

RESIDUS ORGANIQUES:

Production d Insectes pour la
Chaine Alimentaire : Lyon 29 Juin 2017



FARMING INSECTS for FOOD and FEED



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Overview

- How Insects as *Industrial* farming system came to Europe

Industrial : 1 or more tons of dried insect product output\day????

- And how it will affect the development of the agricultural and food industry:
 - Livestock & animal feed production
 - Organic waste management
 - (Novel) Food processing and innovation
 - Chemicals and Health care products

Insect Farming in Europe

for different products and services

- Since prehistory: Bees (from gathering honey to farming bees)
- Between 14th till 19th century: Silk moth farming
- Early **1900**: For pet food, fish bait, zoo's, medicinal, ornamentals,.....:
 - Mealworms, fly larvae, butterflies, crickets, beetles, etc..
some 20 species
- Since **1960**thies: IPM , Pollination (> 100 species)
- Since **2000**: insect farms exclusively for human food (< 10 species: crickets, mealworms,.....)
- By **2010**: mass rearing of insects as feed for (farmed) animals (< 5 species: fly larvae – BSF)



Carmine red



Carmine red (E120)

ECODIPTERA EU project - 2006 !

- biodegradation of pig slurry with fly larvae 2006 - 2008
- Reduce nitrification, smell, GHGs and spread of pathogens



Tianyuan Agriculture Company

Hangzhou, CHINA 2014



200.000 pigs on 3 floors

Fly larvae rearing on pre-treated pig manure
(6 day cycle)



Manure gathering and pre-fermentation



FLY LARVAE REARING ON PRE-TREATED MANURE ON A 6 DAY CYCLE





Global **FOOD** & **FEED** production

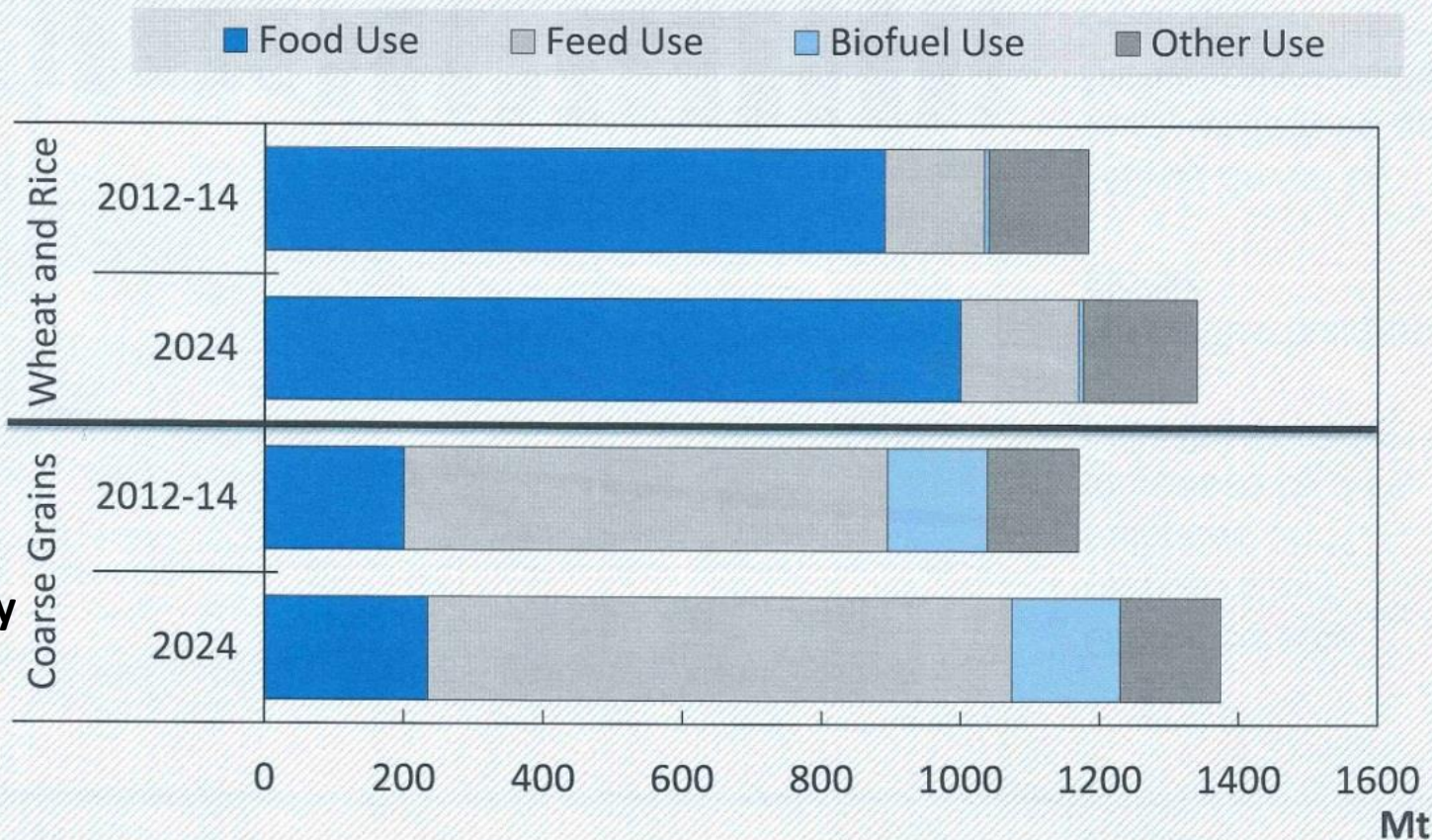
- **FOOD** for direct human consumption, including food ingredients like colorants, flavours, fragrances, spices, thickeners, etc:

8.4 b tons (fresh)/year (source FAOSTAT 2015)

- **FEED** for our animals (feed, fodder, ingredients,...)
 1. Livestock, farmed animals for human consumption
 2. Pet animals (cat, dogs, race horses, zoo animals,.....):

6.4 b tons dry matter/year (source GLEAM 2014)

Cereals utilisation



To feed our animals

In 2013

795 million tonnes of cereals (1/3 cereal production)

By 2050

an additional 520 million tonnes (1/2 cereal production)

Monogastric sector (chickens, pigs, aquaculture,..)

In 2013

Consumed 155 million tonnes of feed protein (mainly Soy)

In 2050

Additional 110 million tonnes of feed protein (50% from cereals/soy and rest from alternative protein sources, such as **INSECTS !!!!!**)

In 2013

110 million tonnes of coarse grains used for bioethanol

FOOD - FEED - ENERGY (+bioplastics) COMPETITION

60%

30%

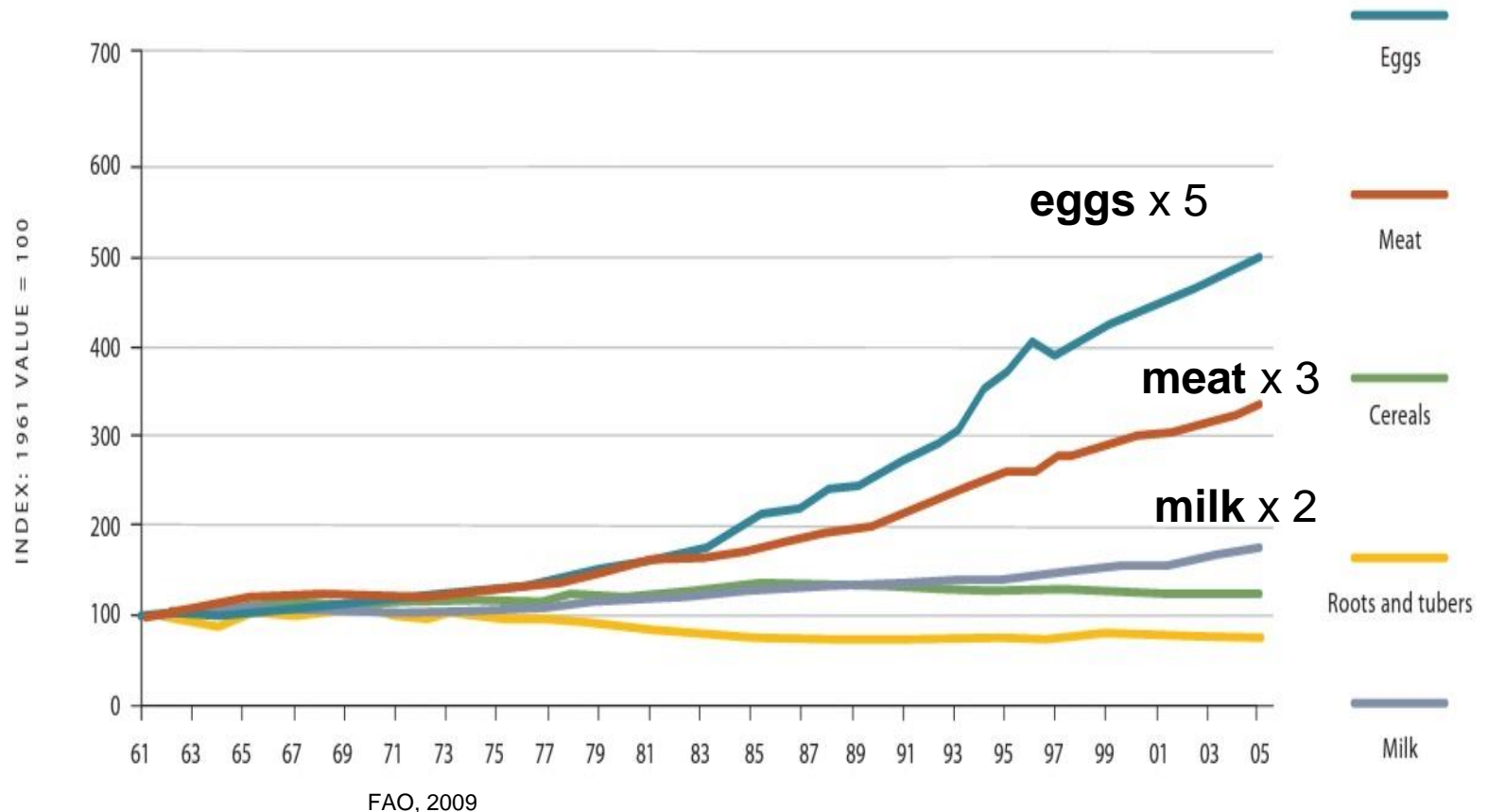
10%

Revolution in our **Meat and Fish** consumption!

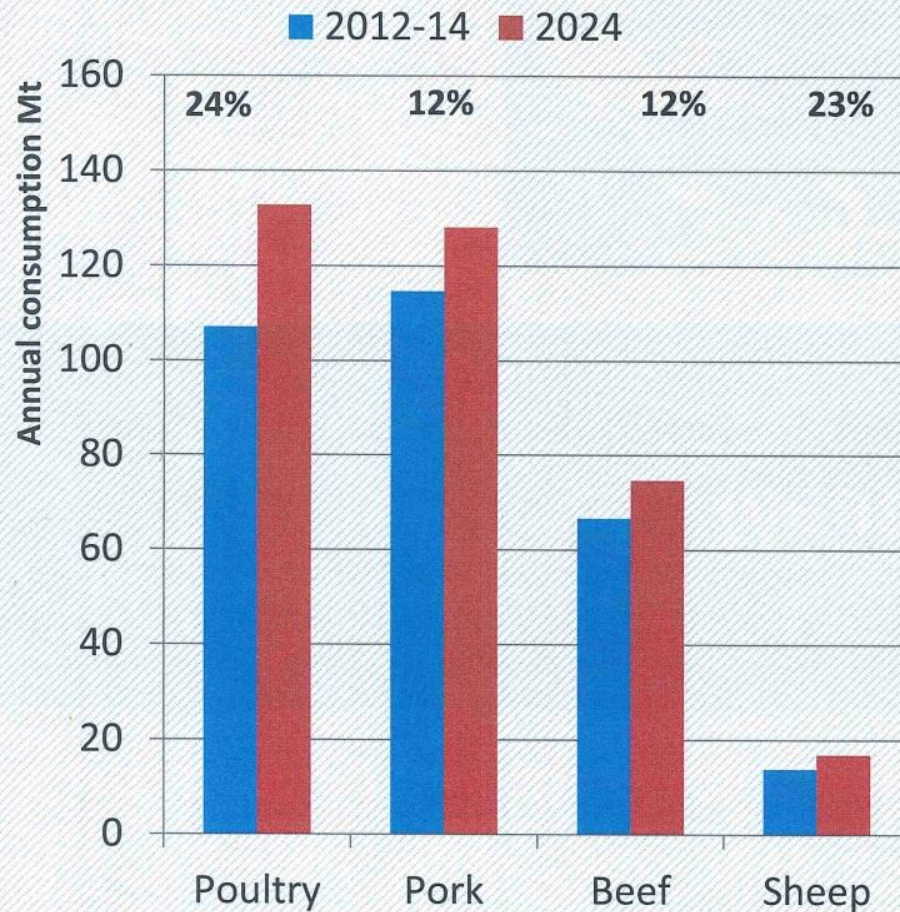
- global meat production has grown 25-fold since 1800
due to population growth ↑ and per capita consumption ↑
→ **global trend: from occasional luxury to centrepiece of every meal !!!!**
- Farmed fish: fastest growing sector !
Fish Shortage foreseen by 2030 everywhere

Pressure: more PROTEIN !

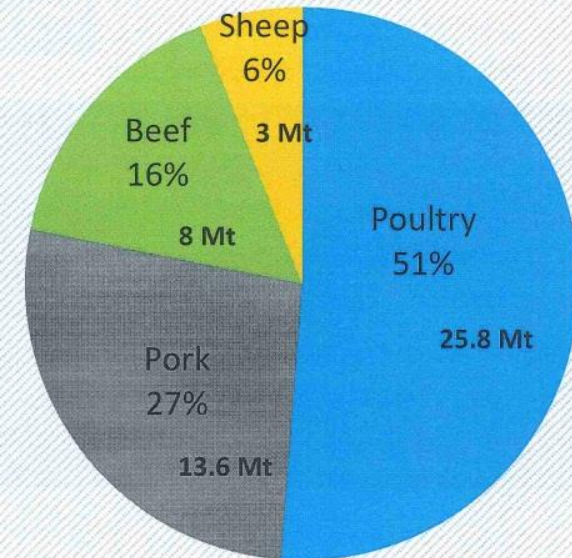
- Per capita consumption of major food items in developing countries (1961-2005) → **increasing demand for meat and other animals products**



Global meat consumption



50 million tons additional meat consumed by 2024

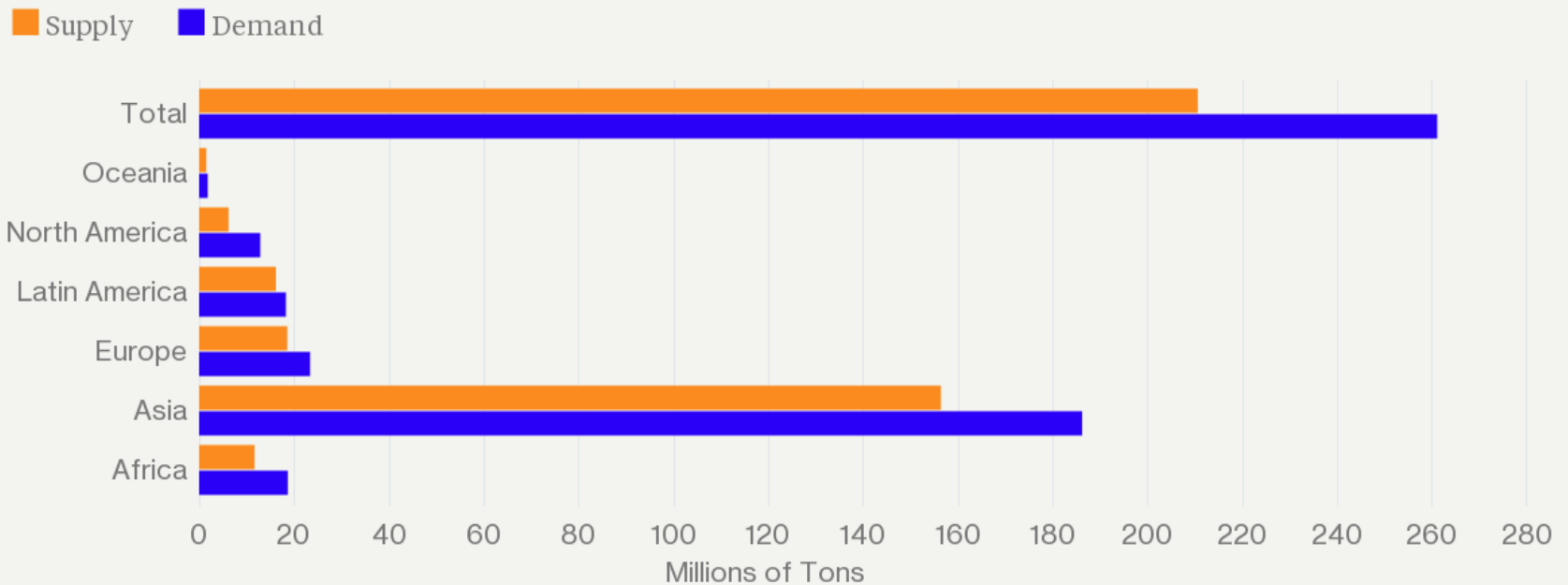


Global Fish Shortages by 2030



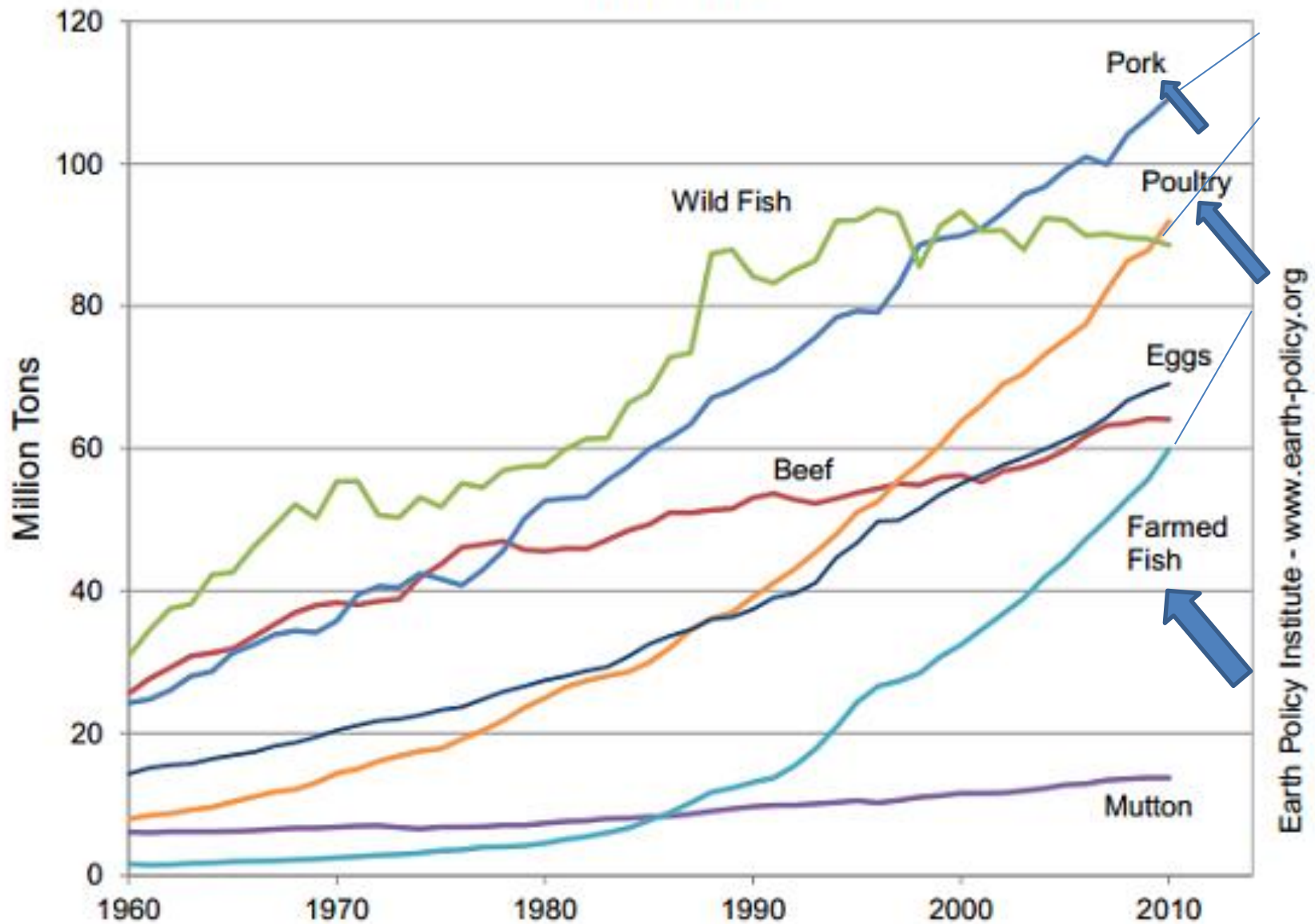
Global Fish Shortages by 2030

Demand set to outstrip supplies in all regions



Source: United Nations' Food and Agriculture Organization.

World Animal Protein Production by Type, 1950-2010



Source: Worldwatch, FAO

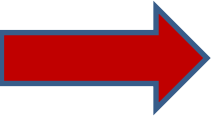
Protein alternatives....

in addition to improve existing protein production and consumption practices

- **Capture** more out of oceans: Medusae, Jelly fish, krill,...
- **Farming** the sea: macro, micro **Algae** (Spirula – High tech)
- **Artificial** proteins(Ap): meat (120.000\$/kg), synthetic AAs (6-16 \$/kg)
- More out of **Agro-industry processing(Aip)** byproducts: corn gluten, brewers grains, yeasts, potato protein concentrate, DDGS, ...
- Farming more **plant protein** sources: oil seeds; legumes, forages, trees, duck weed, (Moringa leaves),.....

**OR Compete for land, water, fertilizers, farm inputs OR
High capital/tech (AP,Aip, spirula,)**

potential: regional- niche markets

 Can we produce enough, safe food,
responsibly for 9 billion people
(and 100+ billion animals) by 2050 ?

Global agriculture production tripled in last 50 years with only 12% increase in farmed area

(population doubled during the last 50 years!)

Water consumption growing twice as fast as population growth

Food loss and waste at 1.3 billion tons/year (out of the 8.4b). Net food availability: 1 ton/ person/ year.....

 can **Insects** help Feed the planet ?

Global Insect Supply

- mostly by **gathering in nature** (2000+ species)
- some 20+ species by semi domestication (bees, bamboo worms)
- and now by farming (fly larvae)



FOR FOOD MAINLY

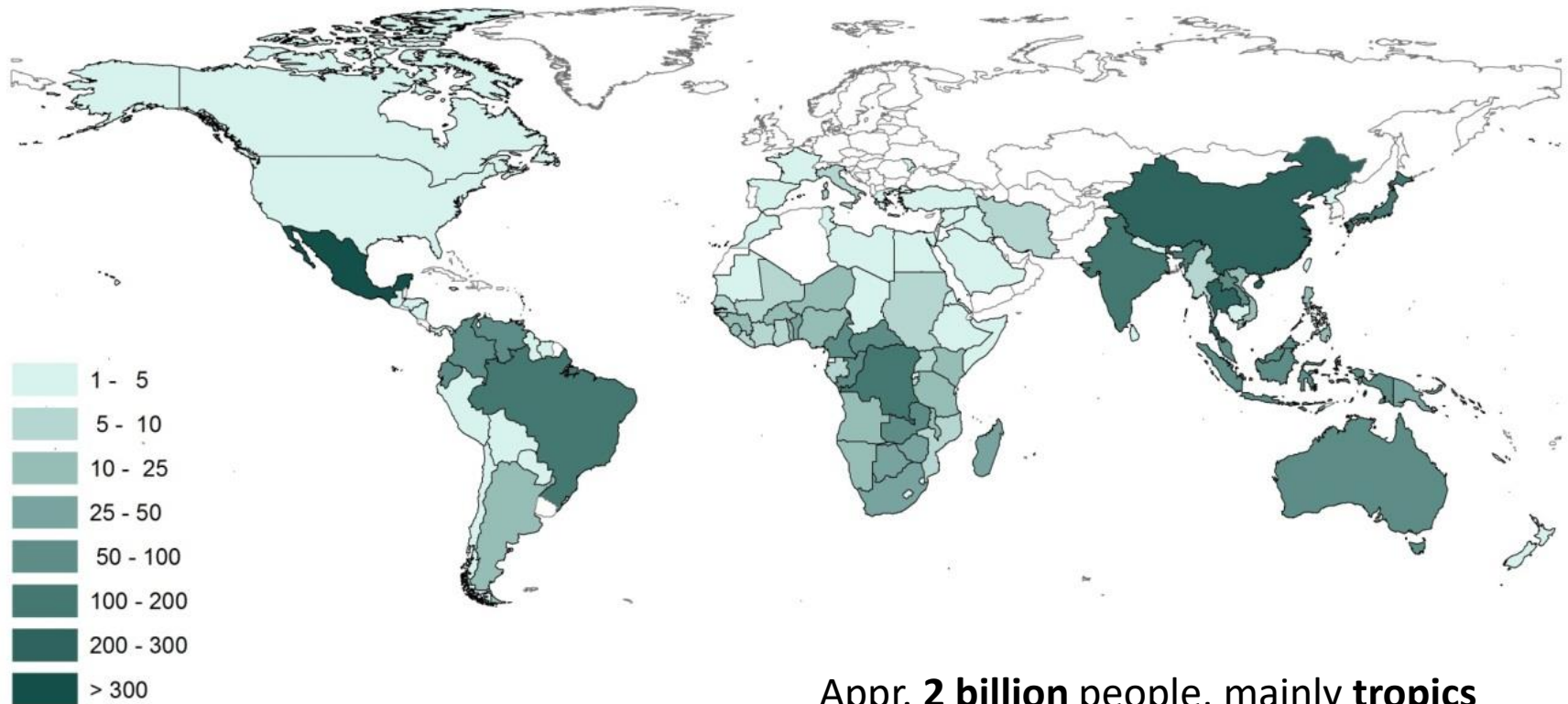
Insects as animal feed

- Chicken feed:
 - Silk worm pupae: from Europe to China
 - Termites: [Africa](#), Laos,
- Fish feed: # species



1. Consumption of Insects

Recorded edible insect species, by country



Appr. **2 billion** people, mainly **tropics**
some **50 Countries** (with at least 5 species)



27.10.2014



ZHAW - Switzerland



Samia ricini caterpillars on Ligustrum



ZHAW - Switzerland



Opportunities for farming Insects

Food – Feed – Non Food - Pharma

- Proteins
- Fats
- Chitin
- Enzymes, peptides and other products
- Services (IPM, pollination, ...)
- Waste management.....



More than proteins & fats: ex. Chitosan

Agricultural uses:

fungicide
fining agent for wine
Bio polymer

.....

Food additive: as soluble dietary fiber

.....

Possible **biomedical uses:**

- reduce bleeding in bandages
- as an antibacterial agent
- help deliver drugs through the skin
- limiting fat absorption (?)



Farming - **Substrate**

Wide variety of different types of organic materials :

- # insect species
- Species have specific feed requirements
- sequential species on same substrate + interaction with others: earthworms, nematodes, fungi, yeasts
(fermentation).....for waste disposal or for non-food/feed uses

For FEED mainly , less relevant for rearing insects for food

- **Competing** with the human \ farm animal food chain: for example rearing crickets with commercial chicken feed **NO EFFICIENCY GAINS !**
- **Not Competing**: low value rest streams, for example: food\feed\farmland and animal processing wastes (manure) **HIGHEST EFFICIENCY GAINS !**

Phasing Out Certain **Antibiotic Use** in Farm Animals

➔ CAN INSECTS HELP US TO REDUCE LEVELS OF ANTI-BIOTICS IN FARMED ANIMALS ?



Antimicrobial Peptides (AMPs)


Torino Creaa VII Convegno 29 may 2014 VANTOMME FAO.pptx - Microsoft PowerPoint

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Evidence-Based Complementary and Alternative Medicine
Volume 2014, Article ID 904958, 21 pages
<http://dx.doi.org/10.1155/2014/904958>



Hindawi

Review Article

Recent Advances in Developing Insect Natural Products as Potential Modern Day Medicines

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ENVIRONMENTAL BENEFITS

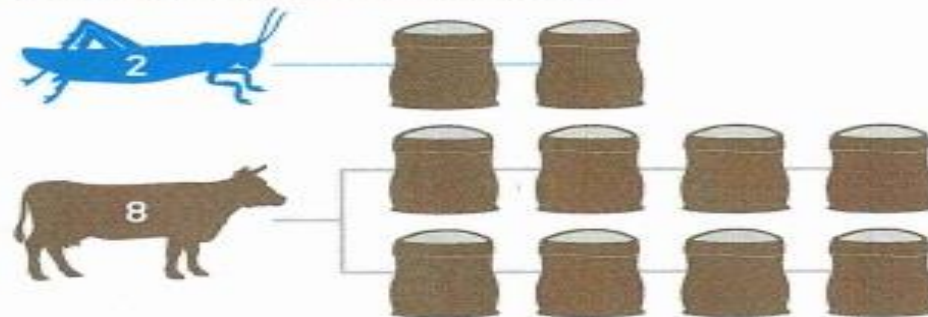
GREENHOUSE GAS PRODUCTION

Average GHG [g/kg mass gain]



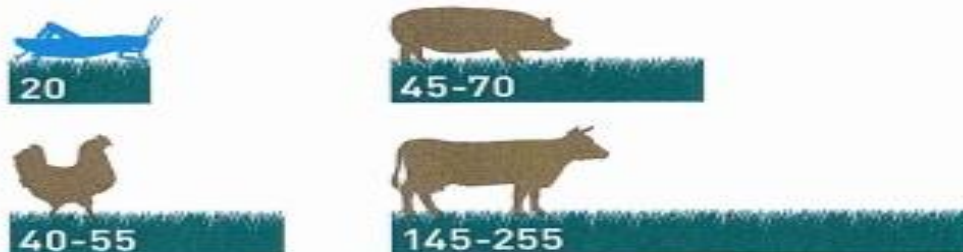
FEED CONVERSION EFFICIENCY

kg of feed required to produce 1kg of edible weight



LAND USE

Land use m² for 1 kg of protein



10 to 100 times less WATER as compared with cattle





Insect farming contributes to a closer, local circular economy in livestock rearing

- Locally produced side-streams from agriculture, agro-industries, food and waste management available to local insect farmers to produce proteins, fats as feed ingredients for livestock, meat & fish producers in the same region
- Shortening the chain for feed producers by incorporating more locally produced ingredients
- Improving local farming economies (including for small farm operators!power of the numbers !)

Insects are Socially more accessible

Farming insects does NOT require high investments

Knowledge – Capital - Land - Resources :

- also possible for the poor to farm insects, improve their diets and gain cash income
- Farming insects is possible **at any scale** of commercial undertaking , **everywhere** around the world and **during the full year**.
- Good for the **local economy** and **jobs** for the young !



Black Soldier Fly larvae production



Supermarket waste

1 ton fresh vegetables
(13 % Dry Matter)



~1 Million BSF eggs

17 days @ 25°C



Frass

100 kg fresh
(70% DM)



Larvae

160 kg fresh
(~40% DM)

62 Kg dry

- Protein (30 kg)
- Lipids (24 kg)
- Chitosan (5 kg)

Black Soldier Fly larvae production



bioflytech
Alicante, Spain



100 Kg brewery waste



0,4 kg seed larvae

10 days
25°C

Bio digester



33 kg fertilizer



33 kg larval biomass



12 kg fly meal

Larvae production



DANISH
TECHNOLOGICAL
INSTITUTE



+



+



Water: 20 L

Poultry manure: 80 kg

Fly eggs: 1 mio (100 mL)

3-4 days
@ 25-40 °C

Theoretic outcome:
10 gram larvae pr.
hen pr. day



+



Compost: 50 kg

Larvae: 8 kg



Examples from around the world

Global stakeholders : 1000+... and fast increasing

- <http://www.fao.org/forestry/edibleinsects/stakeholder-directory/en/>

An example from China (feed):

- http://foris.fao.org/static/edible_insects/China_pig_farm_manure_treatment_larvae.pdf

Examples from the US (Food\feed): Chapul, Exo, Tiny Farms, Enviroflight..... <https://www.exoprotein.com/>
<https://www.youtube.com/watch?v=cpol2d0c820>



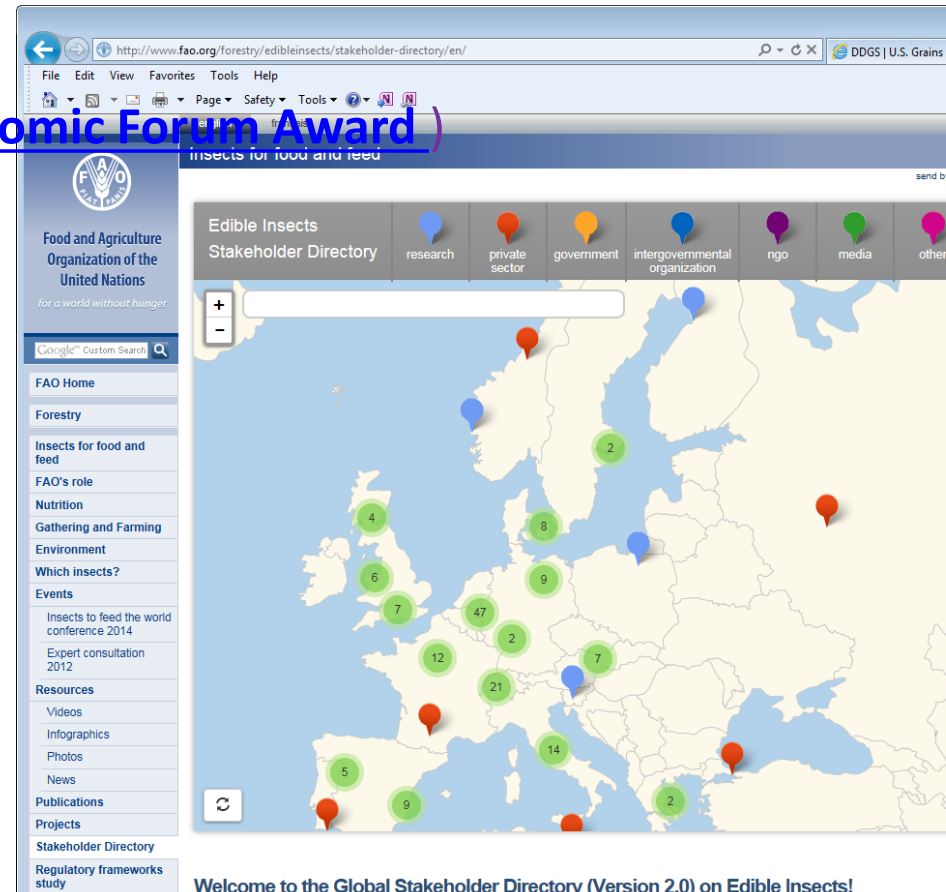
- uses co-product from breweries, ethanol production, and pre-consumer food waste as feedstock for Black Soldier Fly larvae
- cost-effective production of complete diets for aquaculture species, with reduced reliance on fish meal and fish oil

<http://www.enviroflight.net/>



From Europe

- Proteinsect EU project: <http://www.proteinsect.eu/>
- Greeinsect Denmark : <http://greeinsect.ku.dk/>
- Protix – NL ([Davos World Economic Forum Award](#))
- Bioflytech - Spain
- Hermetia – Germany
- Millibeter – Belgium
- Ynsect – France
-



Insects ? **YES !!!!** , but.....

- Biggest challenges:

- 1. Yuck factor:** more for food than for feed !

- 2. Legal framework** (in progress: US, EU (Novel Food, fish feed), CH, China, Thailand, RSA, Mexico, South Korea,.....)

- 3. Use of “Waste” to feed insects** (Tech + Legal)

- 4. Product innovation and scaling up**

.....no validated production and trade data by countries are yet available!

Product innovation



FOODS





Contains 20% cricket flour, a superfood that's rich in proteins, omega 3, vitamin B12

CRICKET
PASTA
bugsolutely

NET WT: 350 g (12.3 OZ)

Contains 20% cricket flour, a superfood that's rich in proteins, omega 3, vitamin B12

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bugsolutely
Cricket Pasta

Cricket pasta is a superfood and a very innovative product, the only pasta containing 20% cricket flour in the world.

This unique food is part of the fast growing edible insects market and features great nutritional values, including high levels of protein, calcium, iron, vitamin B12 and Omega 3.

Contains 20% cricket flour, a superfood that's rich in proteins, omega 3, vitamin B12

CRICKET
PASTA
bugsolutely

28.05.2016 01:43

Way Forward

- **Improve and focus awareness** (Media, sectors: food, feed,...
 - Events, projects, gastronomy..  Consumer acceptance
- **Increase knowledge generation, dissemination, networking....** (incl. protection of (indigenous) knowledge, nutrition data, environmental benefits, LCA, socio-economic contribution, jobs,
- **Legislation and regulatory frameworks** (food, feed, waste disposal, insect inclusive nature conservation strategies, habitat protection, gathering, processing, trade, consumer protection, health, (Codex Alimentarius, production and trade stats,...)
- **Economic's and technology:** reduce costs, improve efficiencies, automation, business innovation and new products,

Academia

Policy makers

Private sector



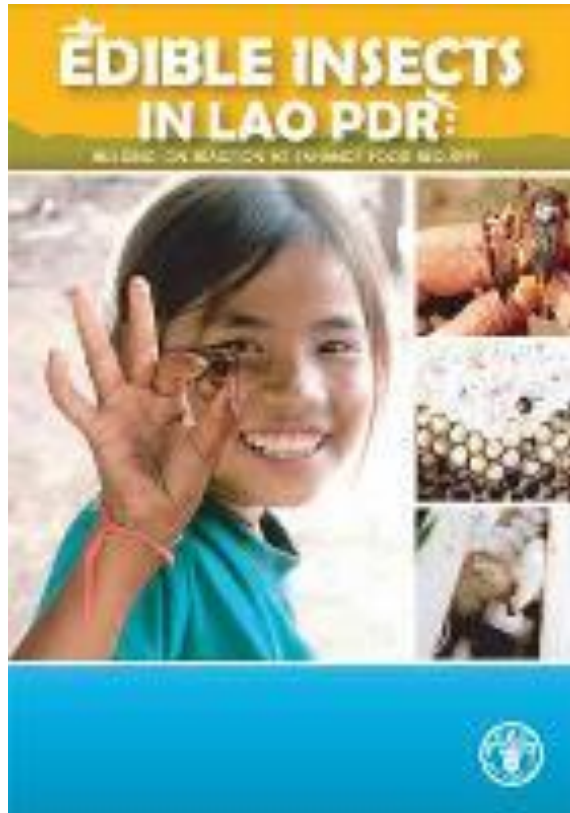
help structuring this emerging sector (organizing expert meetings – Chiang Mai 2008, Rome 2012, International Conferences – Wageningen 2014 ,Wuhan, China 2018,.....)

MANY THANKS !



FAO's role

Sharing Information among Countries




**TRAINING 1000
INSECT FARMERS
IN KINSHASA**

LAOS

THAILAND

CONGO



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Insects for food and feed

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EDIBLE INSECTS : A SOLUTION FOR FOOD AND FEED SECURITY?



[Read our publications on this overlooked protein supply](#)

○ ● ● ● ●

Trends towards 2050 predict a steady population increase to 9 billion people, forcing an increased food/feed output from available agro-ecosystems resulting in an even greater pressure on the environment. Scarcities of agricultural land, water, forest, fishery and biodiversity resources, as well as nutrients and non-renewable energy are foreseen.

Edible insects contain high quality protein, vitamins and amino acids for humans.

[Journal of Insects as Food and Feed](#)

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Edible Insects Stakeholder Directory

research

private
sector

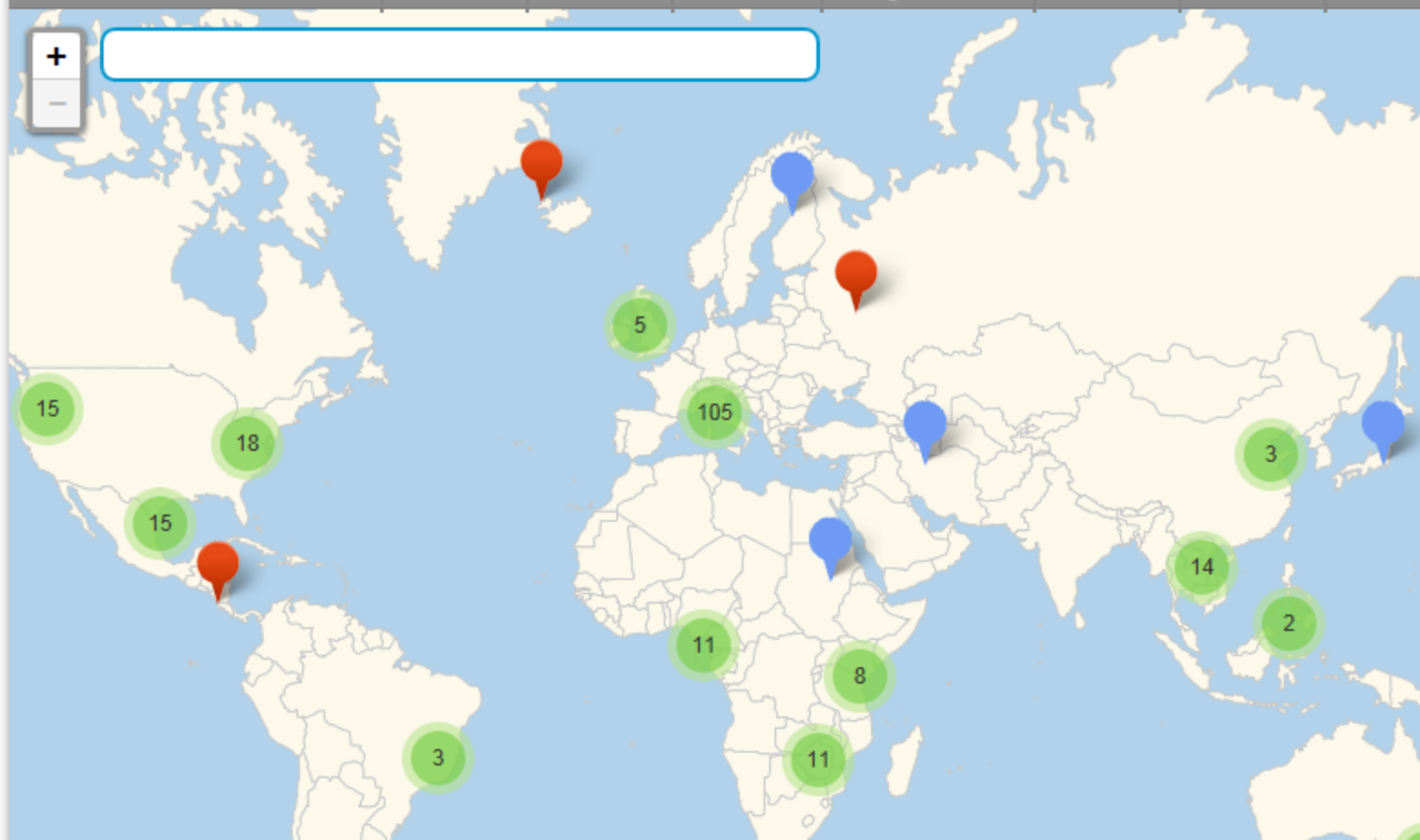
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organization

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other



FAO support to Food and Animal Feed



Regulations

- Country driven regulations, standards, codes for feed (ingredients) and animal health

Feed industry HACCP/ [OIE](#)/....

- CODEX ALIMENTARIOUS

Ad Hoc Intergovernmental Task Force on *Animal Feeding* ([TFAF](#))

(Aflatoxin b1).

(Laos, [crickets](#))

- **FAO Guidelines**

- Good [practices](#) for the Food/Feed Industry



Regulatory frameworks at country level

- **Insects for human food**

- a) De facto in # countries with entomophagy (Thai+conserving gathering of insects in nature policies tbd)
- b) recently in Belgium, Netherlands, Switzerland, Korea, and in progress at the EU (Novel Food 2018).

- **Insects as animal feed**

EU: Allowed for pet animals,
and fish farming (2017 ?)

what “substrate” to feed the insects ?

Regulatory frameworks at global level

- [Codex Alimentarius](#) (food/ feed) : to facilitate **TRADE** among countries
 - No entries yet on “Insects” (as food/feed) as there is no officially reported trade on insects in country statistics
 - Up to countries (national food safety agency) to propose regulations through CA regional or thematic commissions

Importance of the EU regulation on EI as a global standard setting

What next for FEED ?

Develop policies, regulatory frameworks, procedures, rules and legislations gradually allowing the use of insects (meals) as animal feed, incl:

- Setting up of sanitation procedures for safe use of bio-wastes as substrate
- Mitigating protocols for addressing diseases, heavy metals and pesticides
- Elaborate risk assessment methodologies (globally acceptable)
- Improve product safety and quality
- Animal welfare standards applicable to Insects (“slaughterhouse” issue)
-

Both at National, country level AND International level (EU, CA,....
Incl. by the feed **industry such as voluntary corporate standards**....

Edible insects

Future prospects for food and feed security



+7 million downloads...!

(since may **2013**)

and

+10 million tweets !

(launch on 13 May 2013)

Free available at :

<http://www.fao.org/docrep/018/i3253e/i3253e.pdf>

also in FRENCH, KOREAN, ITALIAN, CHINESE

"Insects to feed the world"

International Conference, NL

May 14-17, 2014.

- 450 participants from 45 countries
- organized by Wageningen University and the Food and Agriculture Organization of the United Nations

The conference was a milestone in the **recognition of the professional insect industry**. Feed industry leaders, insect breeders, universities, NGO's and other stakeholders gathered for the first time, with a clear message - **insects for feed and food are a viable solution for the protein deficit.**