UNIVERSITÄT HOHENHEIM

CORE organic DOMINO

FoU-dagarna

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New Fertilisation Strategies in Organic Apple Cultivation

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Gefördert durch:

Bundesministerium für Ernährung und Landwirtschaft

BÖLN

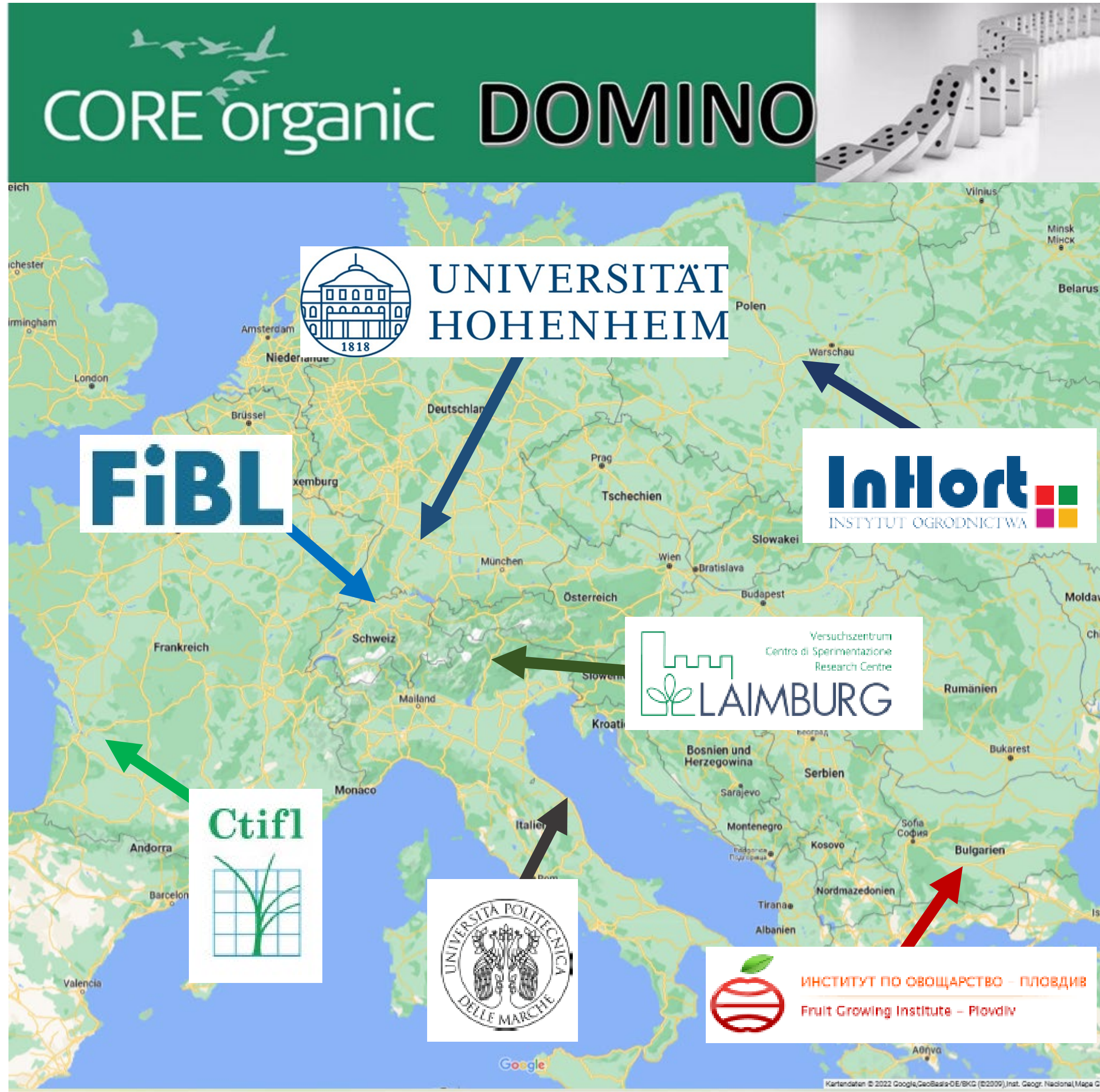
aufgrund eines Beschlusses des Deutschen Bundestages

KOB Kompetenzzentrum Obstbau-Bodensee

föko Fördergemeinschaft Ökologischer Obstbau e.V.

Dynamic sod mulching and use of recycled amendments to increase biodiversity, resilience and sustainability of intensive organic fruit orchards and vineyards

Implementation period:
Mai 2018 – August 2021



www.domino-coreorganic.eu

DOMINO: Activities

Activities in the project:

- Improving diversity in the cropping system
- New plant protection systems
- Environmental and economic effects
- Fertilisation management (incubation-, pot- and field trials)

Activities in Germany (UHOH / KOB / FÖKO):

- Development of new fertilisation strategies in organic apple production based on recycled products or legumes for a balanced nutrient budget and more sustainability

Background

Goals of organic fertilisation strategies:

- Closing nutrient cycles as much as possible
- Using legumes for N_2 fixation
- Sustainability of fertilisers used
- Phasing out of conventional inputs

Organic orchard production systems are intensive perennial systems

- Use of legumes for N_2-fixation is rare
- Use of external multi-element fertilisers:
  1) Base fertilisers: Compost, animal manure
  2) Commercial fertilisers: vinasse, keratin products (from conventional farming)
- Application of pesticides containing K, S, Ca

→ Nutrient imbalances

Approach

1. What is the **current status** of fertilisation on fruit farms with regard to **nutrient budgets** and their **effect on soil** nutrient status in Northern and Southern Germany

   → Interviews and data collection on fruit farms

2. Which fertilisers can **substitute** contentious inputs and at the same time improve sustainability by a more **balanced nutrition** of organically managed orchards.

   → Field trial: Fertilisation strategies based on legumes, clover grass based-fertilisers and biogas residues (2018 – 2020)

   → On-farm data collection on Inter-row management

1. Field budgets of organic apple orchards in Germany

Field budgets over 5 years:

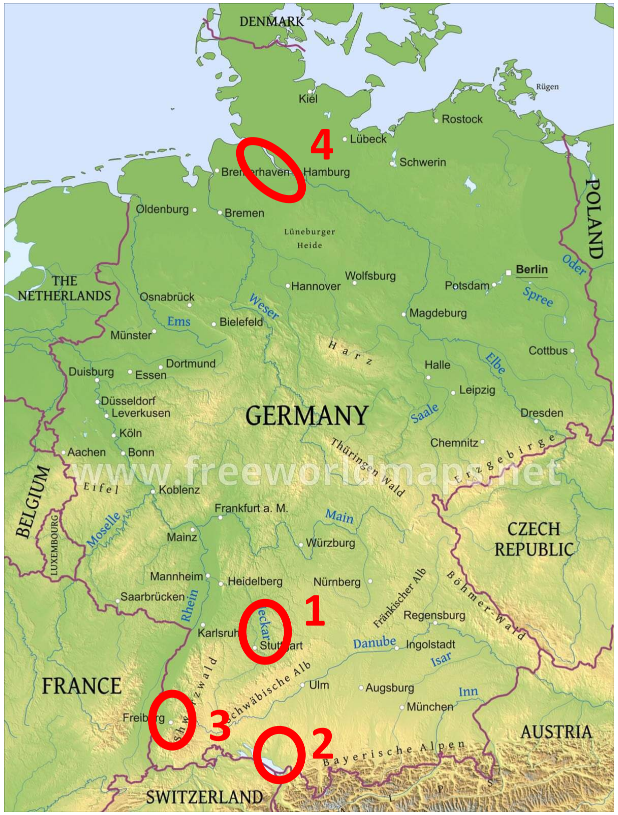
- South-West Germany: Years 2012 – 2016, 4+5+6 farms, 50 orchards
- Northern Germany: Years 2014 – 2018, 4 farms, 15 orchards

Research questions:

I. What is the current status of **nutrient field budgets**?

II. What impact does the **type of fertiliser** (commercial or base fertiliser) have on the budget?

III. Can nutrient budgets be connected to **soil** nutrient contents (plant available P, K, Mg)?



The regions in Germany where farmers were interviewed (Neckar (1), Constance (2), Freiburg (3) and Altes Land (4)). Source: www.freeworldmaps.net

Summary

- Current fertilisation strategies show moderate nutrient imbalances

Base fertilisers

- Higher ratio of N to other nutrients
- Lower Nitrogen Use Efficiency
- ➢ Can cause nutrient surpluses

Commercial fertilisers

- Low amounts of other nutrients
- Higher Nitrogen Use Efficiency
- ➢ Can cause nutrient deficiencies

- Soil nutrient status is stronger connected to other factors than to the budget, like
    - Region
    - Soil texture
    - Years of organic management
    - Inter-row management

2. Field trial „Use of alternative fertilisers in organic apple production“

Fertilisation trial at KOB: 2018 - 2020

4 replicates, 10 trees per replicate

Target N application: 25 kg ha^{-1} / 8.75 g $tree^{-1}$

Treatments:

- Control: no fertilisation, horn grit, vinasse
- Biogas digestates
- Compost
- Legume based fertilisers:
  - Clover grass silage
  - Clover grass pellets
  - Summer peas
  - Winter peas (2 mulching dates)

Fertilisers: Horn grit, Vinasse, Digestates, Compost, Silage, Pellets, Spring and Winter peas

Amount of fertiliser per tree:

8,75 g N tree^{-1} → 25 kg N ha^{-1}

Fertiliser	N content in fresh matter	Amount applied per tree*
Horn grit	13.4%	65 g
Vinasse	3.96%	221 g
Biogas digestates	0.69%	1,270 g
Compost	0.53% – 0.72%	1,220 g – 1,660 g
Clover grass silage	1.24% – 1.59%	550 g – 705 g
Clover grass pellets	3.29%	266 g
Peas	3.59%	244 g

* With 2857 trees/ha

Amount of fertiliser per tree:

8,75 g N $tree^{-1}$ → 25 kg N ha^{-1}

Fertilisation one week before flowering:

Silage (left) and Winterpeas (right) before mulching

Pea treatments

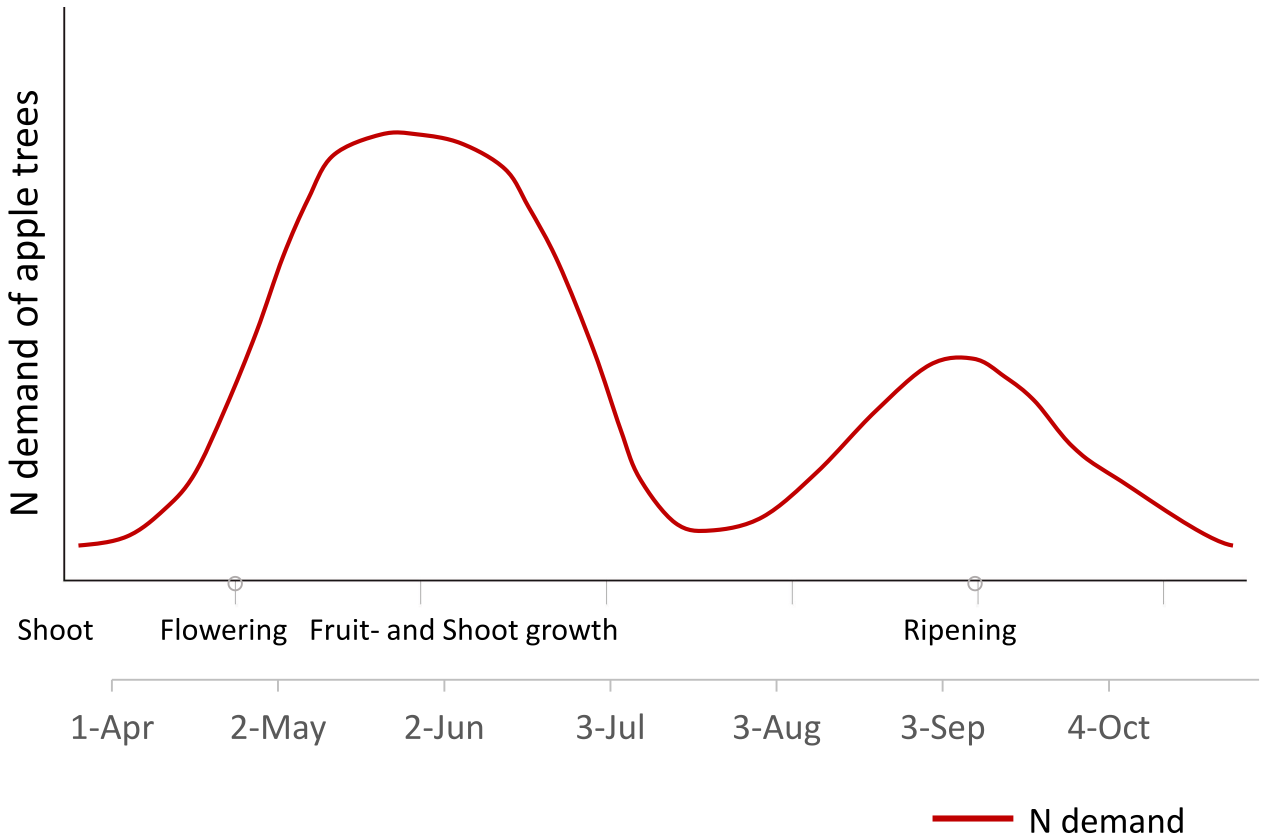
	Autumn	4-5 weeks before flowering	1 week before flowering	Seeds per m^2	Plants per m^2	Plant height (cm)	Plant biomass (dry matter, g m^{-2})	C/N
				mean of 3 years (spring peas) mean of 2 years (winter peas)				Winter seeds: 11.5 Spring seeds: 11.2
Winter peas short	seeding	mulching		2084 ± 482	1008 ± 291	12 ± 3	146 ± 33	10.7
Winter peas long	seeding		mulching	2084 ± 482	994 ± 384	24 ± 3	290 ± 47	10.5
Spring peas		seeding	mulching	1261 ± 263	765 ± 331	9 ± 2	44 ± 25	8.1

Spring peas

Winter peas short

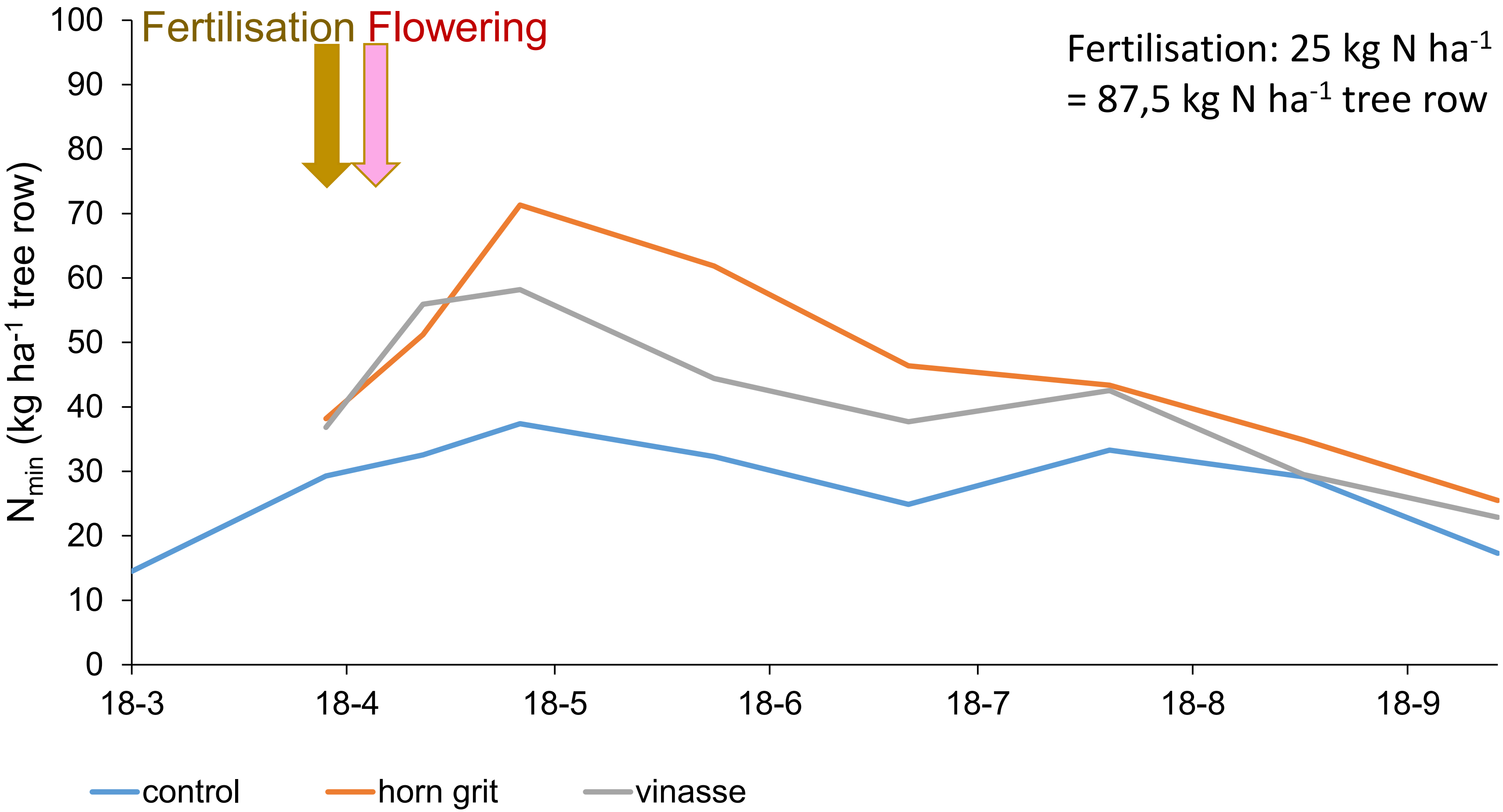
Winter peas long

N demand of apple trees



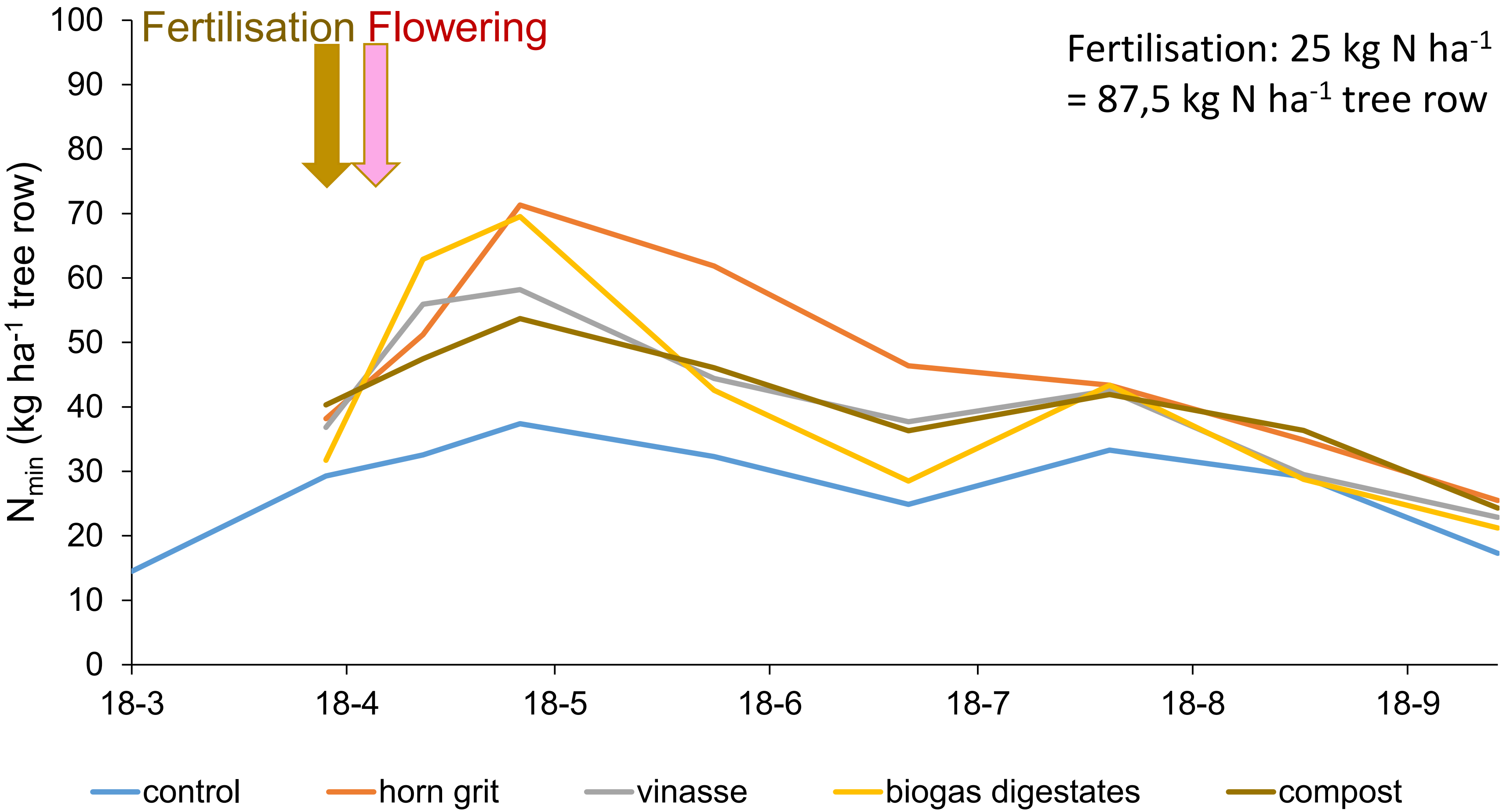
N demand modified after: Paoletti, Flavio; Kelderer, Markus; Cellura, Maurizio; Ortolani, Livia: Düngung und Bodenpflege im biologischen Apfelanbau. Hg. v. Land- und Forstwirtschaftliches Versuchszentrum Laimburg. Italy.

N_{min} in the soil (mean value 2019+20)



Fertilisation: 25 kg N ha^{-1}
= 87,5 kg N ha^{-1} tree row

N_{min} in the soil (mean value 2019+20)



Digestates: early and high N availability
Compost: moderate mineralisation

Evaluation Digestates

Advantages:

- Early N-release
- Easy Distribution
- More balanced budget, higher K content
- Closing of nutrient cycles possible (when using permitted digestates for organic farming)
- Improvement of soil structure

Disadvantages:

- Regional Availability?
- Contamination with plastics/microplastics?
- Potential organic pollutants?

Compost

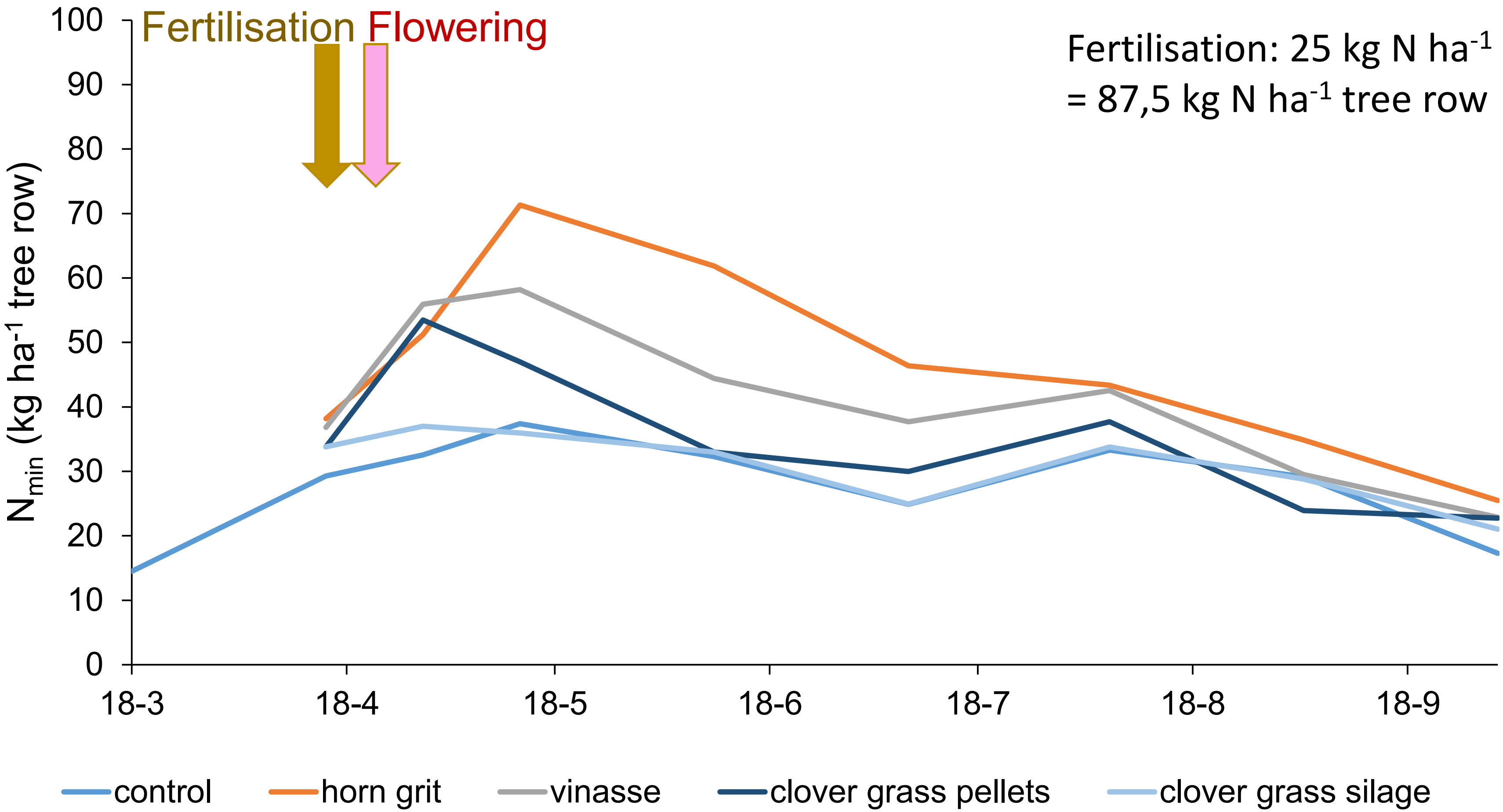
Advantages:

- Can be produced by the farmer himself
- Closing nutrient cycles when using Compost from green waste
- Improvement of soil structure

Disadvantages:

- Regional Availability?
- Own production is complex (compostable material, soil material, machines for turning)
- Nutrient ratio (K:Ca), P oversupply
- Higher costs through high application rate
- Plastic/Microplastic?

N_{min} in the soil (mean value 2019+20)



Pellets: early moderate mineralisation

Silage: very low mineralisation

Clover grass silage

Advantage:

- Can be produced by tha farmer, nutrient cycling within the farm
- No risk of contamination
- If machines are available, easy and cheap
- Vegan
- Improvement of soil structure

Disadvantages:

- Late N-release
- More difficult application
- Availability of machines?
- Additional land area needed for fertiliser production

Clover grass pellets

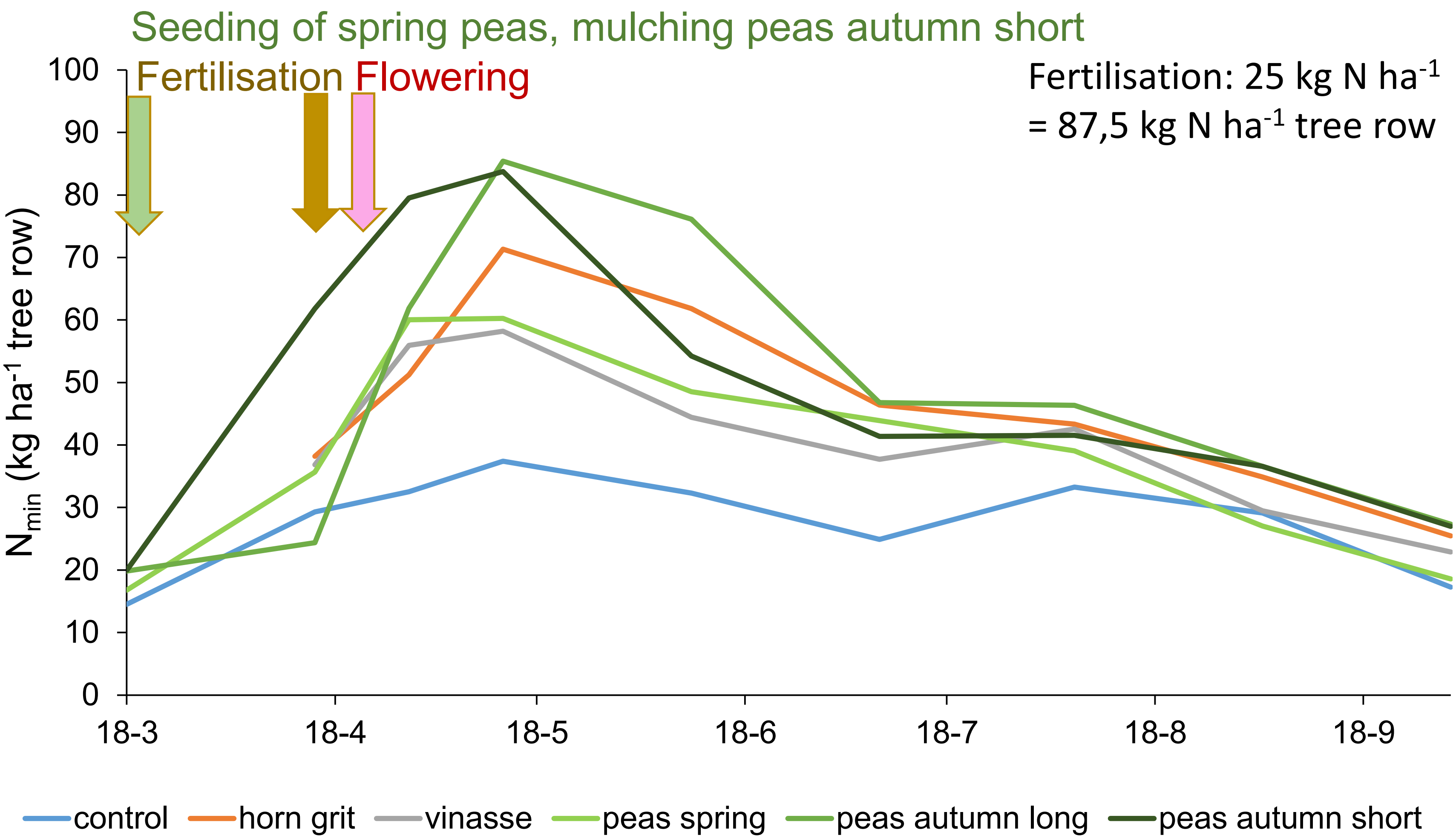
Advantages:

- Easy application
- No/ small risk of contamination
- Vegan
- Improvement of soil structure

Disadvantages:

- Availability?
- Cannot be produced by the farmer himself
- High energy demand in production
- Costs

N_{min} in the soil (mean value 2019+20)



Peas: early and high mineralisation

Mineralisation peek can be influenced by mulching date

Peas

Advantages:

- Early N-release, variable with application date
- Easy application
- No risk of contamination
- Vegan
- Improvement of soil structure

Disadvantages:

- Dates for seeding and incorporation into the soil differ from site to site, dependent on climate conditions
- Losses through rodents or birds?
- Competition for use as feed or food
- Costs

Summary

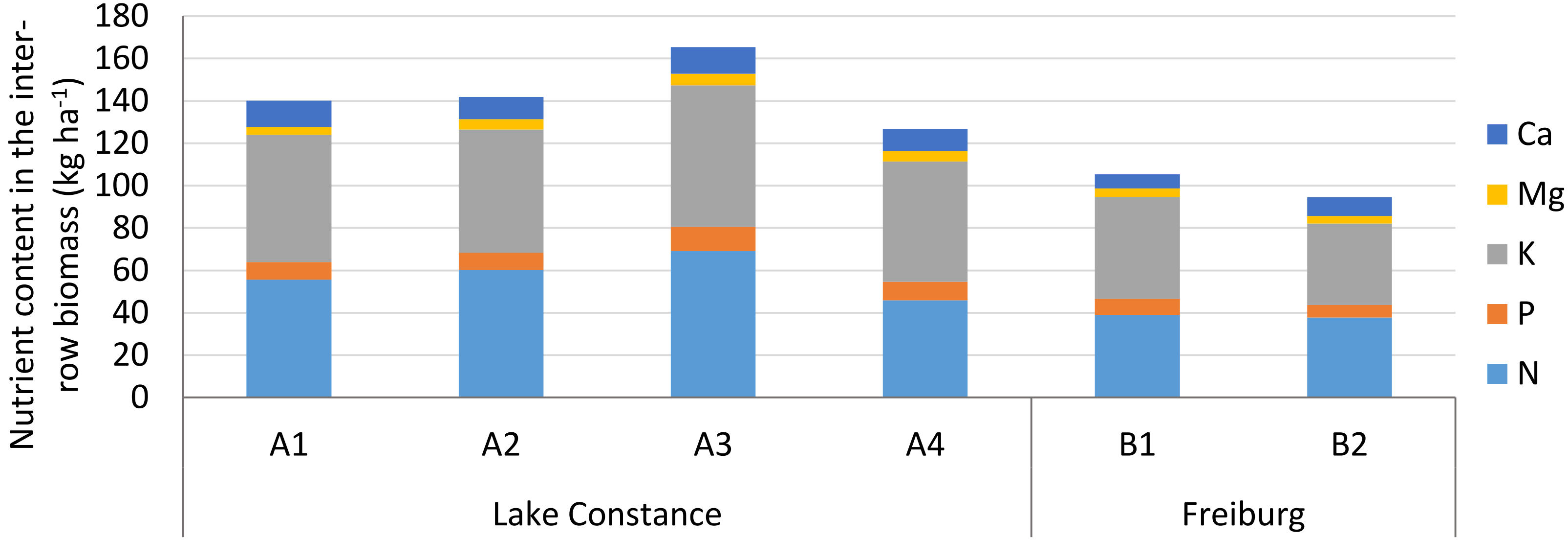
- Compost: highest Ca and Mg surplus
- Biogas digestates: fast mineralisation, most balanced fertiliser
- Peas: biodiversity, lowest K input, water competition
- Silage: low mineralisation
- Pellets: high energy input in production
- Other considerations:
  - Competition with use as feed
  - Fertilisers differ in cost, application techniques and regional availability
  - Soil nutrient status

Inter-row Management and its Role in Fertilisation Strategies in Organic Apple Cultivation on Farms in South-West Germany

Master Thesis by Marion Metzger

- Interviews and data collection on inter-row management on 6 fruit farms in Southern Germany
  - Goals of shifting the biomass from inter-row to row
  - How many cuts per year
  - Vegetation in the inter-row
  - Measurements on fresh and dry matter of the cut biomass and nutrient analysis over the whole vegetation period of 2019

Amounts of nutrients transferred to the tree row (ha orchard year^{-1}) on six farms

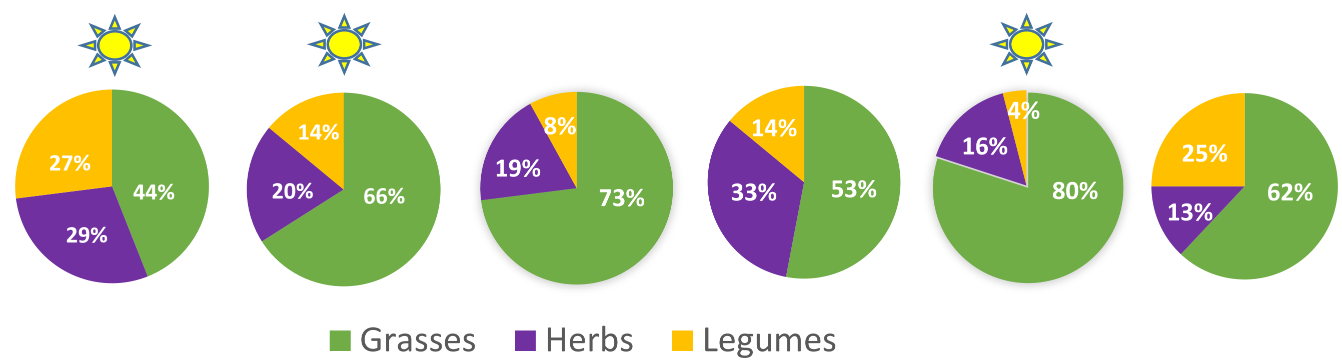


Cuts per year, C:N ratio in the biomass, presence of flower strips and the composition of the inter-rows on the six farms.

Farm:	A1	A2	A3	A4	B1	B2
Number of cuts per year:	6	7	7	3	4	3
C:N ratio in the biomass:	13.2	11.4	13.6	15.3	17.9	18.8

Flower strip:

Species composition of the inter-row:



→ Main goals of mulching and biomass transfer from inter-row to the tree row (according to farmers in the interviews) like

- Soil cover
- Reduction of water transpiration
- Weed control
- Increasing soil organic matter content

need to be balanced with the fertilisation effect.

Summary

- Soil P and K contents are much higher in the tree row than in the inter-row
- P and K levels in the tree row far beyond the recommended range
- Transfer of nutrients from inter-row to tree row by mulch:
  - 38 – 69 kg ha^{-1} a^{-1} N
  - 6 – 11 kg ha^{-1} a^{-1} P
  - 39 – 67 kg ha^{-1} a^{-1} K

Output: 12 kg ha^{-1} a^{-1} N
3 kg ha^{-1} a^{-1} P
29 kg ha^{-1} a^{-1} K

Conclusions

- Current fertilisation strategies lead to moderate nutrient imbalances.
  - Use of various fertilisers
  - Both types of fertilisers, base and commercial, should be combined
  - Use of base fertilisers only in amounts between 10 and 50% of the total N demand
  - Liming is required
- Alternative fertilisers (closing nutrient cycles / using N fixation / replacing fertilisers with conventional origin) are available
  - Choice of fertiliser depends on site conditions and applicability
- Inner-orchard biomass transfer from the inter-row shifts high amounts of nutrients to the tree row
  - Inter-row management should be considered in fertilisation management
  - Nutrient transfer from inter-row to tree row overlies expected long term effects of nutrient imbalances

Conclusions

- Nutrient budgets can help to reach a balanced nutrition in the long term
- Soil nutrient status and ratio of nutrients in the fertilisers need to be considered
- Other inputs: Competing goals in orchard management:
  - Soil protection (shift of biomass from inter-row to row → nutrient transfer)
  - Plant protection (S input and its influence on other nutrients)
- site specific decisions

Thank you