APPROXIMATING GREENHOUSE GAS EMISSIONS FOR A FARM NETWORK USING READILY AVAILABLE DATA

Andreas Roesch, Anina Gilgen, Aurelia Nyfeler-Brunner, Martin Stüssi

Agroscope, Life Cycle Assessment Research Group, Zurich, Switzerland

Agroscope

ESA 2020

XVI European Society for Agronomy Congress 1 to 3 September, 2020 - Sevilla - Spain

1 Introduction

IP-SUISSE

- Swiss farming association IP-SUISSE (20,000 Members (out of 50,000 Swiss Farmers; 40%))
- 10,000 Members produce for the IP-SUISSE Label
- Label producers must satisfy additional standards, e.g. ones that promote biodiversity
- If the additional standards are met, farmers receive higher prices for their products

Agroscope

1 Introduction

Current project (IP-Suisse/ Agroscope)

✓Extension of Label standards with climate-change mitigation measures **(e.g., solar panels, heat recovery, biogas, covering of slurry pit, etc.)**

✓Aim of this collaboration: 10% reduction in GHG emissions for IP-SUISSE Label producers in 2022 compared to 2016

⇒ Requires estimate of total GHG emissions of all IP-SUISSE Label farms in 2016.

Problem: Full LCA based on SALCA/SimaPro too time-consuming

Solution: Apply simple method to approximate GHG emissions at farm level (using readily available input data at farm level)

Agroscope

2 Materials and Methods

Data

(1) Computed global warming potential (GWP) for 33 IP-Suisse pilot farms (covering typical production systems in Switzerland) using SALCA/ SimaPro

(2) Farm Structure Survey: Land area/ Livestock numbers

→ Preselection of relevant variables taking into account the main drivers for methane CH_4, fossil carbon dioxide CO_2, nitrous oxides N_2O.

Land	Livestock
Utilised agricultural area (UAA)	Total livestock [LU]
Open arable land (OA)	Total cattle [LU]
Permanent grassland	Pigs [LU]
Biodiversity-promotion areas	Poultry [LU]

2 Materials and Methods

After eliminating insignificant variables by stepwise model selection using AIC, the following approach was discovered:

Model: Quadratic polynomial regression (POLMOD)

$$y = a + \beta_1 * x_1 + \beta_2 * (x_1)^2 + \beta_3 * x_2 + \beta_4 * (x_2)^2$$

Explaining variables

x_1= Livestock density (TLD) [LU/ha UAA]

x_2= Proportion of open arable land (POA) [ ]

Target (dependent) variable

y: GHG emissions per UAA [t CO_2eq /ha]

3 Results

Estimation of coefficients for polynomial regression (POLMOD)

$$y = 10.56 - 2.73 * TLD + 1.48 * (TLD)^2 - 23.61 * POA + 17.91 * (POA)^2$$

y = GHG emissions per UAA [t CO_2eq /ha]

TLD= Livestock density (TLD) [LU/ha UAA]

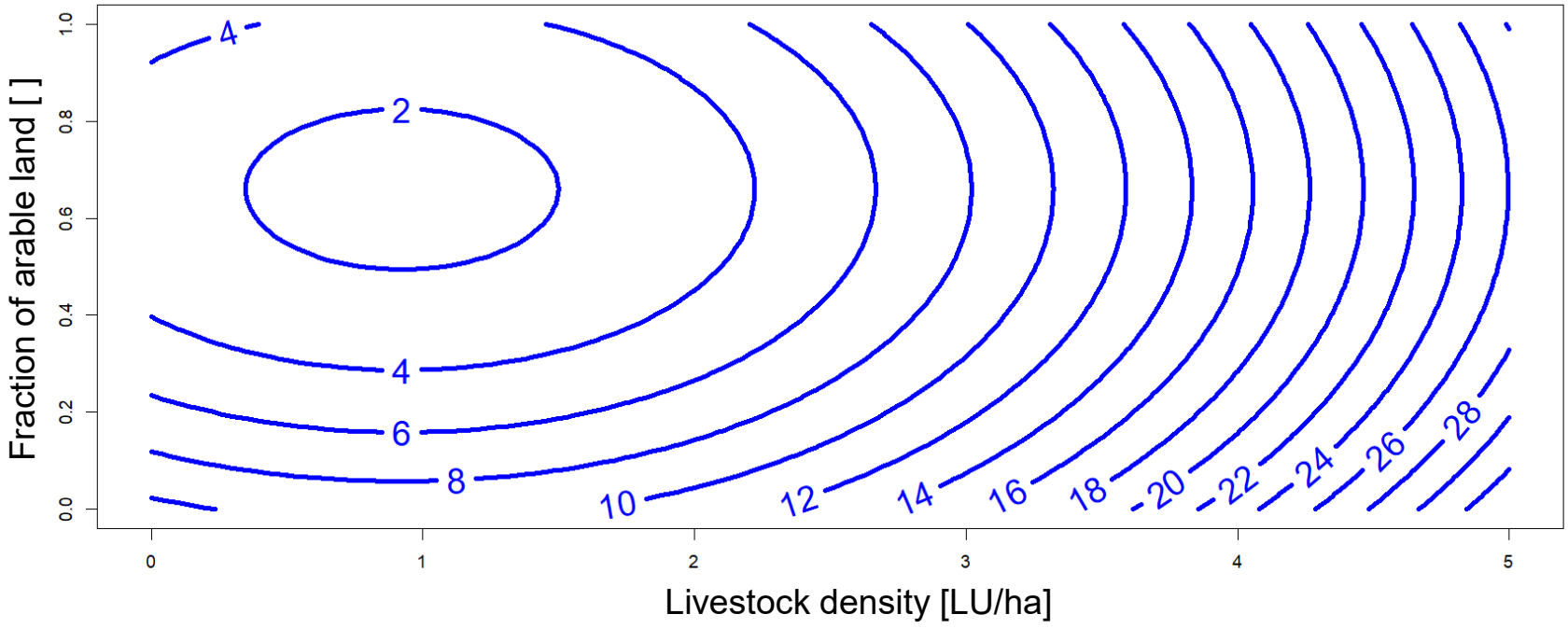
POA= Proportion of open arable land (POA) [ ]

The following comments are worth noting:

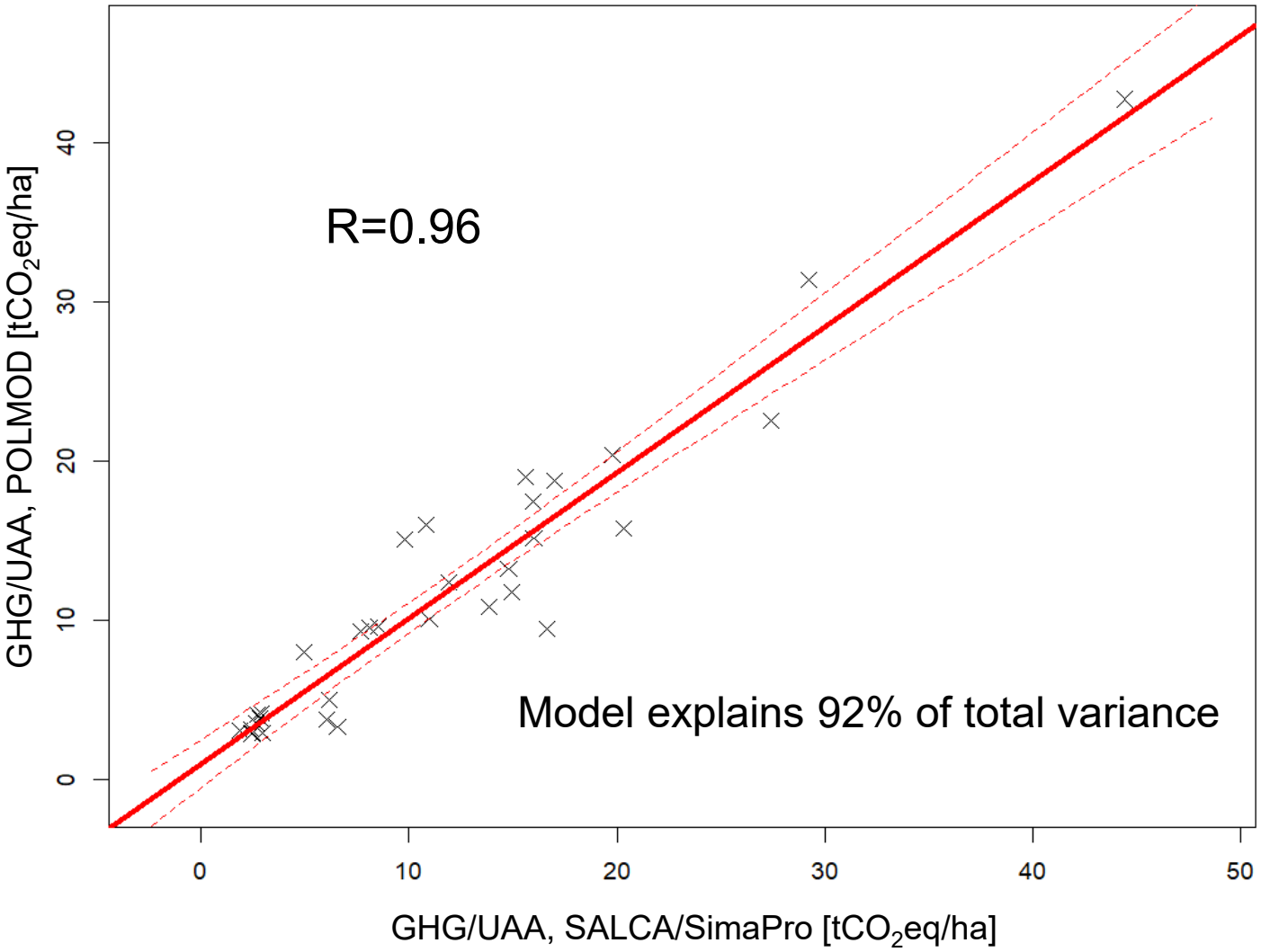
(i) Small sample → avoid overfitting → use limited number of explaining variables
(ii) Model assumptions are well satisfied (e.g. residuals are randomly distributed)
(iii) Application of robust methods did not improve the results

3 Results

Estimated GHG Emissions [t CO_2eq] per ha
Method: POLMOD

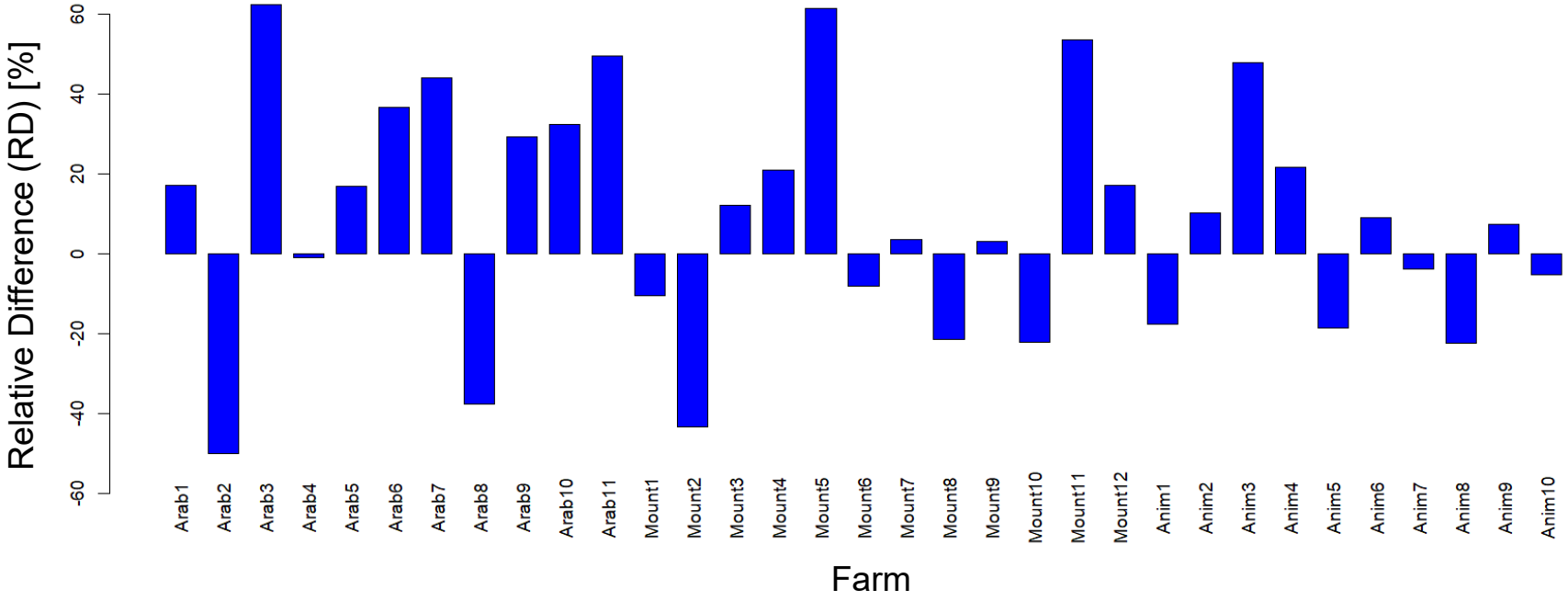


3 Results



3 Results

Relative GHG difference: POLMOD minus SALCA



Mean = 9% , std. dev. = 30%

16 out of 33 farms *RD*<20% , 4 out of 33 farms *RD*>50%

3 Results

Extrapolation to Swiss agricultural sector (2016)

Application of POLMOD to all Swiss farms
=> total GHG emissions from the Swiss agricultural sector

GHG Emissions CH = 6.93 +/- 1.24 million t CO_2eq

Plausibility check/ Verification by independent source (Bretscher et al., 2020)

GHG Emission CH = ~ 7.5 million t CO_2eq

→ Good agreement

4 Discussion/ Conclusions

- POLMOD allows the computation of GHG emissions at farm level based on two readily available variables
- The POLMOD method is well suited to estimating GHG emissions at farm level (92% of the variance can be explained)
- POLMOD allows extrapolation to all IP-Suisse Label farms or to the entire Swiss agricultural sector

- Percentage deviations from SALCA/Simapro computed GHG estimates may exceed 50% for certain farms
- Small size of sample may be critical
- More independent evaluations (based on larger samples) are required












Thank you very much for your attention

Andreas Roesch

andreas.roesch@agroscope.admin.ch

Agroscope Good food, healthy environment

www.agroscope.admin.ch