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Benefit of the Agrammon model as a tool to support mitigation options for ammonia emissions from livestock

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Introduction

- Mitigation of gaseous nitrogen emissions (e.g. ammonia, NH_3) is an important issue regarding a sustainable livestock production

  $\rightarrow$Benefits for

  - The environment:
    - Reduction of nitrogen loads to natural ecosystems
    - Reduction of energy consumption and release of greenhouse gases (less consumption of mineral N fertilizer)
  - Human health (particulate matter)
  - Economical situation of the farmers due to saving of costs for mineral N fertilizer (potentially)

Introduction

- It is impractical to measure emissions from all the sources that, together, represent the emissions from an individual farm or from all farms of e.g. a country.

  ➔Thus model calculations are applied by combining information on human activity (called activity data, AD) with coefficients that quantify the emissions per unit activity (called emission factors, EF).

  Emissions = AD x EF

  ➔Mass flow model

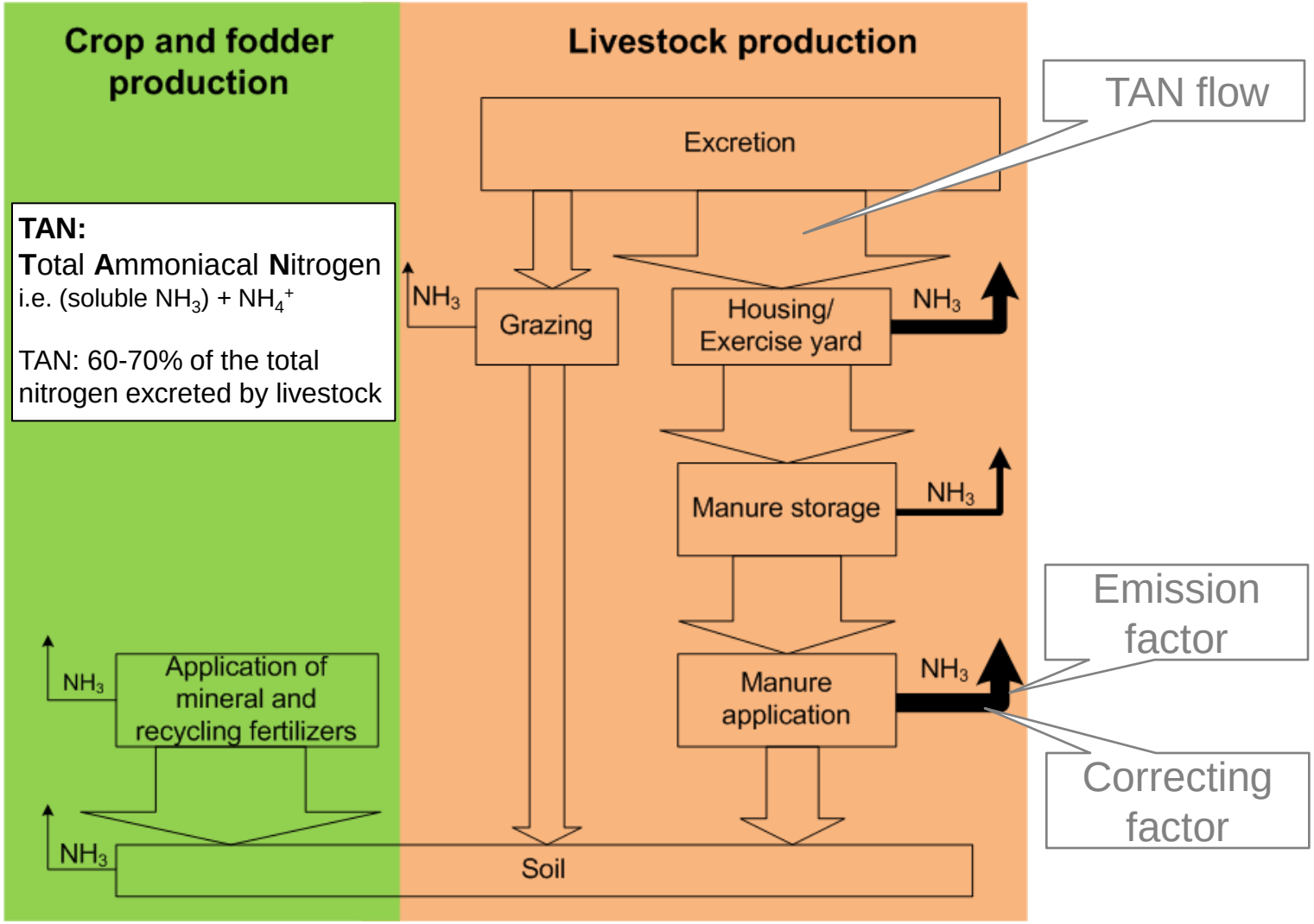
Source: EEA. 2009. EMEP/EEA air pollutant emission inventory guidebook 2009. EEA Technical report No 9/2009. Technical guidance to prepare national emission inventories. European Environment Agency. Downloaded from http://www.eea.europa.eu/publications/emep-eea-emission-inventory-guidebook-2009 (07/05/2012).

Emission calculations

- State of the art for emission modeling: Mass flow models using a tier 1, 2 or 3 level approach (a tier represents a level of methodological complexity)
- Tier 1 methods apply a simple linear relation between activity data and emission factors
- Tier 2 methods use the same or similar activity data to Tier 1 methods, but apply country-specific emission factors
- Tier 3 methods go beyond tier 2; these may include using facility level data and/or sophisticated models

Source: EEA. 2009. EMEP/EEA air pollutant emission inventory guidebook 2009. EEA Technical report No 9/2009. Technical guidance to prepare national emission inventories. European Environment Agency. Downloaded from http://www.eea.europa.eu/publications/emep-eea-emission-inventory-guidebook-2009 (07/05/2012).

The Agrammon model is a Tier 3 approach implemented for the calculation of ammonia emissions of Switzerland



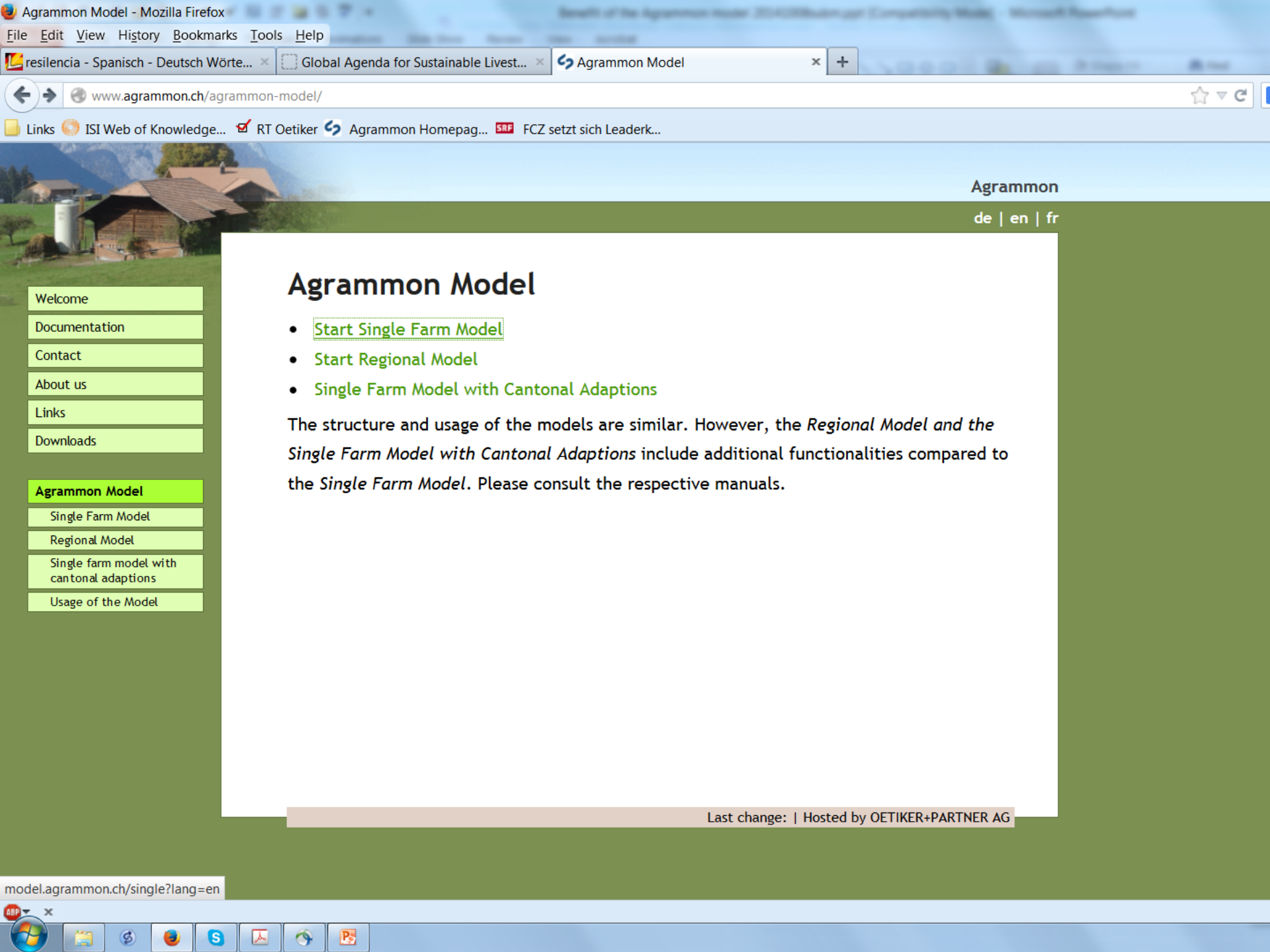
Model principles of the Agrammon model (Switzerland)

- Emission factors, correction factors:
  - Based on scientific trials in Switzerland wherever possible.
  - If not available, data from other countries were used
    - Where appropriate they were matched with UNECE (United Nations Economic Commission for Europe)* recommended values.
    - Data from other countries were, where necessary, adapted to suit conditions in Switzerland.
  - Where specific information was not available from the literature, expert judgment was used.

*UNECE. 2012. Draft guidance document for preventing and abating ammonia emissions from agricultural sources. Paper ECE/EB.AIR/2012/L.9, October 2, 2012. United Nations Economic Commission for Europe (UNECE). Geneva, Switzerland. pp 96.

Transparency regarding the model principles: Agrammon website*

*http://www.agrammon.ch/documents-to-download/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Regional Model
Single farm model with cantonal adaptions
Usage of the Model
Agrammon Model
Start Single Farm Model
Start Regional Model
Single Farm Model with Cantonal Adaptions
The structure and usage of the models are similar. However, the Regional Model and the Single Farm Model with Cantonal Adaptions include additional functionalities compared to the Single Farm Model. Please consult the respective manuals.
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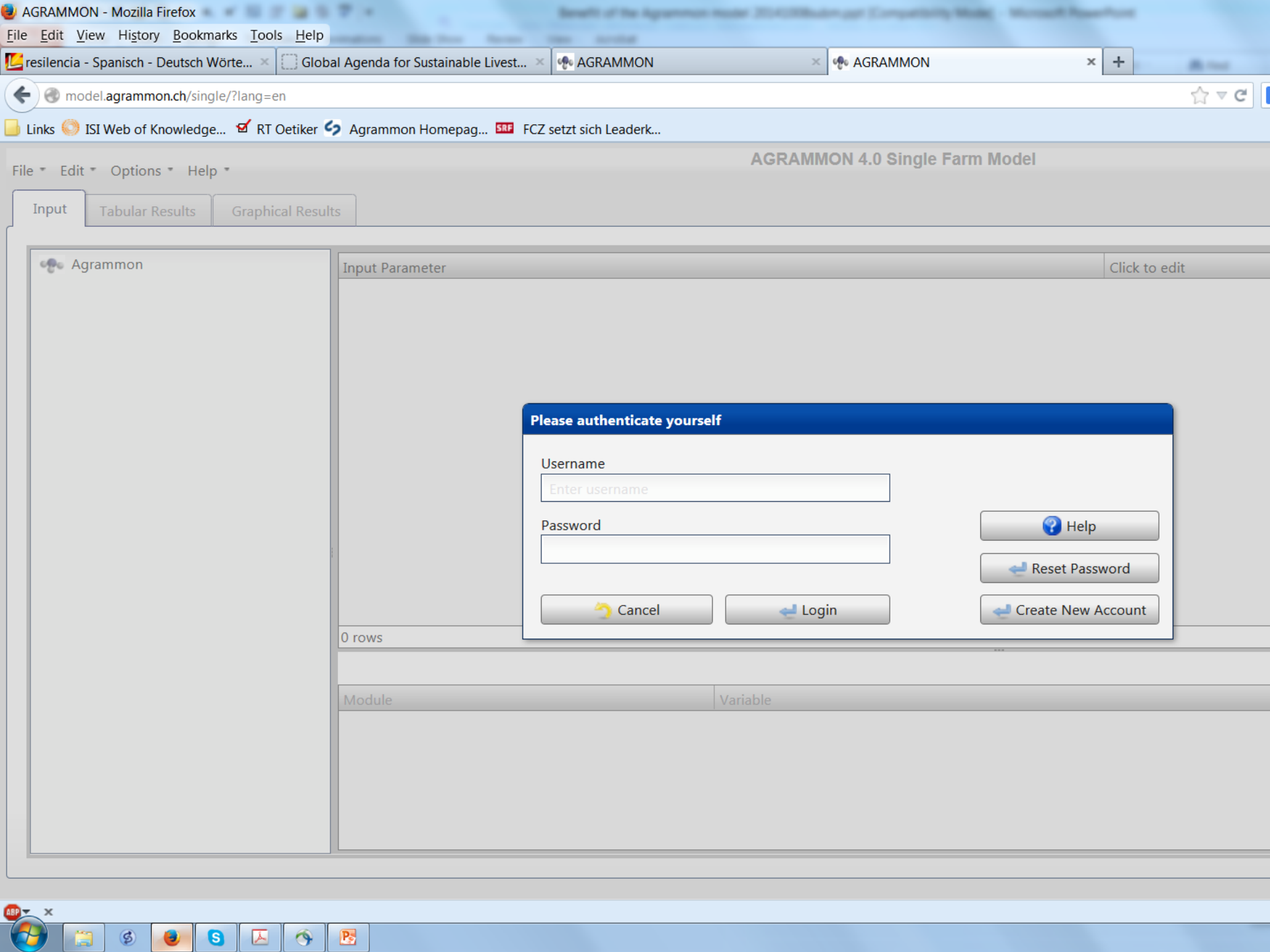
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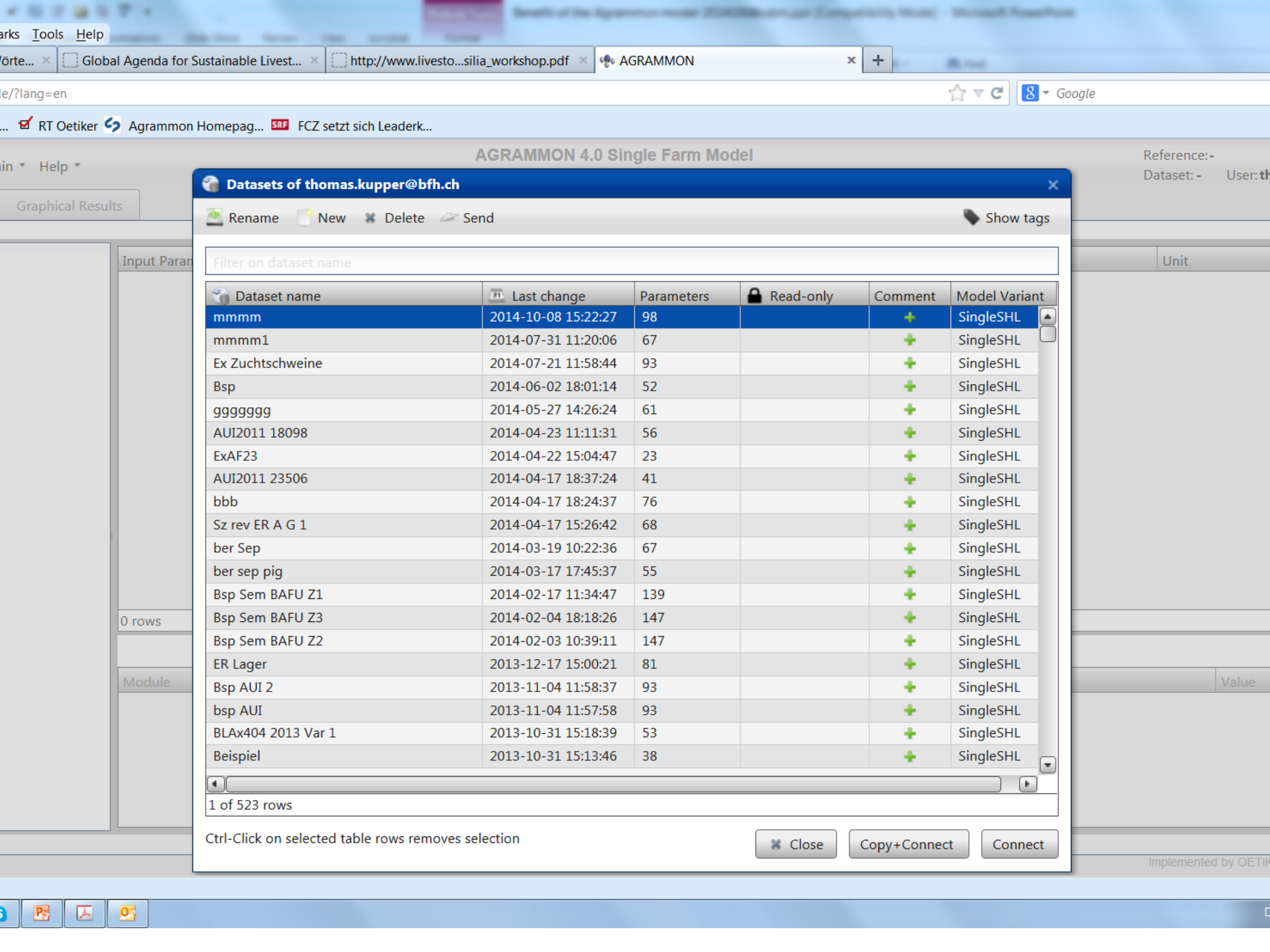
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Model Variant
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mmmm1 2014-07-31 11:20:06 67 SingleSHL
Ex Zuchtschweine 2014-07-21 11:58:44 93 SingleSHL
Bsp 2014-06-02 18:01:14 52 SingleSHL
ggggggg 2014-05-27 14:26:24 61 SingleSHL
AUI2011 18098 2014-04-23 11:11:31 56 SingleSHL
ExAF23 2014-04-22 15:04:47 23 SingleSHL
AUI2011 23506 2014-04-17 18:37:24 41 SingleSHL
bbb 2014-04-17 18:24:37 76 SingleSHL
Sz rev ER A G 1 2014-04-17 15:26:42 68 SingleSHL
ber Sep 2014-03-19 10:22:36 67 SingleSHL
ber sep pig 2014-03-17 17:45:37 55 SingleSHL
Bsp Sem BAFU Z1 2014-02-17 11:34:47 139 SingleSHL
Bsp Sem BAFU Z3 2014-02-04 18:18:26 147 SingleSHL
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AGRAMMON 4.0 Single Farm Model

Input | Tabular Results | Graphical Results

- Agrammon
  - Livestock
    - Dairy cows
      - Dairy cows
    - Other cattle
      - Heifers
    - Pigs
    - Fattening pigs
      - Fattening pigs
    - Poultry
    - Horses and other equids
    - Small ruminants
  - Storage
    - Solid manure
    - Slurry
      - Slurry storage tank
  - Application
    - Slurry
    - Solid manure
  - Plant production
    - Agricultural area
    - Mineral fertiliser
    - Recycling fertiliser

Input Parameter	Click to edit	Unit	Help
Number of animals	30	-	
Milk yield per dairy cow	9'061	kg/year	
Proportion of animals receiving hay in summer	0	%	
Proportion of animals receiving maize silage in summer	100	%	
Proportion of animals receiving maize pellets in summer	0	%	
Proportion of animals receiving maize silage in winter	100	%	
Proportion of animals receiving grass silage in winter	100	%	
Proportion of animals receiving maize pellets in winter	0	%	
Proportion of animals receiving potatoes in winter	0	%	
Proportion of animals receiving beets in winter	0	%	
Amount of concentrates per animal and per day in summer	2.5	kg/day	
Amount of concentrates per animal and per day in winter	3.5	kg/day	
Housing system	tied housing slurry plus solid man...	-	
Number of available animal places	30	-	
Mitigation option floor for loose housing systems	none	-	
Additional emission mitigation measure for the housing	0	%	
Duration of access to exercise yard over the year	0	days/y...	
Exercise yard	available roughage is not supplie...	-	
Type of exercise yard	solid floor	-	
Additional emission mitigation measure for the exercise yard	0	%	

22 rows

Result summary

Module	Variable

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Reference:-

Dataset: **mmmm**

Input | Tabular Results | Graphical Results

Choose table: Ammonia emissions (in kg N per year) - summary

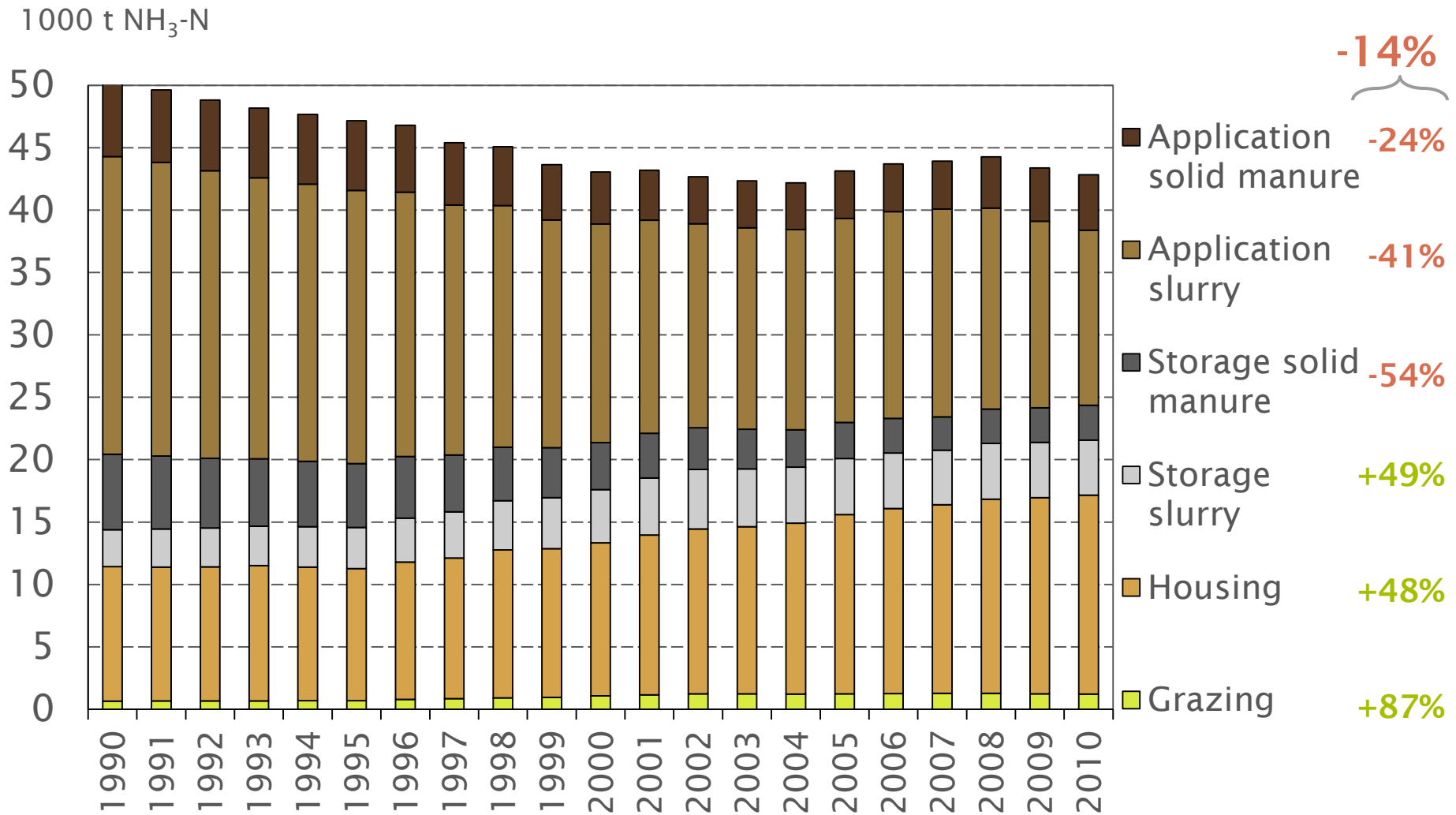
Module	Variable	Value	Unit
Livestock			
	Grazing NH3-Emissions	38	kg N/year
	Housing and Yard NH3-Emissions	2136	kg N/year
	Storage NH3-Emissions	316	kg N/year
	_Storage liquid NH3-Emissions	117	kg N/year
	_Storage solid NH3-Emissions	199	kg N/year
	Application NH3-Emissions	3318	kg N/year
	_Application liquid NH3-Emissions	3124	kg N/year
	_Application solid NH3-Emissions	194	kg N/year
	Total Animalproduction NH3-Emissions	5808	kg N/year
Plant production			
	Mineral fertiliser NH3-Emissions	8	kg N/year
	Recycling fertiliser NH3-Emissions	0	kg N/year
	Agricultural Area NH3-Emissions	44	kg N/year
	Total Plantproduction NH3-Emissions	52	kg N/year
Total			
	Total NH3-Emissions	5860	kg N/year

Notes on the results

Open in Excel | Create PDF

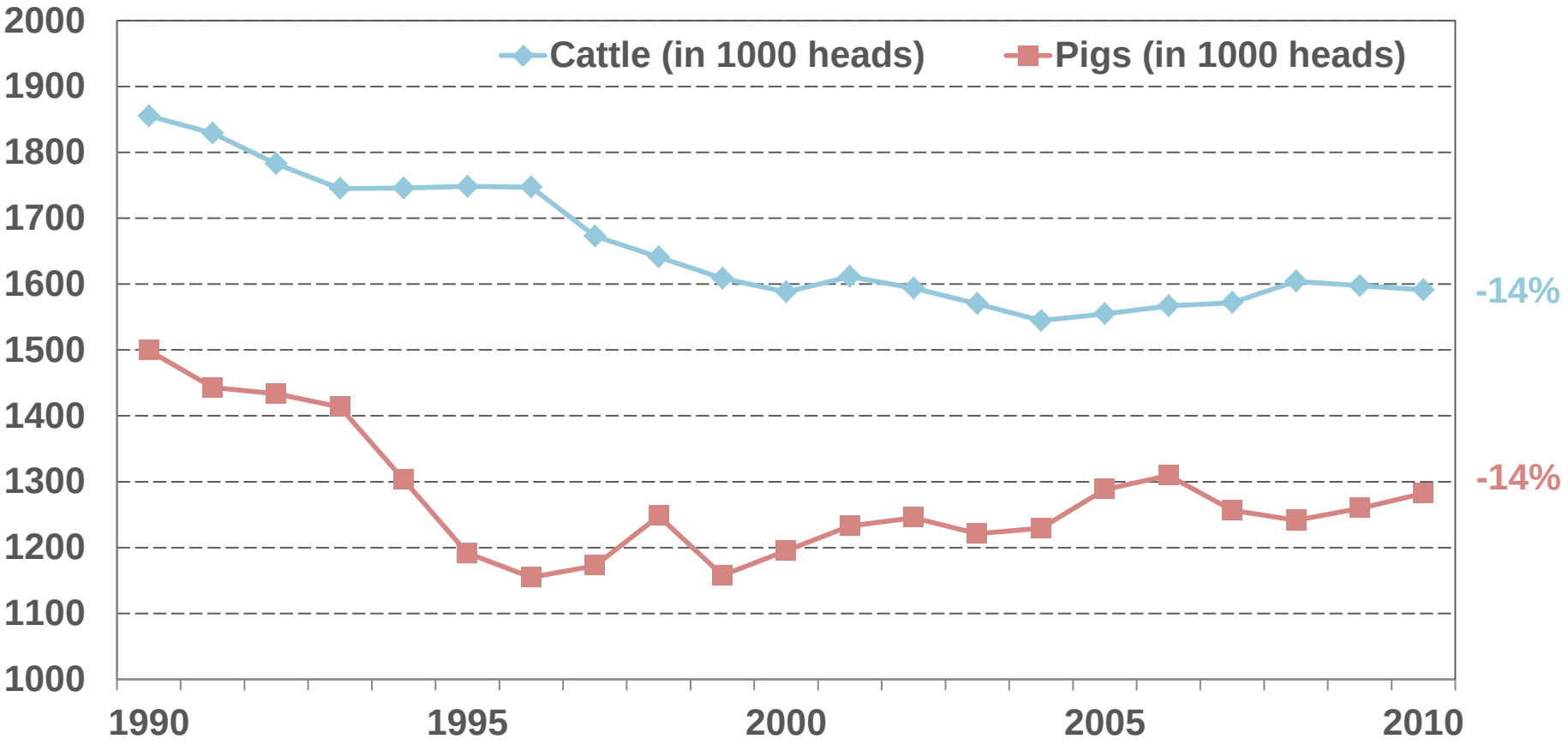
Example of modeling results

Ammonia emissions from livestock production 1990-2010 in Switzerland

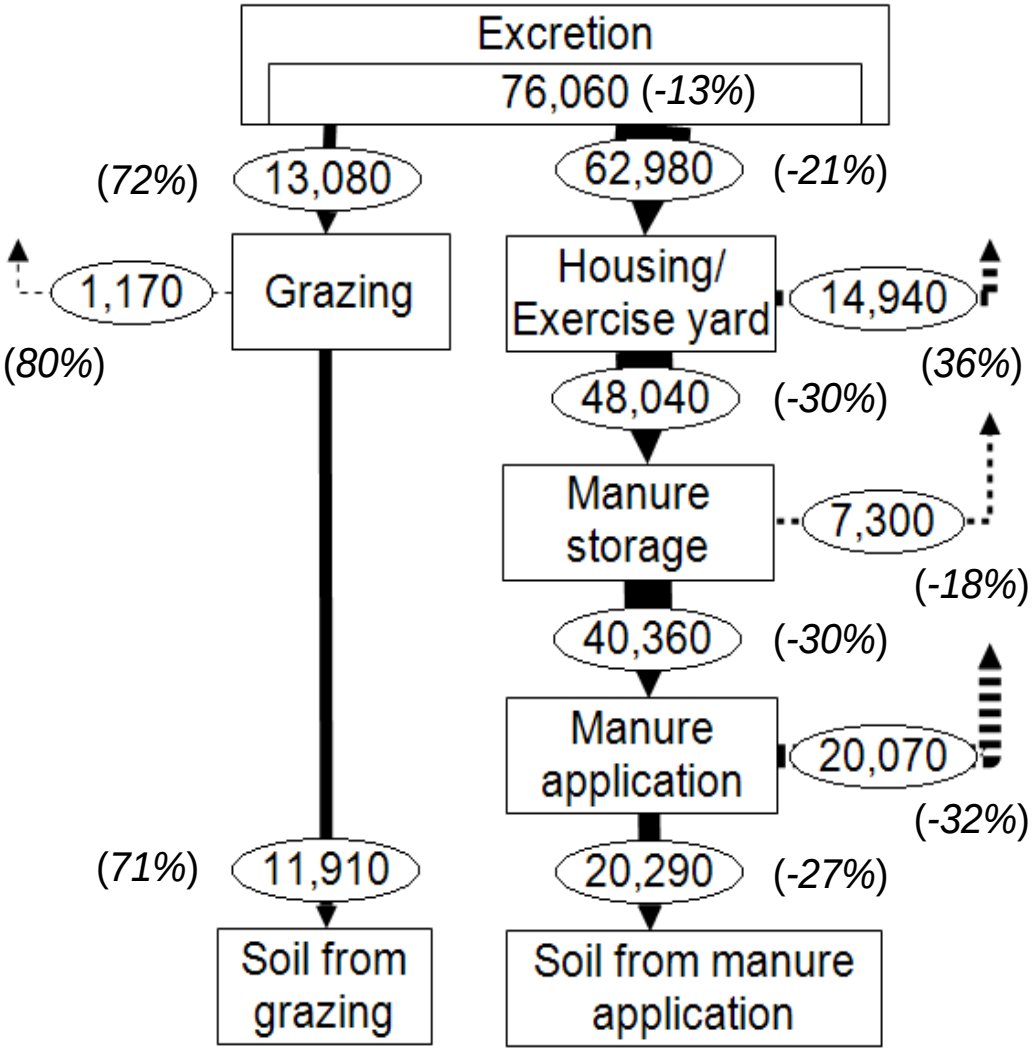


Factors driving the evolution of emissions

Livestock numbers 1990-2010 for Switzerland



Example of modeling results for Switzerland:
TAN flows and ammonia emissions in 2010



Relative change compared to 1990

Numbers represent:
t N

-Total soil: 32,200 (-7%)
-Emission total: 43,480 (-14%)
(= 57 % excretion)

Conditions regarding the use of Agrammon for any country and livestock production system

- Livestock production systems have to be adapted in the model
- Emission factors have to be defined:
  - Based on results of scientific experiments at the level of the livestock production system
  - If such data is not available emission factors have to be defined based on:
    - Process oriented models such as e.g. VOLT'AIR* and other models to be elaborated
    - Expert judgment

*Genermont S., Cellier P., 1997. A mechanistic model for estimating ammonia volatilization from slurry applied to bare soil. Agricultural and Forest Meteorology 88, 145-167.

Conditions regarding the use of Agrammon for any country and livestock production system

- More measurements on ammonia emissions are required in countries and production systems outside of Europe, USA, Canada
- Knowledge on basic processes driving ammonia emissions should be enhanced in order to generate e.g. process oriented models

Take home messages

- Public available mass flow models such as Agrammon can show at which stages ammonia emissions are produced and how they respond to mitigation measures
- Greenhouse gas emissions can be modeled as well
- Such models can contribute to improve the sustainability of livestock production
- Knowledge should be improved which allows extension such models to regions outside Europe, North America

Acknowledgements

We thank the Swiss Federal Office for the Environment for financial support