SUSTAINABLE INTENSIFICATION IN THE NETHERLANDS

Dutch front-runner dairy and arable farms – final workshop KNSI

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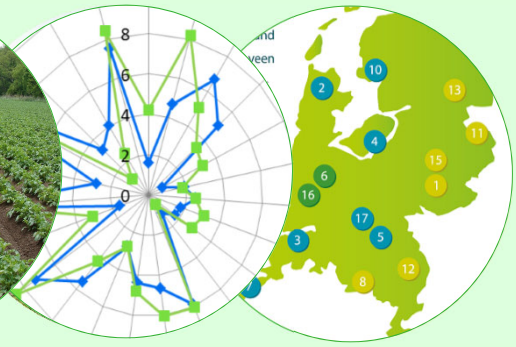

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FACCE KNSI
KNOWLEDGE NETWORK FOR SUSTAINABLE INTENSIFICATION

INTRODUCTION

Contribution to KNSI

1. Background
2. Materials & methods
3. Results & discussion
   - Arable farms
   - Dairy farms
4. Conclusions

SUSTAINABLE INTENSIFICATION (SI)
INTRODUCTION

Task 2 of KNSI

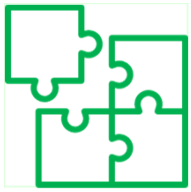
- Aim: mapping SI related activities of partners, key sites, key sectors covered and SI metrics
  - Inventory and network analysis of front-runner farms and their cutting edge activities
  - Indentify key indicators for SI + standardized metrics
  - Quantify indicators for the front-runner farms

INVENTORY
INTRODUCTION

Country - organisation	Arable	Dairy farming	Beef production	Sheep
UK	+	+	+	+
Ireland - Teagasc	+	+	+	
Ireland - University College Dublin			+	
Finland - Natural Resources Institute (Luke)	+	+	+	
The Netherlands - WUR	+	+		
Denmark - Aarhus University	+	+	+	

- Focus on The Netherlands: arable and dairy farming

RESEARCH AIM
INTRODUCTION



- **Identify the current state-of-the-art of SI of front-runner arable and dairy farms in the NL**

➢ Compare arable and dairy front-runner farms with national average
  - ➢ Main differences in each sector?
  - ➢ Underlying reasons?

➢ Main differences between front-runner arable and dairy farms?

FRONT-RUNNER GROUPS OF FARMS
MATERIAL & MEHTODS

Skylark (SL)

- Aim: Achieve similar or better results, with no further damage to the environment, preferably at lower costs

➢ >400 farms applied

Cows & Opportunities (C&O)

- Aim: Meet strict environmental standards, be entrepreneurial, economically strong, and socially accepted

➢ 17 farms selected

➢ Representation of all conditions, focus on sandy soils

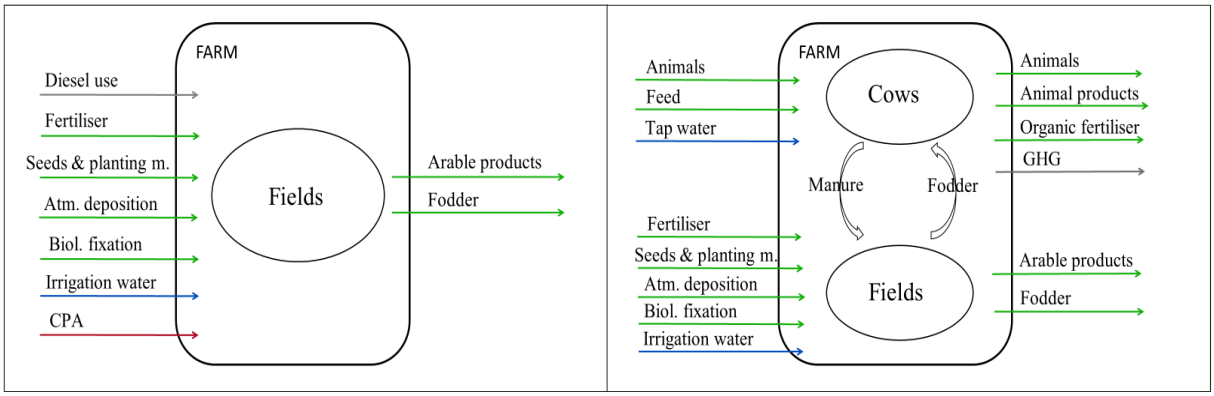
DATA COLLECTION
MATERIALS & METHODS

- BIN (Agrimatie) data from WEcR for 2012 – 2017
- National average representative sample
  - 190 arable & 340 dairy farms
  - Front-runner farms excluded
- SL sample (30 farms in BIN)
- C&O complete (all 17 farms in BIN)

INDICATORS
MATERIALS & METHODS

- Farm, crop and livestock level
- Crops: sugar beet, wheat, onion, ware potato, and seed potato
- N surplus and GHG emissions also per kg product for dairy farms
- Principles
  - **Productivity**
  - **Environmental sustainability**
  - **Socio-economic sustainability**

INDICATORS SYSTEM BOUNDARY
MATERIALS & METHODS

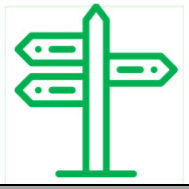


INDICATORS PRODUCTIVITY
MATERIALS & METHODS

Aspect SI	Principle	Indicator	Unit arable farms		Unit dairy farms	
			Crop	Farm	Livestock	Farm
Intensi-fication	**Produc-tivity**	Yield	kg/ha	€/ha	kg & €/ha	€/ha
		Fertiliser use	-	kg/ha	-	kg/ha
		CPA use	EIP/ha	EIP/ha	-	-
		Feed costs	-	-	-	€/ha

- Farm level yield as the revenues per ha
- Livestock level yield in revenues & kg milk per ha

INDICATORS ENVIRONMENT
MATERIALS & METHODS



Aspect SI	Principle	Indicator	Unit arable farms		Unit dairy farms	
			Crop	Farm	Livestock	Farm
Sustainability	**Environment**	Nutrient use efficiency	-	kg/kg	-	kg/kg
		Nutrient surplus	-	kg/ha	kg/kg	kg/ha
		Water use (efficiency)	-	m^3/ha	kg/m^3	€/m^3
		GHG emissions	-	-	CO_2eq/kg	CO_2eq/ha
		Feed self-sufficiency	-	-	-	%
		Diesel use	-	GJ/ha	-	-
		Biodiversity	-	#	-	%

- Feed self-sufficiency as the share of maize and grass in total feed intake
- Biodiversity as agro-diversity and cutting percentage of grassland

INDICATORS SOCIO-ECONOMICS
MATERIALS & METHODS

Aspect SI	Principle	Indicator	Unit arable farms		Unit dairy farms	
			Crop	Farm	Livestock	Farm
Sustai-nability	**Socio-Econo-mics**	Preservation of grazing	-	-	-	#
		Income per entrepreneur	-	€/uawu	-	€/uawu
		Income variability	-	(€/uawu)[2]	-	(€/uawu)[2]
		Age farmer	-	years	-	years

[2] unpaid annual work unit

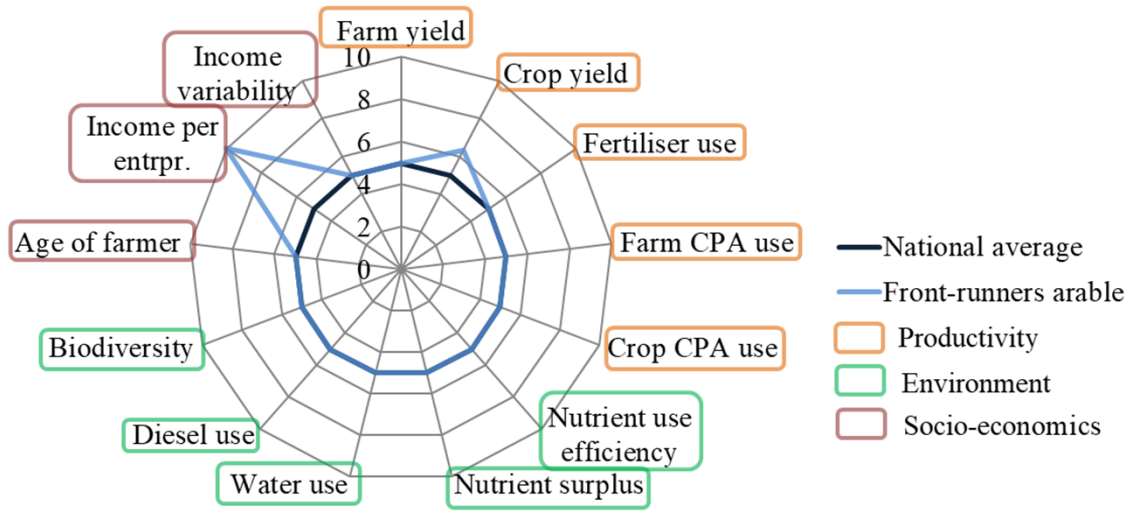
- Animal welfare excluded from assessment
- Preservation of grazing as the no. of grazing days per year

DATA ANALYSIS
MATERIALS & METHODS

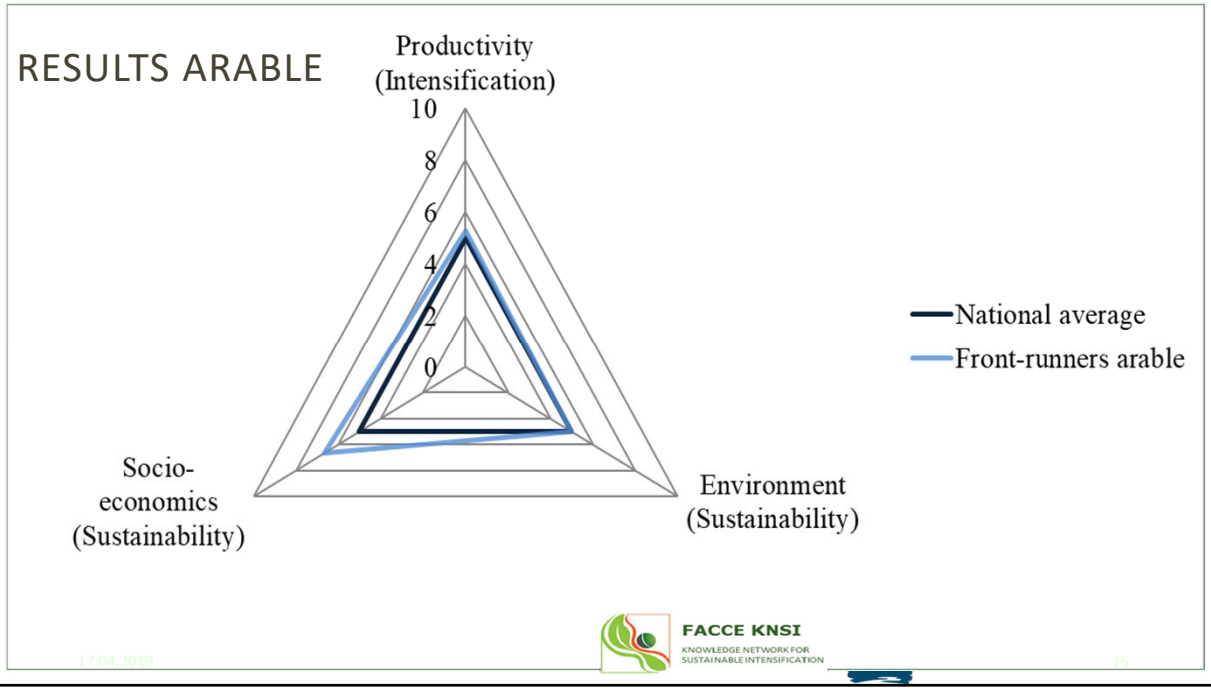
- ANOVA: * if p<0.05, ** if p<0.01, *** if p<0.001
- **Radar charts**
  - Scaling based on level of significant difference of front-runners compared to national average, national average scaled as 5
  - Principle level
  - Equal weighing

Level of significance	If „better“	If „worse“
n.s.	5.00	5.00
*	6.67	3.33
**	8.34	1.66
***	10.00	0.00

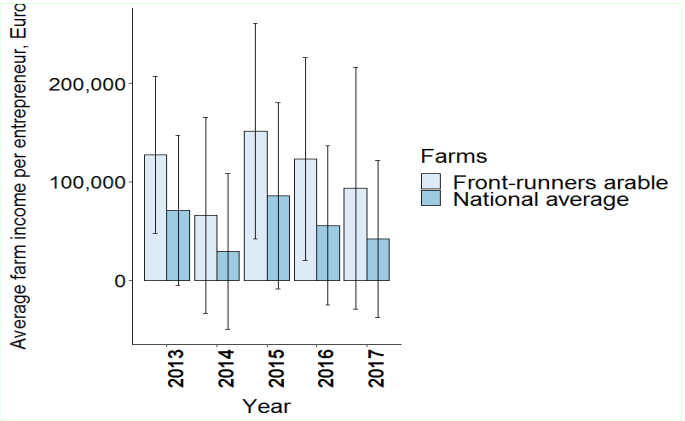
RESULTS ARABLE



RESULTS ARABLE



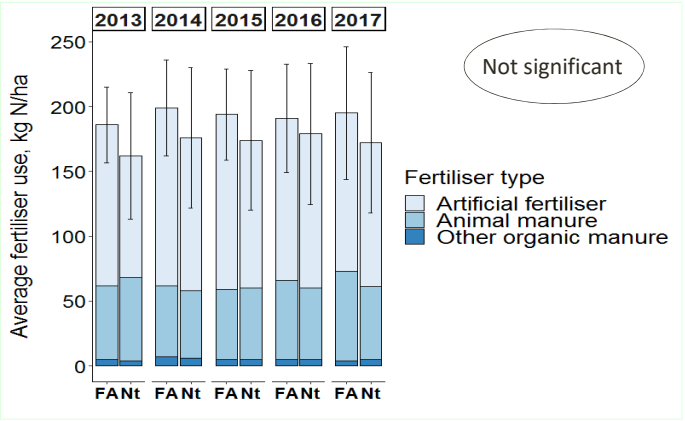
INCOME PER ENTREPRENEUR
RESULTS & DISCUSSION ARABLE



- SL farmers have higher income

1) Focus of SL to achieve high yields and incomes with little costs
2) Engaged farmers, better managers
   - ➢ Regular meetings and discussions
3) Lower costs, scale advantage

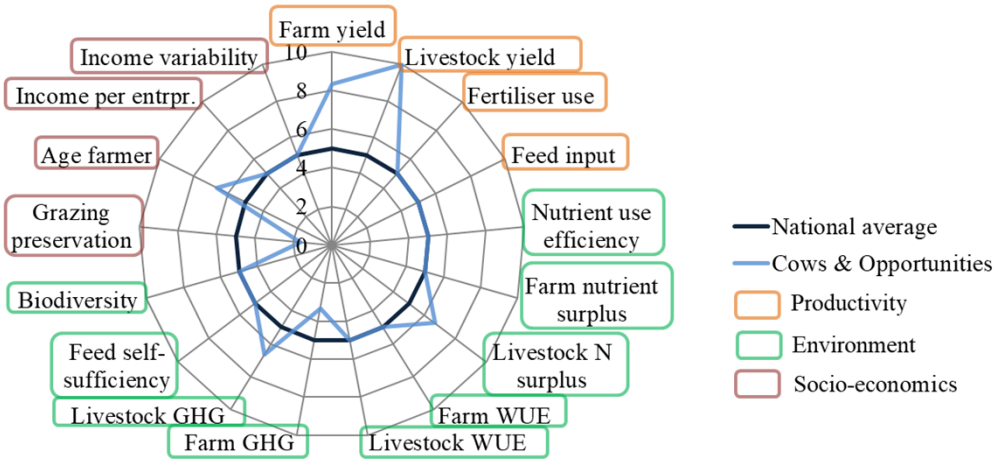
FERTILISER USE
RESULTS & DISCUSSION ARABLE



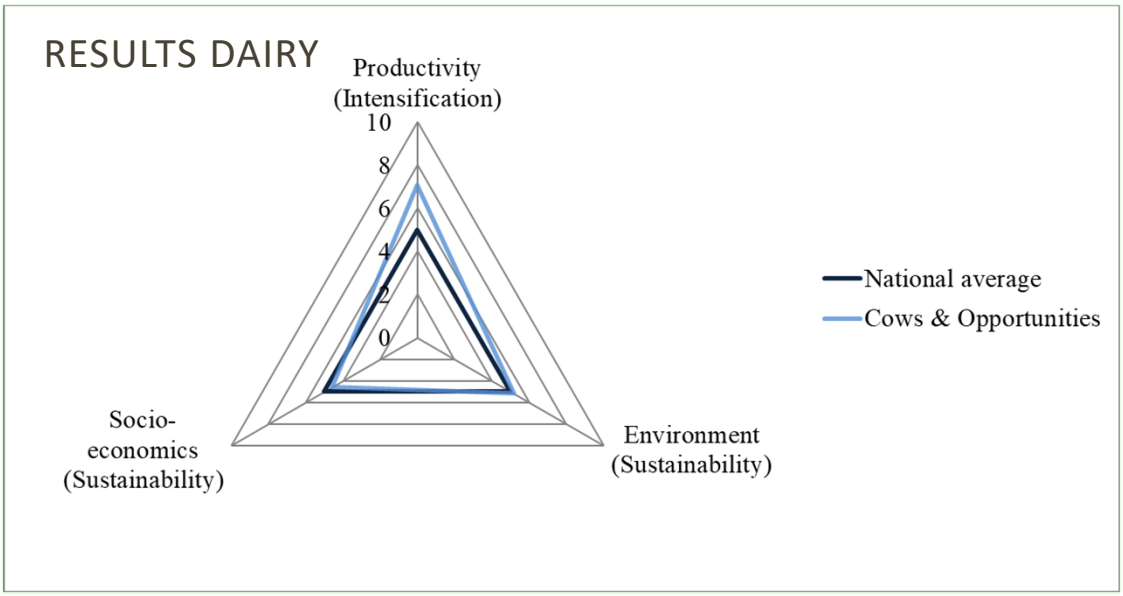
- Tendency for higher N fertiliser use by SL (FA) farms

1) In recent years higher share of ware potato in rotation
2) More attention to soil fertility management

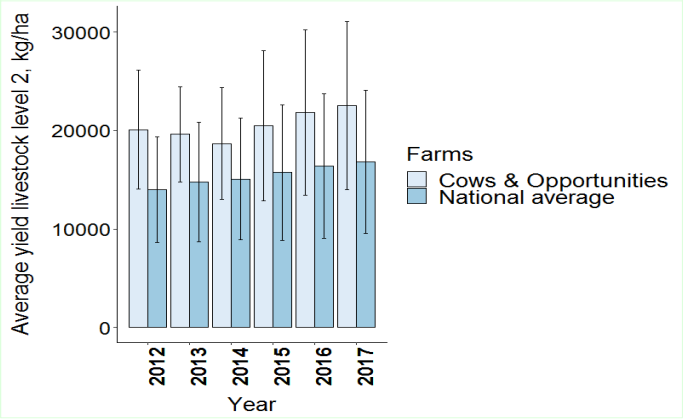
RESULTS DAIRY



RESULTS DAIRY



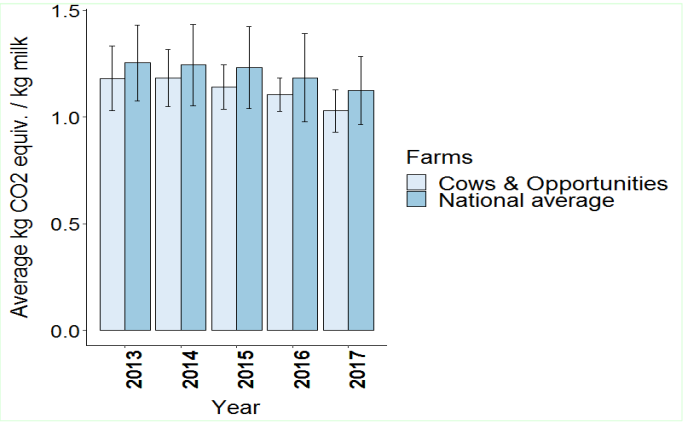
YIELD
RESULTS & DISCUSSION DAIRY



- C&O farms higher yields

1) C&O farms more intensive farm structure
2) Engaged farmers, better managers
   - ➢ Regular meetings & discussions

GHG EMISSIONS
RESULTS & DISCUSSION DAIRY



- For C&O farms GHG emissions higher per unit area, lower per unit product

1) C&O more intensive
   - Main sources: rumen & bowel fermentation, puchased feed
2) Connected to higher yields

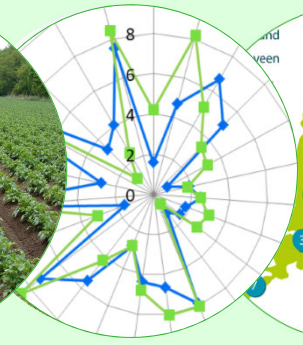
CONCLUSIONS

- Both front-runner groups more intensive than the national average
- No advantage in environmental sustainability per unit area
- C&O advantage in environmental impact per kg product, expected for SL
- No clear conclusion on social sustainability from results
- **Main difference: increased economic sustainability for SL, not for C&O**

CONCLUSIONS

- Suggestion to WEcR to expand registration on animal welfare and biodiversity and GHG (arable); subjectivity connected to radar charts
- **Front-runners more intensive, have socio(-economic) advantages, environmental sustainability ambiguous**
  - Intensification or extensification more important in the NL?
  - Focus on decreasing the environmental impact
- Differences between front-runners and national average result of farm structures and motivation of farmers
- Recommended next step: interviews of individual farmers to assess cutting edge practices

THANK YOU FOR YOUR ATTENTION!



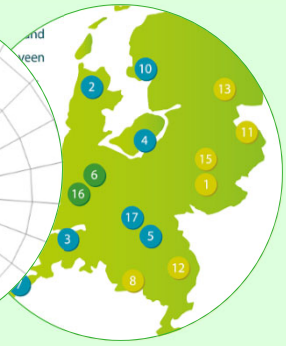


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Table 3: Number of farms representing Veldleeuwerik (VL), Cows & Opportunities (C&O), and the national average (source: BIN, 2019).

Group	2012	2013	2014	2015	2016	2017
VL	-	25	30	33	33	33
C&O	15	15	16	16	16	18
National average arable	-	192	196	191	193	191
National average dairy	347	343	330	344	355	350

NUTRIENT USE EFFICIENCY & NUTRIENT SURPLUS

$$\textbf{NUE} = \frac{\text{Nutriet output}}{\text{Nutrient input}}$$

$$\textbf{Nutrient Surplus} = \text{Nutrient inputs} - \text{Nutrient outputs}$$

$$\textbf{N surplus livestock} = \frac{\text{Nutrient surplus} * \text{area}}{\text{kg milk produced by farm}}$$

Input fields Fertiliser, seeds & planting materials, biol. fixation, atm. deposition

Input dairy Animals, feed

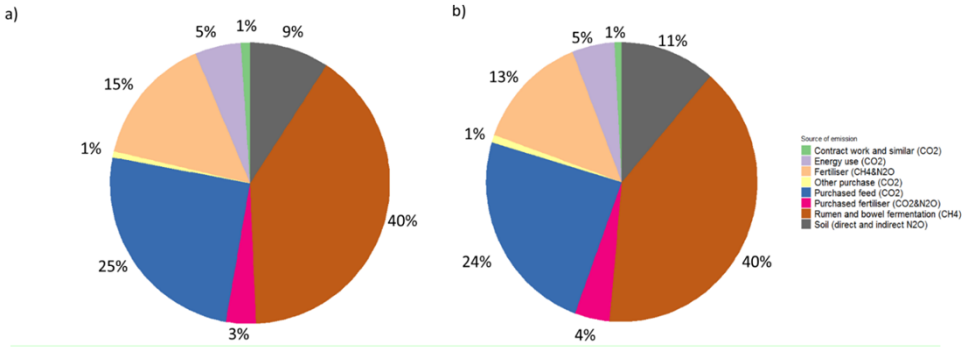
Output fields Arable products, fodder

Output dairy Animals, animal products, organic fertiliser

SOURCES INCLUDED FOR GHG EMISSIONS

- Rumen and bowel fermentation (CH_4)
- Manure (CH_4 and N_2O)
- Soil (N_2O directly and indirectly)
- Energy use (CO_2)
- Contract work and similar (CO_2)
- Purchased feed (CO_2)
- Purchased fertiliser (CO_2 and N_2O)
- Other purchase (CO_2)

SOURCES FOR GHG EMISSIONS



Average proportion (over 2012 – 2017) of the sources of the greenhouse gas emissions for a) Cows & Opportunity farms and b) the national average.

M&M – „BETTER“ PERFORMANCE

Intensification
- Higher yield and input use

Environmental sustainability
- Higher nutrient use efficiencies, WUE, feed self-sufficiency, and biodiversity
- Lower values for nutrient surpluses, water use, GHG emissions, and diesel use

Socio-economic sustainability
- Higher preservation of grazing, income per entrepreneur
- Lower farmer's age, and income variability

BIODIVERSITY

Possible options:
- Length of hedges / ha
- Percentage of permanent grassland
- Protection measures for meadow birds (e.g. nest protection in grasslands)
- Buffer zones of pesticide use
- Flower strips

ANIMAL WELFARE

Possible options:

- Health indicators: body condition, integument, behaviour, locomotion and claw condition
- Somatic cell count, mortality and production are assessed routinely in the NL but not very strong indictors of welfare

➢ several indicators needed to get a good assessment

(Eddie Bokkers, personal communication)

YIELD CALCULATION

Farm level yield (€/ha) = Total revenues (€)/Area of cultivated land (ha)

Crop level yield (kg/ha) = Weight of crop (kg)/Area of that crop (ha)

Livestock yield 1 (€/ha) = Revenues dairy cows (€)/Area feed surface (ha)

Livestock yield 2 (kg/ha) = Milk production (kg)/Area feed surface (ha)

WATER USE (EFFICIENCY) CALCULATION

$$\text{Water use arable farms}(m^3/ha) = \text{Water use irrigation } (m^3)/\text{crop area (ha)}$$

$$\text{WUE farm level dairy } (€/m^3) = \text{Total revenues } (€)/\text{Total water use } (m^3)$$

$$\text{WUE livestock dairy } (kg/m^3) = \text{Milk yield } (kg)/\text{Total water use } (m^3)$$

Crop area refers to the area of carrots, winter carrots, chicory, potato (ware, seed and starch potato), onions, and shallots

FEED SELF-SUFFICIENCY CALCULATION

$$\text{Feed self} - \text{sufficiency } (\%) = \frac{\text{Grass (kVEM)} + \text{Maize(kVEM)}}{\text{Total feed value intake (kVEM)}} * 100\%$$

INCOME PER ENTREPRENEUR CALCULATION

Farm income = Farm revenues – (paid costs + depreciation + balance of extraordinary income and expenses)

AWU = 2000 hours worked, one person can be a maximum of one AWU.

INCOME PER ENTREPRENEUR CALCULATION

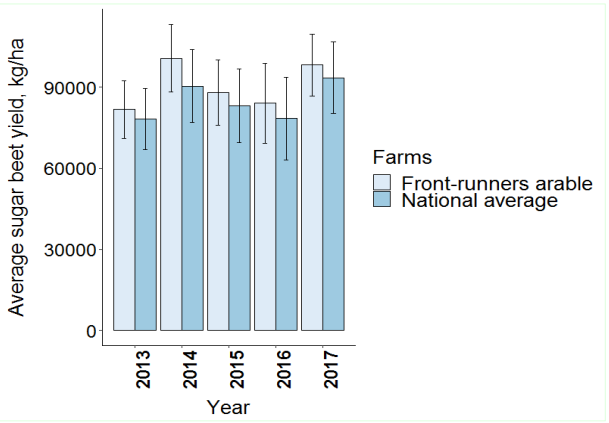
$$\text{Income variability} = \text{mean}\left(\frac{\sum(x_i - \bar{x})^2}{n-1}\right)$$

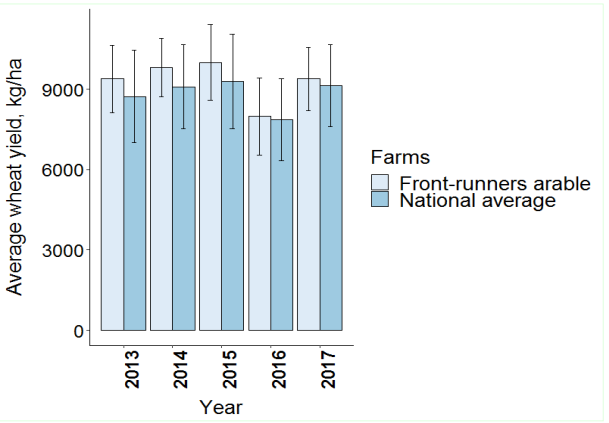
x_i = Income per unpaid AWU of individual farm

$\bar{x}$ = Mean of income per unpaid AWU over 2013 – 2017 (arable farms) and 2012 – 2017 (dairy farms)

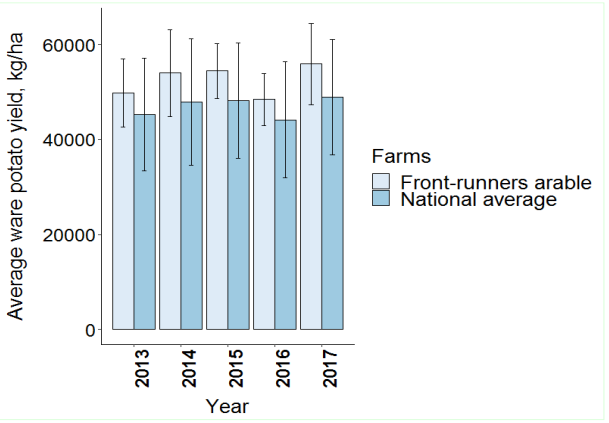
n = number of observations

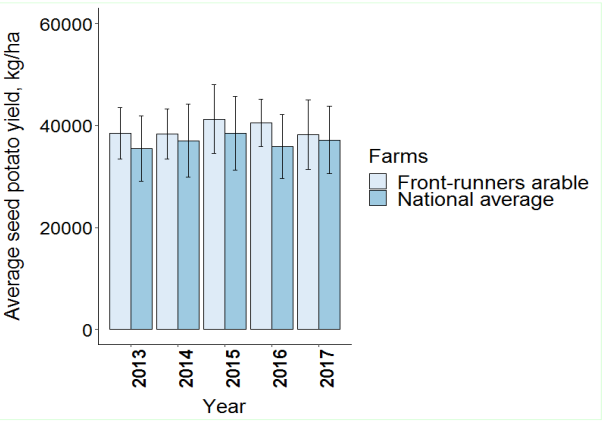
YIELD
RESULTS & DISCUSSION ARABLE





YIELD
RESULTS & DISCUSSION ARABLE





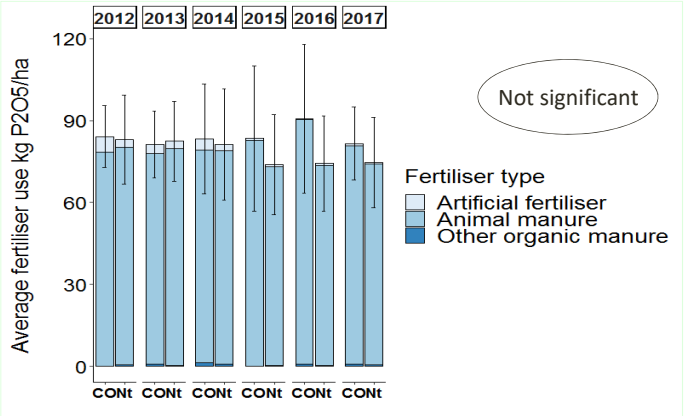
TENDENCIES FOR DIFFERENCES ARABLE

- Tendency for lower CPA use at crop level
- Tendency for lower diesel use

➢ supported by other studies

FERTILISER USE

RESULTS & DISCUSSION DAIRY



➢ Tendency for more fertiliser use 2015 - 2017

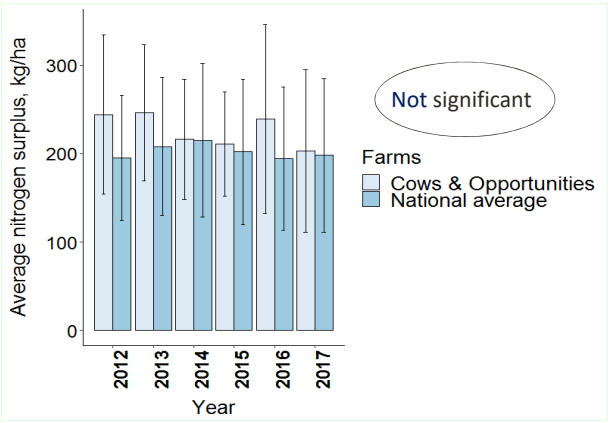
➢ Pilot projects BEP and BES, farm-specific fertilisation

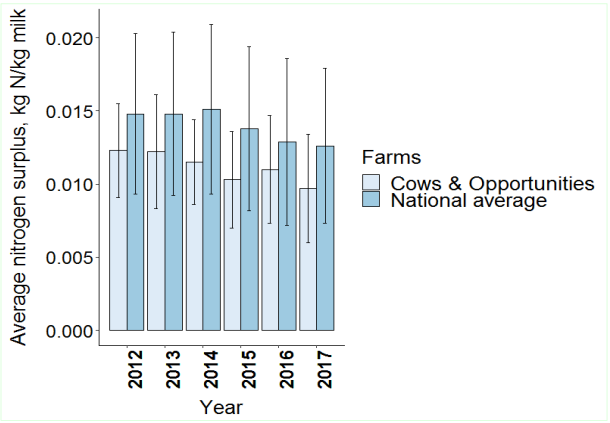
➢ Standard fertilisation norm lowered from 2014 – 2015

N SURPLUS
RESULTS & DISCUSSION DAIRY

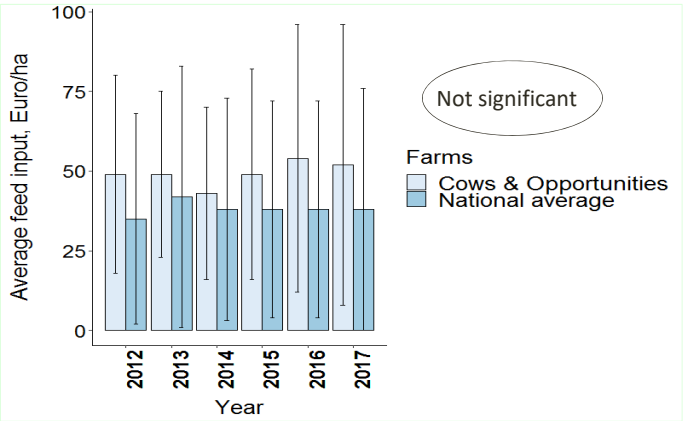
Advantage lost

Reduction of fertiliser use



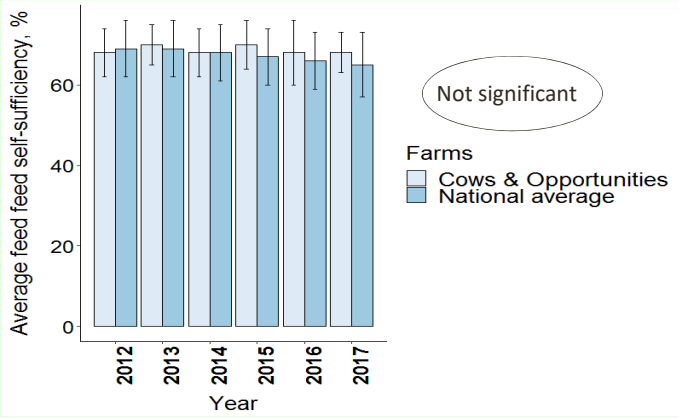


FEED COSTS
RESULTS & DISCUSSION DAIRY



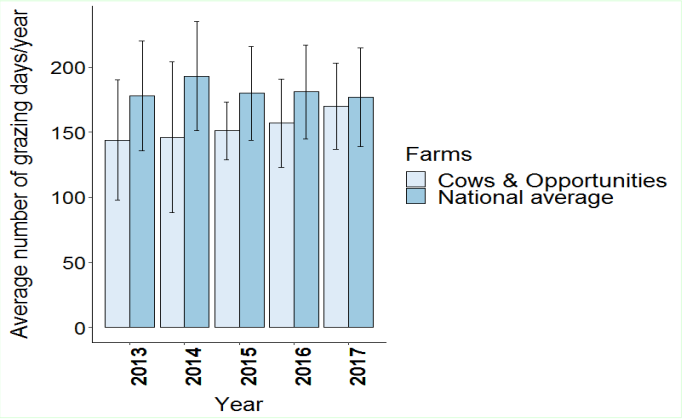
- Tendency for higher feed costs
- More cows/ha
- More attention to quality

FEED SELF-SUFFICIENCY
RESULTS & DISCUSSION DAIRY



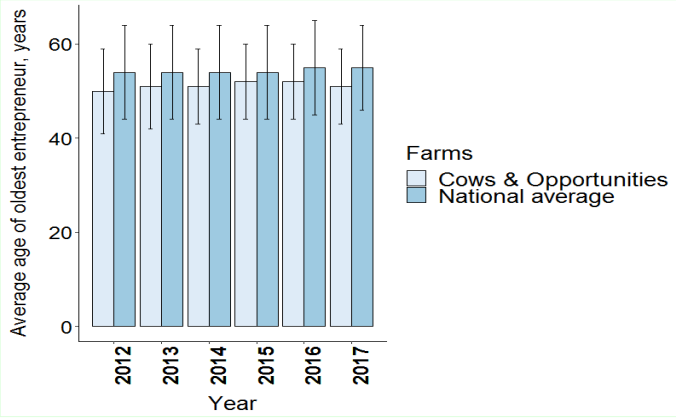
- In combination with more cows/ha
  - Produce more feed
  - Less off-farm emissions per cow
- In combination with higher milk yield
  - Better feed efficiency

PRESERVATION OF GRAZING
RESULTS & DISCUSSION DAIRY



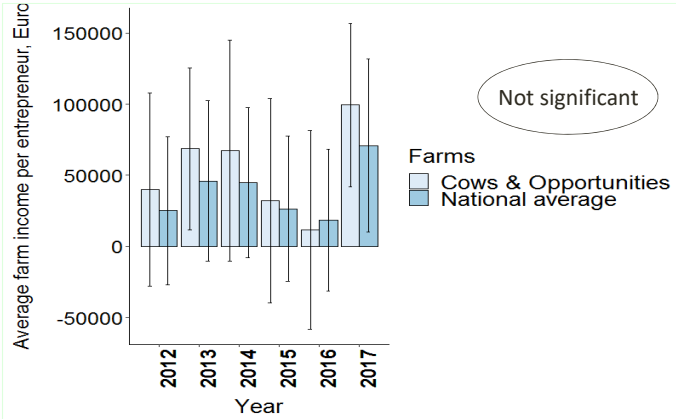
- C&O farms less grazing days per year
  1) High intensity
  2) Farm set-up
  3) Measure for improved nutrient management
- Tendency for increase for C&O

AGE OF FARMER
RESULTS & DISCUSSION DAIRY



- More innovative, future-oriented farmers
- Selected so that open to research
- Often younger

INCOME PER ENTREPRENEUR
RESULTS & DISCUSSION DAIRY



- Significantly higher yield but no significant difference in income
- Number of entrepreneurs the same
- C&O higher costs
- Large variation

TENDENCIES FOR DIFFERENCES DAIRY

- Tendency for more fertiliser use in 2015 – 2017
- Tendency for a higher NUE
- Tendency for higher feed costs

DISCUSSION OF METHODS

Data availability
- Only six years available
- No conclusions on animal welfare & biodiversity

Radar charts
- Underlying variation lost
- Scaling is subjective
- Number of indicators per principle varies
- Equal weighing of indicators