


Trudy Rood

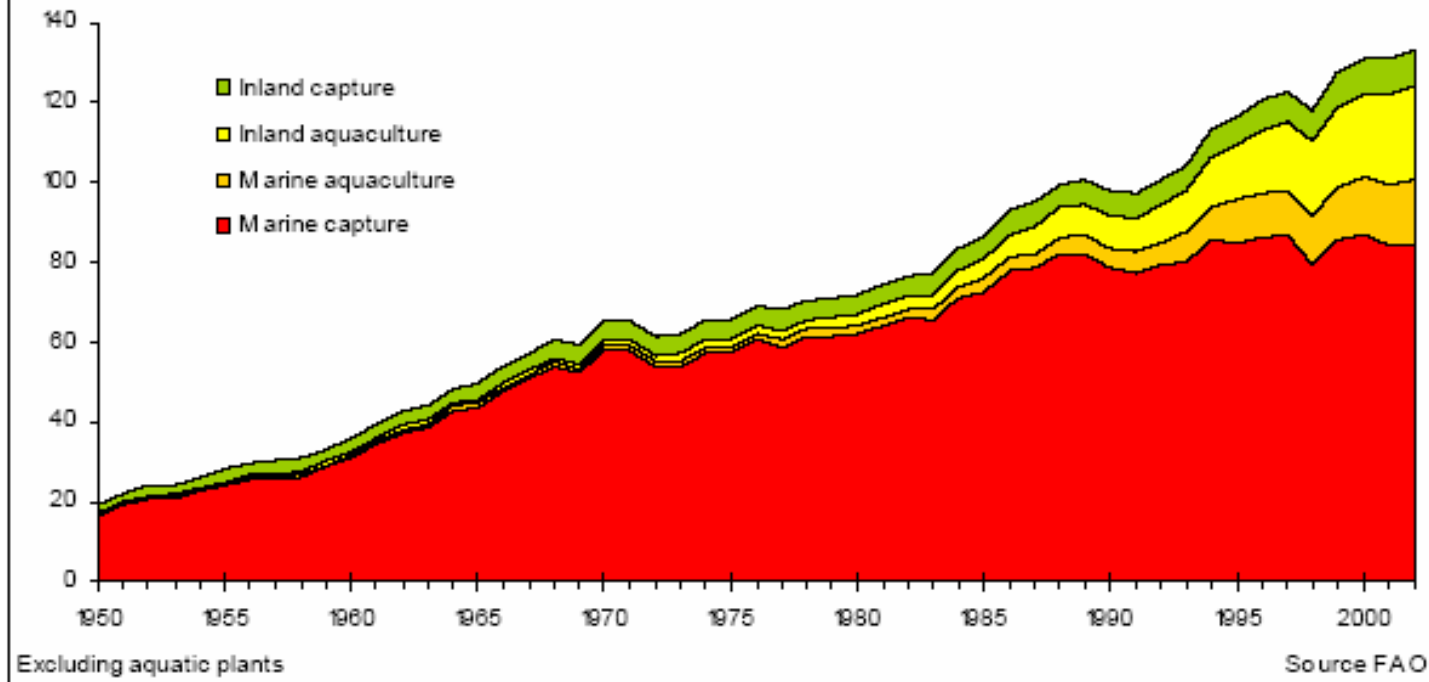
Potential effects of innovations in aquaculture



Netherlands Environmental
Assessment Agency

Transition in the fish sector

Figure A1.1 - World production (million tonnes) from capture fisheries and aquaculture



* FAO, Marine Resources Service, Fishery Resources Division

Scope for increased catches is nil

- Marine ecosystems are under severe stress

(Millennium Ecosystem assessment)



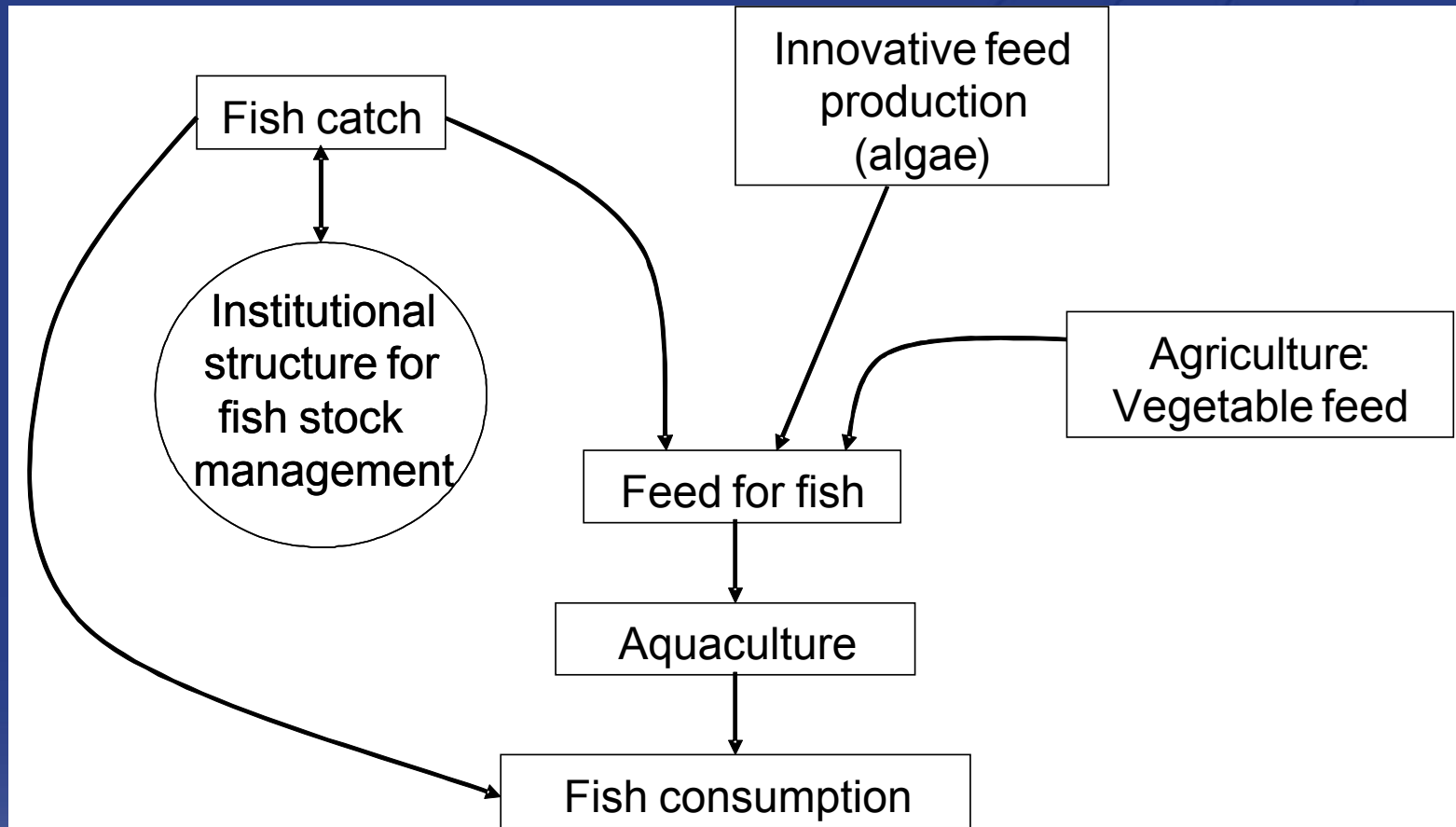
- Fish stocks:

- 52% fully exploited
- 25% overexploited or exhausted (FAO, 2006)

System innovation needed for achieving sustainable development of aquaculture



System option Sustainable aquaculture



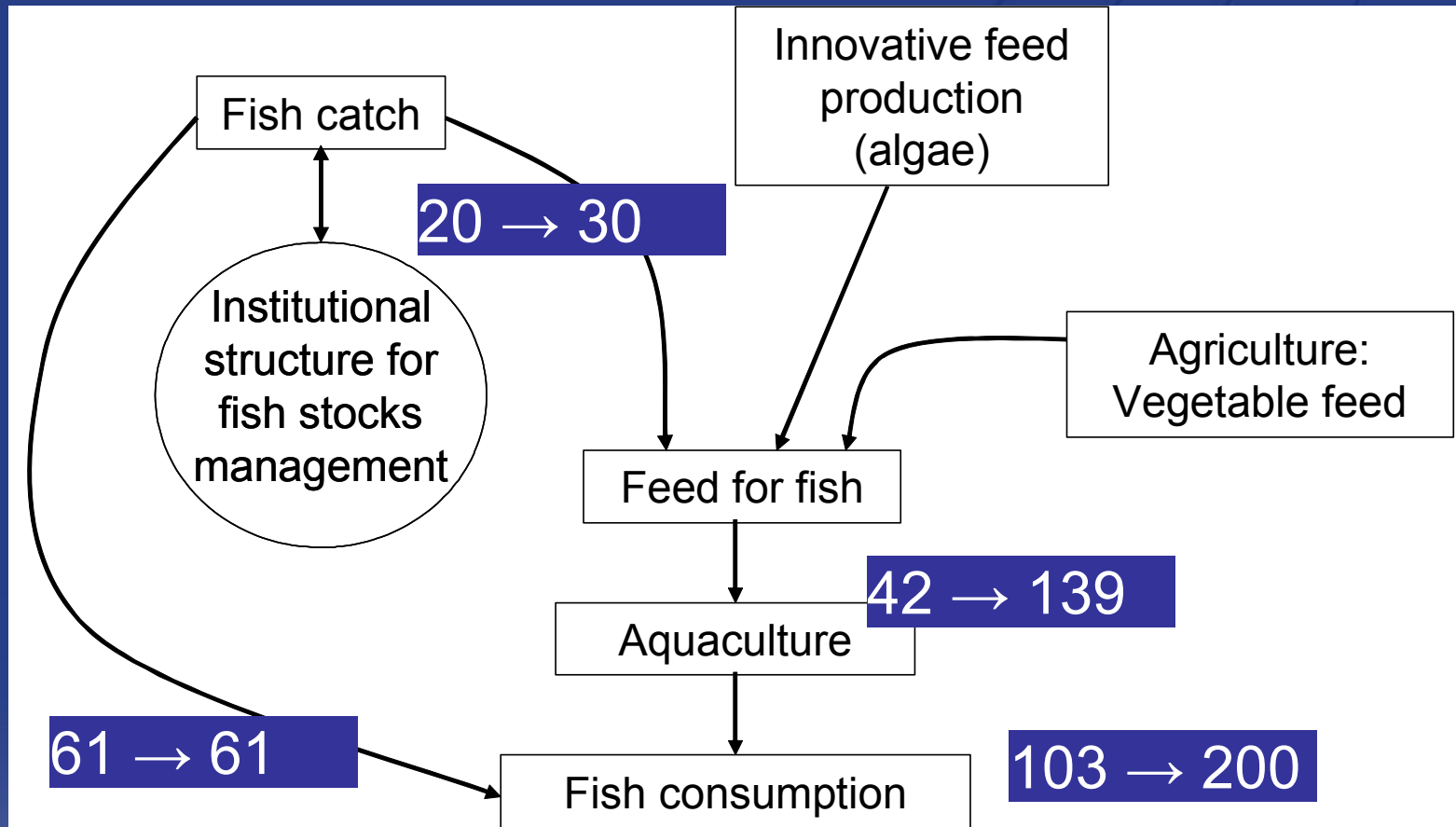
- Fish consumption: 103 million ton,
 - Of which 61 directly from catch
 - And 42 from aquaculture



- Scenario, 2040, growing population, no underfed people:
200 million ton fish



System option: 2005 → 2040



Sustainable Aquaculture:
























- Conserve fish stocks
- Produce enough fish to feed growing world population
- With replacements of fish components in feed
- Keeping beneficial health effects
- Environmental aspects



Sustainability assessment

	People	Profit	Planet
In the Netherlands	<i>Indicators</i>		
Elsewhere			

Sustainability assessment for alternative feed in aquaculture

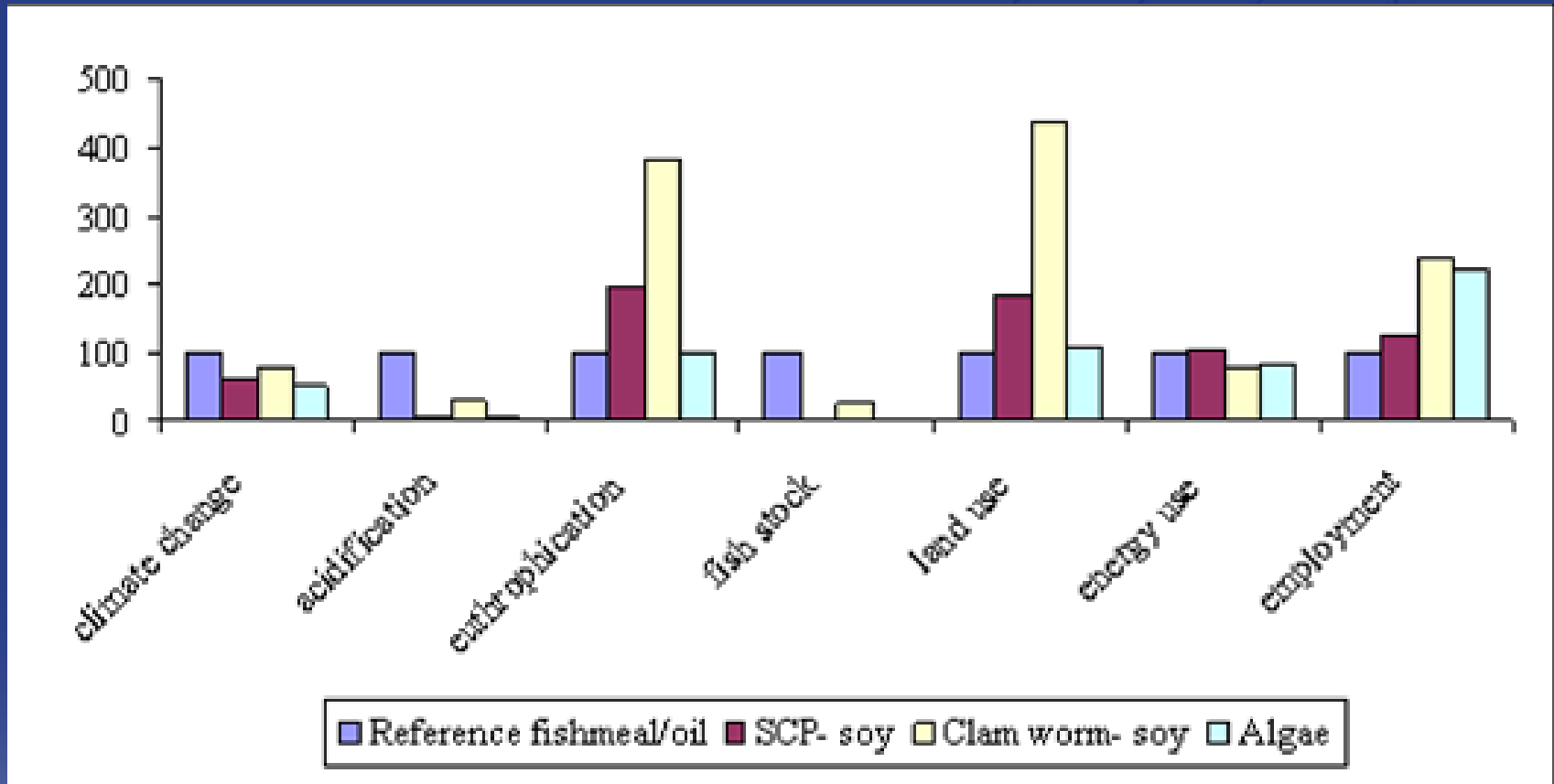
	People		Profit		Planet	
In the Netherlands	Public Health Landscape	 	Employment Purchasing power	 	Acidification Eutrophication Quality North Sea Animal well-being	   
Elsewhere	Production of food Poverty	 	Employment in DC Knowledge DC Fish stocks	  	Value of nature Ecological quality oceans GMO Eutrophication Greenhouse gases	    
 worse  somewhat worse  neutral  somewhat better  better						

Environmental aspects

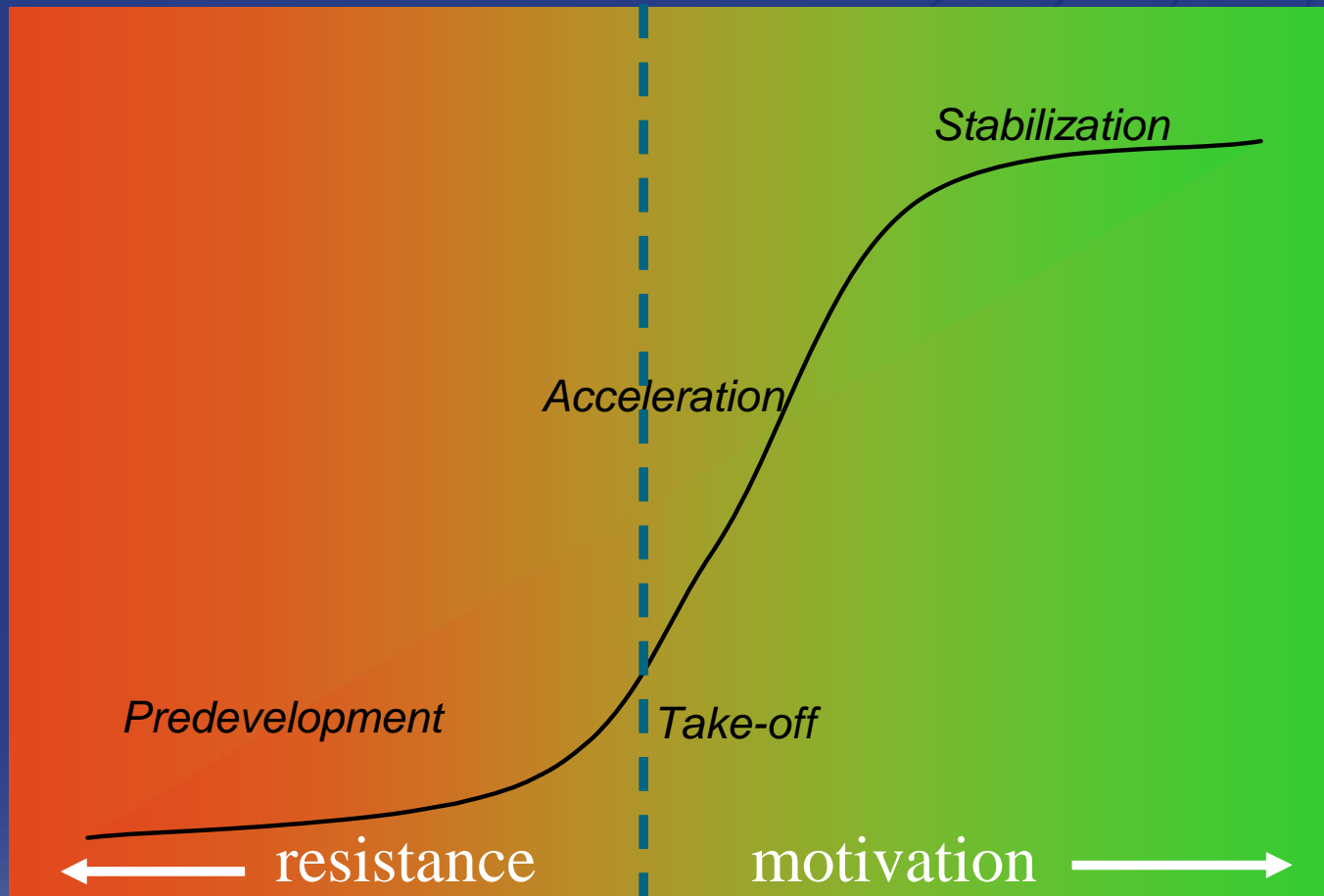
Potential effects of replacements of fish oil and fishmeal

Composition (%) of potential fish feeds						
<i>Ingredients</i>	<i>Single Cell Protein (SCP)</i>	<i>Algae</i>	<i>Clam worm</i>	<i>Vegetable components</i>	<i>Fish meal/ Fish oil</i>	<i>Others</i>
<i>Alternatives</i>						
Reference				25	50 / 15	10
1. SCP soy	25	15		50		10
2. Clam worm soy			15	75		10
3. Algae		65		25		10

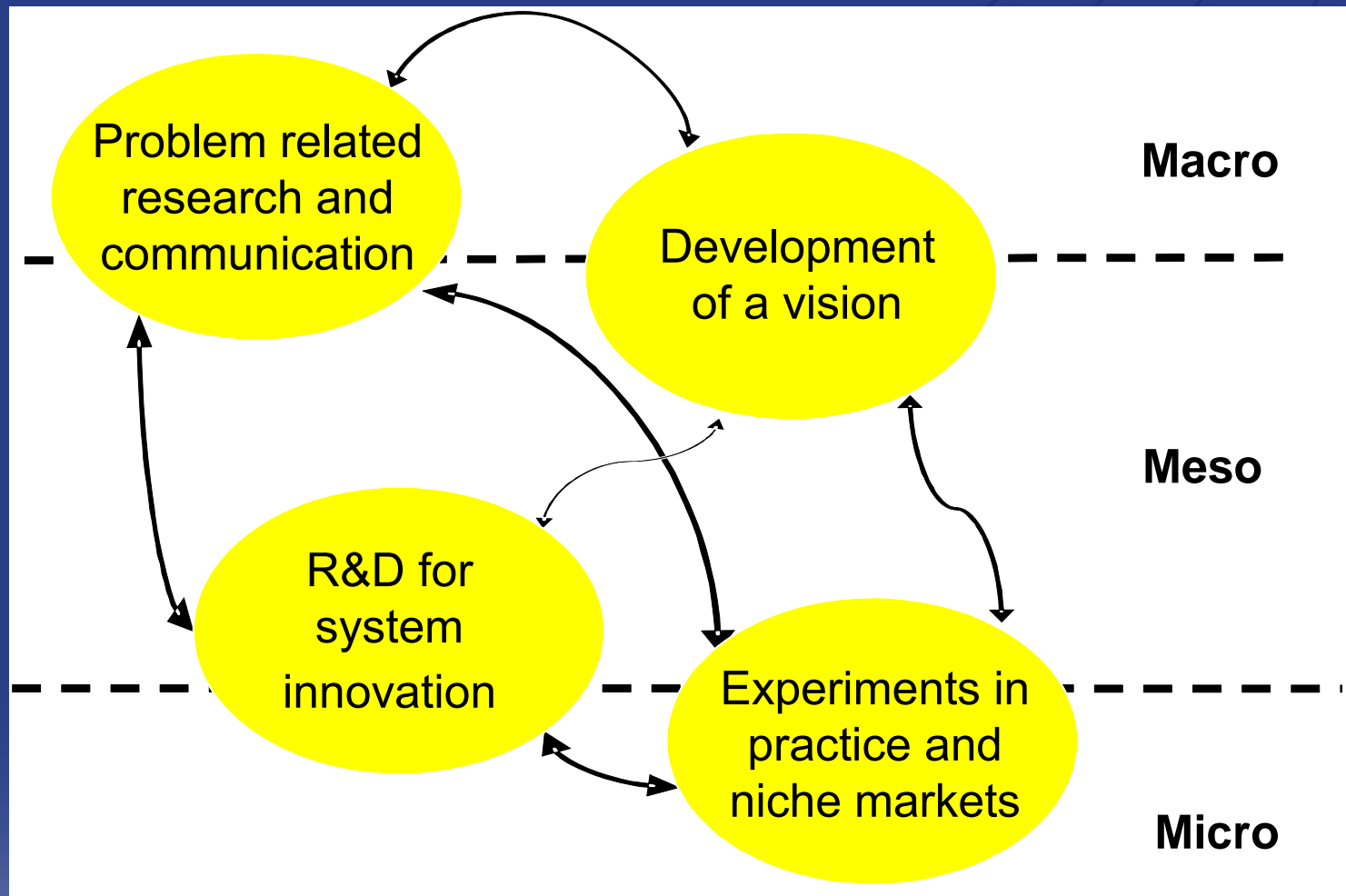
Effects of feed alternatives with replacements of fishmeal and fish oil



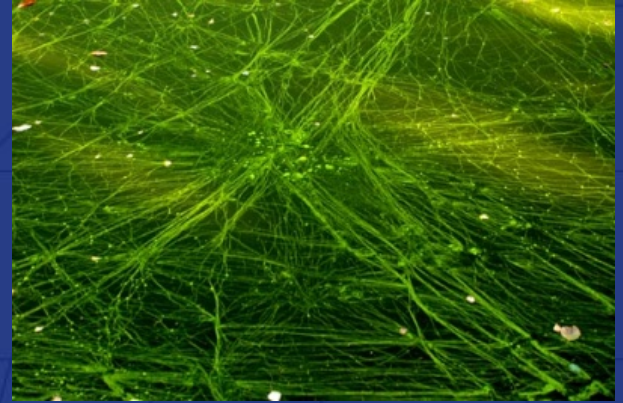
Progress to a sustainable aquaculture



Activities in the predevelopment phase



R&D, Experiments in practice



Netherlands Environmental Assessment Agency

Alternatives for fishmeal and fish oil

<i>Alternative</i>	<i>Disadvantages</i>
Small marine sources (krill, copepods)	High energy costs in catching; Difficulty of preservation; Risk of ecological impacts.
Genetic modification of crops	Public resistance.
Industrial production of algae	High costs.
Vegetable proteins	Lower protein content leading to more pollution; Negative for health and well-being of fish.
Vegetable oils	Fewer omega-3 fatty acids in product

(based on SMC)

Reduction of fatty acid in fish after replacements in feed

<i>Replacement of fish oil with vegetable oil (after first life phase)</i>	<i>Reduction of fatty acid in edible part of the fish</i>
100%	50 - 65%
60%	50%
100% and in the last weeks fish oil	10 - 30%

source: RAFOA, 2006

Ongoing reduction in the amount of caught fish for farmed fish

	<i>Ratio of caught fish to farmed fish</i>		
	1997 ¹⁾	2002 ²⁾	2010 ²⁾
Carp - fed	0.75	0.2 - 0.25	0.02
Tilapia	1.41	0.24- 0.27	0.11- 0.14
Salmon	3.16	2.6 - 3.3	1.2 - 1.5
Marine finfish (excl. salmon)	5.16	2.6 - 3.3	1.5 - 1.9
Trout	2.46	1.9 - 2.3	0.8 - 1
Catfish	0.84	0.22- 0.27	0.16 - 0.2
Milkfish	0.94	0.23 - 0.4	0.11- 0.14
Eel	4.69		
Carnivorous freshwater fish			

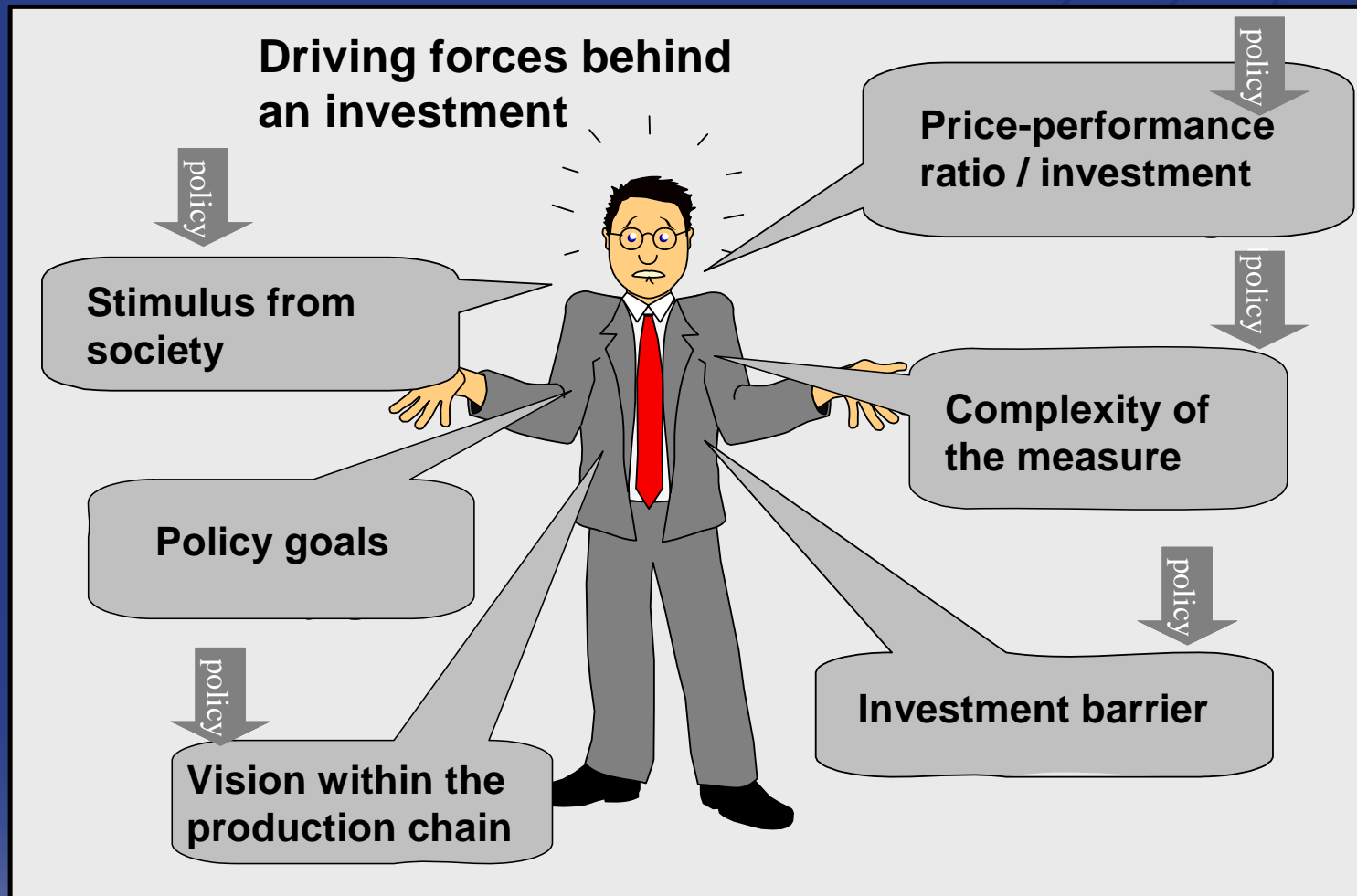
Source: ¹⁾ Naylor, ²⁾ Tacon

Ongoing reduction in the amount of caught fish for farmed fish

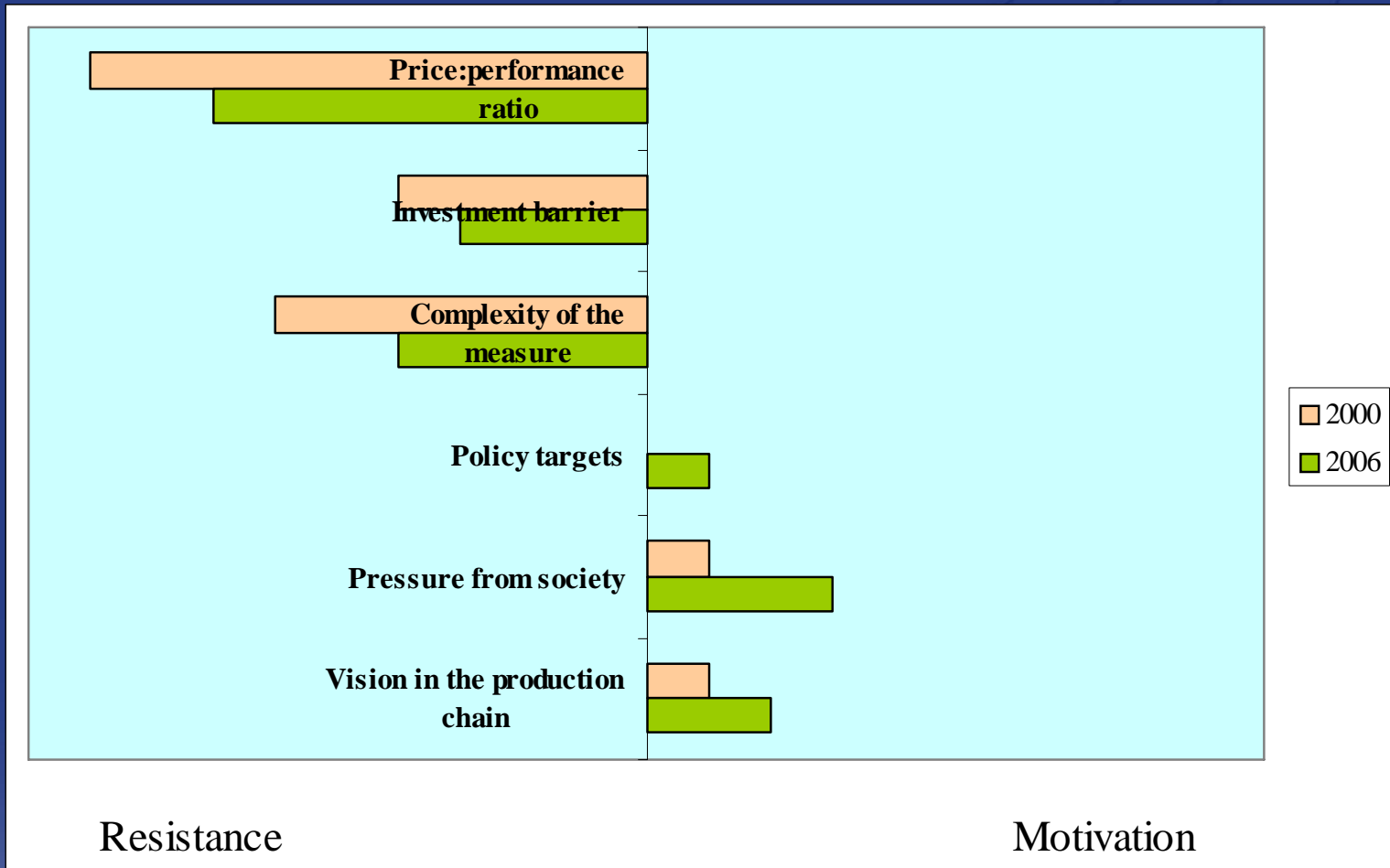
- Factor 2 is possible in short term.
- Higher replacements are uncertain.



Analysis of driving forces to 'measure' motivation



Driving forces for investing in algae production



Conclusions

System innovation focuses on developments for replacements of fishmeal and fish oil as important - but scarce - components of the feed for aquaculture.

- Developments on fish feed with minimal use of fish, such as vegetable materials, algae, worms or methane, but...
- Almost all developments are just starting and - at the moment - also have obstructions or negative effects.