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INSECTS AS A SUSTAINABLE SOURCE OF PROTEIN
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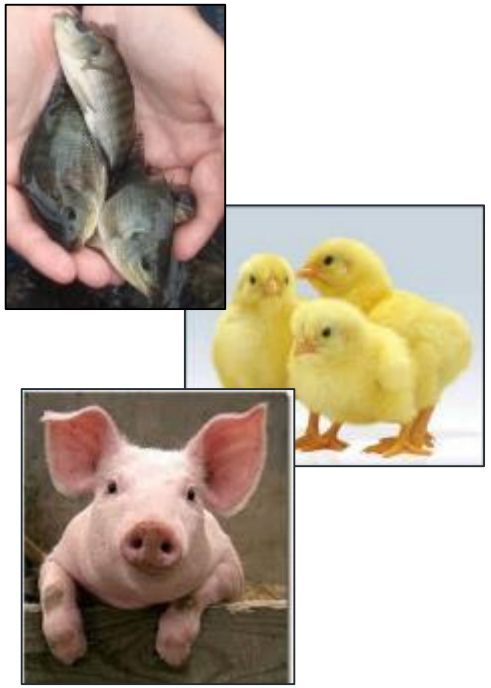
Insects as a Sustainable Source of Protein



fera

Durham University

DG AGRI November 2016
Elaine Fitches

To cover:

- Background
- PROteINSECT Research outcomes

Why Insects ?

- Insects **highly efficient** in the **rapid** conversion of “waste” into biomass
- A **natural** component of the diets of carnivorous fish and free-range poultry
- **Protein levels** in insect meals 55-75 %, comparable to animal protein sources
- Protein **digestibility** (86-89%) higher than many vegetable based proteins

Land Use

Protein crops (e.g. soya)
2.5 t/ha./year
90% dry wt & 40 % crude protein = 0.9 t protein

Fly larvae potential (non-optimised)
25 t/ha./8-10 days = 1000 t/ha./year.
25% dry wt & 60 % protein = 150 t protein

200 fold reduction in land use

- Value of product ?
- Cost of production ?
- Safety/legislation ?

2013 values

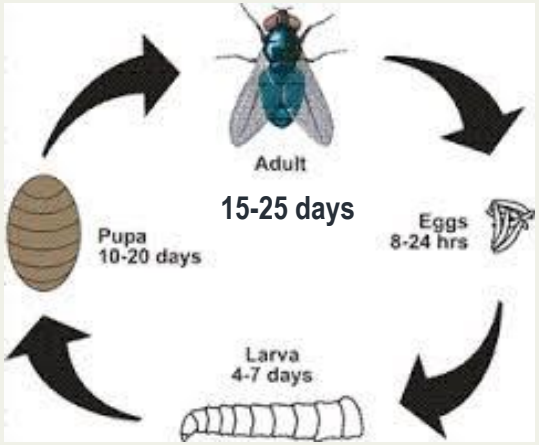
Which Insects ?

Black soldier fly: *Hermetia illuscens*

- food, swine, poultry & human waste
- min. 14 days: egg to mature larvae
- require > 30 °C for development
- mean wt. 0.2 g/ larvae
- adult breeding/egg production is challenging

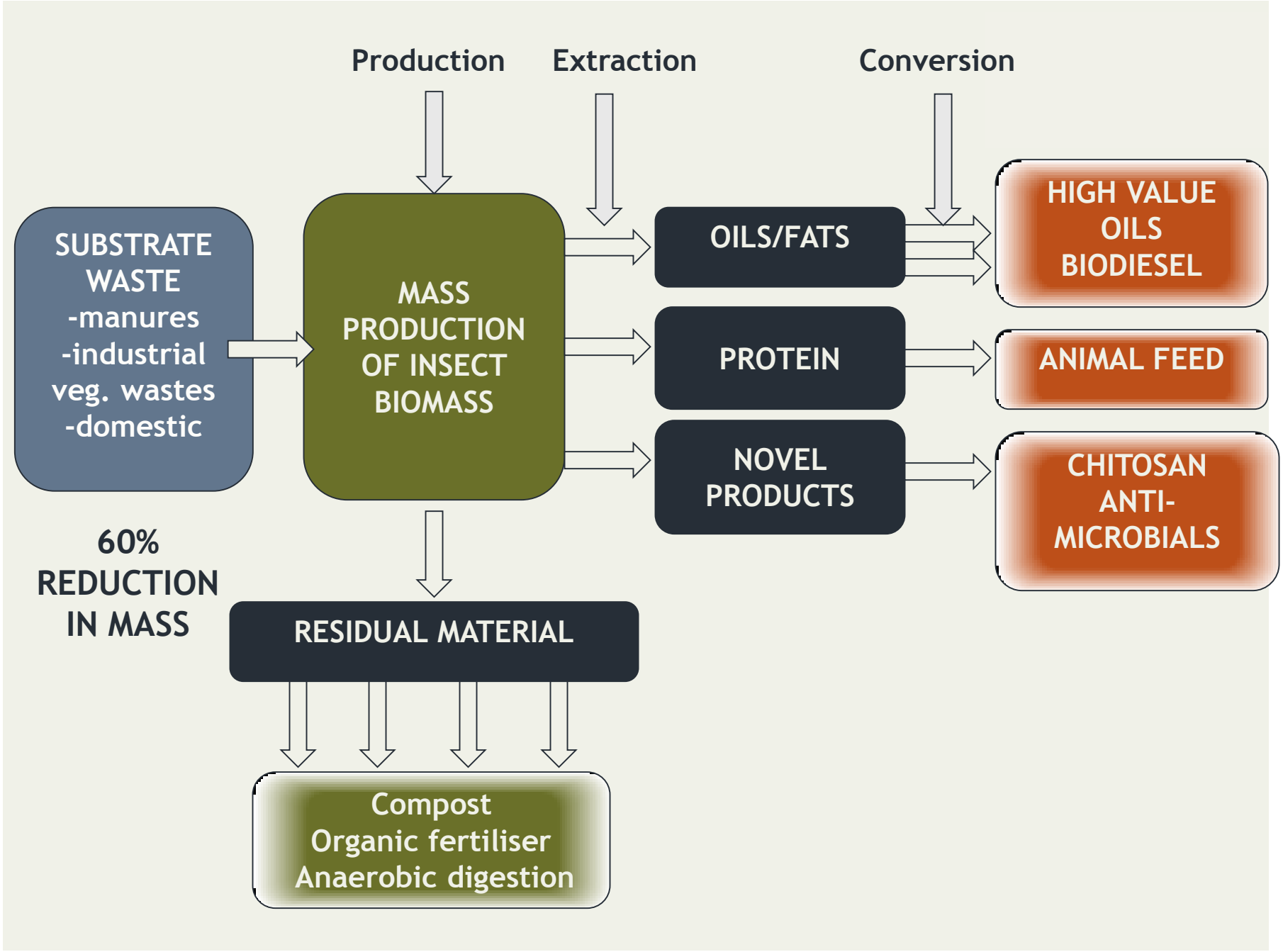
Complete life cycle 5-6 weeks

House fly: *Musca domestica*



- food, swine & poultry waste
- 4-13 days: egg to mature larvae
- require > 17 ° C for development
- mean wt. 0.02 g/larvae
- 500 eggs/adult

Complete life cycle 3-6 weeks


Production
Extraction
Conversion
SUBSTRATE WASTE -manures -industrial veg. wastes -domestic
MASS PRODUCTION OF INSECT BIOMASS
OILS/FATS
PROTEIN
NOVEL PRODUCTS
HIGH VALUE OILS BIODIESEL
ANIMAL FEED
CHITOSAN ANTI-MICROBIALS
60% REDUCTION IN MASS
RESIDUAL MATERIAL
Compost
Organic fertiliser
Anaerobic digestion

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- 3-year EU-funded project (2013-2016) with 12 partners from 7 countries (China, Africa, Europe)
- Focus on the use of **fly larvae (housefly & BSF)** in poultry, pig & fish feed
- Evaluating the suitability of **organic waste materials**, including animal manure, as a substrate for rearing flies.

nutrition sciences

cabi.org

IER

Guangdong Entomological Institute 广东省昆虫研究所

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UNIVERSITY of STIRLING

eu|te|ma TECHNOLOGY MANAGEMENT

GRANT BAIT Ltd The Fresh Bait Experts

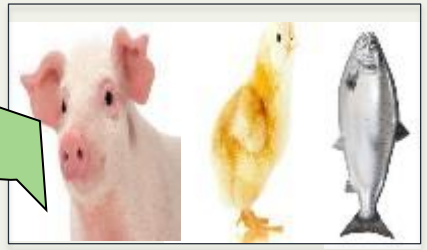
KU LEUVEN

- Substrates- animal manures
- Low value wastes
- Insect rearing systems (China, Africa, UK)

- Nutritional value & quality
- Safety (Chemical & Biological)
- By-product evaluation

- Processing- crude & refined protein

- Regulation
- Consumer perception



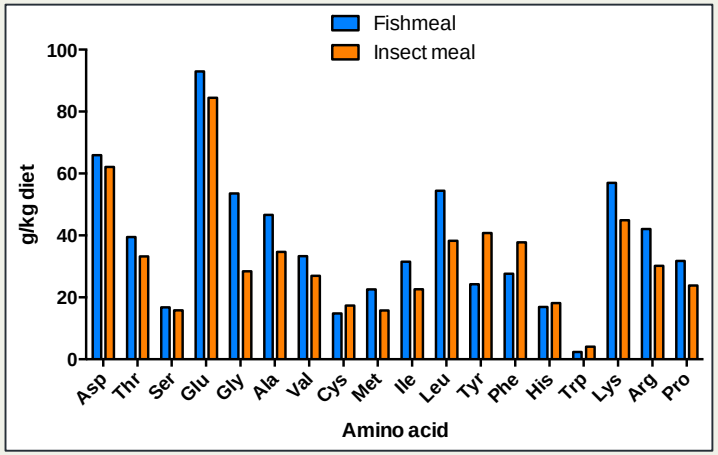
- Animal trials
- Inclusion rates
- Meat quality

Production systems

- 5 Production Systems (2 in China) – all supplied dried larval samples for quality & safety analysis
- More than 100 kg dried larvae produced (UK) for use in European feeding trials for poultry, pigs and salmon

Quality- Insects

- House fly and Black Soldier fly larvae are high in protein (41 – 61 % dry matter); soy approx. 40 % and fishmeal approx. 70 % dry wt.
- Amino acid profile comparable to fishmeal & fatty acids comparable to palm kernal oil (high in lauric acid)
- Hexane extraction is a suitable, scaleable method to produce protein enriched (mean 51% to 68% [w/w]) material



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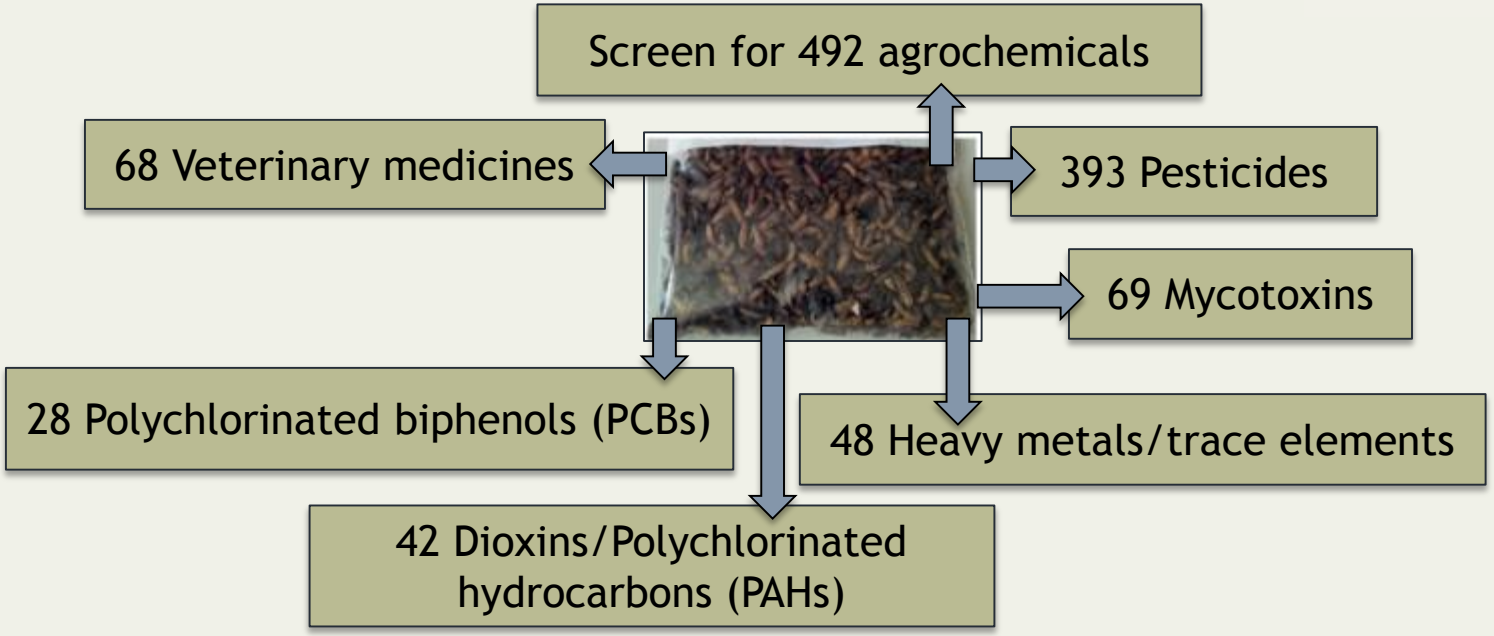
Chemical Safety-Insects



Contaminants below recommended max. concentrations (EC, WHO, & Codex)

- **Cadmium high in 3 samples**
- **Contributed to EFSA expert opinion 2015**


Exploring the chemical safety of fly larvae as a source of protein for animal feed

Journal of Insects as Food and Feed

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Biological Safety-Insects

- Feedstock and insect species dependant
- Potentially managed through processing e.g. heat, pressure.
- Anticipated persistent risks may include; Salmonella spp, and Hepatitus E.

The absence of viable *Salmonella*, *Campylobacter* and *Listeria monocytogenes* was confirmed for all samples tested.

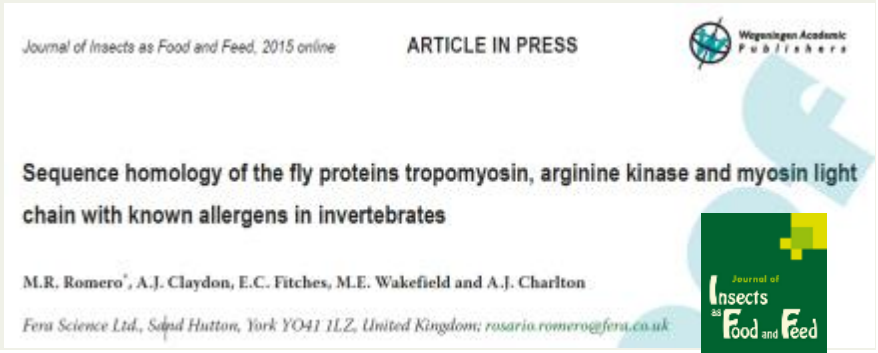
Allergenicity in humans

- Very little information available about insect allergens
- Low probability of insect proteins being contained in meat/egg/fish produced from insect-fed animals.
- Higher risk from insects as food.
- Potentially allergenic proteins include tropomyosin

Allergen detection

- LC-MS/MS enables the identification of known allergens including tropomycin, arginine kinase and myosin light chain.
- Bioinformatics search for orthologues of allergens where insect genomes are available – high homology may indicate allergenic potential.

High potential of allergenic response to eating insects if sensitive to shellfish



Aquaculture- feeding trials

Ghana: Nile Tilapia fingerlings
Black soldier fly meal (MM)

Commercial conditions

- Treatments: FM100; MM25, 50, 75% replacement of FM
- 22, 500 fingerlings, (1 m^2 cages, 1500 fingerlings per cage, triplicate), 32 days
- Hand feeding (experienced operator)

Results

- All dietary treatments performed well & similarly to control fishmeal diet
- Fish oil-free diets impacted on the fish composition (reduced in omega 3)- to consider for further application to grow-out fish

UK: Atlantic salmon freshwater parr: housefly meal (MM) and de-fatted meal (DMM)

Freshwater Research Unit

- Treatments: FM100; MM25, 50, 75, 100 % replacement of FM; 50% replacement of FM with DMM
- 3,600 parr, 18 tanks (1 $m^{3;}$ 200 fish/tank), triplicate, belt-feeder, 8 weeks

Results

- MM & DMM suitable alternative to FM – **can replace up to 50% FM** in a practical diet for parr
- A good source of highly digestible protein (amino acid profile, digestibility)
- Lipid digestibility was reduced when up to 75% or more FM was replaced by MM or DMM

Pig- feeding trial

Nutrition Sciences

- Treatments: control, MM 2.0 % & DMM 1.25 % w/w (replacing fishmeal)
- 48 male castrated 3 week old pigs (12 pens, 4 pigs per pen, 16 per treatment), 4 weeks
- Diets iso-nitrogenous & energetic

Results

- All treatments performed similarly well (WG,FI,FCR)
- Significantly more +ve bacteria (lactic acid bacteria) detected in the ileum of piglets receiving insect-supplemented diets.
- No taints detected in pig meat

Poultry- feeding trials

Nutrition Sciences

- Treatments: control, MM 2.0 % & DMM 1.25 % w/w (mainly replacing soybean meal & oil)
- 300 male day-old Ross 308 chicks (15 pens, 20 chicks per pen, 5 per treatment), 39 days
- Diets iso-nitrogenous & energetic

Results

- All treatments performed similarly well (WG,FI,FCR)
- Significantly less pathogenic bacteria (coliforms, *Enterbacteriaceae*) detectable in gizzard of chickens fed insect-supplemented diets
- No taints detected in chicken meat

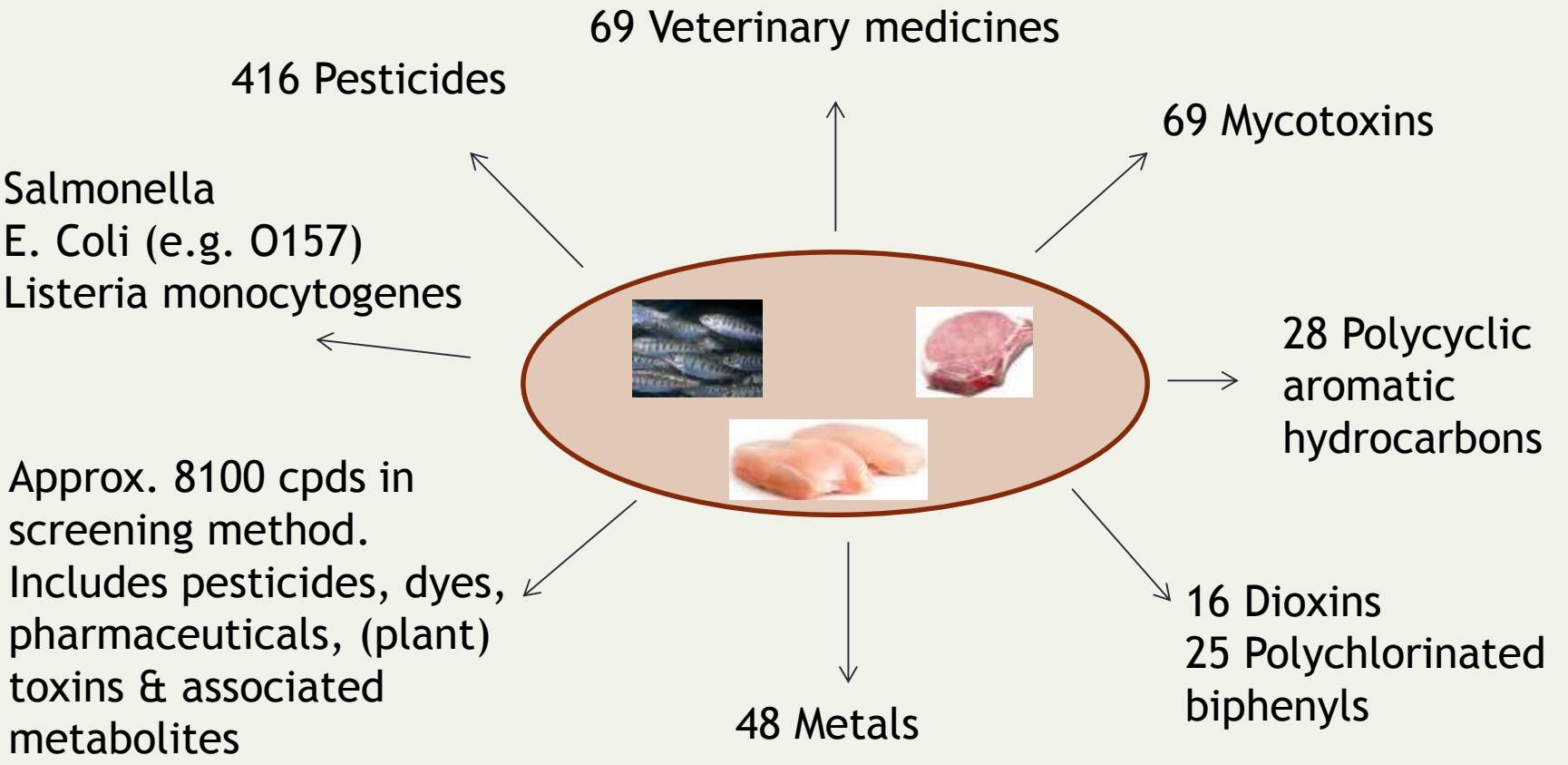
Other poultry trials

Broiler breeder trial China

Layer trial Mali

Broiler trial Mali

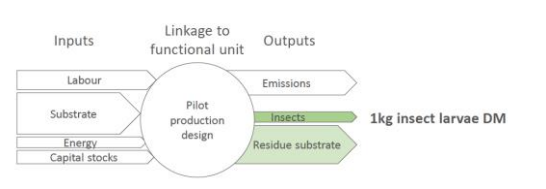
Animal trials- Safety analysis

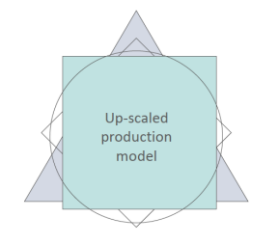


No safety concerns for fish, chicken & pork samples from analytical/ microbiological results.
Residue / contaminant levels < current EU regulatory limits

Life Cycle Analysis

- Ex-ante life cycle sustainability assessment of insect-derived animal feeds in different geographical regions
- Compare insect product performance with conventional protein feeds
- Develop optimization pathways towards more sustainable insect production systems





Modelling of up-scaled systems

IMPLEMENTATION

- Depending on the geographical context and scale of production, the **sustainability** performance of **current production designs** was found **comparable** to the one of **fishmeal**
- Important **performance-critical site conditions** are prevalent **wage level**, **climate**, **substrate availability**, **energy mix of national grid**
- Use true **waste streams** (no economic value) or **substrates** that are **not** yet **valorized in other value chains.**
- Where possible, we recommend a direct **integration** in **substrate providing facilities**

Consumer Perception

Challenges

- Lack of cultural history of entomophagy in the west.
- Negative perception; insects as pests/vectors of disease.
- Consumers increasingly interested in how their food is produced and want to be sure that it's what it says on the tin!

Two Consumer Perception Surveys

Survey 1: Baseline exercise to discover whether people would be accepting of insects in animal feed and food – and if not, what objections they raised.

Survey 2: To gain a better understanding of current consumer perceptions about eating animals fed on existing and novel proteins (insects benchmarked against current sources of protein for animal feed)

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Survey 1

- People more accepting of the idea of insects in food and feed than we might have predicted
- Clear desire for more information to be made available

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Survey 2

of 1150 respondents...

ACCEPTABILITY

70%

SAID THAT IT IS TOTALLY ACCEPTABLE/ACCEPTABLE TO FEED INSECT PROTEIN TO FARMED ANIMALS, INCLUDING FISH

COMFORT

66%

WOULD BE VERY COMFORTABLE/COMFORTABLE EATING MEAT FROM A FARMED ANIMAL (INCLUDING FISH) FED ON INSECT MEAL

RISK TO HEALTH

64%

SAID THERE IS NO RISK OR LOW RISK TO HUMAN HEALTH IN EATING FARMED ANIMALS (INCLUDING FISH) FED ON INSECT MEAL

KNOWLEDGE GAP

30%

THE DIFFERENCE BETWEEN HOW KNOWLEGABLE THEY ARE, AND HOW KNOWLEGABLE THEY FEEL THEY SHOULD BE

Communications

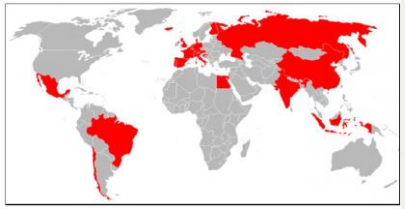
Expert Round Table: April 2015
Consensus Business Case

White Paper "Insect Protein Feed for the Future" European Parliament launch April 2016

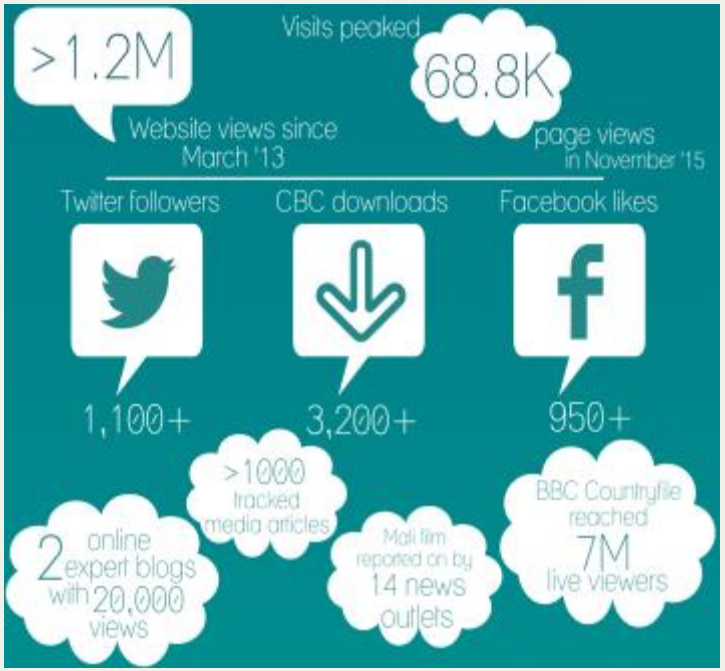
MEP Sponsor: Jan Huitema, member of the European Parliament Committee on Agriculture and Rural Development

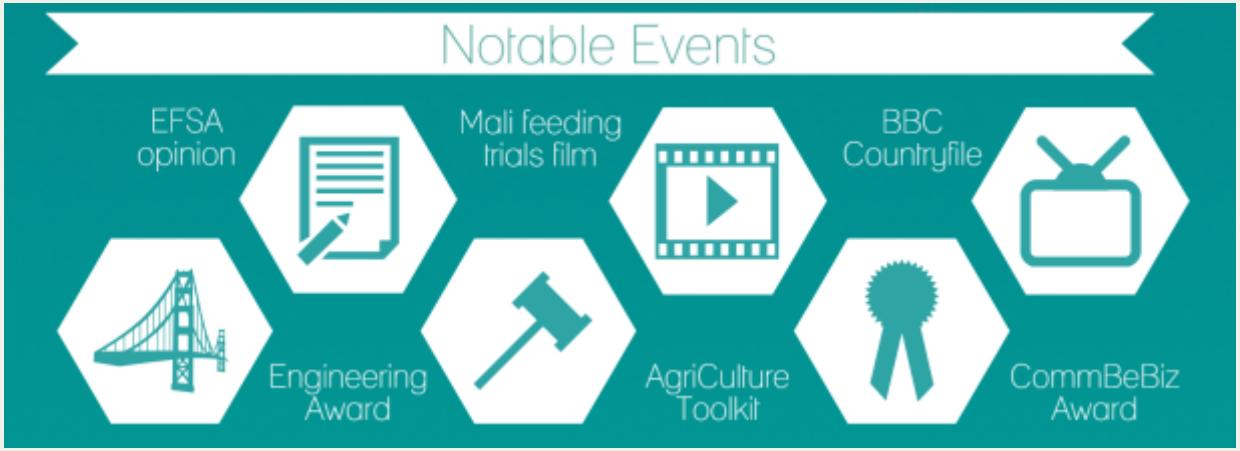
Final Conference April 2016

130 attended from across Europe, South America, USA & India



Media Activity





Summary – Research Findings

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- Housefly & Black Soldier fly larvae can be reared on manures and by-products: systems established across different global locations
- Nutritional quality of larvae excellent (comparable to fishmeal) & highly suitable for use in animal & fish feeds
- Extensive safety screening suggests minimal risks and that potential risks can be mitigated by processing (eg. microbes)
- Quality & safety data formed part of the evidence base needed for regulatory authorities to assess potential for inclusion of insects in feed regulation (EFSA expert opinion – October 2015)
- Fish, chicken and pig feeding trials all suggest insect meal and/or refined insect protein is a suitable replacement for fishmeal and/or soymeal
- Consumer perception & media monitoring suggest a high level of support for use of insects in animal feed but also a desire for more information

Thanks to:

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