Fitting legumes into an established farming system

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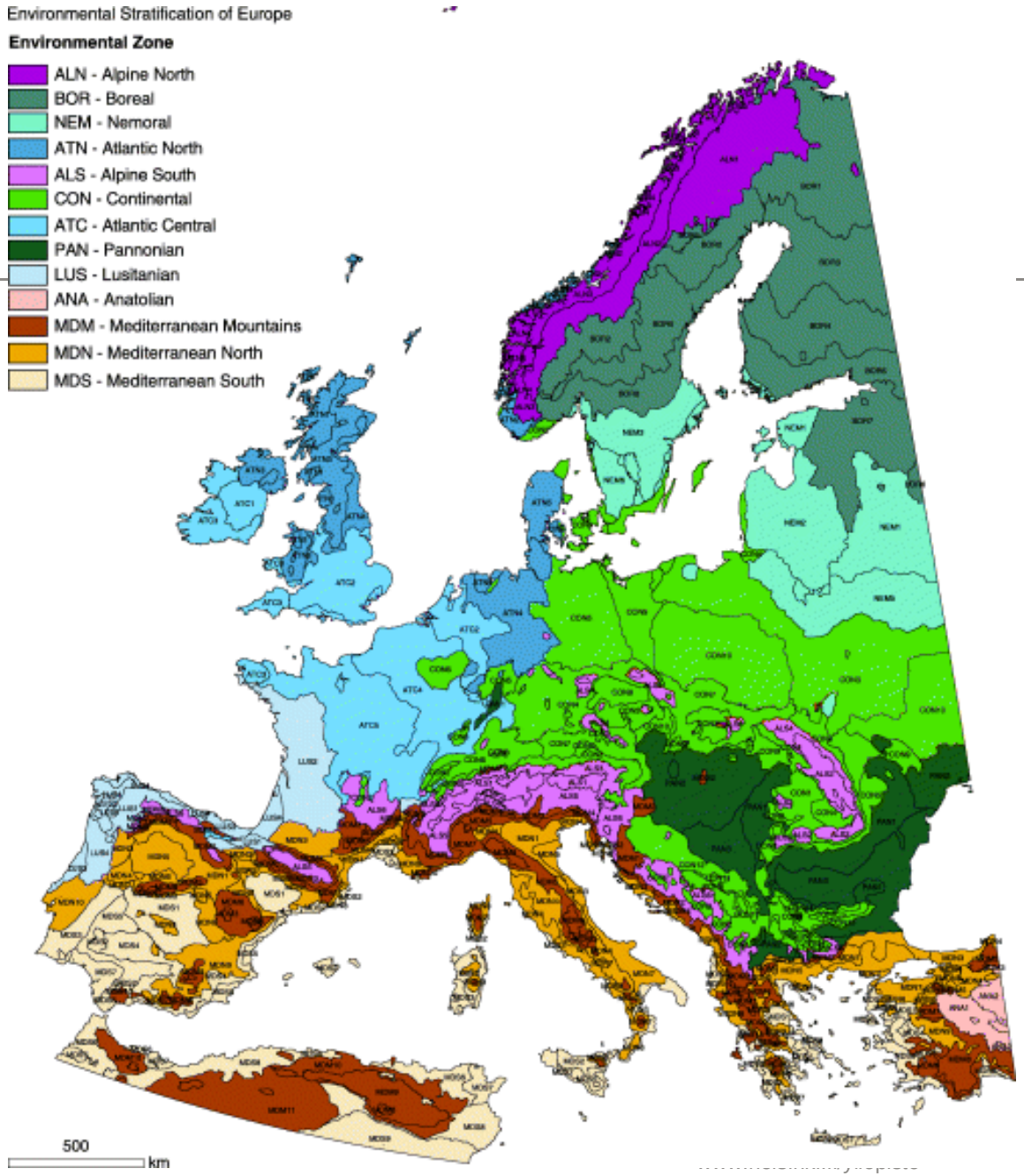


Metzger et al., 2007

Will legumes save Finnish agriculture?

Yes

[tumultuous applause]

[end of talk]

Why? How?

1 Nitrogen fertilizer is expensive

1 t fossil fuel / t fertilizer ammonium

About 15% of greenhouse gas emission in cropping attributable to nitrogen fertilizer

→Need for biologically fixed N

Contributions to soil N (examples from faba bean)

16 – 68 kg N/ha (Germany, Spain, Ethiopia)

- 64% of N in grain, 21% in stem & leaves, 15% in root zone

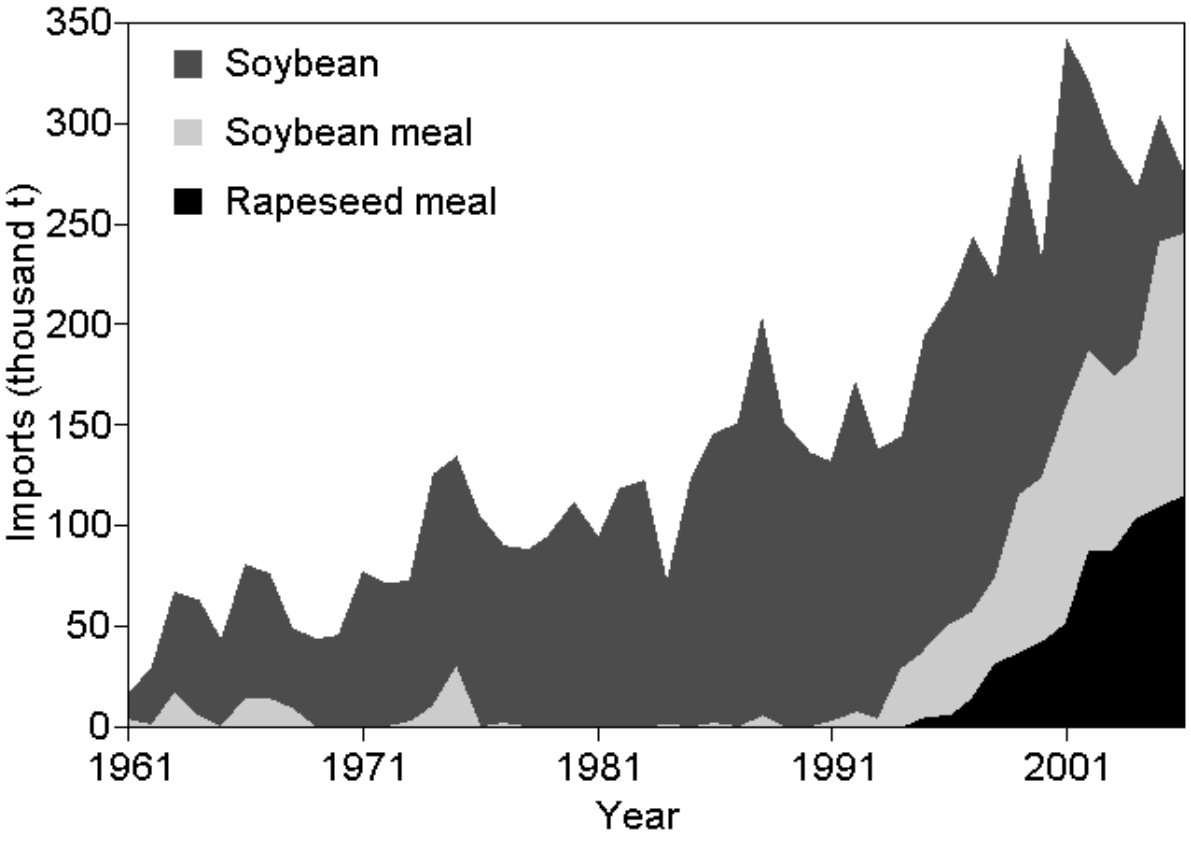
108 kg N/ha (NSW, Australia)

- only 43% in grain
- 0-17 kg fertilizer needed for next crop (cotton)

204 kg N/ha (Alaska)

- green manured

2 We import a lot of protein



Imports primarily for livestock feed

Protein supplements for ruminants

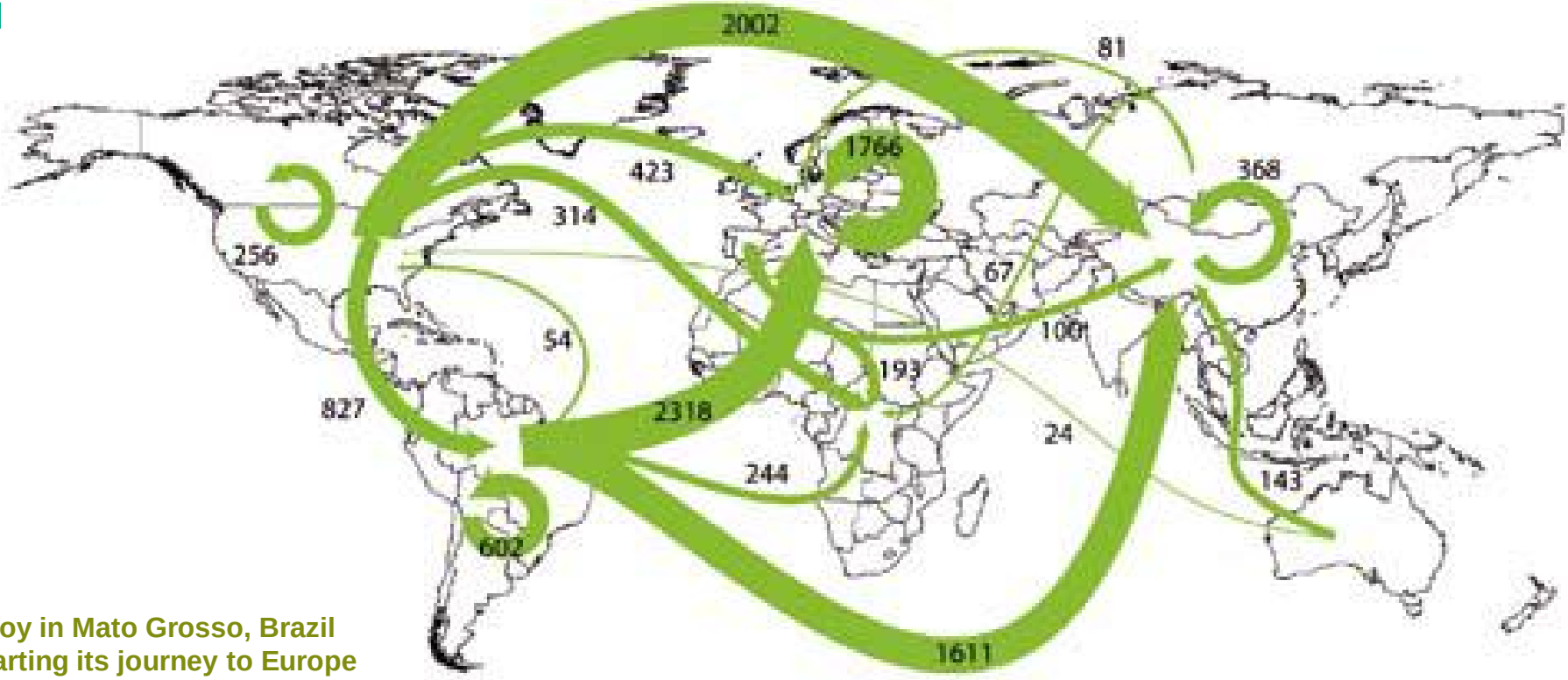
Components of feed mixes for pigs and poultry

Potential for use for fish feed

Soy preferred because of uniformity as well as amino acid composition

- Blended many times during processing

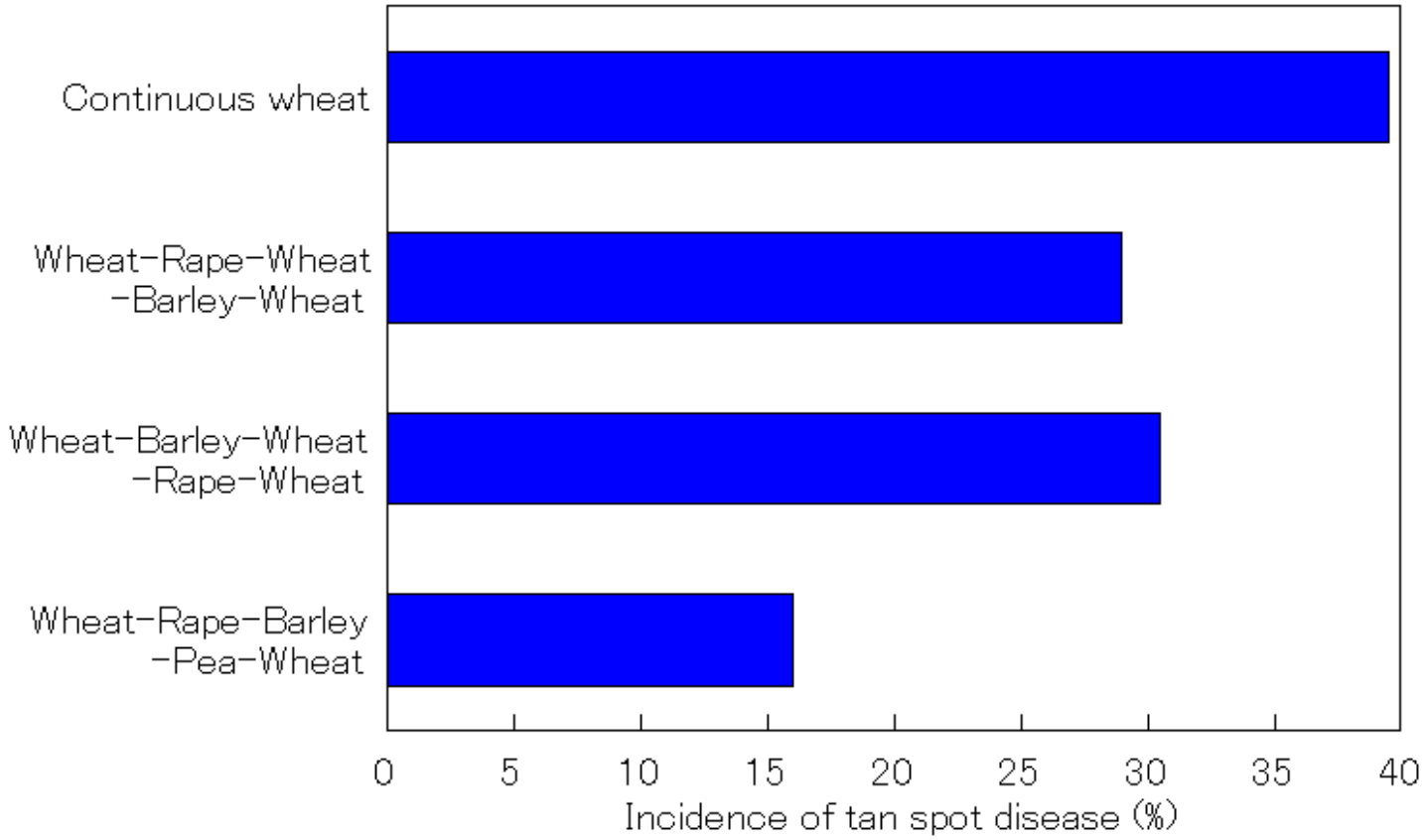
N in intercontinental crop trade



Soy in Mato Grosso, Brazil starting its journey to Europe

2004 data in thousands of tons of N; minimum requirement for drawing a line is 20,000 tons N. The total amount of nitrogen transferred in the trade of crop commodities was 11.5 million tonnes in 2004. (From Braun, 2007; Galloway et al 2008).

3 Break crop reduces cereal disease incidence



(*Pyrenophora tritici repentis*; data from MTT Jokioinen)

Other benefits

25-50% increase in wheat yield, Australia, Spain, Ethiopia

- cf. grass pasture or continuous wheat
- green-manure better than seed crop
- N, soil-borne pathogenic fungi & nematodes, grass weeds, more

Increased % protein in wheat

- also increased dough strength
- Improved quality in other crops

4 Reduced unemployment of worker bees

Flowers adapted to bees

Pollen generally available (used for brood)

Nectar in some species

Maintains bee species diversity and population health

5 Improved soil health

Structure

- Generation of biopores / deeper root growth by following crop
- Water-infiltration / water holding capacity

Chemistry

- Carbon sequestration
- Buffering capacity
- Nutrient availability (particularly P)

Biology

- Growth of beneficial bacteria

What can we do here? (i.e., in Europe or Finland)

How much should we grow?

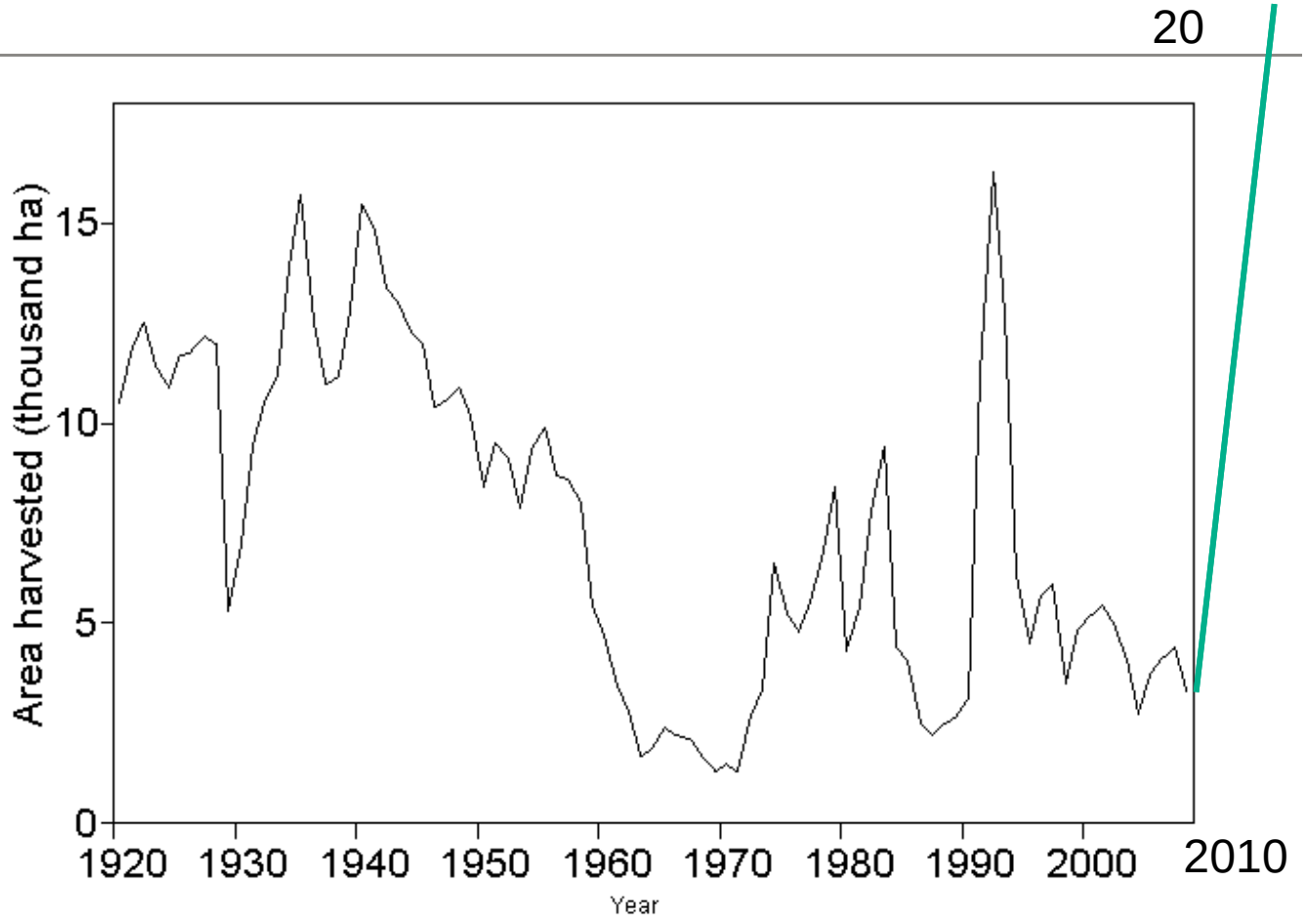
Enough to replace 50% of soybean imports (8%)

~10% of cropping area: Australia, Canada

Every 3-6 years: Central Europe from Denmark to Mediterranean

- Nemecek et al., 2008
- Legume Futures FP7 project extending this

How much do we grow?



There is a legume for every field

Pea	Faba bean	Blue lupin	Lentil
Soil requirements			
Protein content			
(Anti-) Nutritional factors			
Lodging			
Length of growing season			
Diseases & pests			
Other useful aspects			

Pea (*Pisum sativum*)

- Familiar to growers and consumers
- Earliest-maturing of available grain legumes
- Lodges
- Several diseases
- Low trypsin-inhibitor needed for feed use
- 10 000 ha of feed pea contract-grown in 2010

Faba bean (*Vicia faba*)

Moderately known

Moderate lodging

Early enough only for deep south of Finland (107 d)

Only cultivar old, susceptible to chocolate spot

Resurgent since 2007, now 10 thousand ha in 2010 contracted to feed manufacturer

Yields 2009 at Viikki

Cultivar	Maturity date (90%)	Seed yield (t/ha)	Seed size (mg)
Kontu	22 Aug.	6.3	400
Jõgeva	25 Aug.	6.0	880
Aurora	5 Sept.	7.3	570
Mélodie	14 Sept.	6.3	690
SE		0.35	

Lentil (*Lens culinaris*)

- Low biomass, for food only
- Clear potential
- Management systems needed
- Consumers, growers interested

Narrow-leaf (blue) lupin (*L. angustifolius*)

New to growers

High standing power is very attractive

Many acid, sandy soils in the country

Low starch content suits feed manufacturers

Health benefits interest consumers

Yields 2009 at Viikki

Cultivar	Maturity date (90%)	Yield (t/ha)	Seed size (mg)
Haags Blaue	14 Aug.	3.28	176
Boruta	27 Aug.	3.94	166
Boregine	13 Sept.	4.08	182
Sanabor	23 Sept.	4.82	203
SE		0.23	

Challenges of *sustainable* energy cropping

Maximum output for minimum input

Minimum GHG release, nutrient leaching

Different crops suit different uses

- Combustion
- Biogas
- Whole-crop bioethanol

We evaluate crops, their environmental responses, and their biochemical quality

Partners evaluate energetics, economics, energy conversion

Legume in rotation or as energy crop or in mixture

White lupin (*L. albus*) achieves early ground coverage

Dry matter production in grain legumes in 2009

Species	Cultivar	Dry matter yield (t/ha)
Faba bean	Kontu	10.3
	Jõgeva	10.2
	Aurora	12.9*
	Mélodie	10.9
	SE	0.56
White lupin	Amiga	10.8


Phalaris arundinacea


Galega orientalis

Grass-legume blends for combustion

2 sites, Viikki & Suitia

8 treatments

Reed canarygrass, fodder galega, 75:25, 50:50; other legumes, other grasses

Established 2008

First spring harvest this week

Galega for bioremediation of oil contamination, shown in glasshouse, now being tested in field

Maize – clover, maize – vetch

Yields of maize blends, 2007

Maize with	Yield, t/ha, 15 Sept
100 kg/ha N	30.3
Persian clover (*T. resupinatum*)	24.0
Fodder vetch	21.4
Faba bean	15.5
SE	1.8

Annual crop mixtures

Maize, fibre hemp, Jerusalem artichoke impressive biomass crops

So far, legume intercrops have suppressed yield (maize, artichoke) or made no difference (fibre hemp)

- Our springs cooler than where maize-clover succeeds

Residual N from rotational legume likely to suffice for hemp, artichoke

Conclusions

Legume crops are an important part of healthy crop rotations

They offer more than just the harvested part

- Residual N
- Healthy soil
- Broken cereal disease cycles
- Ecological services

In 10 years 10% of the arable land of Europe could be under legumes to meet our needs for livestock feed

Increased production of legumes will …

Provide local feed

Reduce international nitrogen imports and other “feed miles”

Contribute biologically fixed nitrogen to energy crops as well as mainstream crops

Increase yield and quality of following crops

Add diversity to farm income streams

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Thank you

[tumultuous applause]

[end of talk]

Any questions?