









Smart Aqua4 FuturE

WAISTER drying technology: Transformation of salmon hatchery sludge into mushroom growth substrate



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WAISTER

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Transformation of salmon hatchery sludge into mushroom substrate

- ✓ 12 000 tons of freshwater sludge from salmon hatcheries is produced annually in Norway
- ✓ Sludge contains valuable nutrients when transformed with WAISTER drying technology:
  - ✓ Approx. 7 % N
  - ✓ Approx. 3.4 % P
  - ✓ Organic content: Approx. 85 %
- ✓ The WAISTER drying technology was used to transform the sludge into a suitable mushroom substrate







Transformation process

Wet salmon sludge









Transformation process

Wet salmon sludge

Transformation with WAISTER drying technology









Transformation process

Wet salmon sludge

Transformation with WAISTER drying technology

Dried product









Transformation process

Wet salmon sludge

Transformation with WAISTER drying technology

Dried product

Mushroom production





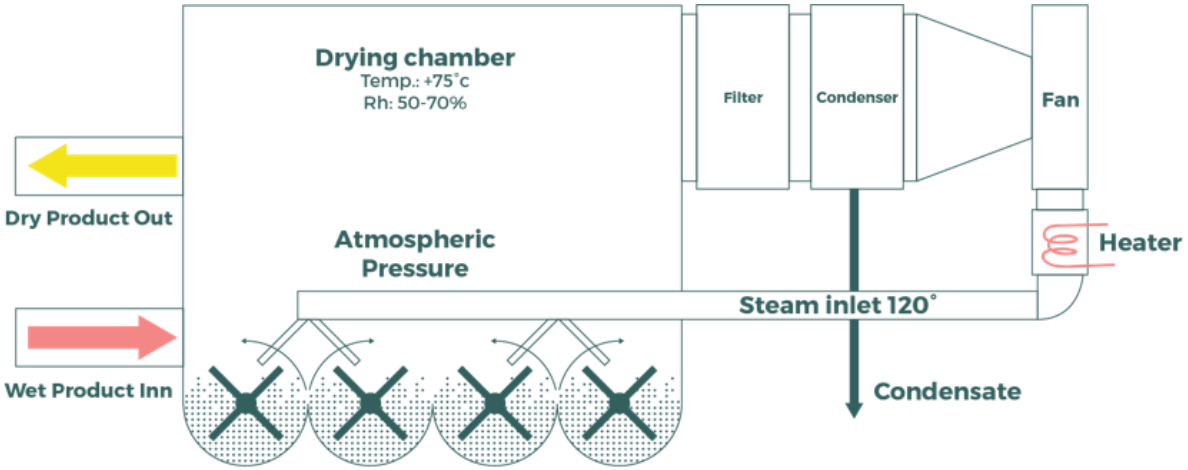




Compliance of Dried FW Fish Sludge with Norwegian Quality Classification of Bio-Fertiliser Products

Element	Content in analysed fish sludge [mg/kg DM]	QC 0 [mg/kg DM]	QC 1 [mg/kg DM]	QC 2 [mg/kg DM]	QC 3 [mg/kg DM]
N	70 ± 14	-	-	-	-
P	34 ± 7 [2.1 plant avail.]	-	-	-	-
K	2.2 ± 1.1 [plant avail.]	-	-	-	-
Ca	20 ± 3 [plant avail.]	-	-	-	-
Cd	0.22 ± 0.11	0.40	0.80	2.0	5.0
Pb	1.0 ± 0.5	40	60	80	200
Hg	<0.20	0.20	0.60	3.0	5.0
Ni	<5.0	20	30	50	80
Zn	350 ± 50	150	400	800	1 500
Cu	24 ± 4	50	150	650	1 000
Cr	3.0 ± 2.2	50	60	100	150
Organic content	≈85%	-	-	-	-
Max allowed use [kg/1000 m^2 per 10 years]	4 000 kg	As required by soil	4 000 kg	2 000 kg	None

Key elements in the transformation



- ✓ Quality of nutrients in the dried sludge
  - ✓ Keeping temperatures at a suitable level to reduce loss of N
  - ✓ Mechanical fluidisation → homogeneous drying
  - ✓ Micro granulated product gradually releasing nutrients during growth period
- ✓ Eliminate emissions to air
  - ✓ Output is dried product + condensate
- ✓ Low power consumption
  - ✓ Development of a transcritical CO_2 based heat pump integrated WAISTER dryer: 0.85 kWh → 0.35-0.40 kWh per kg of evaporated water







What are the challenges?

- ✓ How can we build a value chain?
  - ✓ Economic feasibility?
  - ✓ Geography – distance between aquaculture sites and mushroom producers!
  - ✓ Need of partnership between aquaculture and mushroom production – no previous experience of such partnerships
  - ✓ Dried aquaculture sludge needs to cross between Norway – EU border?
- ✓ Can these barriers be overcome?
- ✓ Use for mushroom product can only apply a small amount of the total sludge!
  - ✓ Multiple applications for salmon sludge are needed









Which mushrooms would you rather eat?

(1) Grown on soy meal; (5) grown on salmon sludge; (2-4 intermediate mixes)

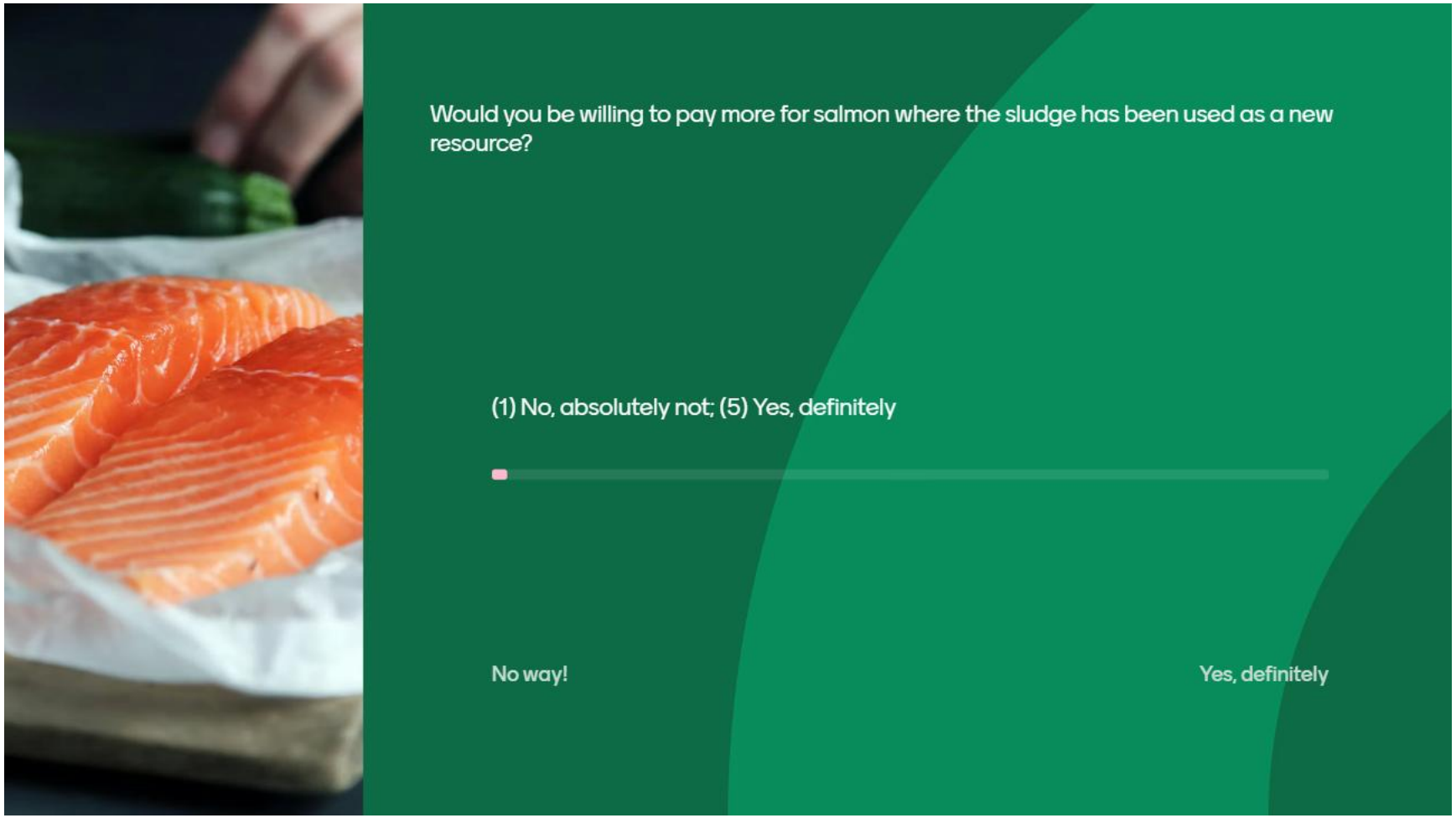
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Thank you for your attention

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