# Data for the evaluation of effects on emissions

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# Emissions from agriculture

**FADN provides a suitable sample and information source for:**

- Estimating farm level GHG emissions and,
- Evaluating impacts of rural programmes and policies

Contents:

- A quick reminder of I.07
- Where the FADN sample fits in the assessment exercise
- Use FADN returns to estimate emissions
- Face the challenges and overcome the barriers
- Data related recommendations for the ex-post
- Recommendations for the CAP post 2020
- Appendix – Case Studies from European Union countries

# Impact Indicator I.07

## Emissions from agriculture – National Data: Databases

**I.07. Emissions from agriculture** (CAP Context Indicator 45)

1) GHG emissions from agriculture including agricultural soils

2) Ammonia emissions from agriculture

**Main Databases**:
GHG Emissions: European Environment Agency (EEA)
Ammonia emissions: European Environment Agency (EEA)

**Other data sources:**
UNFCCC, Eurostat, Eionet, Convention on Long Range Transboundary Air Pollution

# Evaluating RDP and Ag. Policy Impacts

## Data requirements of evaluation strategies at farm level

| Re-create activity data | Environmental data | Emission coefficients | Farm GHG emissions |
|---|---|---|---|
| **Data requirements:**<br>• **FADN**<br>• Farm Business Survey<br>• Agricultural Census | **Data requirements:**<br>• Temperature<br>• Rainfall<br>• Soil<br>• LPIS | **Data requirements:**<br>• NIR<br>• EFDB for mitigation<br>• LPIS<br>• Academic literature | **GHG emissions:**<br>• per activity<br>• per gas<br>• total $CO_2$ equivalent<br>• total carbon footprint-CF |
| **Examples:**<br>• FADN (Italy, Lithuania, Poland)<br>• Farm Business Survey (England)<br>• Ag. Census and typical farms (Ireland, Scotland) | **Examples:**<br>• LPIS to provide georeferenced farm plots<br>• Met Office (England), Met Éireann (Ireland)<br>• Scottish Soils Knowledge Information Base (Scotland) | **Examples:**<br>• Adapt emissions coefficients for LULUCF (Italy)<br>• IPCC and academic literature - $N_2O$ (Ireland) | **Examples:**<br>• per gas and total $CO_2$ equivalent (Ireland, Italy)<br>• per gas and total $CO_2$ including energy (England)<br>• carbon footprint (Italy) |

# Evaluate GHG emissions using FADN Data: The Basic Idea

The FADN Farm Return

| Activity Data - FADN | | Implied Emission Factor | | GHG Emission |
|---|---|---|---|---|
| Table J – Livestock | × | 160.59 Kg $CH_4$/head/year | = | $CH_4$ enteric fermentation |
| Activity Data Example: | × | 26.49 Kg $CH_4$/head/year | = | $CH_4$ manure management |
| SE 125D – Dairy Cows | × | 0.62 Kg $N_2O$/head/year | = | $N_2O$ manure management |
| Table H – Inputs<br>Activity Data Example:<br>SE 296 – Fertiliser N | × | 0.01 Kg $N_2O$-N/Kg N | = | $N_2O$ agricultural soils – Inorganic N fertilisers |
| Table I – Crops<br>Activity Data Example:<br>SE 110D – Wheat | × | 0.01 Kg $N_2O$-N/Kg N | = | $N_2O$ agricultural soils – Crop residues returned |

NIR and IPCC 2006

# FADN **Is Not** an environmental database
# Challenges using FADN

**Management practices are not reported by FADN returns:**

Example: Manure management practices, manure spreading, winter/cover crops, etc.

**Activity data may be missing:**

Example: Usually quantities of fertilizers or of other soil improvers are not recorded (but expenditure for these substances is recorded)

**What to do:**

**Prepare**
- The Programme
- Output and
- Results indicators

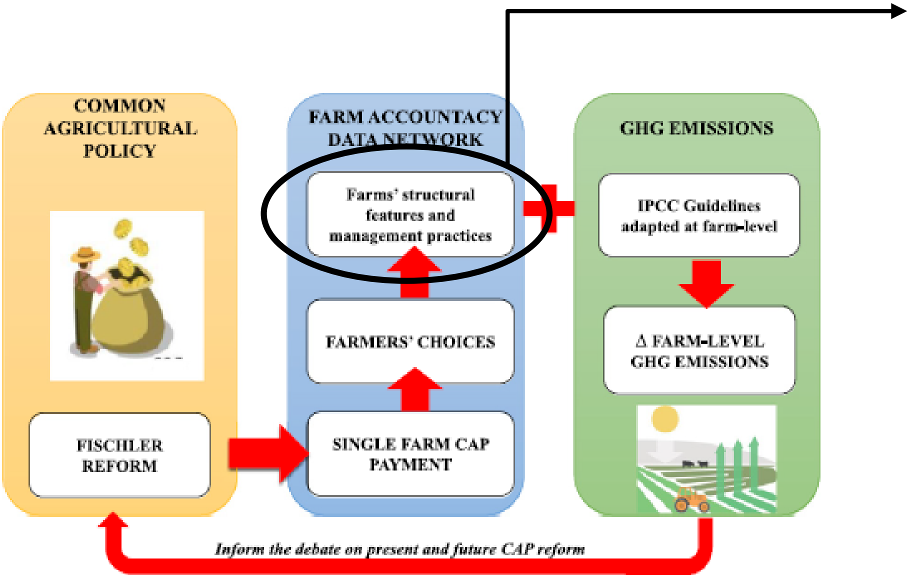
**Consult**
- The MA and PA
- The GHG Reporter
- Field experts

**Decide**
- What is relevant
- What is important
- How to complete missing info

**Design and Field Test Follow Up Actions**

# Facing challenges using FADN: Example

Silvia Coderoni and Roberto Esposti: CAP payments and agricultural GHG emissions in Italy, 2018.




Farms' structural features = Activity Data

Management practices = Emission Coefficients

GHG Emissions

The evaluators explain how they overcome challenges:

- Panel data of 6,542 farms between 2003-2007
- Decided not to measure changes in management practices unless these are depicted by FADN
- Estimated quantity of fertiliser applied on soils from expenditure recorded on FADN using field experts, an external database and extensive consultation
- They did not estimate any LULUCF tables

# Data and Database related recommendations for the ex-post

1. Does the evaluation focus only on I.07 or on a number of environmental indicators (water, soil, biodiversity)
2. Establish contact with your national reporters for GHG and ammonia
3. Decide if the core farm database will be a panel or a cross-section
4. Make heavy use of IACS
5. Will you use a GHG calculator to convert activity data to GHG emissions?
6. Which external databases do you need to link to the core database

# Recommendations for setting up the data management system for the CAP post-2020

1. The future sounds “integrated” and “sustainable”
2. This points out to “holistic” evaluations instead of piecemeal assessments fragmented by the type of impact or by the resource base (water, soil, biodiversity)
3. Evaluations will target the environmental sustainability of the farm
4. Think that you may have to link environmental evaluations to ecosystem services and ecosystem accounts

For “farm level” evaluations:

Design open systems that will be able to connect and integrate various environmental databases and parameters

The major challenge is to make use of national and EU environmental data infrastructure (e.g., LUCAS, ESDAC, Farm Birds, Waterbases) that is generated outside the conventional statistical system

# Thank you

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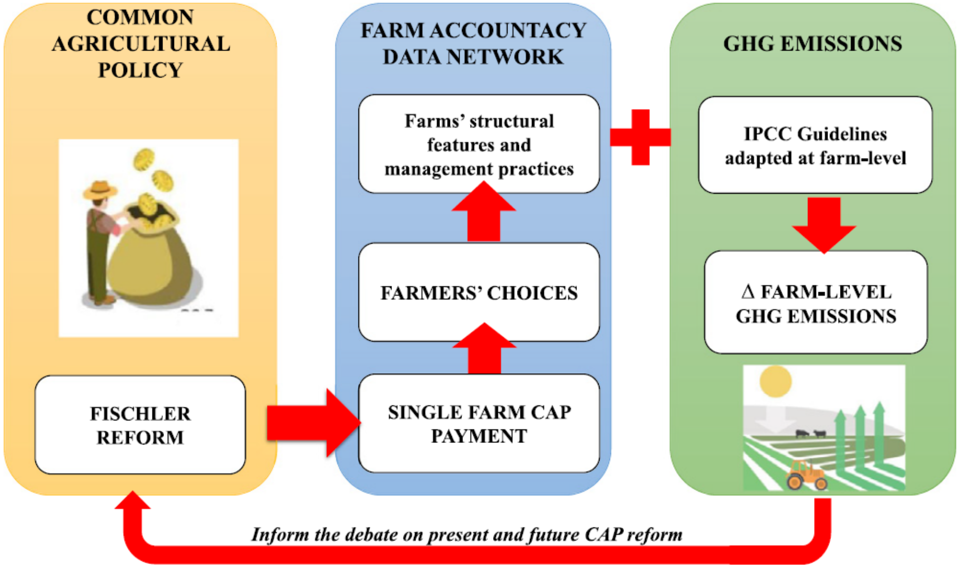
Download the presentation notes here

# Appendix – Case Studies

# Case Study 1: Italy

## Using FADN data to evaluate the effects of CAP payments including RDP on GHG emissions




The evaluation logic

**Table 1**
Likely impact of FR CAP instruments on GHG emissions.

| Measures | Actions | Expected impact on GHG mitigation |
|---|---|---|
| Decoupling | Reduced incentives for intensive production (less fertilizer use, extensification); Farmers more careful to market signals | +++ |
| Modulation | Structural measures | +/++ |
| | More resources for rural development (agri-environmental measures, training, etc.) | + |
| Cross-compliance | Soil erosion reduction | + |
| | Better management of soil organic carbon | + |
| | Reduction of fertilizers use | + |
| Set aside* | Reduction of fertilizers use | +/++ |
| | Potential carbon sequestration improvement | +/++ |
| Energy crops | Potential fossil fuel replacement, but higher emissions from land conversion | ? |
| Agri-environment | F1-Low environmental impact | +++ |
| | F2-Organic Farming | ++ |
| | H-Afforestation-costs of planting | +++ |
| | H-Afforestation-maintenance | +++ |
| | H-Afforestation-loss of revenue | +++ |
| | I1-Afforestation non-agricultural areas | +++ |
| | E-Less Favourite Areas (LFA) | + |
| | I6-Reforestation for natural disturbances | +++ |

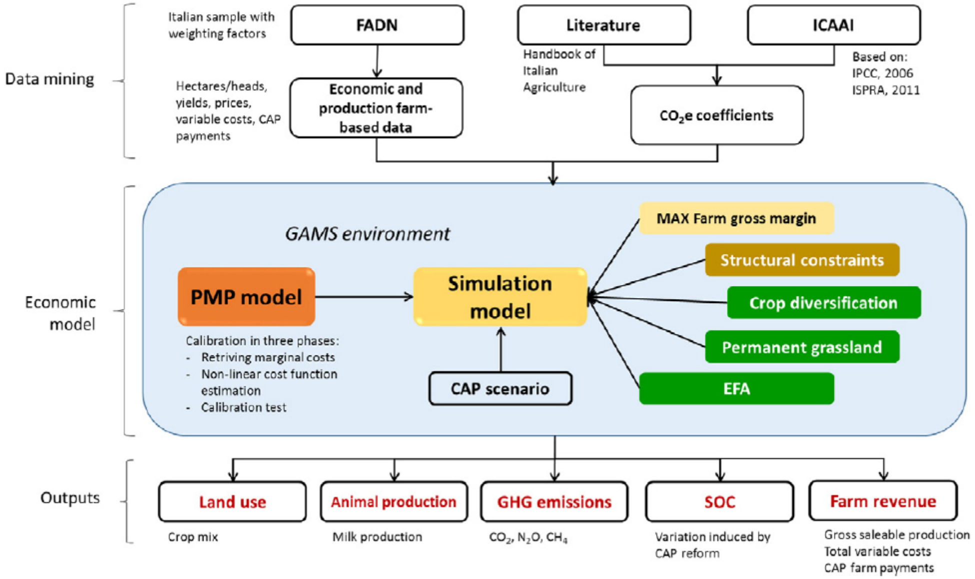
* until 2008.

**Table 2**
Summary of GHG emission sources considered for each CF category and the respective FADN activity data used.

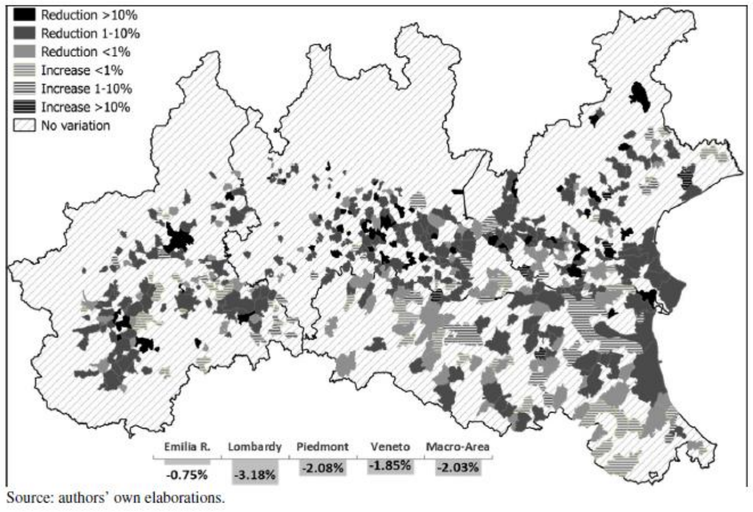
| CF category | Emission sources | FADN data |
|---|---|---|
| CF Livestock | $N_2O$ manure management | Animal numbers |
| | $CH_4$ manure management | Animal numbers |
| | $CH_4$ enteric fermentation | Animal numbers |
| CF Cultivation | $CH_4$ rice cultivation | Rice area (UAA) |
| | $N_2O$ Biological N fixation | N-fixing crop area |
| | $N_2O$ Crop residues | Crop area (UAA) or crop yield |
| | $N_2O$ Atmospheric deposition | Animal numbers |
| | $N_2O$ Leaching and run-off | Animal numbers |
| CF Fertilizer | $N_2O$ Use of synthetic fertilizers | Fertilizers expenditure |
| | $N_2O$ Atmospheric deposition | Fertilizers expenditure |
| | $N_2O$ Leaching and run-off | Fertilizers expenditure |
| CF Fuel | $CO_2$ Energy | Fuel expenditure |
| CF Land use A and B | $CO_2$ Forest land | UAA |
| | $CO_2$ Cropland | UAA |
| | $CO_2$ Grasslands | UAA |

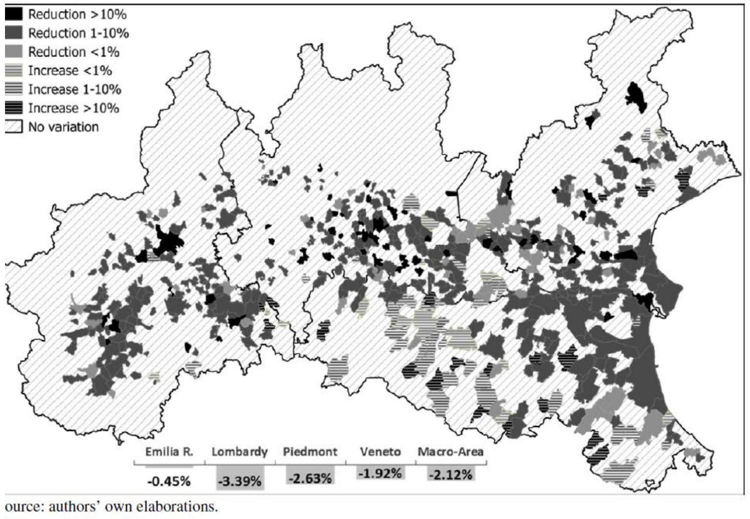
**Objective**: Evaluate the effects of the Fischler CAP reform on GHG emissions.
**Database**: A balanced panel of 6,542 Italian Farm Accountancy Data Network observed over years the 2003–2007.
**Evaluated measures**: Pillar and I (decoupling, modulation), Pillar II (Set aside, agri-environment) and Conditionality measures (table 1 above)
**Evaluated emissions and sectors**: $CH_4$, $N_2O$, $CO_2$ see table 2 above for sectors
**Information**: Coderoni, S. and Esposti, R. 2015; Coderoni, S. and Esposti, R. 2018; Coderoni, S. and Bonati, G. 2013; Coderoni, S., Valli, L. and Canavari, M. 2015

# Case Study 2: Italy
## Using FADN data to evaluate the effects of greening on GHGs




The evaluation logic

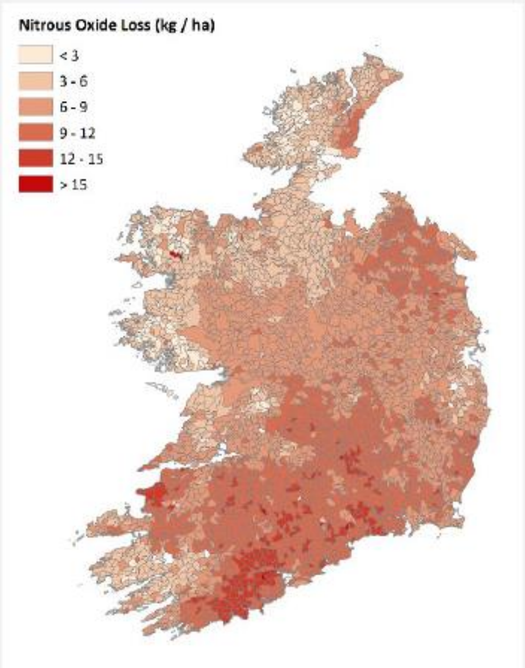


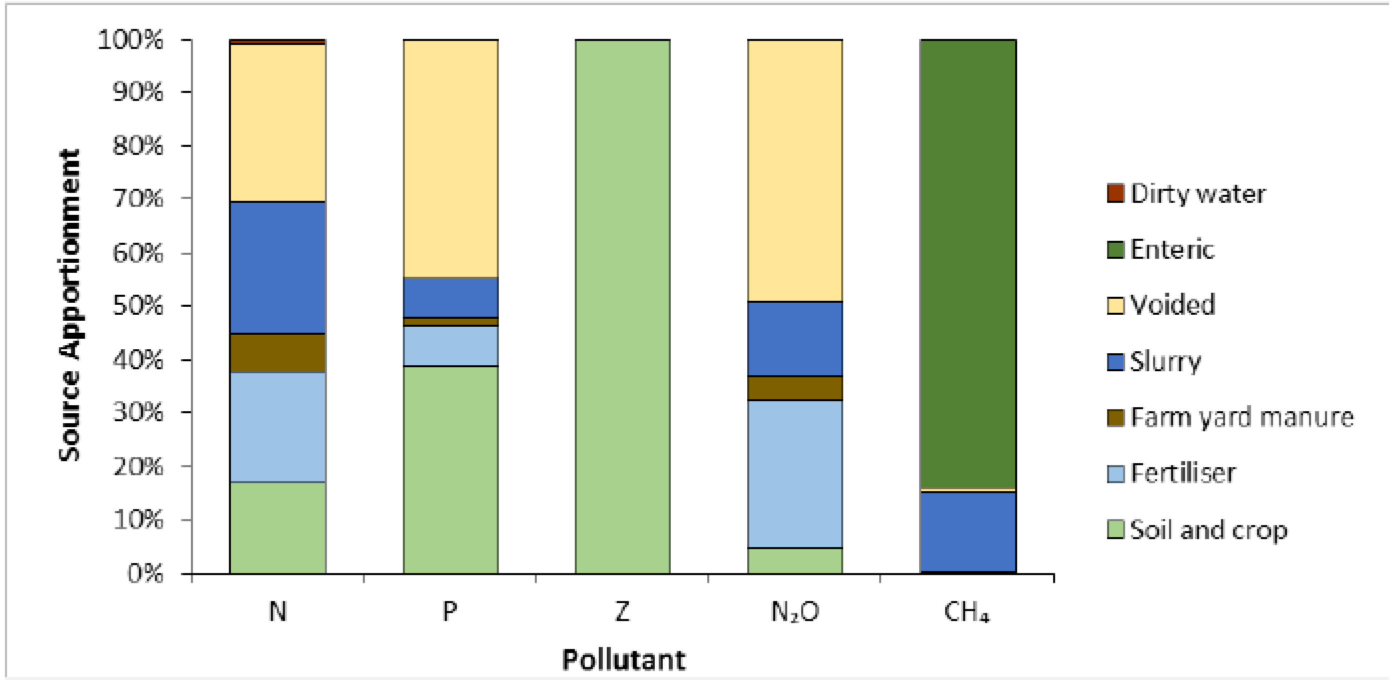




Impacts of greening on $CO_2$ (left) and $N_2O$ (right)

**Objective**: Evaluate the potential benefits from greening in terms of GHG emissions in four regions of Northern Italy.
**Database**: A cross section of more than 3,000 farms from Emilia-Romagna, Piedmont, Lombardy and Veneto of the 2012 Italian FADN sample.
**Evaluated measures**: Greening proposals of the Commission (crop diversification, permanent grassland, EFA, Entitled IPSO Facto)
**Evaluated emissions and sectors**: $CH_4$, $N_2O$, $CO_2$ and SOC
**Information**: Solazzo, R., Donati, M., Tomasi, L. and  Arfini, F. 2016

# Case Study 3: Ireland
## The Green Low Carbon Agri-Environment Scheme (GLAS)



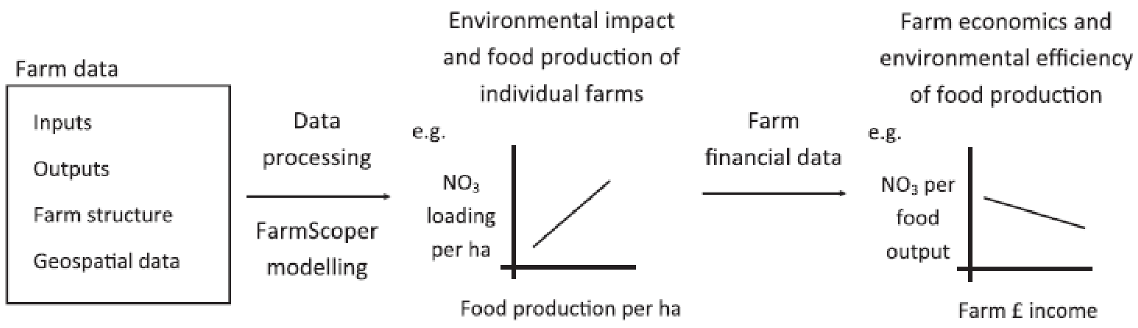

**Objective**: Evaluate the effects of GLAS on a series of environmental indicators including GHG emissions.
**Database**: Agricultural Census data at holding level for 2015 to determine cropping / livestock within catchments and use it with export coefficients.
**Evaluated measures**: All GLAS Measures
**Evaluated emissions and sectors**: Greenhouse gas (methane, nitrous oxide) and ammonia emissions
**Information**: Gooday, R. 2018; Baseline Analysis of Actions under GLAS: Full Report; Model Evaluation of GLAS;

# Case Study 4: England

## The use of Farm Business Survey data for estimating on farm GHG emissions

**Table 1**
Summary of FBS derived data for input into the Farmscoper tool.

| Input data | Units | Source | Notes/conversion |
|---|---|---|---|
| Farm structure | | | |
| Main farm type | n/a | Direct extraction | Defined as enterprise groups (e.g. cereals) accounting for >2/3 total Standard Output |
| Utilised agricultural area | Ha | Direct extraction | Total area excluding land, roads and buildings |
| Land use | Ha | Direct extraction | Individual main crop, fodder crop, grass and grazing areas |
| Livestock counts | No. | Direct extraction | |
| Crop production | | | |
| Total production of major crop product | T | Main crops: direct extraction<br>Fodder crops: typical yields | Typical fodder crops yields per hectare (SAC Consulting, 2012) |
| Straw production | T | Direct extraction | |
| Livestock and dairy production | | | |
| Livestock sales | No. | Direct extraction | |
| Milk Production | Litres | Direct extraction | Separated into milk and milk products (litres milk equivalent) |
| Inputs/resource use | | | |
| Fertiliser inputs | Kg N<br>Kg P<br>Kg K | Direct extraction<br>and/or<br>Conversion from expenditure | Where fertiliser input data available, extracted directly. Where not available, expenditure used to estimate inputs (see text) |
| Electricity | kWh | Conversion from expenditure | Assumes rate of £0.0069/kWh (SAC Consulting, 2012) |
| Machinery and vehicle fuels | Litres | Conversion from expenditure | Assumes all red diesel, at a cost of £0.63l (SAC Consulting, 2012) |
| Heating fuels | Litres | Conversion from expenditure | Assumes all kerosene, at a cost of £0.53l (SAC Consulting, 2012) |
| Water use | $m^3$ | Conversion from expenditure | Rate of £0.95/$m^3$ (AHDB, 2011) |
| External geo-referenced data | | | |
| Long-term annual precipitation | mm | Geo-referenced extraction | Correlated farm location with Met Office UKCP09 observed climate data (UKCP09, 2015) |
| Dominant soil type | n/a | Geo-referenced extraction | Correlated farm location with British Geological Survey Soil Parent Material Model (British Geological Survey, 2011). |




Estimation logic (above) and correspondence between the FBS variables and emissions extraction (left).

**Objective**: To demonstrate how the FBS (an enhanced FADN for England) can be used to extract emissions data at the farm level.
**Database**: Data were extracted from the FBS for a sample of East Anglian cereal farms and southwestern dairy farms.
**Evaluated measures**: No particular measures are evaluated
**Evaluated emissions and sectors**: Farm-level estimates of greenhouse gas emissions were generated using the Farmscoper mode
**Information**: Lynch, J., Skirvin, D., Wilson, P. and Ramsden, S. 2018.

# Case Study 5: Lithuania
## A Comparative Analysis of On-farm Greenhouse Gas Emissions from Family Farms In Lithuania

**GHG emission sources accounted in the paper**

| Emission sources | FADN activity data | Source in IPCC, 2006 |
|---|---|---|
| $N_2O$ manure management | Animal numbers | Equation 10.25, 10.26, Annex 10A.2, Tables 10A-4 to 10A-8 |
| $CH_4$ manure management | Animal numbers | Equation 10.22 |
| $CH_4$ enteric fermentation | Animal numbers | Equation 10.19, 10.20 |
| $N_2O$ agricultural soils | | |
| *Direct emissions* | | |
| Use of synthetic fertilizers | N fertilizers | Equation 11.11, Table 11.1 |
| *Indirect emissions* | | |
| Atmospheric deposition | N fertilizers, animal numbers | Equation 11.9, Table 11.3 |
| Leaching and run-off | N fertilizers, animal numbers | Equation 11.10, Table 11.3 |

**Objective**: Comparative analysis of on-farm greenhouse gas emissions across family farm types and farm size classes using FADN data in Lithuania.
**Database**: A sample of 1,304 family farms from the 2014 FADN database
**Evaluated measures**: Adaptation of the IPCC guidelines using Lithuanian emission factors from Lithuania's NIR and activity data from Lithuanian FADN
**Evaluated emissions and sectors**: $CH_4$, $N_2O$, $CO_2$ and $CO_2$ equivalent
**Information**: Dabkienė, 2017

# Case Study 6: Poland

## Assessing Greenhouse Gas Emissions from Conventional Farms Based on the Farm Accountancy Data Network

Table 2. Summary of GHG emission sources considered and the respective FADN data applied.

| Emission source | Emission category | FADN data |
|---|---|---|
| $N_2O$ manure management | Animal production | Animal numbers |
| $CH_4$ manure management | Animal production | Animal numbers |
| $CH_4$ Enteric fermentation | Animal production | Animal numbers |
| $N_2O$ agricultural soil | | |
| *$N_2O$ direct emissions* | | |
| Use of N mineral fertilizers | Fertilizers | N quantities |
| Use of N organic fertilizers | Fertilizers | Animal numbers |
| Crop residues | Crop production | Crop area (UAA) and crop yield |
| Urine and dung depositing by grazing animals | Crop production | Animal numbers |
| *$N_2O$ indirect emissions* | | |
| Atmospheric deposition | Fertilizers | N quantities / Animal numbers |
| Leaching and run-off | Fertilizers | N quantities / Animal numbers / area and crop yield |
| $CO_2$ Urea | Fertilizers | Urea quantities |
| $CO_2$ Energy | Fuel | Fuel quantities |

Source: Our own elaboration based on Coderoni et al. 2013

Table 3. Economic and environmental farm level data for different farm types; standard deviations are shown in brackets.

| Variable | Unit | Total | Field crops | Perm. crops | Fruits | Dairy | Grazing livestock | Pigs | Poultry | Mixed crops and livestock |
|---|---|---|---|---|---|---|---|---|---|---|
| *Economic data* | | | | | | | | | | |
| Farm represented | | 688,967 | 136,104 | 28,353 | 30,644 | 93,350 | 30,013 | 25,814 | 4,769 | 339,922 |
| Sample farms | | 11,701 | 3,185 | 348 | 402 | 2,703 | 428 | 768 | 73 | 3,794 |
| Economic size | Euro | 47,557 | 43,330 | 72,318 | 25,369 | 49,881 | 32,827 | 100,578 | 216,776 | 37,204 |
| Total utilized agricultural area | ha | 36 | 55 | 7 | 14 | 32 | 31 | 33 | 23 | 29 |
| Total livestock unit (LU) | LU | 28 | 3 | 1 | 0 | 41 | 31 | 108 | 200 | 25 |
| Total output | PLN | 235,075 | 241,512 | 379,157 | 181,707 | 234,824 | 119,276 | 440,615 | 1,689,403 | 165,764 |
| *Emissions data* | | | | | | | | | | |
| GHG farm | Mg $CO_2$ eq. | 96.47 (113.8) | 65.4 (80.4) | 14.0 (19.2) | 12.6 (14.2) | 184.9 (144.2) | 108.2 (119.6) | 111.4 (121.9) | 93.9 (87.9) | 71.3 (80.0) |
| Emission intensity | g $CO_2$ eq. $PLN^{-1}$ | 410 (300) | 270 (270) | 40 (20) | 70 (70) | 790 (590) | 910 (830) | 250 (170) | 60 (60) | 430 (420) |
| Emission intensity per ha | Mg $CO_2$ eq. $ha^{-1}$ | 2.7 (2.7) | 1.2 (1.3) | 2.1 (1.9) | 0.9 (1.3) | 5.7 (6.4) | 3.5 (3.3) | 3.3 (3.3) | 4.1 (2.8) | 2.5 (2.9) |
| Emission intensity per LU | Mg $CO_2$ eq. $LU^{-1}$ | 3.5 (2.11) | 2.2 (9.5) | 24.3 (7.9) | - | 4.5 (4.6) | 3.5 (3.9) | 1.0 (9.1) | 0.5 (0.4) | 2.8 (2.9) |

Source: own calculation based on FADN data

**Objective**: Assess how the FADN can be used to estimate GHG emission

**Database**: A cross section of 11,701 farms from the Polish Farm Accountancy Data Network observed over years 2003–2007.

**Evaluated measures**: No specific measures evaluated

**Evaluated emissions and sectors**: $CO_2$ equivalents

**Information**: Syp, A. and Osuch, D. 2018.

# Impact Indicator I.07

## Going regional

Locating or deriving regional values for I.07 is not easy.

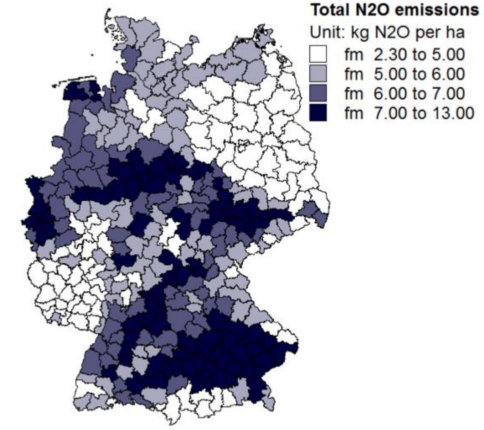
Certain tables can be regionalised, e.g. emissions from enteric fermentation or manure management, because activity data and coefficients are regionally available.

Certain tables, e.g., emissions from agricultural soils, require data such as the use of inorganic and organic fertilisers that usually do not exist at regional level.

Certain MSs produce their own regional estimates of GHG or ammonia emissions (box 1).

The JRC has used European wide estimates of GHG emissions based on simulations based on the CAPRI model for 2016 (box 2).

### Box 1. Projected regional estimates of $N_2O$ emissions in



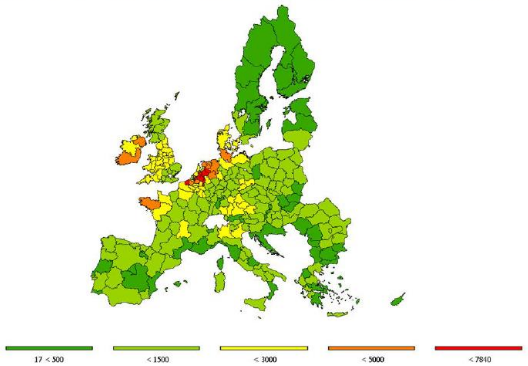

Projected direct and indirect nitrous oxide emissions from agricultural land use in 2020 by integrated modeling (© Thünen-Institut/René Dechow)

Statistical approaches are developed which are trained on data sets of measured GHG emissions and related anthropogenic and natural factors. These models are used to regionalize GHG emissions and mitigation potentials from land use in Germany.

More Information: Thünen Institute

### Box 2. Environmental Impacts of CAP Greening – European Union

Figure 1: GHG emissions in reference scenario (kg $CO_2$ equivalent/total ha)




Among others, GHG emissions per total area, measured by the global warming potential of agriculture (GWPA) in kg of CO2 equivalent, are estimated for the reference scenario, i.e. a baseline development of the agricultural sector as a counterfactual to greening scenarios.

More Information: JRC