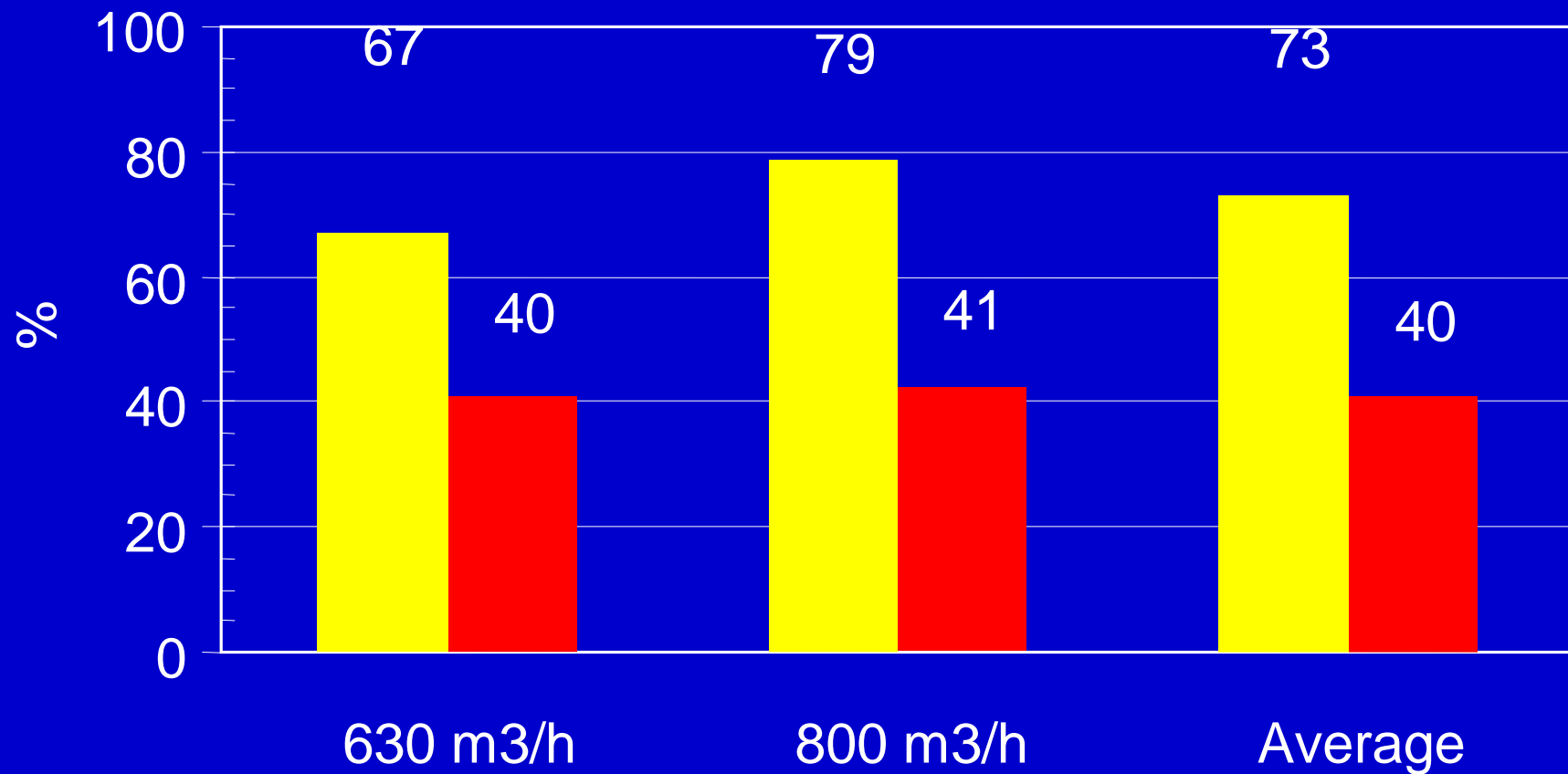
NUTRIENT REMOVAL

Removed as sludge (% of the feed)



NUTRIENT REMOVAL

Absorbed [assumed^{*)}] +
removed as sludge (% of the feed)



■ Phosphorus ■ Nitrogen

^{*)} 3.7 gP/kg
25.4 gN/kg

SPECIFIC DISCHARGES

- Average:
 - 2.4 g P/kg weight gain
 - 42 g N/kg
- In practice, further sludge concentration is needed (e.g., DAF)
- Dissolved air flotation (DAF), efficiency $\geq 80\%$
- Total system discharge:
 - 2.9 g P/kg weight gain
 - 42 g N/kg

Bag Pen - CONCLUSIONS

- High stocking densities possible
- Based on removal of nutrients bound to solids:
good P removal, less efficient in N removal
- Moderate sludge flow:
0.2 % of the influent flow
- Needs to be coupled with sludge concentration unit, e.g., DAF