Breeding fish species to cope with new vegetable substituted feed

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The process to define this priority

Step 1 : 2005-2007

FABRE • TP

Aquaculture Expert Group

• Core group: Hans Komen (Wageningen University), Ashie Norris (Marine Harvest), Anna Sonesson (NOFIMA), Pierrick Haffray (SYSAAF)

• 70 people from industry and research

• **Preliminary identification of opportunities** for research for the European aquaculture breeding sector

• **Vision for the next 5, 15 and 25 years**

General feeling : Need to a more precise and enlarged work

Step 2 : 2007-2008

AQUA BREEDING

FP6-2005-SSP-044424

Towards enhanced and sustainable use of genetics and breeding in the European aquaculture industry

www.aquabreeding.eu

- **Define the research priorities** of the industry already involved in aquaculture breeding

- **Promote the dissemination** of knowledge to support a major involvement of the industry in breeding activities

- **Consolidate these actions at the European level** promoting to a progressive integration of the European aquaculture industry into the FABRE-TP and the emerging EATP

Definition of research priorities in Aquabreeding

- Identification of research gaps (2 days meeting)
- Definition of research objectives (2 days meeting)
- Redaction of a questionnaire
  - 7 pillars
  - 50 research objectives
- Ranking of the top 4 priorities by 45 stakeholders (50% industry)

The questionnaire

MARKET-VALUE TRAITS

T01 **Quantitative genetics: growth**

VISION: Shortening the time to harvest through growth improvement — Quote : 1 for 1st priority, 2 for 2nd priority …

T01.a	Assessment of the economical impact of selection for growth. Extension to main selected traits and systems (including shellfish and pond fish)	
T01.b	Study of the growth curve shape, estimation of the genetic component of allometry	
T01.c	Estimate the negative impact of growth	

T02 **Quantitative genetics: feed efficiency**

VISION: Increased and best utilisation of new feeds — Quote : 1 for 1st priority, 2 for 2nd priority …

T02.a	Estimate the genetic basis for feed efficiency, nutrient retention, amount of slaughter waste or by product and meat quality on animal and non-animal diets during different life-stages of the fish (from fry to slaughter).	
T02.b	Individual measurement of the food conversion rate	

T03 **Quantitative genetics: correlated responses**

VISION: correlated responses known to avoid unfavourable side effects — Quote : 1 for 1st priority, 2 for 2nd priority …

T03.a	Identification of correlation between productive, disease resistance and welfare traits	
T03.b	Better understanding the physiology of correlated traits	
T03.c	Estimation of the correlated response on polyploids	
T03.d	Development of predictors based on correlated traits	

T04 **Quantitative genetics: Quality traits**

VISION: Knowledge on the genetic basis of quality traits for breeding — Quote : 1 for 1st priority, 2 for 2nd priority …

T04.a	Development of tools for non-destructive, rapid, low-cost, and high resolution measurements of meat quality (fat%, pigmentation, texture, muscle size of bivalves)	
T04.b	Estimation of the genetic basis of (new) quality traits: shelf-life, toxin content, gaping (fish), nutritional value	

HEALTH AND WELFARE TRAITS

T05 **Quantitative genetics: robustness, plasticity and welfare**

VISION: More robust animals capable to adapt to changing environments — Quote

T05.a	Implementation of indicators (direct and indirect) and conditions in which such traits are assessed	
T05.b	Estimation of the genetic variation of the indicators	

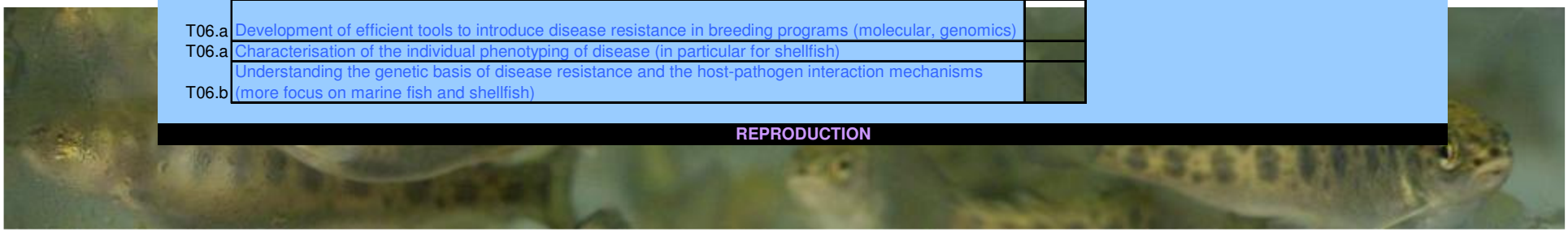
Robustness is the characteristic of being stro
Plasticity is the ability of an organism with a g
Welfare is intended as the well-being state of

T06 **Quantitative genetics: disease resistance**

VISION: Improved genetic resistance, reduced use of drugs — Quote : 1 for 1st priority, 2 for 2nd priority …

T06.a	Development of efficient tools to introduce disease resistance in breeding programs (molecular, genomics)	
T06.a	Characterisation of the individual phenotyping of disease (in particular for shellfish)	
T06.b	Understanding the genetic basis of disease resistance and the host-pathogen interaction mechanisms (more focus on marine fish and shellfish)	

REPRODUCTION



The top 4 research priorities identified in Aquabreeding

1. **Estimate the genetic basis for feed efficiency**, nutrient retention, amount of slaughter waste or by product and meat quality **on animal and non-animal diets** during different life-stages of the fish (from fry to slaughter)

2. **Development of efficient tools to introduce disease resistance in breeding programs** (molecular, genomics), general testing and practical challenge tests

3. **Identification of sex determinism and markers for sex** (phenotypic and molecular) at early stage, for all species

4. **Identification of correlation between productive, disease resistance and welfare traits**

Futur up-dating : collaboration between EU plateforms

FABRE TP

2005-2008

AQUA BREEDING

FP6-2005-SSP-044424

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• 70 people from industry and research

AquaBreeding Network

• Managenent team: Hervé Chavanne (Spallanzani Institut), Marc Vandeputte (INRA), Kari Kolstad (NOFIMA), Pierrick Haffray (SYSAAF), Béatrice Chatain (IFREMER), Hans Komen (Wageningen University)

• 120 people from industry and research

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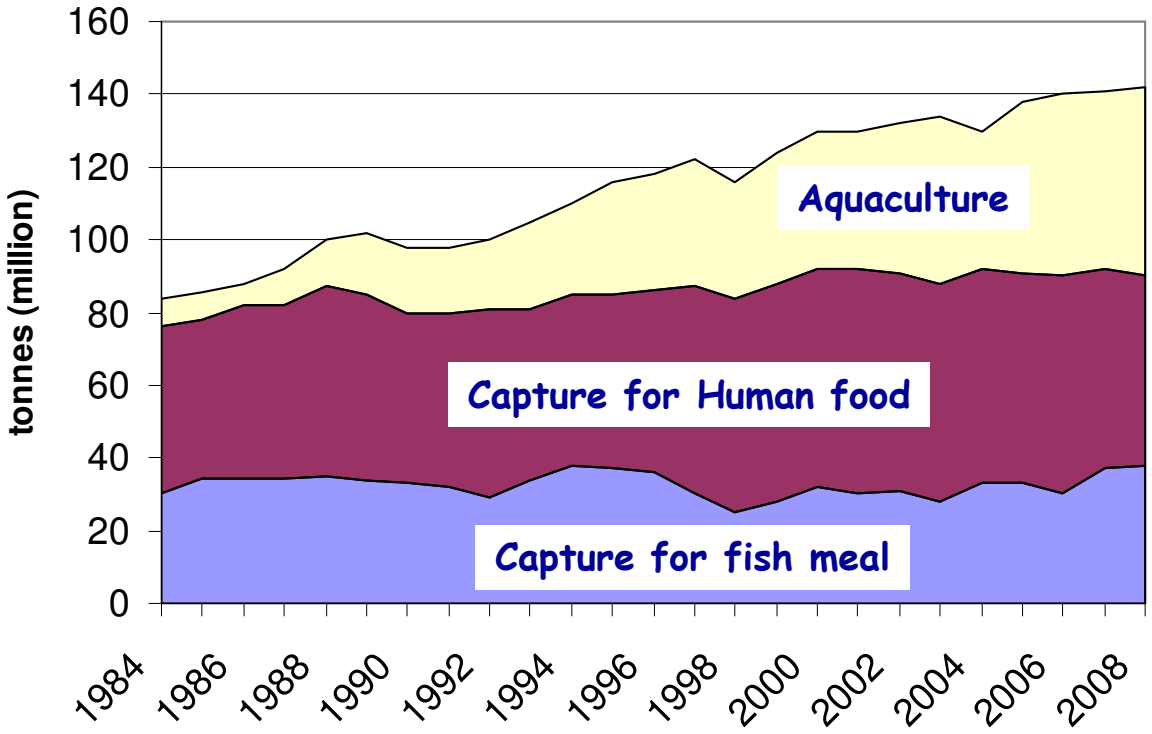
« Managing the biological life cycle » WG 1: Genetic & Reproduction

• Team leader : Béatrice Chatain (IFREMER) and Patrick Lavens (INVE)

• Working group composed with **AquaBreeding**, **FABRE** and **Aquagenome** representatives (9)

Why this research priority ?

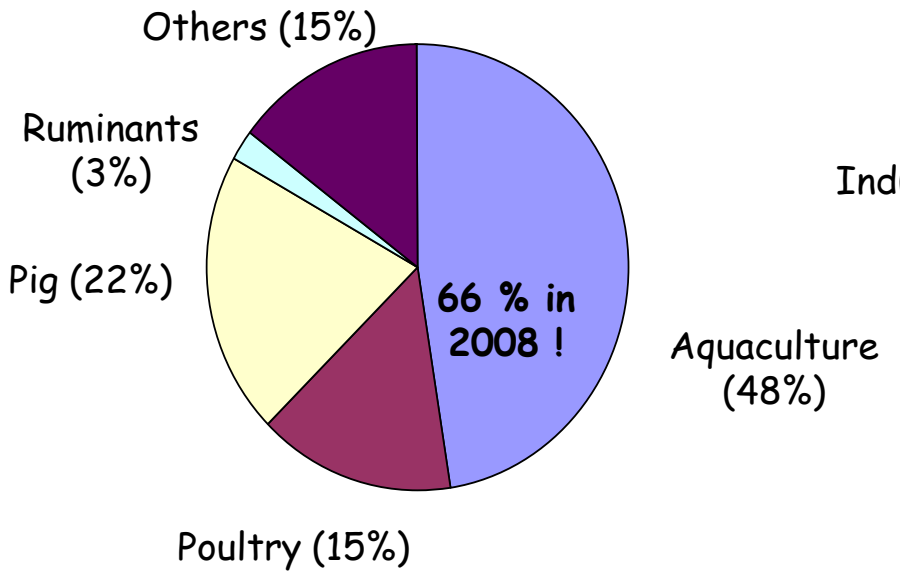
World capture from fisheries and aquaculture development



(plant excluded, Source FishStat)

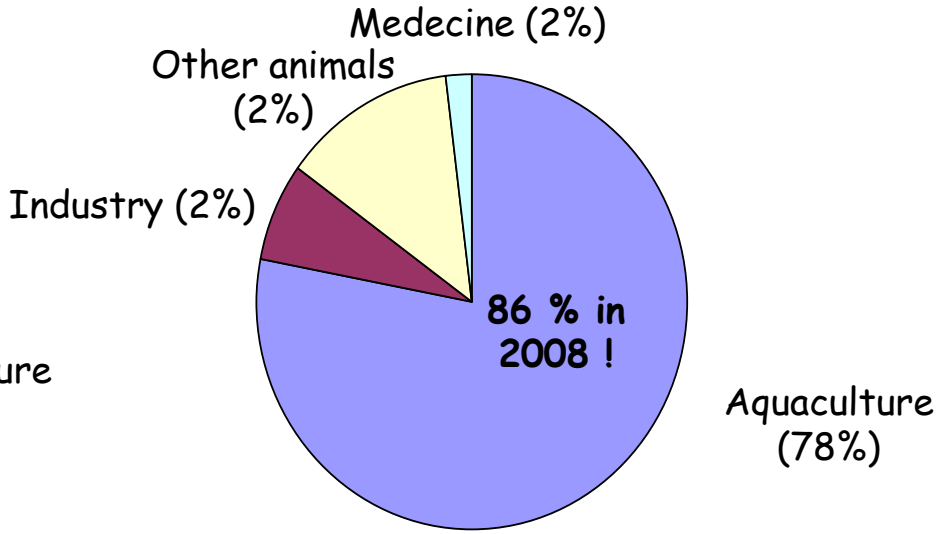
Aquaculture is the major user of fish meal and fish oil resources

Fish meal



Ian Pike 2002 projection for 2010

Fish oil



FAO 2002 prospect for 2010

Recent advances in fish nutrition and substitution

- Fish are **poor users of carbohydrates**
- Regims rich in proteins
- Opportunity for plant-based diets, but :
  - ✓ Unbalanced amino-acid composition
  - ✓ Anti-nutritional factors, carbohydrates, phytats, allergenic proteins…

- **Fish meal substitution**
  - ✓ Ok if substitution < 75 % protein
  - ✓ If > 75 % then growth and survival decrease

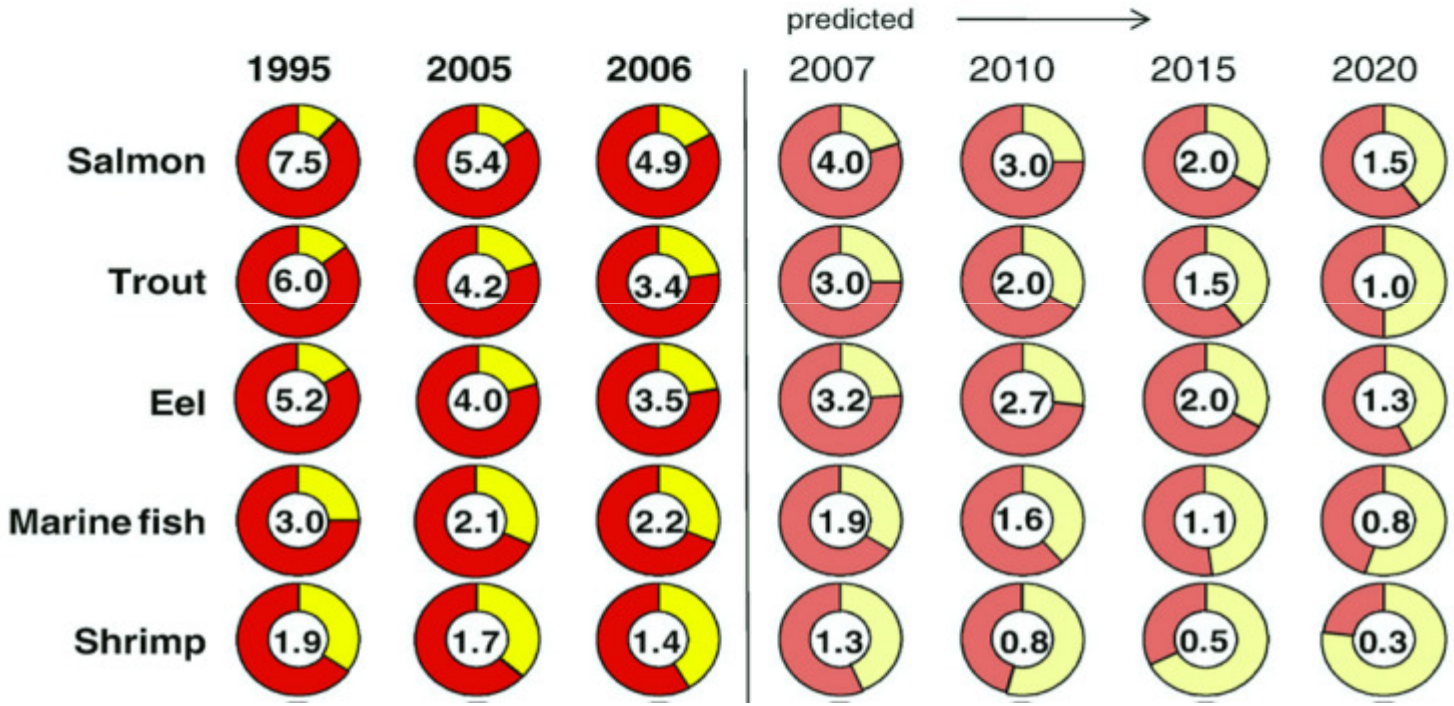
- **Fish oil substitution :**
  - ✓ No problem if substitution < 80 %
  - ✓ But decrease in PUFA (poly-unsaturated fatty acids)

Prospective : Fish in/fish out ratio < 1

(From Tacon & Metian, 2008)

Pelagic forage fish (fish in)

Annual production (fish out)



The challenge for a sustainable aquaculture

TODAY

Diets based on fish meal and fish oil
Selection for high growth rate with
fish fed marine ingredients based diets

Genotype-diet interactions ?

TOMORROW

Diets based on plant ingredients
Selection of fish able to cope efficiently with
plant based diets ?

A limited number of scientific publications

Palti et al., 2006
Quinton et al, 2006, 2007

↓

No interaction but :
- Low level of substitution
- Late feed delevery in the life

Pierce et al, 2008
Dupont-Nivet et al., 2009

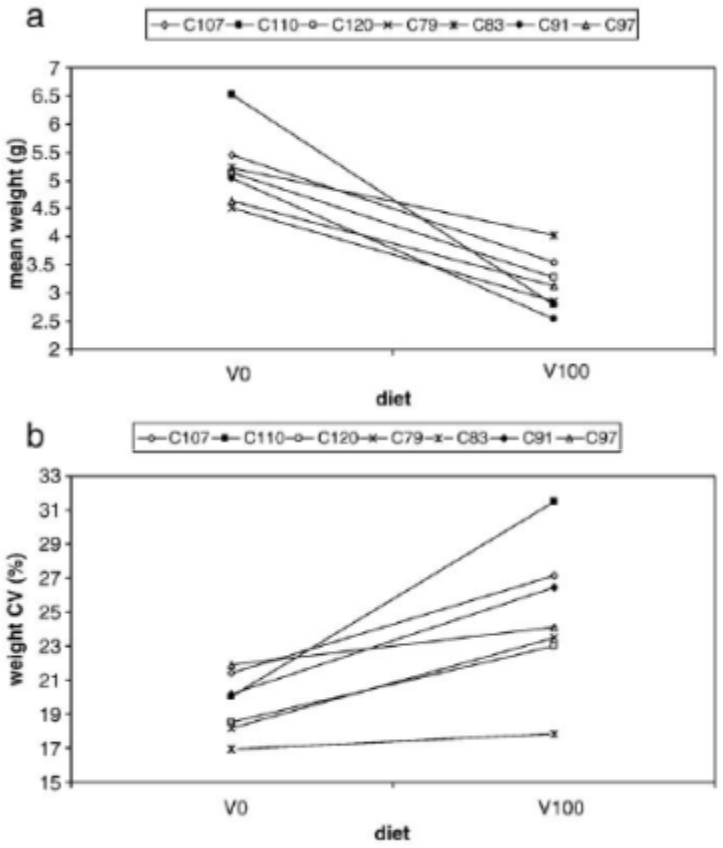
↓

Significant interactions for growth, feed intake and feed efficiency

Family * Diet interaction in rainbow trout fry clones (Dupont-Nivet et al., 2009)

Formulae and analytical composition of the experimental diets (V0: fishmeal based diet, V100: all fishmeal replaced by plant protein sources).

Diet	V0	V100
Ingredients (g/kg)		
Fishmeal LT 94 [a]	472	0
White sweet lupin (CP 40%) [b]	0	100
Corn gluten meal (CP 62%) [c]	0	150
Wheat gluten (CP 80%) [d]	0	250
Extruded whole wheat (CP 10%) [c]	362	94
Extruded dehulled peas (CP 24%) [e]	0	24
Soybean meal (CP 46%) [c]	0	120
L Lysine [f]	0	11
CaHPO4.2H20 (18%P)	0	43
Fish oil [a]	160	202
Mineral and vitamin premix [g]	6	6
Analytical composition		
Dry matter (g/kg WW)	934.7	925.7
Crude protein (g/kg DM)	392.6	445.7
Crude lipids (g/kg DM)	220.9	208.8
Gross energy (MJ/kg DM)	23.3	24.6
Ash (g/kg DM)	82.6	58.4
Phosphorus (g/kg DM)	12.8	11.7



- V100 :
  - - 39 % body weight, -53 % feed intake, -28 % feed efficiency
  - + 26 % CV %
  - Mortality : 12% V100 and <1% en V0

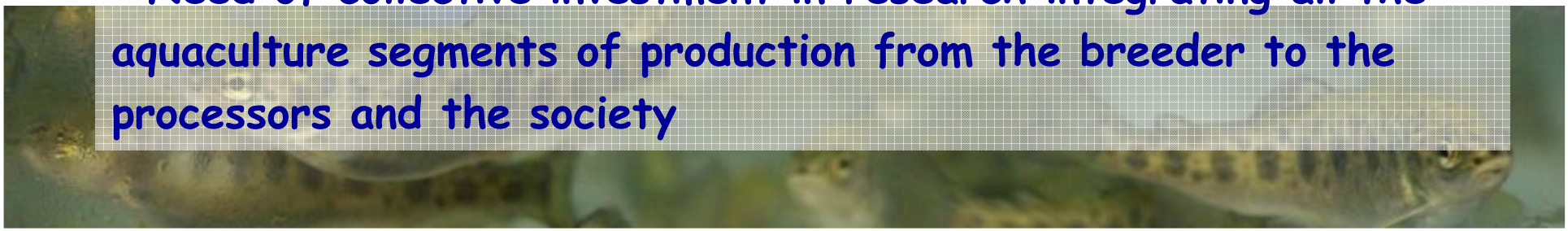
Why to support this research priority ?

- Substitution is one of the more important challenge for a sustainable aquaculture

- Preliminary results, limited and uncertain

- Multiple factors of variation :
  - Species, size, environment
  - Vegetal feed sources
  - Final product quality
  - Biological functions (reproduction, welfare…)

- Need of collective investment in research integrating all the aquaculture segments of production from the breeder to the processors and the society



Thank you for your attention

and also:
• Béatrice Chatain (IFREMER) and Mathilde Dupont-Nivet, Françoise Médale, Marc Vandeputte (INRA) for their help to prepare this presentation
•All participants to the FABRE Aquaculture Expert group and the AquaBreeding SSP