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Nitrogen and phosphorus fluxes of grassland-based dairy production systems on mixed farms in Switzerland

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Introduction – **Agriculture and nutrient emissions**

- ▶ Agricultural production is responsible for substantial N and P emissions to the environment
- ▶ In the case of Switzerland, about two thirds of the N emissions to the environment originate from agricultural activity
- ▶ Dairy production one of the principal sources for N emissions
- ▶ Increasing political pressure to reduce negative impacts on environment

Introduction – Research question

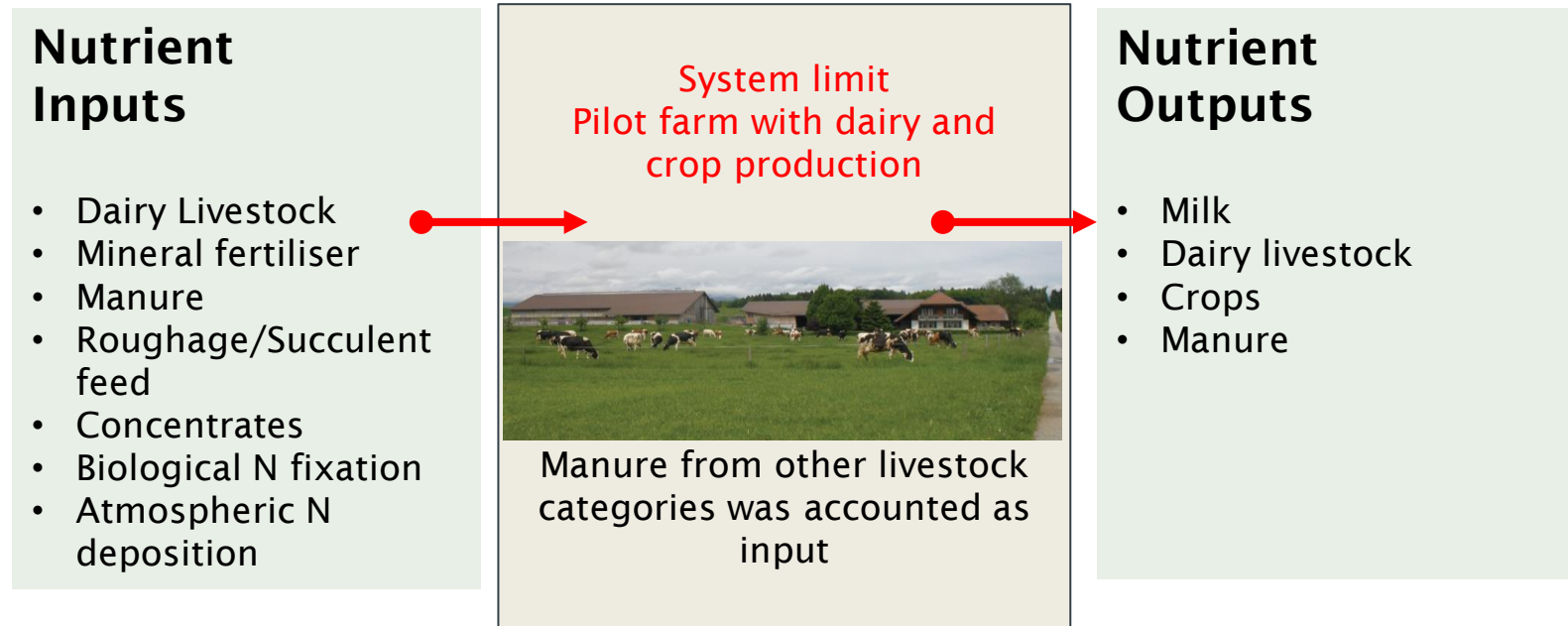
- ▶ How do typical Swiss grassland-based mixed dairy farms perform with respect to nutrient surpluses and nutrient use efficiency for N and P ?
- ▶ Farm gate nutrient balances provide an easy applicable and effective tool for the quantification of nutrient surpluses
- ▶ Calculation of farm gate balances for 31 mixed pilot dairy farms in the framework of a system comparison experiment

Material & Methods – Grassland-based mixed dairy farms



	Indoor feeding fresh grass Reduced concentrates (IF)	Indoor feeding fresh grass Increased concentrates (IF _{plus})	Full grazing (FG)
Concentrates (kg cow ⁻¹ yr ⁻¹)	425 (111-718)	991 (623-1'534)	115 (0-347)
Milk yield (kg ECM cow ⁻¹)	7'125 (6'367-8'349)	8'225 (6'893-9'619)	6'444 (5'024-8'535)
Arable land (%)	28.1 (0-70.4)	29.6 (5.8-52.2)	13.9 (0-43.4)

Material & Methods - Nutrient accounting with farm gate balances

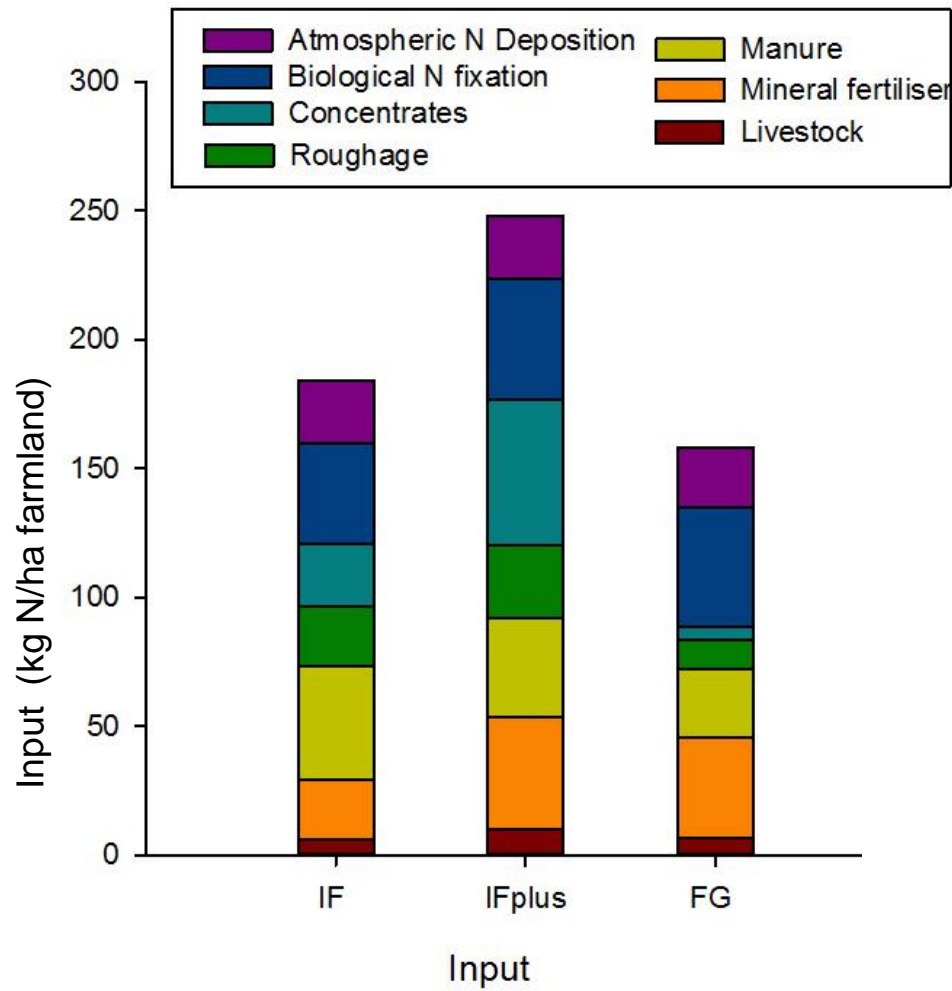


Evaluated parameters

- Surplus per ha farmland
- Nutrient use efficiency: Output/Input

Nitrogen

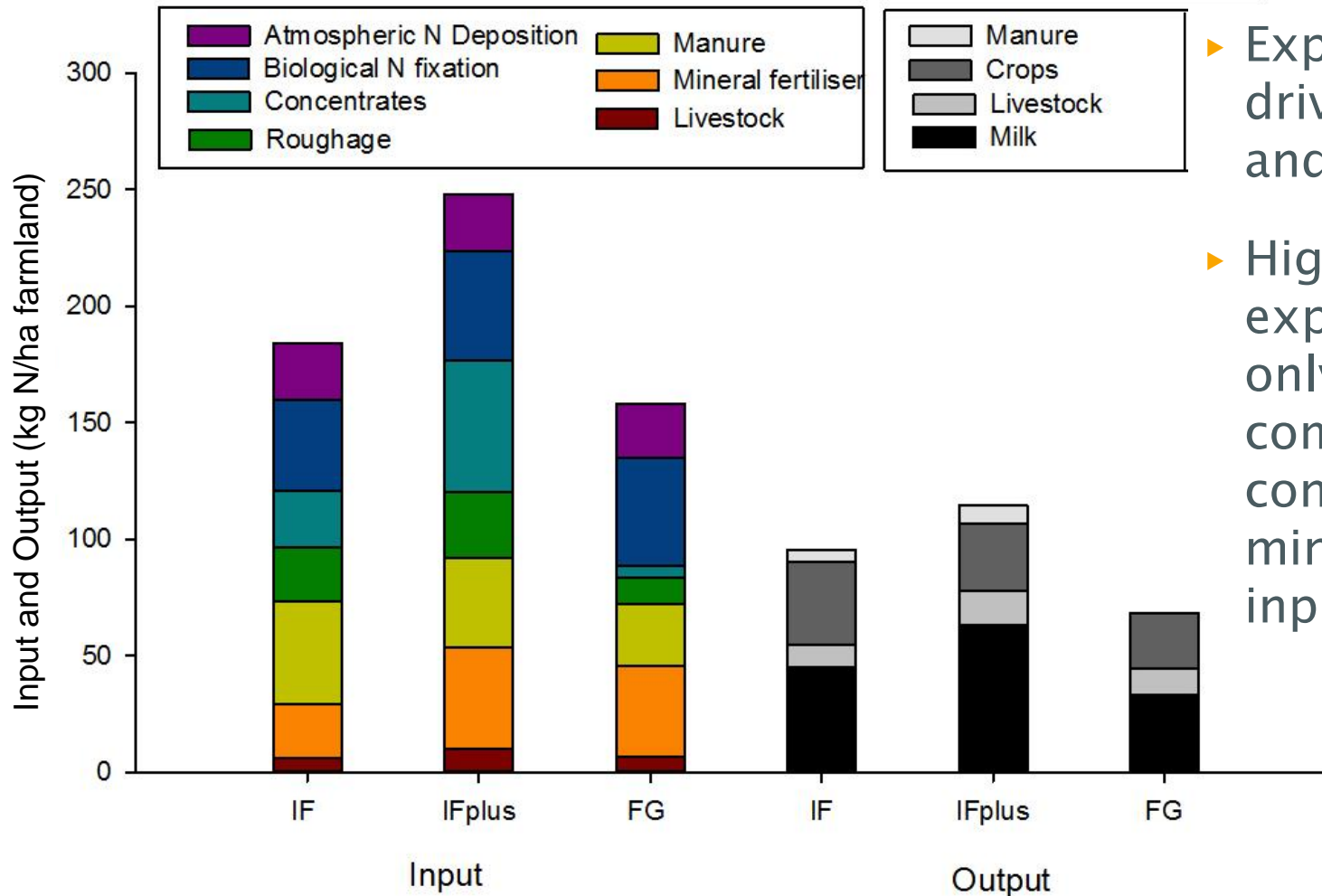
Average inputs per ha farmland



- ▶ Highest inputs on IF_{plus} farms with about 250 kg N per ha
- ▶ Most important inputs
 - ▶ Concentrates
 - ▶ Mineral fertilizer
 - ▶ Biological N fixation
- ▶ Biological N fixation most important input for full grazing system

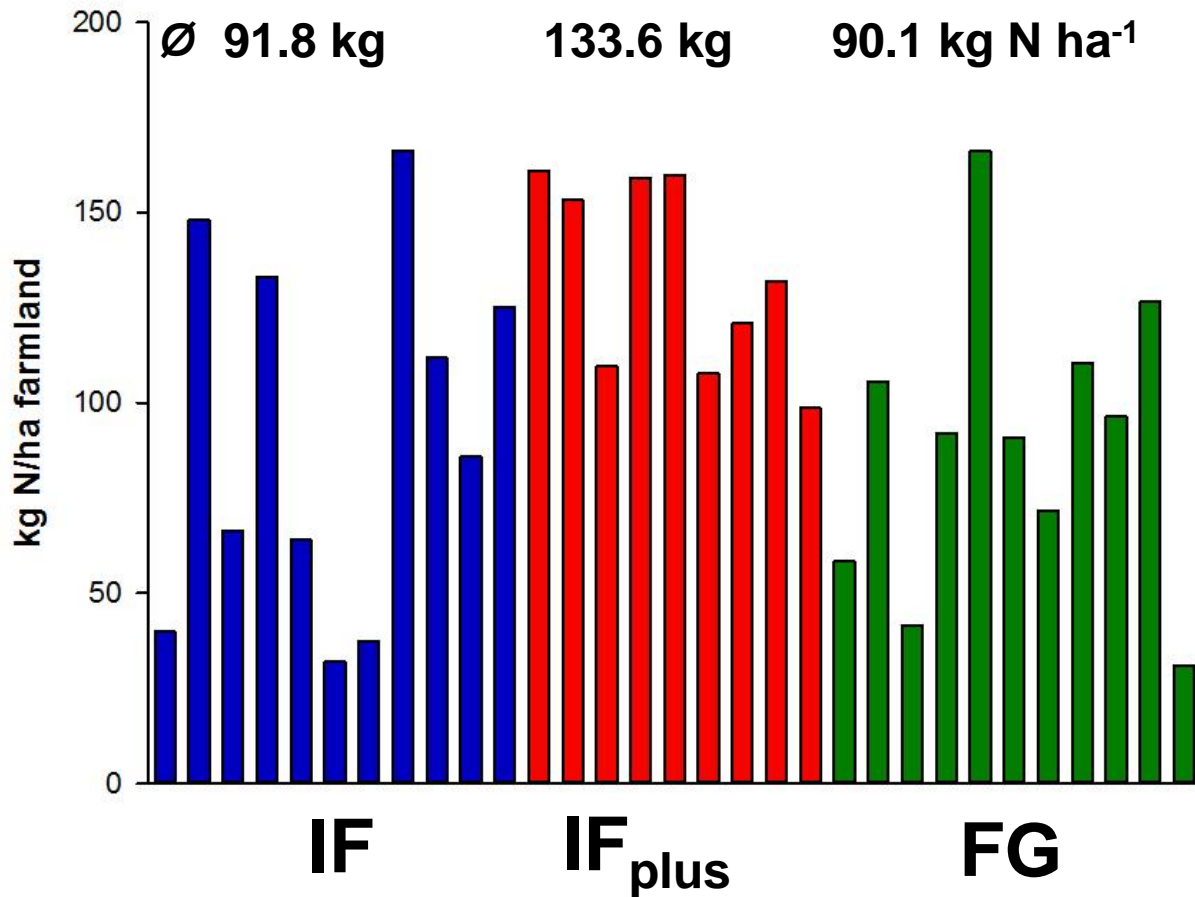
Nitrogen

Average outputs per ha farmland



- ▶ Exports mainly driven by milk and crops
- ▶ Higher milk exports of $I_{f_{plus}}$ only partly compensate concentrate and mineral fertilizer input

Nitrogen Surplus per ha farmland

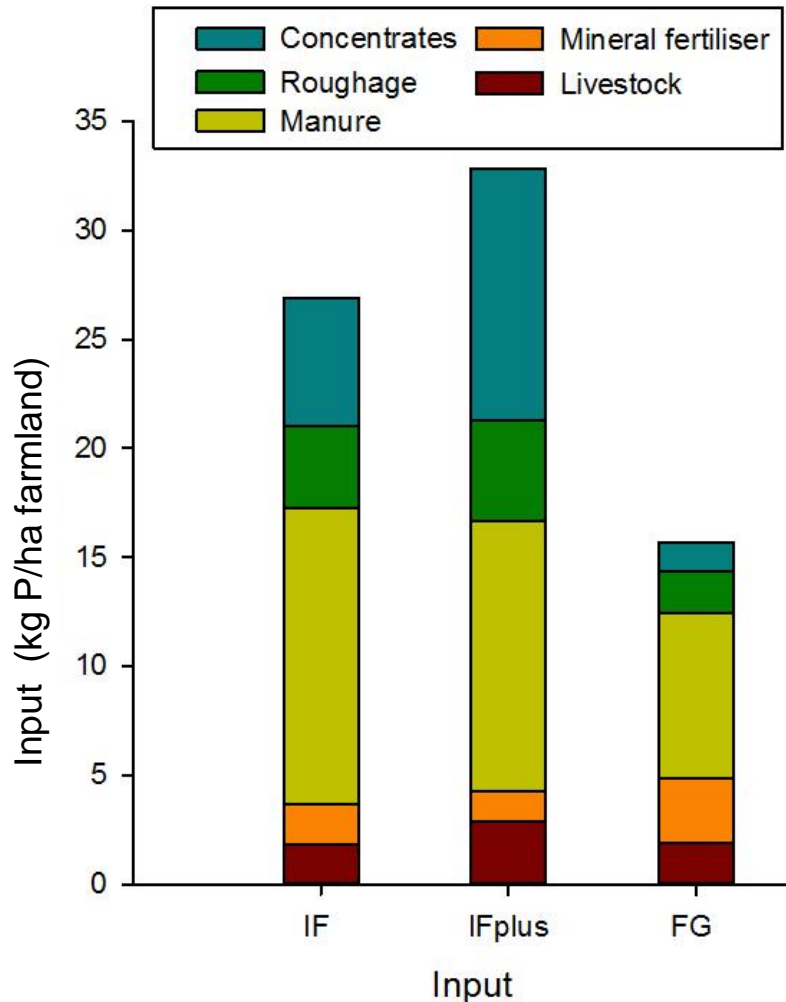


Nitrogen use efficiency (%)

	Mean	SD
IF	53.2	13.5
IF _{plus}	46.1	6.8
FG	44.6	11.9

Phosphorus

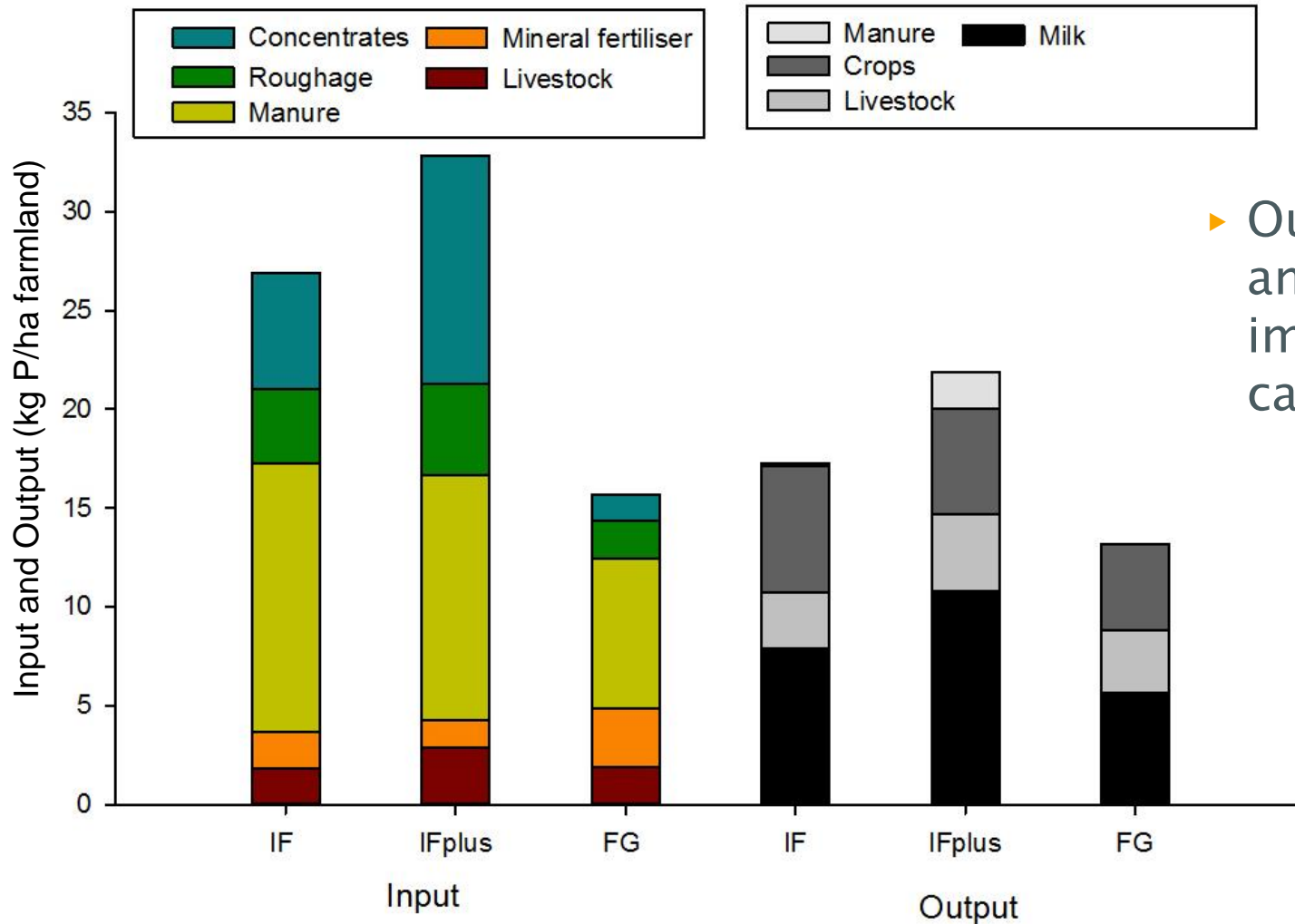
Average inputs per ha farmland



- ▶ IF/IF_{plus} farms with substantial higher P input than FG
 - ▶ Concentrates
 - ▶ Manure from other livestock categories
- ▶ Relatively low input of mineral fertiliser in all systems

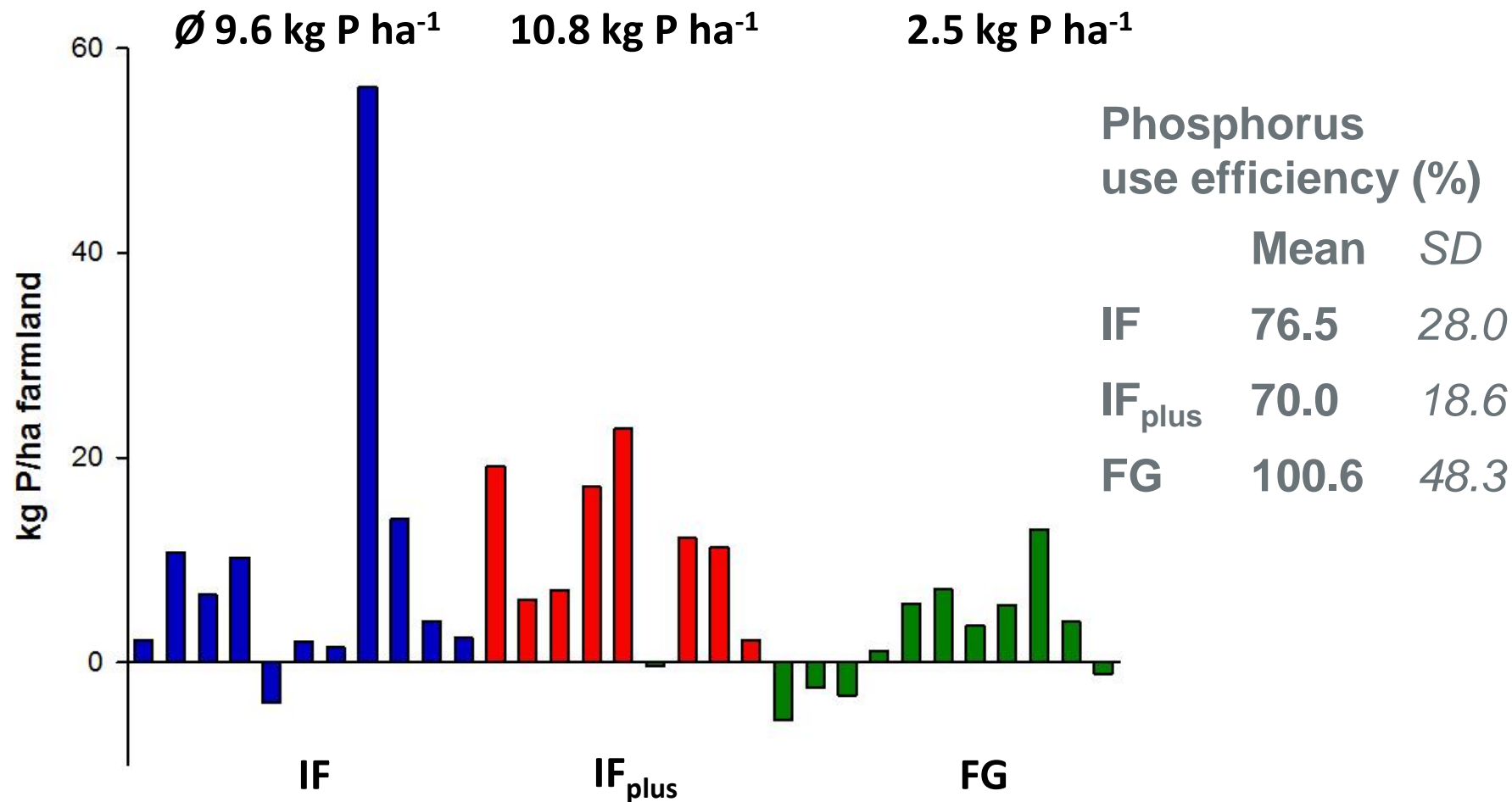
Phosphorus

Average outputs per ha farmland



- ▶ Output via milk and crops most important export categories

Phosphorus Surplus per ha farmland



Correlation coefficients between different parameters of the farm gate balances

	IF	IFplus	FG
P surplus vs. input concentrates	$r = 0.74$ $P=0.013$	$r = 0.79$ $P=0.012$	$r = 0.67$ $P=0.025$
P surplus vs. input manure	$r = 0.65$ $P=0.037$	$r = 0.97$ $P<0.001$	$r = 0.71$ $P=0.015$
NUE vs. percentage arable land	$r = 0.70$ $P=0.016$	$r = 0.86$ $P=0.003$	$r = 0.34$ n.s.
N surplus vs. Bio. N fixation	$r = 0.38$ n.s.	$r = 0.55$ n.s.	$r = 0.71$ $P=0.014$
N surplus vs. input manure	$r = 0.69$ $P=0.019$	$r = 0.56$ n.s.	$r = 0.46$ n.s.
PUE vs. output milk	$r = -0.62$ $P=0.042$	$r = 0.18$ n.s.	$r = 0.12$ n.s.

Conclusions

- ▶ Considerable variability between farms with respect to surpluses and nutrient efficiency
 - ▶ General potential for optimisation
- ▶ IF_{plus} farms with highest N- and P-surplus
 - ▶ Optimisation of inputs by concentrates and manure
- ▶ Lower N-use efficiency of FG farms
 - ▶ Limited possibilities to balance ration
- ▶ Mixed farming helps to improve the nitrogen use efficiency of IF/IF_{plus} farms