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Towards a Sustainable Use of Agricultural Waste
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Insect-technology: A new approach to use organic waste in agriculture and it’s relation to the development of the organic market.

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Contents of the presentation

➢ The IFOAM EU Group
➢ Introduction to Organic Farming
➢ Insect Technology
➢ Research & Application
➢ Conclusion: Expectations for the Organic market
The IFOAM EU Group

- The EU Group of the International Federation of Organic Agriculture Movements is the European umbrella organisation for organic food and farming.

- Is engaged for the adoption of ecologically, socially and economically sound agriculture systems based on the principles of organic agriculture – health, ecology, fairness and care.

- More than 170 member organisations.

- Work spans the entire organic food chain and beyond: from farmers and processors, retailers, certifiers, consultants, traders and researchers to environmental- and consumer advocacy bodies.

Source: IFOAM
What is Organic Farming?

- Organic Agriculture (OA) is an alternative to conventional and industrial agriculture, legally defined by Regulation (EC) No 834/2007, complemented by private standards.

- OA is based on a systemic approach, considers the interaction between the plants and their environments,

- OA is a driver for agronomic innovation.
What is Organic Farming?

➢ OA forbids the use of GMOs and pesticides.

➢ OA is a production system that sustain health of soils, ecosystems and people. It relies on ecological processes, biodiversity and cycles adapted to local conditions, rather than the use of inputs with adverse effects.

➢ OA combines tradition, innovation and science to benefit the shared environment and promote fair relationships and a good quality of life for all involved.

Source: IFOAM
A growing market
Organic Market Trends 2004-2013

Europe and EU-28: Market development 2004-2013
Organic agriculture and utilisation of agricultural waste

Organic agriculture is a systemic approach that can tackle the issue of agricultural waste, which should not be discarded. The focus should be on the ways that they can be utilised in order to close the nutrient cycles and benefit the farm’s economy.

Such ways are
- Biogas production
- On-farm use as fertilizer
- Insect technology – that will be presented here

Source: IFOAM
Insect Technology

- *Hermetia illucens*; Black Soldier Fly
- Global abundance: Tropics, Subtropics, Mediterranean, Temperate Europe
- Larvae could use nearly all organic substrate for growth
- Last larval stadium (pre-pupa) contains 45% protein; 35% fat
- Meal can be purified to > 60% protein, < 10% fat
- Favourable amino-acid profile (similar to fish meal)
Legal situation I

- The legislative situation in the EU is slowing down the fast industrial development of insect production at present.

- Insects must be processed in accordance with the EU Animal By-Products Regulation (EC) 1069/2009 to become processed animal protein (PAP) before they can be fed to livestock.

- Under this regulation, non-pathogenic insects are classified as category 3 material (low risk material) and would therefore be suitable for feeding to farmed animals.

- However, the TSE regulation (EC) 999/2001 bans all PAP except fishmeal from being used in animal feeds, if they are not transformed to hydrolysed proteins.

- Insect larvae are considered as livestock and are therefore not allowed to be fed with non-hydrolysed C3-material and any kind of animal manure.
The TSE regulation is based on processing raw materials in certified slaughterhouses – as insects do not follow the same route as livestock when it comes to slaughtering insect PAP can therefore not meet the requirements of the TSE regulation.

Producers of insect meal have to work according to the General Food Law Regulation (EC 178/2002) as well as the regulations on food (EC 854/2004) and feed hygiene (EC 183/2005). These regulations require production sites to be registered and approved following an on-site visit including evaluation of HACCP procedures.

If insects are to be used for feed, maximum permitted levels of contaminants (e.g. heavy metals) are defined by directive (EC) 2002/32 on Undesirable Substances in Animal Feed.
Insect Technology

Focus: BSF

Source: Internet
Insect Technology

Input: Farm- and Food waste

Output: Feed Proteins, Oils

Output: Biogas

Output: Fertilizer

Output: Residues

Source: Anonymus, Internet
90 million tons of food are discarded annually in the EU (agriculture and fishery excluded)

Disposal and further use is mainly done by composting, biogas production, burning or landfilling

Raising competition between formulated feeds and food:

- 20 million tons of small fish are processed to fish meal (4.5 million t, from which 90% are fed to fish again)

Insect technology can use food waste as well as agricultural waste and transform it to feed proteins, fat and fertilizer or bio-gas
Wachstumsverlauf der Larven in Abhängigkeit von der Zeit

Größe der Larven [mm] vs. Zeit [d]

Schweinegülle
Legehennenmehl
Hühnermist
Brot
Pflanzen
Rindermist

Research and application: Substrates

BSF-Larval growth on different substrates

control

Pig manure
Layer hen feed
Chicken manure
Bread
Tomato plants
Cattle manure

Source: Stamer 2008
# Research and application: Organic Waste reduction

<table>
<thead>
<tr>
<th>Species</th>
<th>Feed source</th>
<th>Total amount of feed</th>
<th>Residue</th>
<th>Waste reduction</th>
<th>Yield</th>
<th>FCR</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>H. illucens</em></td>
<td>MOW</td>
<td>151 kg DW</td>
<td>48 kg DW</td>
<td>68% DW</td>
<td>17.8</td>
<td>kg</td>
<td>(Diener, 2010)</td>
</tr>
<tr>
<td><em>H. illucens</em></td>
<td>Pig manure</td>
<td>68 kg DW</td>
<td>42 kg DW</td>
<td>~39% DW</td>
<td>~2.7</td>
<td>kg</td>
<td>(Newton et al., 2005a)</td>
</tr>
<tr>
<td><em>H. illucens</em></td>
<td>Chicken manure</td>
<td>5,240 kg WW</td>
<td>~2,620 WW</td>
<td>~50% WW</td>
<td>196</td>
<td>kg</td>
<td>(Sheppard et al., 1994)</td>
</tr>
<tr>
<td><em>M. domestica</em></td>
<td>Chicken and cow manure</td>
<td>125 kg WW</td>
<td>95 kg WW</td>
<td>25% WW</td>
<td>3 kg</td>
<td>WW</td>
<td>(Morgan &amp; Eby, 1975)</td>
</tr>
</tbody>
</table>

Table 4.5: Biomass yield and waste reduction of different pilot-scale systems. MOW = Municipal organic waste; DW = dry weight; WW = wet weight; FCR = Feed conversion ratio.
Research and application: Hygiene

Reduction of E. coli O157:H7 by soldier fly larvae in different types of manure. Two independent trials were conducted for both chicken and hog manure (n = 2), whereas only one trial (n = 1) was conducted for cow manure systems. All samples contained 75 g of manure, and treated samples also contained 7 g of soldier fly larvae. Samples were stored at 27°C.

Source: Erickson et al 2004
Global warming potential by producing insect meal fishmeal and soybean meal

Land use producing insect meal fishmeal and soybean meal

Energy use producing insect meal fishmeal and soybean meal

Source: Zanten et al, 2014
Research and application:
Investigation on rainbow trout

› BSF-Larvae produced on food waste rich in carbonhydrates

› Harvested in the pre-pupae stage

› Dried, grinded and defatted

› Experimental fish feed on base of HM (50% fish meal replacement)

› Experimental- and control feed iso-caloric (18,4 MJ/kg) but not iso-nitrogenous (49,1% / 45,7%)

Source: Buser, 2014
Research and application: Feed- Performance

Feeding trial on rainbow trout:

- 3 replicates / treatment
- 3000 fish / replicate

Results of degustation

Ger-ang: smell pleasant
Ger-typ: smell typical
Ger-muf: smell muddy
Ger-str: smell strong
Far-wei: colour white
Far-ros: colour pink
Far-dun: colour dark
Far-and: colour different
Tex-fest: texture firm
Tex-saf: texture juicy
Tex-el: texture elastic
Tex-gap: texture gaping
Tex-tro: texture dry
Tex-bre: texture pulpy

Source: Buser, 2014
Conclusion: Expectations for the organic market

- The protein gap in production of organic feeds might be closed by insect proteins (IP)
- The question whether IP produced on conventional or organic feed stock needs to be answered
- The organic sector should find sustainable ways of utilising agricultural waste.
- Organic farmers should look into the alternatives of waste reuse and benefit from new research techniques
- Policy makers are expected to work ASAP on new regulations concerning insect technologies
Thank you very much!
Appendix I:

Literature cited:

› Buser, A. (2013): Analyses of partial substitution of fish meal in the diet of rainbow trout (Oncorhynchus mykiss); Master thesis in agronomical sciences
Appendix II: EU regulations and directives

### Appendix III:
Contents of AS in Hermetia meal and fish meal

<table>
<thead>
<tr>
<th>Aminosäure (g/100g) (essentielle Fettsäuren fettgedruckt)</th>
<th>Hermetia (fed on carbon hydrate rich feeds)</th>
<th>fishmeal 68% CP</th>
<th>requirement rainbow trout</th>
<th>Requirement layer hen</th>
<th>Comparison Hermetia/Fishmeal [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>De-oiled</td>
<td>De-oiled</td>
<td>(g/100g feed)</td>
<td>(g/100g feed)</td>
<td></td>
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<tr>
<td>Aspartic acid</td>
<td>6.56</td>
<td>6.05</td>
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<td>108.4</td>
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<tr>
<td>Threonine</td>
<td>2.77</td>
<td>2.30</td>
<td>1.1</td>
<td>0.50</td>
<td>120.4</td>
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<td>Serine</td>
<td>3.02</td>
<td>2.55</td>
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<td>118.4</td>
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<tr>
<td>Glutamic acid</td>
<td>6.95</td>
<td>7.94</td>
<td></td>
<td></td>
<td>87.5</td>
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<td>Glycine</td>
<td>4.53</td>
<td>5.98</td>
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<td>75.8</td>
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<tr>
<td>Alanine</td>
<td>4.41</td>
<td>4.33</td>
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<td>101.8</td>
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<tr>
<td>Cysteine</td>
<td>0.39</td>
<td>0.43</td>
<td>0.4</td>
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<td>90.7</td>
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<td>Valine</td>
<td>4.51</td>
<td>2.93</td>
<td>1.2</td>
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<td>153.9</td>
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<tr>
<td>Methionine</td>
<td>1.25</td>
<td>1.60</td>
<td>0.7</td>
<td>0.3</td>
<td>78.1</td>
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<tr>
<td>Methionine + Cystine</td>
<td>1.64</td>
<td>2.03</td>
<td>1.1</td>
<td>0.6</td>
<td>80.8</td>
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<tr>
<td>Isoleucine</td>
<td>3.15</td>
<td>2.28</td>
<td>1.1</td>
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<td>Leucine</td>
<td>5.07</td>
<td>4.16</td>
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<td>Tyrosine</td>
<td>4.48</td>
<td>1.48</td>
<td></td>
<td></td>
<td>302.7</td>
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<tr>
<td>Phenylalanine</td>
<td>2.83</td>
<td>2.18</td>
<td>0.9</td>
<td></td>
<td>129.8</td>
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<tr>
<td>Phenylalanine + Tyrosine</td>
<td>7.31</td>
<td>3.66</td>
<td>1.8</td>
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<td>199.7</td>
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<tr>
<td>Histidine</td>
<td>2.08</td>
<td>1.77</td>
<td>0.8</td>
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<tr>
<td>Lysine</td>
<td>3.63</td>
<td>4.09</td>
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<tr>
<td>Arginine</td>
<td>3.33</td>
<td>3.53</td>
<td>1.5</td>
<td></td>
<td>94.3</td>
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<tr>
<td>Proline</td>
<td>4.08</td>
<td>3.69</td>
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<td>110.6</td>
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</table>
Appendix IV:
Proximate analyses of experimental and control diet

<table>
<thead>
<tr>
<th>Ergebnisse Proximatanalyse [g/kg TM]</th>
<th>Hermetia-futter</th>
<th>Kontroll-futter</th>
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</thead>
<tbody>
<tr>
<td>Trockenmasse</td>
<td>942</td>
<td>931</td>
</tr>
<tr>
<td>Protein</td>
<td>491</td>
<td>457</td>
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<tr>
<td>Fett</td>
<td>126</td>
<td>151</td>
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<tr>
<td>Asche</td>
<td>126</td>
<td>134</td>
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<tr>
<td>Rohfaser</td>
<td>44</td>
<td>13</td>
</tr>
<tr>
<td>Stickstofffreie Extrakte</td>
<td>164</td>
<td>189</td>
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<tr>
<td>Brutto Energie [MJ/kg]</td>
<td>22.2</td>
<td>21.2</td>
</tr>
</tbody>
</table>
Appendix V:
Experimental fish farm New Valfish; Le Bouveret, Wallis