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Report on the level of circularity for European territories

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Final

Pathways
FOR SUSTAINABLE FOOD

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1 Introduction

Livestock is seen as a major contributor to environmental challenges, particularly regarding greenhouse gas emissions and biodiversity loss. Indeed, globally, livestock contributes to 18% of agricultural greenhouse gas emissions (Gerber, 2013). Also, livestock is responsible for 70 % of land use globally (FAO, 2009). These impacts are commonly assessed using well-established methodologies such as environmental footprint analysis and life cycle assessment (LCA) (de Vries and de Boer, 2010). These methods measure eco-efficiency: they quantify the resource inputs, such as land, water, and feed inputs, required to produce a unit of animal-sourced product. As a result, animal-sourced products from livestock husbandry systems that deliver the highest output of animal-sourced food with the lowest resource input are typically considered the most sustainable (van der Werf et al., 2020). However, these methods may fail to consider whether the resources used are renewable or if their production stays within planetary boundaries. Moreover, by design, these methods inherently assess livestock as a net source of environmental pressure. This reductionist approach often fails to account for the potential benefits, including ecosystem services that well-managed livestock systems can provide, such as nutrient cycling, biodiversity support, carbon sequestration, or cultural and recreational landscape values. Additionally, these methods are frequently applied at the farm or value chain level, which is typically an inappropriate scale for assessing ecosystem services (Yu et al., 2021). Ecosystem services arise from the interaction between natural ecosystems and humans needs, making them spatially explicit and requiring assessment within their specific context (Andersson et al., 2015). As a result, life cycle assessments often overlook the complexity and variability of livestock-environment interactions, where the environmental outcomes of livestock systems are highly dependent on management practices, stocking densities, and the specific ecological context in which they operate (Houzer and Scoones, 2021).

Methods for quantitatively assessing ecosystem services have been widely developed over the last decades, beginning with the Millennium Ecosystem Assessment, which categorized services into four main groups: provisioning, regulating, cultural, and supporting services (Millennium Ecosystem Assessment, 2005). This laid the foundation for what is now known as the ecosystem service cascade (Haines-Young and Potschin, 2010). A significant shift in this approach has been the reclassification of supporting services, which are no longer considered direct ecosystem services but rather the underlying ecological processes that enable ecosystems to function and provide services. This evolution has led to ecological processes-based approaches to assess ecosystem services provision (Cuddington et al., 2013). These approaches replaced static ecosystem services assessment based on land cover, with dynamic models, including management practices that impact ecological processes (Bruins et al., 2017). While these dynamic approaches have been developed, their capacity to adequately cover livestock systems remains limited (Heidenreich et al., 2024).

The lack of models capable of addressing livestock services and disservices has contributed to the current polarised debate surrounding livestock systems. On one side, anti-livestock narratives, often supported by proponents of veganism, emphasise the environmental degradation and ethical concerns associated with livestock production, advocating for a strong reduction of animal-sourced foods (e.g. Torpman and Röös, 2024). Conversely, pro-livestock arguments focus on the potential of livestock to provide ecosystem services such as landscape protection or soil quality, whilst also delivering essential micro-nutrients as part of a healthy diet (e.g. Leroy et al., 2022). This binary debate overlooks the complexity of livestock husbandry systems, and the nuanced understanding required to balance their environmental, economic, social, and nutritional contributions. Without adequate models that integrate positive and negative outcomes of livestock production, the discussion remains focused on extremes, failing to explore middle-ground solutions that could align livestock production with sustainability goals and within planetary boundaries.

The Geo-SOL model, developed in Tasks 6.2 and 6.3 of the PATHWAYS project, addresses this gap by offering a spatially explicit model designed to evaluate livestock husbandry management practices within their biophysical context. It employs process-driven approaches to identify the tipping points where livestock systems transition from providing ecosystem services to exerting environmental pressures, and vice versa.

The model places a strong emphasis on nitrogen flows and their associated ecological processes, as these provide several key advantages. Firstly, nitrogen serves as a unifying biophysical element in the bioeconomy and the food system, connecting livestock, crops, other biomass, and soils. This makes nitrogen an ideal metric for comparing processes across diverse systems within the bioeconomy, including the food system. Secondly, nitrogen is central to nutrient cycling, which underpins many ecosystem processes critical for the provision of ecosystem services, such as water purification, soil fertility, and climate regulation (Jones et al., 2014). Thirdly, nitrogen cycling enables the simultaneous assessment of efficiency, circularity, and sufficiency (Spiller et al., 2024), offering an integrated perspective on how to achieve sustainability within the bioeconomy. Geo-SOL seeks to address all three perspective, with this deliverable focusing on circularity indicators as well as the detailed modelling of the nitrogen flows that will allow to understand the impacts of changes in livestock husbandry practices on the different indicators. By incorporating variables such as feeding strategies, stocking densities, and breed-specific characteristics, the model enables a deeper understanding of when livestock management practices contribute to environmental sustainability or begin to exceed ecological thresholds. In addition, Geo-SOL is designed to evaluate the extent to which livestock systems contribute to minimising waste and losses within both the food system and the wider bio-economy. By building models that accurately represent resource flows—such as manure management, feed and food losses, and nutrient cycling—Geo-SOL examines the effectiveness of resource allocation across the food system and the wider bioeconomy. This process-driven approach allows to identify livestock management practices that not only stay within planetary boundaries but also enhance circularity and resource efficiency, contributing to more sustainable and resilient food systems

2 Purpose and Scope

The objective of the Geo-SOL model was originally to expand version 5 of the SOLm model (Müller et al., 2020; Muller et al., 2017) that could be used to assess changes in agricultural production on diets at the country level, – by improving the representation of livestock husbandry systems to allow for more accurate and detailed modelling of energy and material flows between livestock and the food system. Additionally, the goal was to integrate a spatially explicit module, enabling the modelling of ecological processes that support the provision of ecosystem services. However, during the course of PATHWAYS, it became evident that developing the Geo-SOL model from scratch, rather than relying on the SOLm version 5, would be a more effective approach to achieve the goal of linking the livestock husbandry system to both the food system and to ecosystem processes. To achieve this some core part of the SOLm version 5 model had to be revisited and recoded in R, which now can be seen as a core piece of a SOLm framework, which is enhanced both with improved livestock modelling as well as a spatial module to assess impacts on ecological processes.

The development and implementation of Geo-SOL within the PATHWAYS project is an ambitious goal which is being realized through an incremental model development process. This deliverable focuses on the first three steps of that process: 1. the overall conceptual framework to link livestock to the food system as part of the wider bio-economy and to ecosystem processes, 2. the creation of the baseline for the model, and 3. flows observed at the regional level in the baseline, with an emphasis on assessing the circularity indicators in different regions. The linkage to additional sustainability metrics, such as ecosystem carrying capacities related to planetary boundaries, the spatial downscaling for spatially explicit assessment, as well as the full linkage to the food system model, are under development and will be presented in upcoming milestones and deliverables.

3 Modelling framework

3.1 Overall Geo-SOL framework

Figure 1 illustrates the overall workflow of the Geo-SOL model and shows its various modules and data flows. Geo-SOL makes use of the SOLm core module as shown the red box in Figure 1. In this module, crops and livestock production units are processed through a utilization and commodity tree, which allows the conversion of raw agricultural production into products. Food and feed types include how much crop production is allocated to livestock feed. Initially, the SOLm model was developed to utilise FAOstat data; however, for this project, it has been entirely re-coded for flexibility, which now allows the integration of any production dataset at any scale, allowing the inclusion of much more detailed data and is considered as the SOLm core module.

Next to the lack of flexibility related to the previous version of the SOLm model, it also had three other limitations. First, the model lacked the ability to model grass as feed for livestock, making it very difficult to assess the amount of grass in livestock diets or calculate how much cattle could be fed from grass, which is essential to model livestock husbandry systems. Secondly, SOLm includes livestock as an overly simplistic livestock production unit, not being able to account for herd dynamics and productivity changes per breed. Thirdly, SOLm did not model ecological processes, therefore it was not possible to link to dynamic ecosystem services provisioning. While the first two challenges can be addressed through more detailed data, the last one requires an additional modelling step, namely modelling the ecological process.

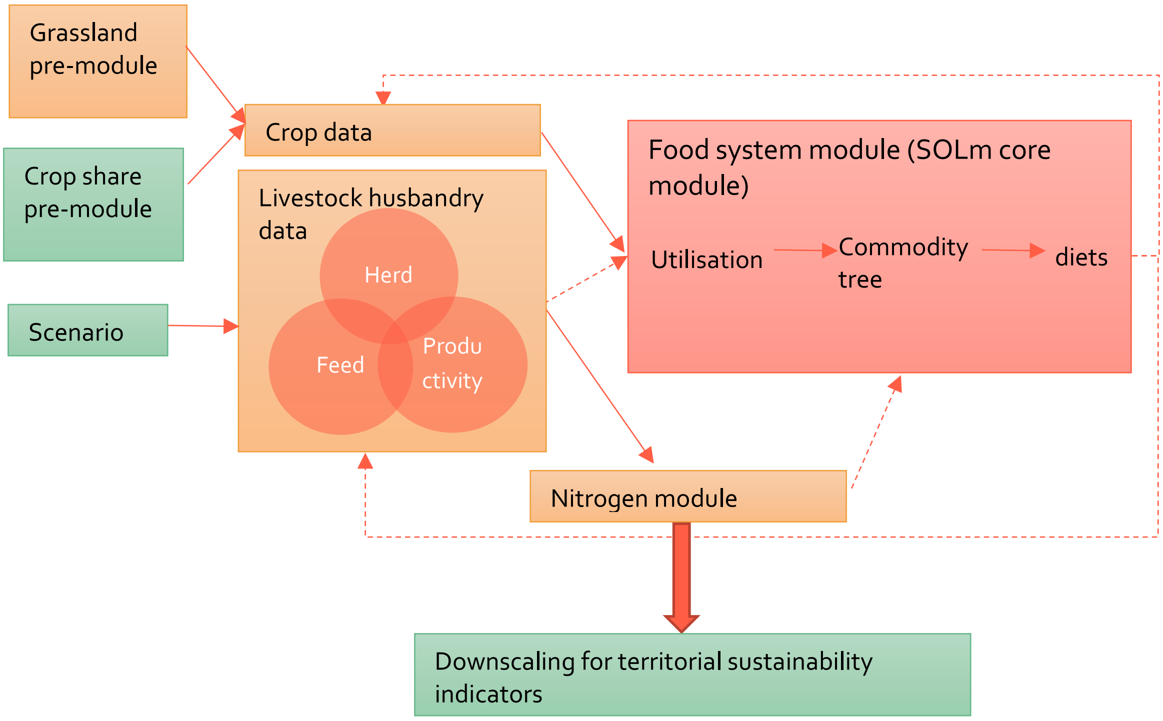

Figure 1 : overall Geo-SOL workflow

Modules that are fully developed and detailed in this deliverable are shown in orange and include the more detailed data as well as the linkage to the nitrogen process, while those in green are still under development—primarily the downscaling and scenario-running modules. This deliverable focuses on detailed crop and livestock data derived from Eurostat and other sources of data. Given the limited data available and high diversity of grasslands, it was necessary to develop a pre-module for grasslands to derive data on grass available as livestock feed. These baseline data are presented in the section 4 of this deliverable.

3.2 Modelling approach for the nitrogen-related processes

The flow within the nitrogen module is shown in Figure 2, and basically has three main steps: 1. Compute N excretion, 2. Calculate N processes including losses, 3. Compute a gross nitrogen balance.

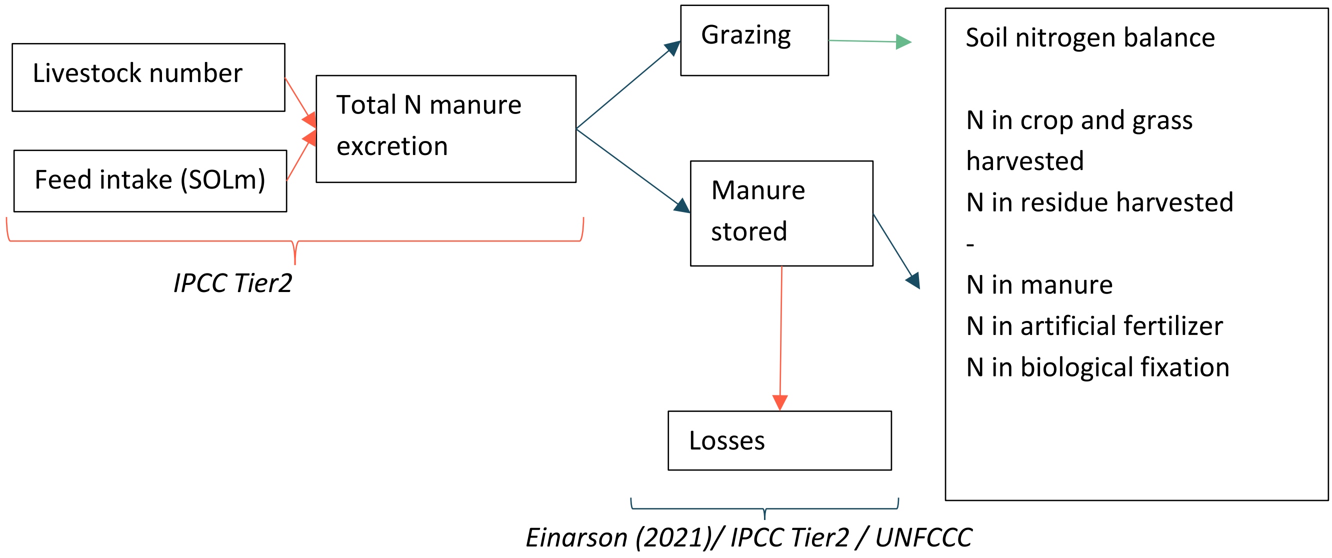

Figure 2 : computation of N excreted by livestock and how it was incorporated in the soil nitrogen balance

The calculation of nitrogen excreted by livestock (Nex) is based on detailed livestock data, incorporating specific animal characteristics, feed intake, and productivity metrics. Following the IPCC (2019) Tier 2 approach, Nex can be computed as the difference between the N intake from feed and the N retention, which is the N that is converted to livestock products. In this context, N intake refers to the total nitrogen consumed by the animals through their feed, while N retention represents the nitrogen utilised by the animal, which depends on factors such as milk production and weight gain. Excretion rates from chicken were calculated based on standard excretion Tier 1 rates taken from IPCC.

We followed the approach proposed by the European Monitoring and Evaluation Programme (EMEP) (EMEP/EEA, 2019) to model nitrogen-related processes. These guidelines enable detailed modelling of nitrogen flows, including losses to soil and air. The method distinguishes between nitrogen excreted during grazing, in the yard, or indoors. Grazing time data was sourced from the UNFCCC (UNFCCC, 2020), while the remaining time, either spent in the yard or indoors, was calculated based on these figures. Yard time was derived from EMEP standards, with the remainder considered indoor time. In rare cases where the combined standard yard and grazing time exceeded 100%, the non-grazing time was assumed to be spent indoors.

The EMEP calculation quantifies the amount of nitrogen stored that can be applied to crops or grassland. This data can then be used in a soil nitrogen balance to estimate nitrogen inputs from synthetic fertilizers, manure, and biological fixation. This applied nitrogen is then put into a gross nitrogen balance following the OECD nutrient budget handbook (Kremer, 2013). The gross nitrogen balance reflects the surplus or deficit of nitrogen in agricultural systems, accounting for the nitrogen that remains in the system after crop uptake and the amount lost to the environment, and, therefore, we are able to utilise it as an indicator of circularity in Europe.

In this deliverable, the nitrogen soil balance is presented as circularity indicator. Other indicators capturing the exceedance of planetary boundaries and ecosystem services related to the nitrogen flows are still under development and will be presented in upcoming deliverables.

4 Baseline data

Geo-SOL is designed to not only model livestock production units but to represent the complexity of livestock systems in their entirety. To achieve this, it requires a baseline dataset that contains detailed information on herd composition, productivity, and feed use. To run the model at the NUTS2 level, it is essential that this baseline data can be differentiated accordingly. This section explains the process of creating this detailed, region-specific dataset, ensuring that it accurately reflects the diverse livestock systems across different regions, allowing for detailed modelling and analysis within the Geo-SOL framework.

4.1 Crops

The crop data used in the Geo-SOL model was sourced from the Eurostat Agricultural Production (APRO) database (Eurostat, 2024a), which provides detailed information on crop production across Europe. For the purposes of this model, data was collected from 2018 to 2023, ensuring a comprehensive and up-to-date representation of crop yields and areas. Geo-SOL uses an average of these years to establish a stable and representative baseline for crop production at the NUTS2 level.

4.1.1 NON-FORAGE CROPS

For non-forage crops, the APRO dataset from Eurostat provides reliable data on both yield and area at NUTS2 and NUTS0 levels. However, NUTS0 data does not always equate to the sum of NUTS2 data as the data does not necessarily come from the same source. The NUTS2 dataset was re-created by downscaling the NUTS0 data based on available NUTS2-level data to ensure that Geo-SOL reflects the national statitics.

The APRO dataset includes a wide range of crops, with various levels of details. We kept all crop that are relevant for feeding livestock separate, for example wheat and triticale were kept separate to the highest level of details, while for crop that plays a less important role for livestock, such olives or vineyards, the aggregate variable was retained, to model the production accurately with and without additional details. Crops that do not require agricultural land, such as mushrooms that are usually grown indoors were omitted. The list of retained crops is found in Appendix 3.1.

4.1.2 FORAGE CROPS

Forage crops (those starting with the letter "G") present more challenges in the dataset. These crops are not consistently available at the NUTS2 level, and when available, the reported yields are not always reliable (Einarsson et al., 2021). To address these issues, a correction routine was developed. When NUTS2-level data was available, it was downscaled in the same manner as other crops. However, when NUTS2 data was missing, it was allocated based on the share of cropland that each NUTS2 region represents, as derived from CORINE Land Cover maps.

Due to significant inconsistencies in yield data, particularly with yields outside of typical values, we relied on yield estimates from Einarsson (2021). This paper highlighted similar issues with this dataset and resolved them. This approach allowed us to replace unreliable yields and ensure a more accurate representation of forage crop production at the NUTS2 level.

4.2 Livestock population

Eurostat provides livestock data as a snapshot of the number of animals on a specific day, usually in November or December, categorized by animal types. While useful, this data does not capture the full picture of livestock numbers present throughout the entire year. The challenge is that the livestock numbers observed at a single point in time reflect current slaughter patterns and trade flows, rather than representing an agronomic herd that can inform production systems over a longer period.
To effectively model livestock husbandry systems, as envisioned by the PATHWAYS project, we need to go beyond static snapshots and construct annual livestock populations. This allows us to simulate changes in the system and assess their impacts. The goal is to derive agronomic herds, which are essential for understanding the dynamics of livestock production and to enable informed adjustments to the system.
For this reason, annual livestock populations were created by triangulating multiple data sources: the APRO livestock population statistics at the NUTS2 level, APRO slaughter statistics at the NUTS0 level, and trade data from Eurostat(Eurostat, 2024b). This approach enables us to account for the flow of animals through slaughter and trade over the course of a year, resulting in more accurate and representative herd data.
For each livestock species, based on data availability, different categories and approaches were developed to derive the animals that live within a given category throughout the year. The following sections explain,

species by species, how this process was carried out, providing the necessary detail to understand the derived annual livestock populations.

4.2.1 CATTLE

For cattle, the Eurostat population statistics provide a limited view, primarily categorizing animals into dairy cows and suckler cows. Other categories, such as heifers and calves, are only differentiated based on whether they are destined for slaughter. However, these statistics do not distinguish whether the fattened and slaughtered animals come from the dairy system or the suckler system. This is a significant issue, as cattle raised for fattening in these two systems are often managed very differently and have other differences such as body conformation that affects weight gain and nutritional requirements.

This lack of distinction is problematic when attempting to model the impact of changes in livestock systems. For example, transitioning to a system with only dual-purpose cattle would affect the entire structure of herd management, from breeding to fattening and slaughter. In order to explore the potential impacts of such systematic changes, it is essential to differentiate between animals that come from the dairy system versus those from the suckler system. Without this distinction, we cannot accurately assess the nutritional needs, weight gain, or environmental impacts of different herd management strategies.

4.2.1.1 Dairy herd

The process of creating a dairy herd begins with the number of dairy cows provided by the Eurostat population statistics, as shown in Figure 3 . We use the calving interval specific to each dairy system to estimate the number of calves born in a given year, sourced from the WP3 Task 3.1 expert database (presented in Milestone 11 - initial characterisation of European Livestock). From this calf population, the number of female calves needed for herd replacement is calculated by applying the replacement rate to the number of dairy cows.

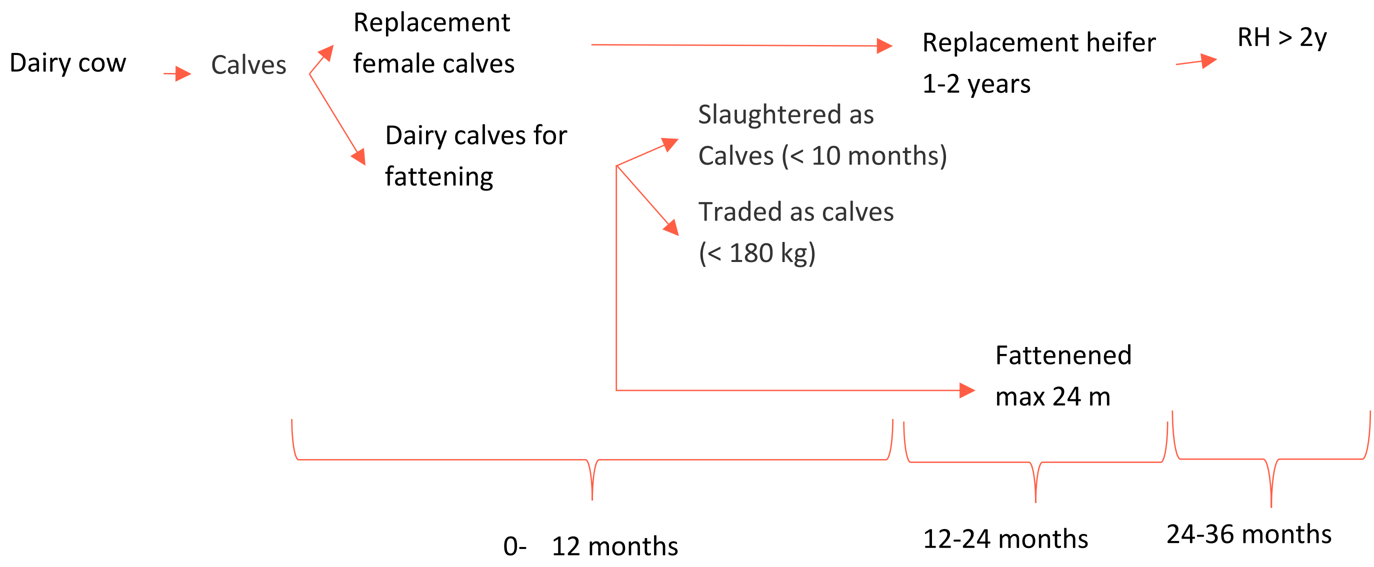

Figure 3: flows to build the dairy herd

The replacement rate itself is derived from the population statistics, based on the assumption that heifers aged 12-24 months in the region are destined to become dairy cows or sucklers the year after. To derive the replacement rate for dairy, replacement animals from sucklers are removed from the replacement heifer in the population statistic. The derivation of the suckler replacement animal is explained in the next section; by dividing the number of heifers aged 12-24 months for dairy by the total number of dairy cows, we can estimate the dairy replacement rate for specific regions as shown in Figure 4.

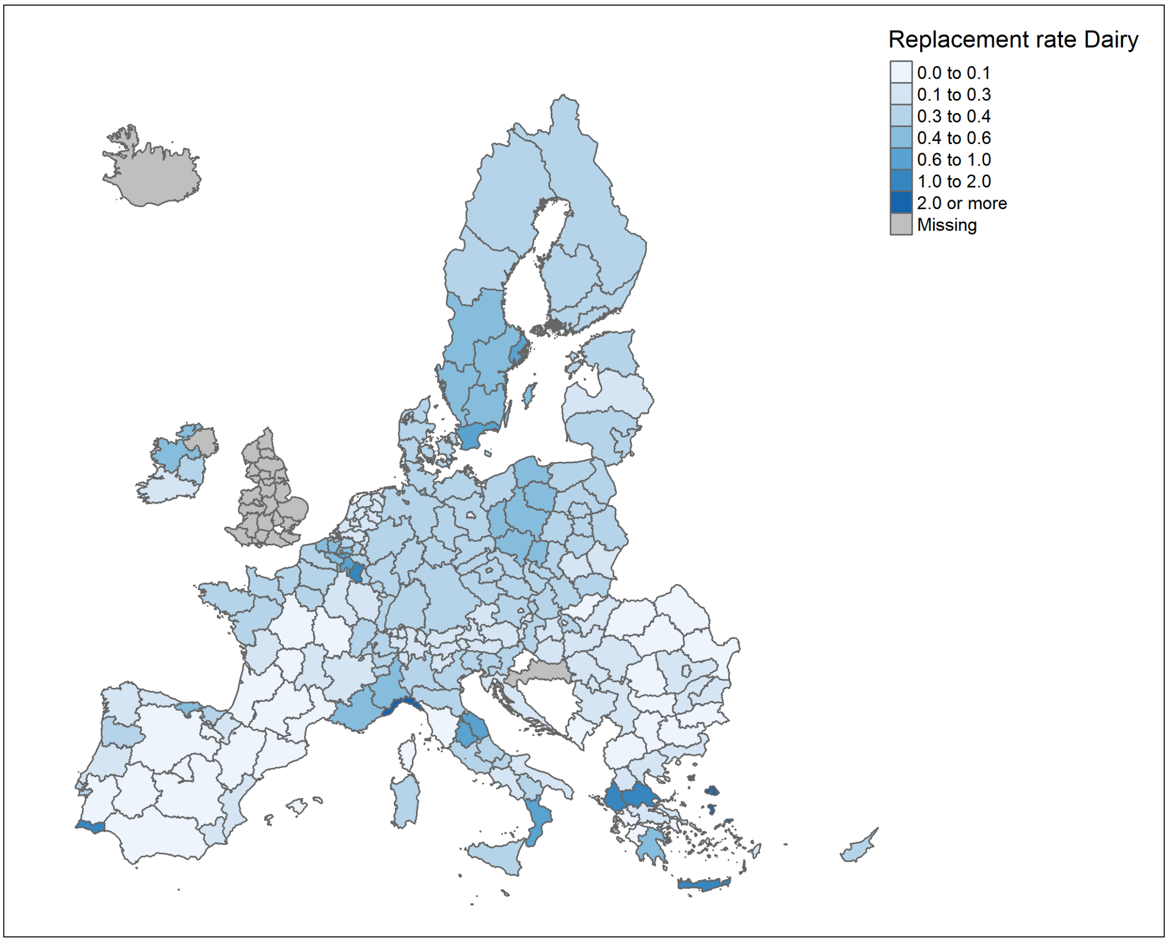

Figure 4: implicit replacement rate in dairy cow (before correction)

In some regions, these replacement rates do not align with realistic herd management practices. To address these inconsistencies, a minimum replacement rate of 10% and a maximum of 55% were applied, ensuring that the derived values remain within plausible biological and management limits.

Surplus calves are generally slaughtered or traded or fattened. To be able to split between dairy and suckler in the statistics, it was assumed that all calves slaughtered before 10 months in the slaughter statistics and all those calves traded below 180 kg in the trade statistics are from the dairy sector. These assumptions allow us to remove or add the traded animals based on the trade statistic and then derive the share of slaughtered calves. It was assumed that all dairy calves for fattening not slaughtered in the first year would be slaughtered in the second year. An intensive weight gain was assumed to derive how long the animals lived in the second year. By dividing animal slaughter weight per daily weight gain, the total number of days an animal has lived can be derived. The animal slaughter weight was deduced from the slaughter, which provides a carcass weight. This weight was then converted to alive slaughter weight, assuming standard dairy type carcass dressing percentages (Agridea, 2024).

4.2.1.2 Suckler

Calculating the suckler herd closely mirrors the approach used for dairy herds, as shown in Figure 5, with a few key exceptions. In addition to the calving interval, the replacement rate for suckler cows is also taken from the Milestone 11 expert database. This replacement rate is specific to the suckler cow system, ensuring that it accurately reflects the management practices of these herds.

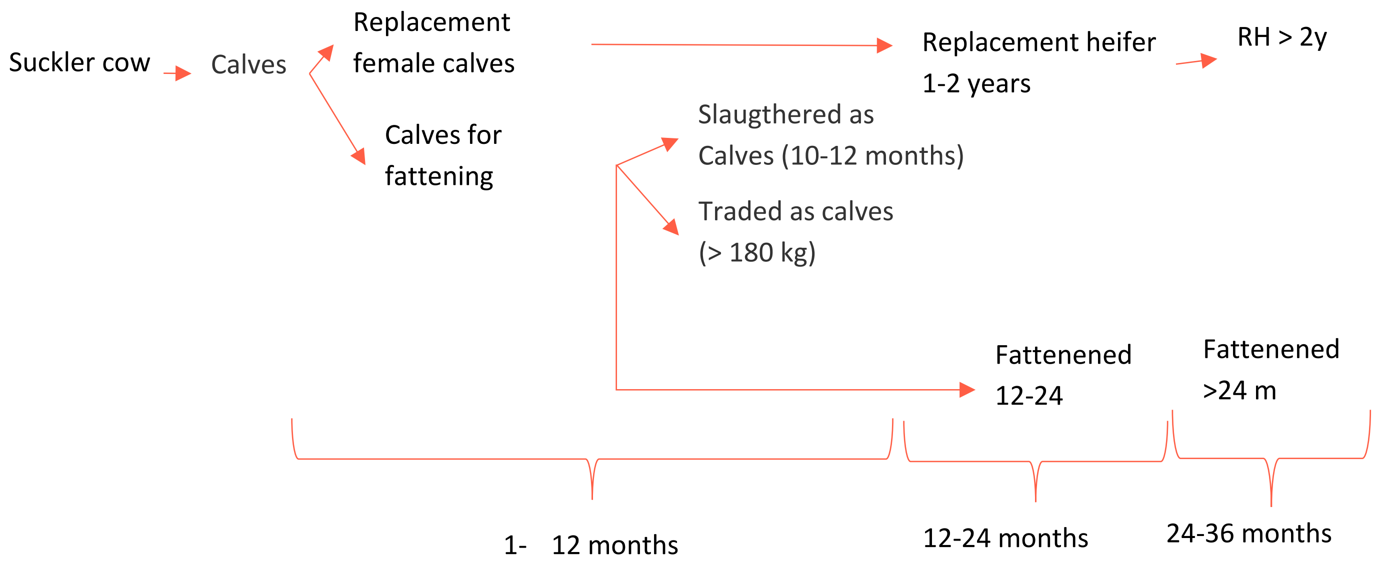

Figure 5: flows to build the suckler herd

When estimating the number of calves and accounting for slaughter and trade, it is assumed that all calves not part of the dairy system—specifically those slaughtered between 10-12 months of age and those traded at weights over 180 kg—originate from the suckler system. This distinction allows us to more accurately track the flow of animals from suckler herds through the production system, ensuring that these animals' nutritional needs and growth patterns are correctly represented. We can thus separate the sucker herd from the dairy herd, which is crucial for understanding the distinct impacts of these two systems on production, environmental outcomes, and potential changes in livestock management.

Also, the slaughter statistics allow us to derive the number of animals older than 24 months. It is assumed that these are both the old cows in dairy and sucklers that are being replaced. If the number of cull cows is lower than the slaughtered animals, then it is assumed that these are coming from an extensive suckler beef system. The difference between the calves for fattening that are not slaughtered or traded and those slaughtered with more than 24 months is assumed to be the amount of fattened beef from sucklers between 12-24 months.

4.2.2 SHEEP

Sheep data is more limited than cattle data, with population statistics only allowing us to differentiate between dairy breeding sheep, meat breeding sheep, and other sheep. Due to these limitations, a simplified approach was necessary for modelling the sheep herd.

We assumed that breeding animals (for milk or meat) are not traded, and trade is limited to "other sheep," with two key moments for trade: as lambs or before slaughter. To estimate the number of sheep fattened, we adjusted the number of sheep slaughtered using trade data. Specifically, the trade data, which differentiates between traded lambs and sheep, was used to correct the slaughter numbers by accounting for sheep traded before slaughter and those traded as lambs.
Finally, an algorithm was developed to fill possible gaps in the data. For example, for those few countries that do not provide livestock breeding animal numbers, it was derived from the animal fattening assuming a 1.8 lamb is born from an ewe, based on a farm management handbook (Agridea, 2023).

4.2.3 GOAT

Goat data is even more scarce than sheep data, providing limited insight into herd composition. Due to this, it was not possible to differentiate between dairy and meat breeds when modelling goat populations. We relied on the number of goats slaughtered to estimate the number of goats in a region, corrected with trade statistics. These adjustments help derive a more realistic estimate of the total goat population in each region.

4.2.4 PIGS

To derive the number of pigs, we used the breeding pigs from the population data (Eurostat, 2024a) and calculated the fattening pigs by working backwards from the slaughter statistics. The number of pigs slaughtered (Eurostat, 2024c) was corrected with the number of pigs traded before slaughter, allowing us to derive the number of pigs fattened in the region. Additionally, we incorporated trade data on weaners to compute the number of piglets born from breeding sows. The derived piglet data was then cross-checked with existing statistics (Interpig, 2024). Our computed results were within 10% of the reported values in the few countries where piglet-per-sow data was available. This suggests that the method chosen provides a reliable estimation of the pig herd and its dynamics, ensuring accurate representation for further modelling purposes.

4.2.5 POULTRY

No chicken data was available in the trade and nuts2 production (APRO) datasets. To estimate chicken populations, we took two different approaches. Broilers (for meat production) were derived from slaughter statistics, assuming there is no trade of live broilers, meaning that locally slaughtered broilers are also locally raised. Layer hens (for egg production) data was taken from Eurostat EF dataset (Eurostat, 2024d). This statistic however does not include replacement laying hens not yet laying eggs. To account for that animal, a pre-start phase to laying of 126 days was assumed based on the Swiss gross margin calculation, and the layer hen population was adjusted accordingly.

4.3 Livestock characteristics

4.3.1 CATTLE

All data for cattle can be found in appendix 7.1. This section describes how the data was created.

4.3.1.1 Dairy cattle

The dairy cattle system and the related database created in Milestone 11 were linked to the different production systems in the Swiss gross margin database (Agridea, 2023), as shown in Table 1. This linkage allows us to derive live animal weight, weight gains, dressing percentage and milk yield for every dairy cow and its replacement animal in the model.

Table 1 : linkage of livestock husbandry systems from milestone 11 to gross margin database

Main_system	Sub_system	Main_system_name	Sub_system_name	Main_breed_type	Gross margin database
DC_MAIZE	DC_MAIZE_HIGH	Green maize-based systems	High green maize systems	High yielding breed	9000 Kg Silozone
DC_MAIZE	DC_MAIZE_PG	Green maize-based systems	Permanent grass and green maize systems	High yielding breed	9000 Kg Silozone
DC_MAIZE	DC_MAIZE_TG	Green maize-based systems	Temporary grass and green maize systems	High yielding breed	9000 Kg Silozone
DC_TG	DC_TG	Temporary grass-based systems	Temporary grass systems	Not provided	9000 Kg Silozone
DC_MAIZE	DC_MAIZE_MIX	Green maize-based systems	Mix grass and green maize systems	High yielding breed	9000 Kg Silozone
DC_GRASS	DC_GRASS_NIT	Intensive grasslands systems	High nitrogen input systems	Smaller dairy breed	6500 kg Grass based
DC_GRASS	DC_GRASS_LARGE	Intensive grasslands systems	Large herds on large areas systems	Smaller dairy	6500 kg Grass based
DC_GRASS	DC_GRASS_SEM	Intensive grasslands systems	Semi-extensive systems	High yielding breed	5000 kg organic

DC_MOUNTAIN	DC_MOUNTAIN	Mountainous systems	Mountainous systems	Dual purposed	6000 kg milk for cheese production
DC_MED	DC_MED_INT	Mediterranean systems	Intensive indoor systems	High yielding breed	9000 Kg Silozone
DC_MED	DC_MED_PROF	Mediterranean systems	High profitability systems	Not provided	7000 kg milk for cheese production
DC_MED	DC_MED_SMALL	Mediterranean systems	Small indoor systems	Dual purposed	6000 kg organic
DC_SUBS	DC_SUBS	Semi-subsistence systems	Semi-subsistence systems	Smaller dairy	5000 kg organic
undefined	DC_UNDEFINED	undefined systems	undefined	Not provided	7000 kg milk for cheese production

For dairy-reared beef, it was assumed the adult weight of the animal is 90% of the liveweight of the dairy cow. While it was assumed for the baseline that all dairy-reared beef is fattened intensively across Europe, the fattening of each individual type of animal was assumed to be different but also linked to the Swiss gross margin database as shown in Table 2. This allows different weight gains per day, time in the system and dressing percentage for each animal.

Table 2 :linkage of dairy-reared beef to the gross margin calculation

Dairy reared beef	Gross margin database linkage
bovine_dairy_fattening_calf_forslaughter	Fattening with milk by-products
bovine_dairy_fattening_heifer_forslaugther	Beef fattening
bovine_dairy_fattening_heifer2_forslaughter	Beef fattening achieving 0.9 end weight dairy cow
bovine_dairy_fattening_ youngbull_forslaughter	Beef fattening

4.3.1.2 Suckler cattle

Suckler cattle were linked to the Swiss gross margin database through the intensity of production based on the description of the system described in Milestone 11. For those systems without a particular livestock husbandry system (undefined in Milestone 11), an average between intensive and extensive was created. Slaughter statistics were used to derive a carcass weight converted to alive weight, assuming a dressing percentage of 57%. Given that the alive weight is based on the intensity of production, the time necessary to achieve that alive weight can be calculated, allowing the slaughter age to be derived. Finally, for all animals that would be slaughtered older than 2 years, it was assumed they are fattened in the extensive system and achieve the alive weight from the suckler cow.

Table 3 : linkage of the livestock husbandry system from milestone 11 to production intensity

Sub_system_code	Main_system_name	Sub_system_name	assumed intensity
SC_MOUNTAIN	Mountainous rearing specialist systems	Mountain extensive French system	extensive
SC_PG_SMALL	Extensive permanent grassland systems	Small farms (30 ha)	extensive
SC_PG_LARGE	Extensive permanent grassland systems	Large farms (200 ha)	extensive
SC_MED1	Mediterranean systems	Large proportion of TG and all year on pasture	intensive
SC_MED2	Mediterranean systems	Small proportion of TG and all year on pasture	extensive
SC_MED3	Mediterranean systems	Small proportion of TG and half year on pasture	extensive
SC_TG	Temporary grassland systems	Temporary grass systems	intensive
SC_MAIZE_TG	Intensive systems using green maize	Systems based on temporary grasslands	intensive
SC_MAIZE_BEET	Intensive systems using green maize	Systems using beetroot	intensive
SC_UNDEFINED	Undefined	Undefined	average

4.3.2 SMALL RUMINANTS

4.3.2.1 Sheep

To compute production for the parameters for sheep, the assumptions shown in Table 4 were made, using the farm management handbook (Agridea, 2023), assuming that all sheep systems are homogenous. Only the housing assumptions were assumed to be different per livestock husbandry system.

Table 4 : assumption made for sheep

system	Animal category	Variable	Unit	
all	sheep_breeding_dairy	alive weight	Kg	65
all	sheep_breeding_meat	alive weight	Kg	70
all	sheep_fattening	start_weight	kg	4
all	sheep_fattening	end_weight		See map
all	sheep_fattening	dressing_percentage		0.46
all	sheep_breeding_dairy	wool	kg/year	4
all	sheep_breeding_meat	wool	kg/year	4
all	sheep_breeding_dairy	milk	kg/day	See map
all	sheep_breeding_meat	wg_mean		25
DS_IND_IN	sheep_breeding_dairy	table 10.4		housed ewes
DS_INT_GRA	sheep_breeding_dairy	table 10.4		grazing flat
rest	sheep_breeding_dairy	table 10.4		grazing hills
MS_indoor	sheep_breeding_meat	table 10.4		housed fattening
rest	sheep_breeding_meat	table 10.4		grazing flat

MS_indoor	sheep_fattening	table 10.4		housed fattening
rest	sheep_fattening	table 10.4		grazing flat

The slaughter weight, shown in *Table 5*, is country-specific and is derived from the slaughter statistics corrected with the dressing percentage. For filling missing values, geographical proximity was used; Bulgaria was assumed to have a similar slaughter weight to Romania and Slovakia, the same as Slovenia. Milk data was derived from variable D1120D, which represents sheep milk delivered to dairies. Although this is the only available data, it likely underestimates sheep milk production, as it does not account for the milk converted into cheese on farms.

Table 5 : sheep slaughter weight and sheep milk per dairy breeding sheep per country

id	Country	Slaughter weight	Milk per dairy breeding sheep per day
AL	ALBANIA	27.3	
AT	ÖSTERREICH	47.8	
BE	BELGIQUE-BELGIË	47.0	
BG	BULGARIA		0.07135
CH	SCHWEIZ/SUISSE/SVIZZERA	46.4	
CY	KYPROS	36.6	0.4621
CZ	ČESKÁ REPUBLIKA	33.9	
DE	DEUTSCHLAND	45.5	0.0449
DK	DANMARK	44.2	
EE	EESTI	43.1	
EL	GREECE	24.6	0.3145
ES	ESPAÑA	26.5	0.658
FI	SUOMI / FINLAND	45.1	
FR	FRANCE	42.2	0.5279
HR	HRVATSKA	25.3	
HU	MAGYARORSZÁG	37.9	0.068
IE	IRELAND	46.4	
IS	ÍSLAND	38.4	
IT	ITALIA	23.4	0.026
LT	LIETUVA	41.6	
LU	LUXEMBOURG	46.2	
LV	LATVIJA	37.1	
ME	CRNA GORA	45.9	
MK	North Macedonia	28.6	
MT	MALTA	54.6	
NL	NEDERLAND	50.7	
PL	POLSKA	36.4	

PT	PORTUGAL	27.6	0.2678
RO	ROMÂNIA	33.2	0.00755
RS	REPUBLIKA SRBIJA /РЕПУБЛИКА СРБИЈА	36.7	
SE	SVERIGE	44.1	
SI	SLOVENIJA	29.1	
SK	SLOVENSKO		0.122
TR	TÜRKIYE	48.1	
UK	UNITED KINGDOM	44.2	

4.3.2.2 Goat

Similarly to sheep, the slaughter weight and milk of goats could be derived from the slaughter and milk statistics, respectively (Table 5). Unlike sheep, it was impossible to differentiate between dairy-breeding and dairy goats. Therefore, the milk production was computed per goat. Here also, the milk delivered to dairies was used, probably underestimating the milk production in those countries that produce goat cheese on the farms.

Table 6 : goat slaughter weight and goat milk per goat per country

geo_code	Slaughter weight	Milk per goat and per day
BE	41.8	3.28
BG		
CZ	0	0
DK		
DE	16.2	2.25
EE	0	0
IE		
EL	22.1	0.23
ES	18.2	1.03
FR	20.1	2.11
IT	24.4	0.82
CY	43.5	0.76
LV	21.9	0
LT	0	0
LU	17.2	0
HU	0	2.83
MT	33.8	0
NL	28.2	3.28
AT	25.4	0.85

PL	44.2	0
PT	16.0	0.59
RO	33.7	1.46
SI	21.1	0
SK		
FI	32.9	0
SE	28.2	0
IS		
CH	24.4	0.68
UK	32.7	0
BA		
ME	0	3.28
MK	15.5	3.28
AL	23.9	0.42
RS	0	3.28
TR	41.3	0.93

4.3.3 PIGS

For pigs, the number of weaners per sow per year was calculated as part of the pig population, while slaughter weight was derived from the slaughter statistics.

Table 7 : weaners per sow and slaughter weight

Country	Weaners per sow	Slaughter weight
BE	28.10	123.42
BG	17.88	85.55
CZ	20.01	116.56
DK	34.14	114.51
DE	26.71	120.51
EE	21.29	103.27
IE	25.48	113.61
EL	16	79.10
ES	20.50	111.83
FR	24.33	118.74
HR	16	92.07
IT	17.27	156.70
CY	18.21	93.83
LV	18.97	103.62
LT	17.74	101.93

LU	16.51	108.05
HU	17.15	119.37
MT	NA	108.06
NL	32.19	124.99
AT	20.77	124.63
PL	20.40	117.96
PT	20.59	82.92
RO	16	111.32
SI	NA	115.98
SK	21.37	118.02
FI	20.54	116.46
SE	20.50	119.46

4.3.4 POULTRY

Productivity data for poultry were taken from the farm management handbook (Agridea, 2023). Eggs produced by a laying hen from that database were corrected for the fact that not all laying hens lay. The share of laying hens effectively laying was also derived from the Swiss gross margin database. This resulted in 0.586 eggs per laying hen a day. For broilers, a slaughter weight of 2110 grams was assumed with a dressing percentage of 75%.

4.4 Feed ratio

4.4.1 RUMINANTS

To create feed ratios for ruminants, we used the FADN public database for farm-level data on hectares of forage crops, including temporary grassland and permanent grassland, though it does not specify the type of forage crop. Using Eurostat crop data, we calculated the share of each forage crop per NUTS2 region, allowing us to estimate the area of specific forage crops on farms. Forage yields from the same dataset were then used to compute the dry matter produced. Grassland was divided into managed permanent grassland and natural permanent grassland based on the CORINE land cover (European Union’s Copernicus Land Monitoring Service information, 2020) and the probability of grazing on natural areas (Malek et al., 2024). The grassland yields were taken from the grassland pre-module and are based on data from Smit et al. (2008). This yield was corrected by 0.8 for managed and 0.4 for natural grassland, accounting for not all grass consumed by animals (de Vries, 2021). In this way, dry matter estimates for grass used for livestock can be computed in each NUTS2 region.

Finally, supplementary feed for grazing animals was assumed to be concentrates, with conversion to volume based on a price of €300 per tonne of concentrate, using a 5-year rolling average from AHDB (2022). Concentrates were then converted to dry matter, assuming 90% dry matter content.

In summary, this approach allows us to compute the volume of feed crops, grass and concentrates that are likely to be fed to livestock in a specific NUTS2 region. When expressed as share, this can be seen as a feed ratio.

To derive species-specific feed ratios, we applied the approach to a subset of farms, namely FADN farms defined as either specialist milk, cattle, or sheep/goat farms, where feed is predominantly used for that species. Dairy feed ratio maps are shown in Appendix 7.3, for other cattle in Appendix 7.4 and for sheep and goats in Appendix 7.5. The creation of these maps is a joint effort of Task 3.1 and Task 6.2 as part of the system characterisation work.

To calculate the effective feed intake per animal, IPCC calculations Tier 2 were applied, deriving the energy demand from ruminants based on energy required for maintenance, lactation, and growth.

4.4.2 MONOGASTRICS

For monogastrics, it was assumed that 100 % of the feed intake is derived from from concentrate feed. The amount of concentrate per animal is computed based on the Swiss gross margin database and is shown in Table 8.

Table 8 : feed conversion used for monogastrics

Livestock	approach	value
Fattening pig	Feed conversion kg feed per kg alive weight	2.7 kg/kg of meat
Breeding pig	Per breeding animal and per weaner	1349 kg per breeding sow per year + 795 kg / per weaner
Broiler	Feed conversion kg feed per kg alive weight	1.525 kg/kg of alive weight
Layer	Feed in gr/day	79 gr per layer

5 Results

5.1 Nex

Nitrogen excretion rates (Nex) were calculated using the IPCC Tier 2 approach, incorporating detailed data as outlined in the previous section. The results, presented as maps, depict N excretion per day.

5.1.1 DAIRY CATTLE

Figure 6 illustrates the nitrogen excretion rates per day for various dairy cattle categories modelled. Dairy cows exhibit the highest excretion rates (top left), largely because they remain in the system for the entire year and are the largest animals. Spatial variation in nitrogen excretion is driven primarily by the type of production systems modelled, particularly the combination of feed ratios. The results show noticeable differences across regions due to varying feeding practices and herd management systems.

The Nex rates for other livestock categories in Figure 6 also provide important insights. Fattening heifers for slaughter (top right) and fattening young bulls for slaughter (middle left) have lower Nex rates compared to dairy cows, as they spend less time in the system as they get slaughtered before the end of the year and are typically fed diets optimised for growth. Dairy replacement calves (middle right) and replacement heifers, both under and over two years (bottom right and bottom left), show lower excretion rates, reflecting their smaller body sizes and shorter presence in the system during the year.

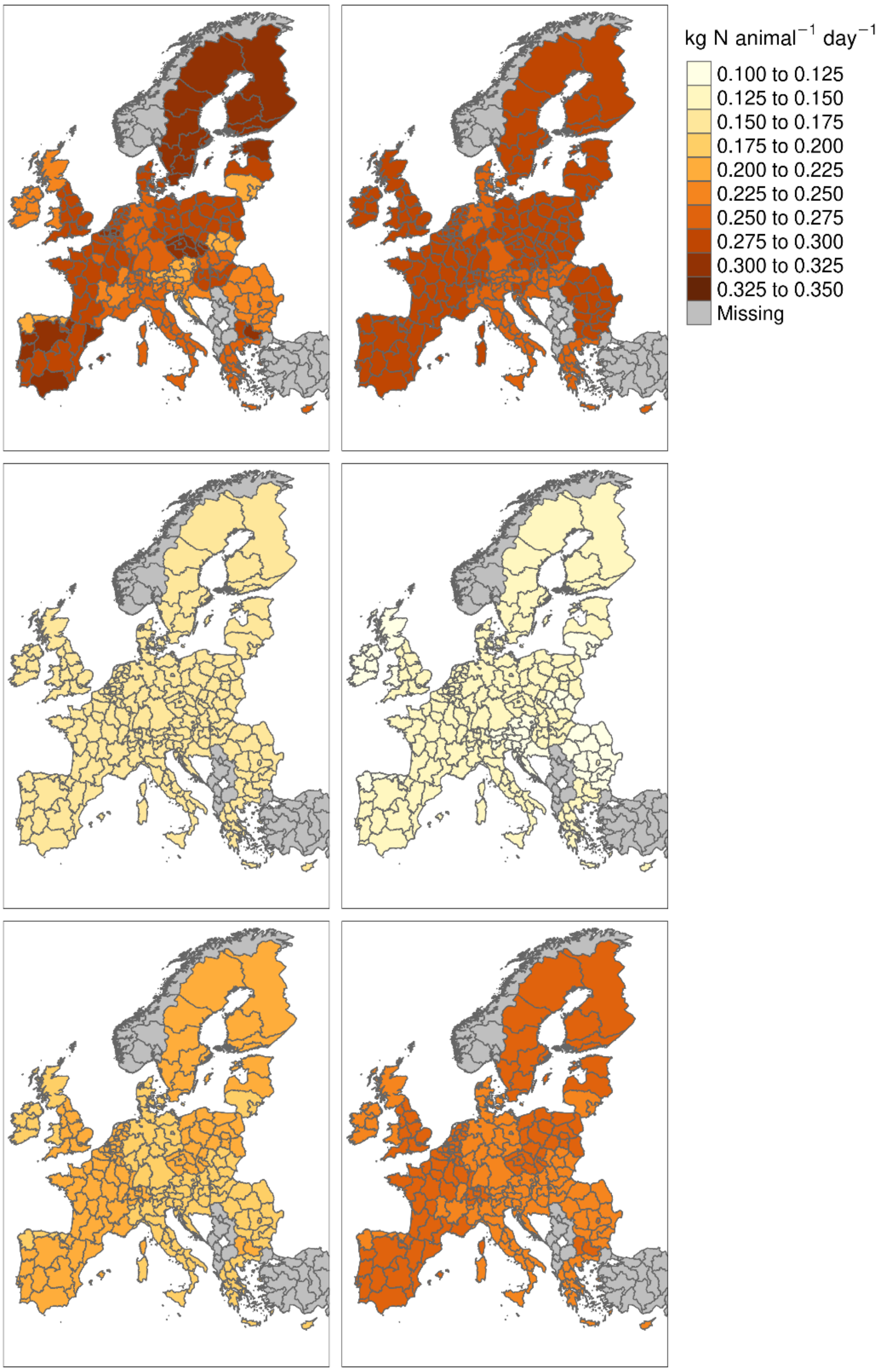

Figure 6: Nex per day for dairy cows (top left), for fattening heifer for slaughter (top right), for fattening young bulls for slaughter (middle left), for dairy replacement calf (middle right), for dairy replacement heifer <2 years (bottom left), for dairy replacement heifer >2 years (bottom right)

5.1.2 SUCKLER COW

Figure 7 displays nitrogen excretion rates per day. Suckler cows (top left) have the highest Nex rates, similar to dairy cows, due to their large size and year-round presence. All other categories, such as suckler heifers and bulls for slaughter (top right and middle left), have lower rates as these animals are smaller and not present for the entire year. Spatial variation is minimal, as the model uses only two systems—extensive and intensive. Feed ratios mainly drive the variation in Nex.

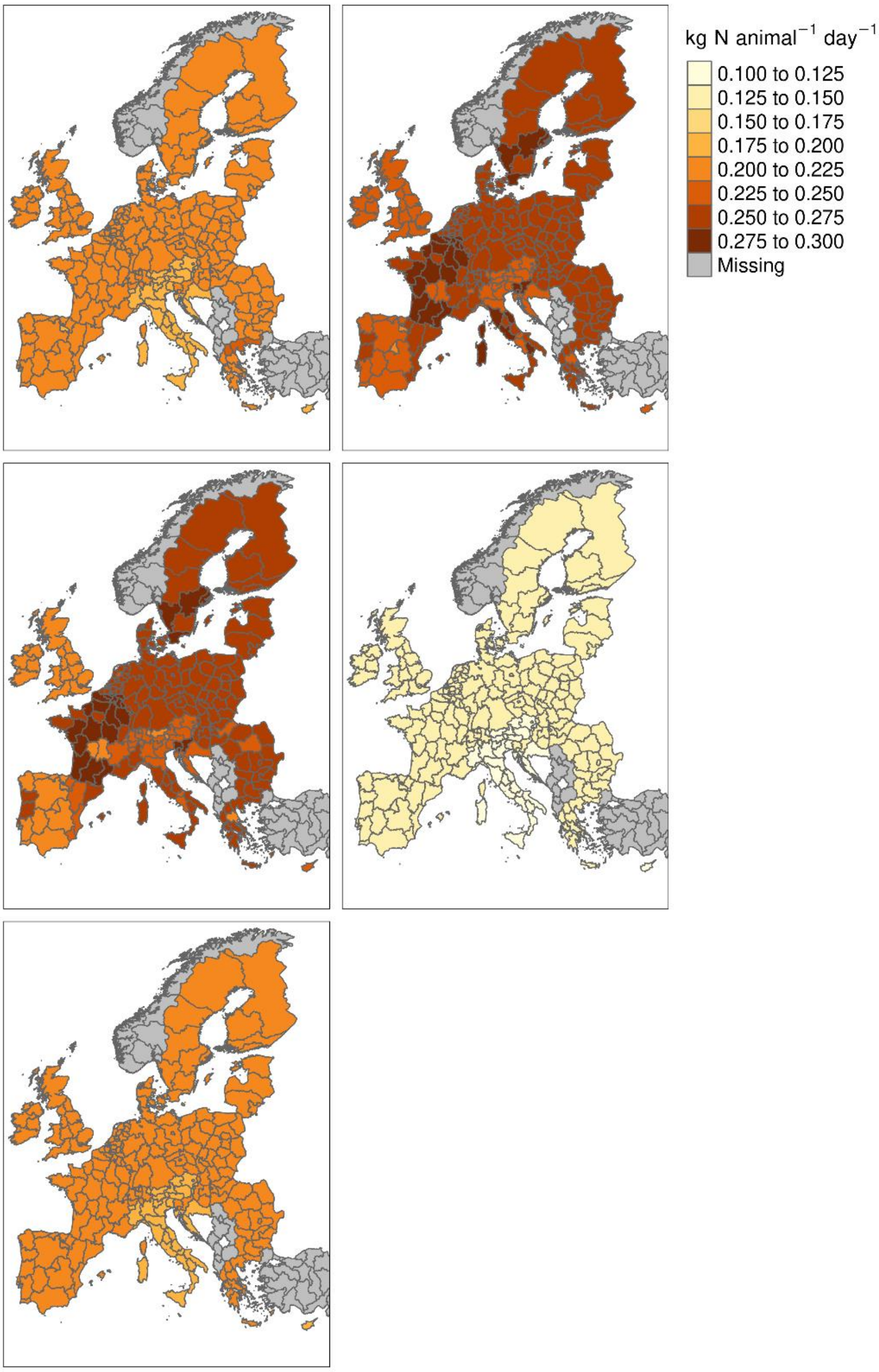

Figure 7: Nex per day for suckler cow (top left), for suckler heifer for slaughter (top right), for fattening young suckler bulls for slaughter (middle left), for suckler replacement calf (middle right), for suckler replacement heifer <2 years (bottom left)

5.1.3 SHEEP

Figure 8 presents annual nitrogen excretion rates for breeding dairy, meat, and fattening sheep.
The spatial variation for fattening sheep is much larger. The varying slaughter weights and ages across countries can explain this. In some regions like the Mediterranean, lambs are slaughtered early, resulting in smaller animals with low Nex rates, often overlapping with dairy breeding systems. Conversely, in countries like the Netherlands and Germany, sheep are slaughtered at a later age, leading to larger animals with Nex rates similar to breeding animals. The age and size differences at slaughter significantly influence the variation in nitrogen excretion rates across regions.

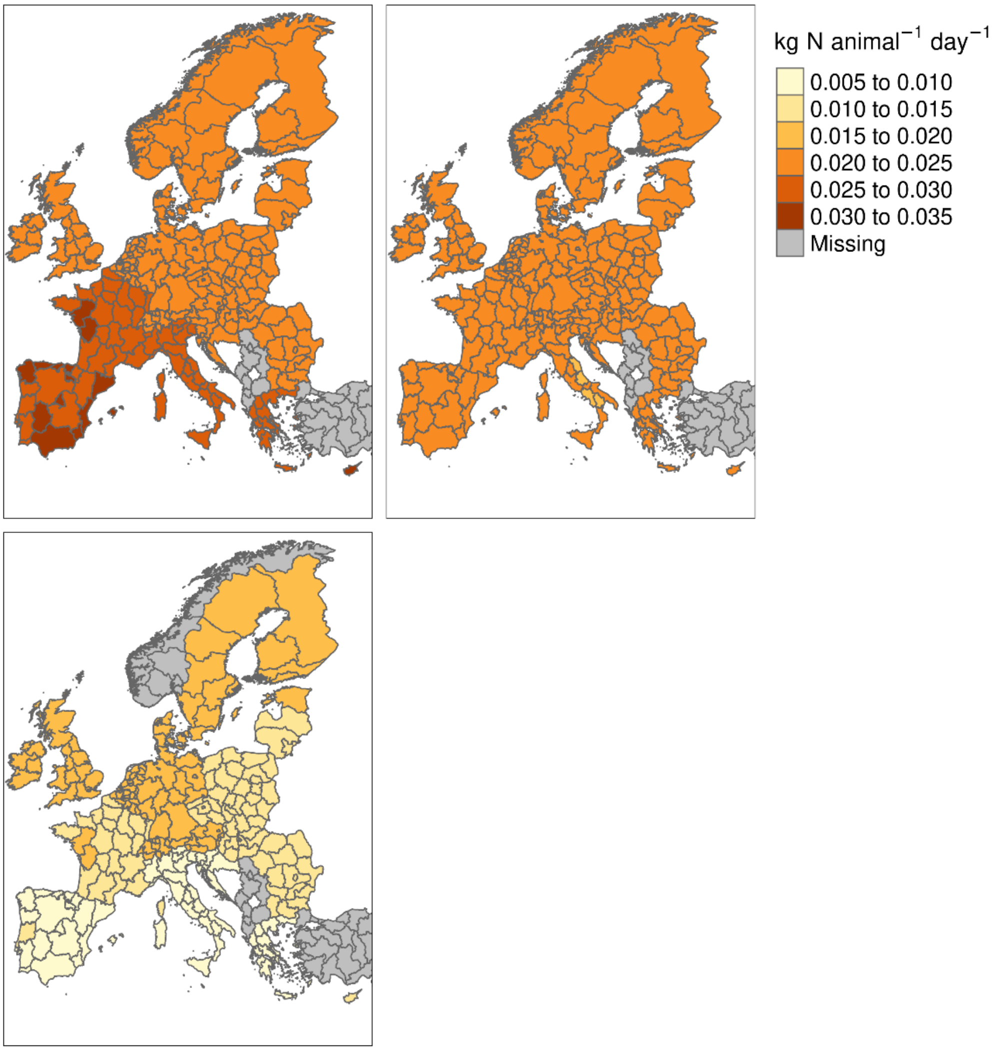

Figure 8 Nex per day for breeding sheep dairy (top left), for breeding sheep meat(top right) , for fattening sheep (bottom)

5.1.4 GOAT

Figure 9 presents nitrogen excretion rates per goat per year, combining data from breeding dairy goats, breeding meat goats, and fattening animals into a single map. This approach models the entire goat production system within a region, which varies significantly across countries. The spatial heterogeneity in Nex is quite pronounced, with countries like the Netherlands and Belgium showing higher Nex due to larger goats that have shorter fattening times, while in regions like Sweden and the Baltic states, smaller goats with longer fattening periods result in lower Nex rates.

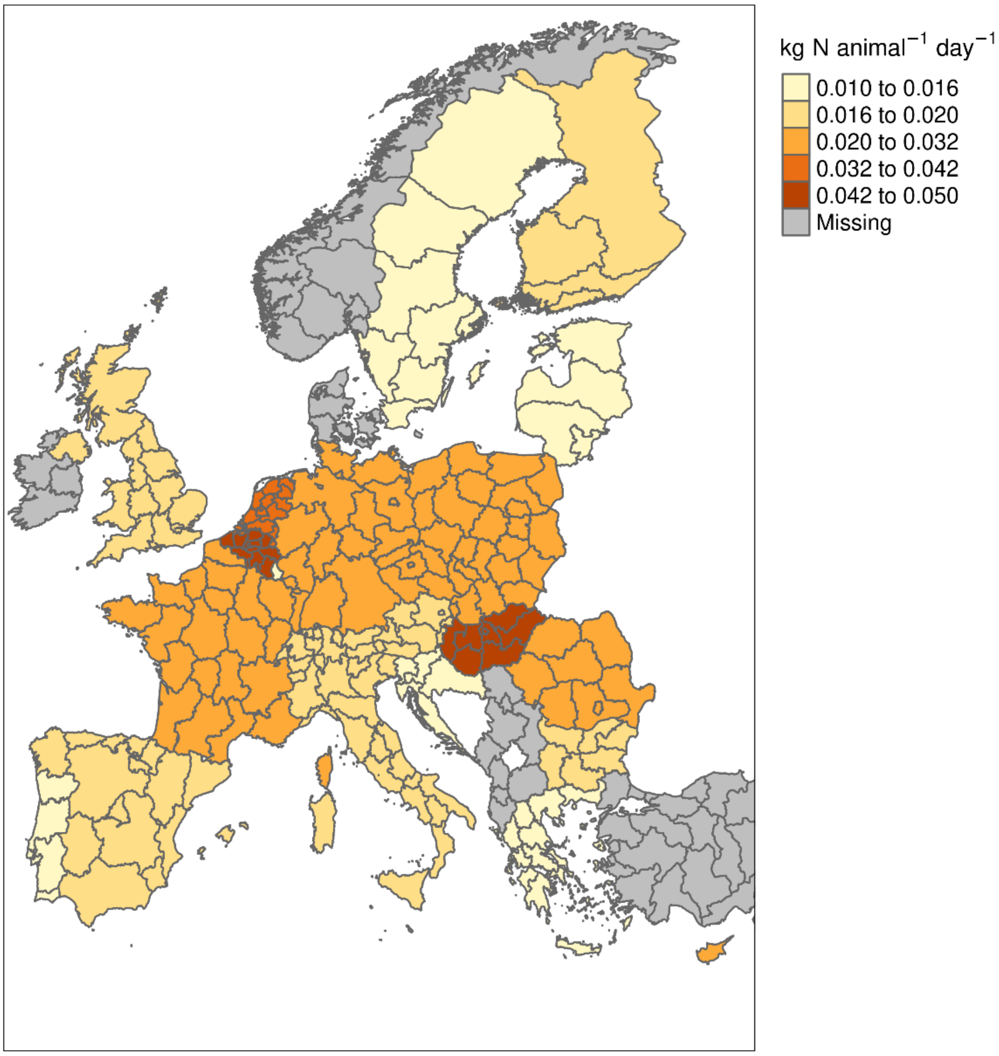

Figure 9: Nex per goat per year

5.1.5 PIGS

Figure 10 shows nitrogen excretion rates for **breeding pigs** (left) and **fattening pigs** (right). The Nex rates for the breeding pigs are much higher than for the fattening pigs due to the inclusion of weaners, and because they are present the whole year round. Since all pigs are modelled under uniform indoor husbandry systems, spatial variation in the maps is driven by slaughter weight, age, and the number of weaners produced. The spatial pattern is directly influenced by the resolution of the input data, which is based on national statistics, leading to broad national pattern

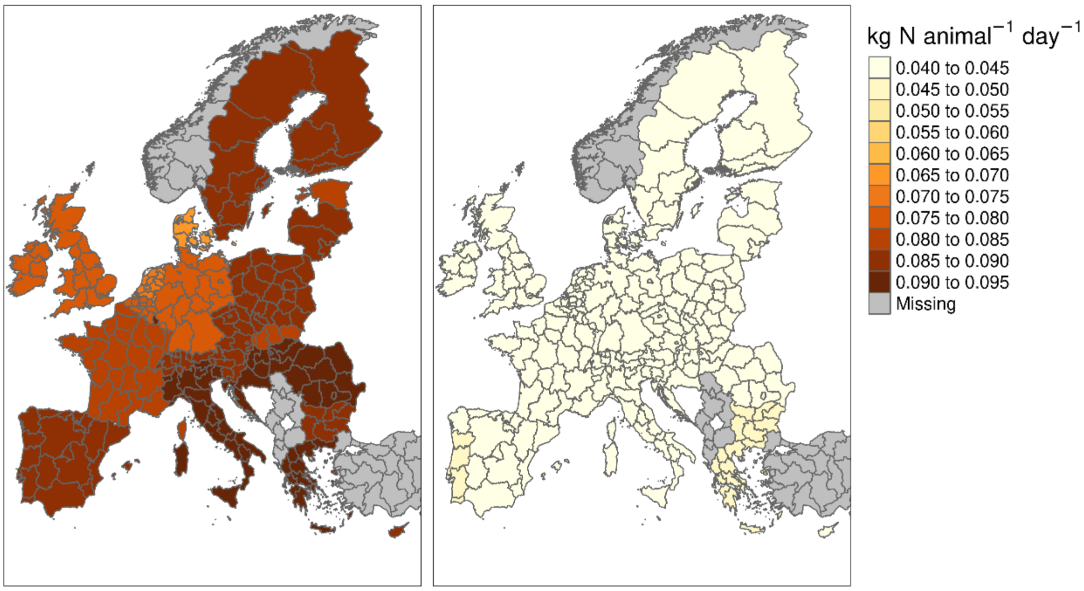

Figure 10 Nex (per year for the days alive) for breeding sows including weaners (left) and for fattening pigs (right)

5.2 Gross nitrogen balance

This section presents the gross nitrogen balance computed based on the data shown in the deliverable. Overall, the map in Figure 11, indicates that the some part European region experiences a surplus of nitrogen, with significant variation between countries and regions. The highest nitrogen surpluses are concentrated in the Benelux countries (Belgium, the Netherlands, and Luxembourg), where intensive agricultural practices—particularly livestock farming and the heavy use of synthetic fertilizers—result in nitrogen inputs that far exceed what the soil and crops can absorb. This leads to environmental issues such as soil degradation, water contamination, and air pollution from ammonia emissions. Southern Spain also has some hotspots.

Central European countries like France and Germany present more moderate surpluses, although specific regions within these countries show local hotspots of excess nitrogen, often linked to concentrated agricultural production.

Southern European countries, including Spain, Italy, and Greece, generally display lower nitrogen surpluses, reflecting fewer intensive livestock production and different crop management practices. However, surpluses are still present, highlighting the overall challenge of balancing nitrogen inputs and outputs across the continent.

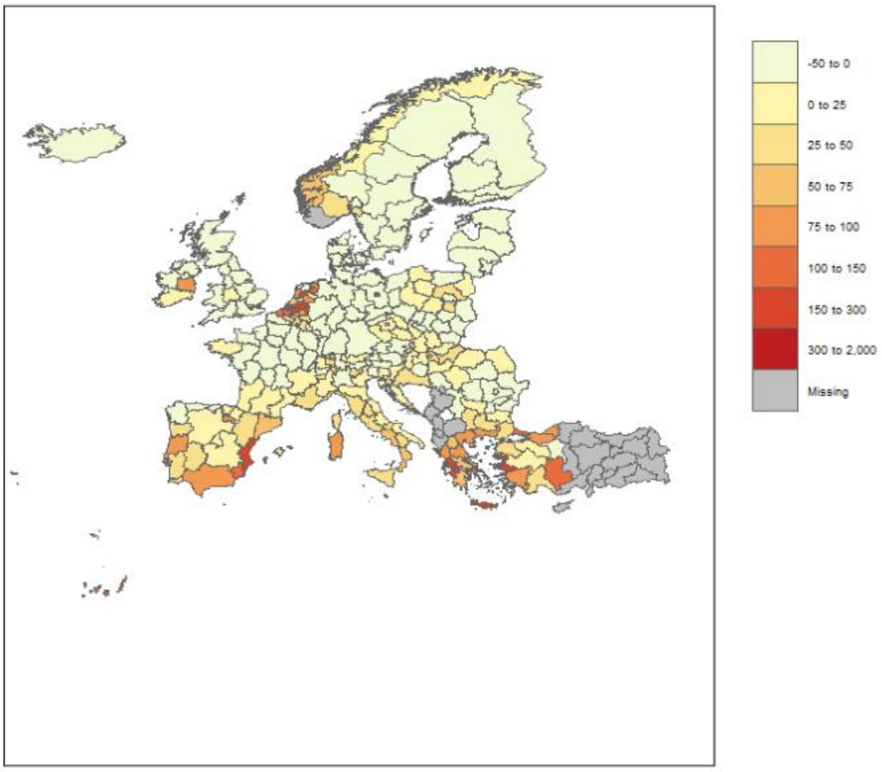

Figure 11 : Nitrogen balance after all losses in kg N / ha

The nitrogen input map in Figure 12 provides an overview of nitrogen levels across Europe but includes only the modelled livestock species, excluding horses, other poultry, and fur animals. Therefore, nitrogen contributions from these species are not represented in the data. The map shows that there are significant surplus inputs in the Benelux region, as well as in certain areas of France and the United Kingdom. These high nitrogen levels are primarily driven by a combination of dense livestock populations and substantial application of artificial fertilizers in these regions. The combination of intensive animal farming and fertiliser use contributes to the elevated nitrogen surplus observed in these areas.

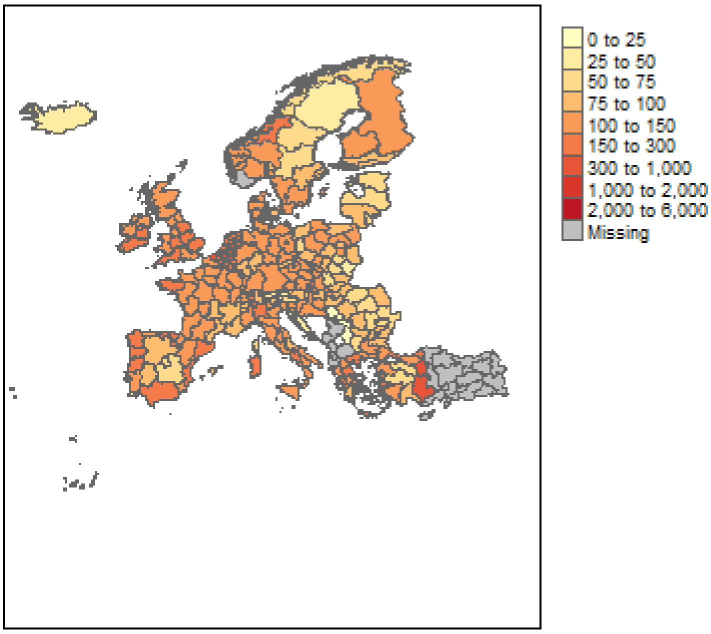

Figure 12 : Nitrogen In Kg N / ha

The nitrogen output, as represented in the Figure 13, reflects the nitrogen harvested from crops and grasses (left) and harvest residues(right). This data includes both arable crops and grasslands, including temporary grassland. The harvested nitrogen accounts for the nutrients removed from the soil through collecting these crops and grasses, contributing to the overall balance of nitrogen in the system.

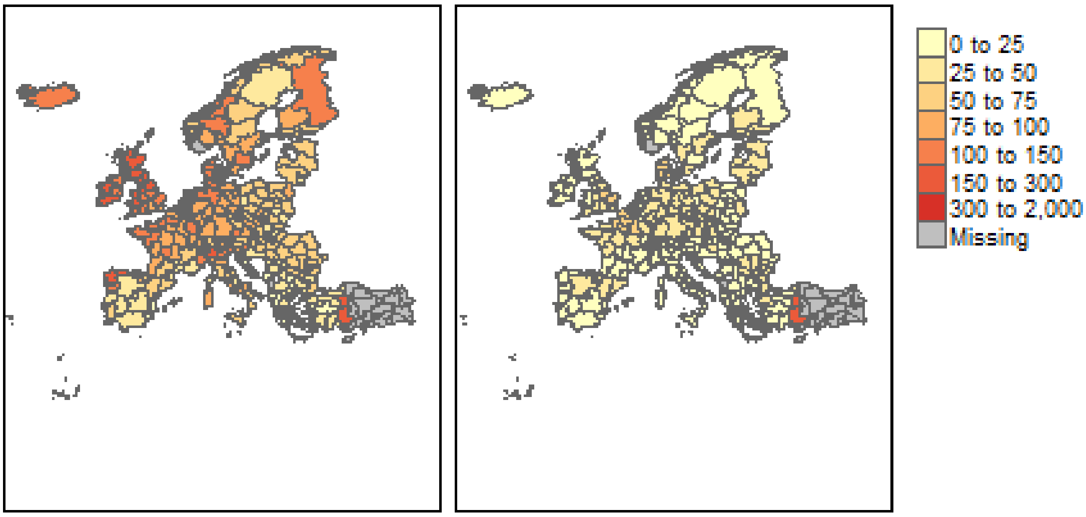

Figure 13 : Nitrogen Out in Kg N / ha

6 Discussion

6.1 N excretion rate

We are not the first to calculate nitrogen excretion (Nex) rates for livestock, and de Vries (2021) provides a valuable comparison. The GAIN model (Amann et al., 2011) used in de Vries' work makes different assumptions, particularly regarding livestock categorisation, as shown in Table 9. While categories like dairy cows are comparable, de Vries groups all other cattle (e.g., suckler cows, replacements, and fattening animals) into a category with a lower average weight, making direct comparisons challenging.

Table 9 : de Vries (2021) excretion rate per animal

Country	Dairy cows	Other cattle	Pigs	Horses	Sheep and goats	Laying hens	Other poultry
Austria	106	46	9	48	13	0.7	0.4
Belgium	118	50	11	50	7	0.7	0.5
Bulgaria	75	45	12	50	12	0.8	0.7
Cyprus	103	40	12	50	12	0.8	0.7
Czech Republic	131	45	12	50	12	0.8	0.6
Denmark	132	37	10	43	17	0.7	0.5
Estonia	113	45	12	50	14	0.8	0.5
Finland	121	53	10	50	16	0.8	0.4
France	112	50	12	50	12	0.8	0.9
Germany	130	40	15	48	8	0.8	0.6
Greece	111	45	12	50	12	0.8	0.7
Hungary	146	45	9	50	12	1.5	1.5
Ireland	105	69	12	50	8	0.8	0.5
Italy	112	47	12	50	16	0.7	0.5
Latvia	88	51	10	51	7	0.9	0.9
Lithuania	95	50	12	50	12	0.8	0.5
Luxembourg	114	42	10	50	12	0.8	0.7
Malta	98	40	12	50	12	0.8	0.7
Netherlands	147	40	9	50	12	0.7	0.6
Poland	81	35	11	50	14	0.7	0.6
Portugal	102	50	9	39	7	0.6	0.9
Romania	67	45	12	50	12	0.8	0.7
Slovakia	135	45	12	50	12	0.8	0.7
Slovenia	110	40	12	50	11	0.7	0.5
Spain	71	52	9	40	5	0.8	0.6
Sweden	132	39	11	50	6	0.6	0.3

United Kingdom	133	49	12	50	6	0.9	0.7
Croatia	112	47	12	50	16	0.7	0.5

For dairy cows, our Nex rates are similar to de Vries's, though we tend to have slightly lower overall excretion rates. One key difference is the spatial heterogeneity: our model, using more spatially disaggregated data, captures greater regional variability and more recent data than de Vries, where broader data may smooth out these differences.

For sheep, our Nex rates are notably lower than those in de Vries, which can be attributed to the fact that de Vries' data is designed for use with snapshot datasets that capture animals simultaneously. In contrast, our data reflects the number of effective animals over time, accounting for shorter durations in the model. This results in lower Nex for non-breeding animals. For breeding animals present in the system year-round, our results are closer to de Vries' figures, although we don't observe the high Nex in Finland. This discrepancy could be due to our reliance on milk delivered to dairies, likely underestimating total milk production, leading to higher feed intake and, consequently, higher excretion rates.

Comparing our nitrogen excretion (Nex) rates for pigs with those from **de Vries (2021)** is challenging because de Vries does not distinguish between breeding and fattening pigs, reporting them as a single category. However, a rough back-of-the-envelope calculation using a weighted average of 1:20 for breeding sows to fattening pigs suggests that our results would fall within a similar range as de Vries's results. Despite the different categorisations, the overall nitrogen excretion rates align reasonably well when considering this ratio.

Our results also align with de Vries regarding monogastric animals. However, our simplified approach using a fixed Nex rate from the IPCC leads to less spatial variation for chickens. It is slightly higher than the one in de Vries, suggesting that we are not fully capturing the diversity of chicken production systems.

Despite some differences in spatial heterogeneity, our results fall within a similar range as de Vries's. This validates the approach we have used for Geo-SOL and allows us to model changes in livestock husbandry and its impact on manure availability in the future.

6.2 Soil nitrogen balance

We compared our calculated soil nitrogen balance with the results from de Vries (2021), which provides maps for nitrogen inputs (including manure, artificial fertilisers, and nitrogen fixation) and nitrogen offtake based on crop yields. Our results display a similar spatial pattern to de Vries's. Yet, we find a much lower surplus than de Vries and even deficiencies, which is driven mainly by our modelling of the nitrogen input, which is lower than de Vries for different reasons. Firstly, we modelled cattle, mall ruminants, pigs, and chicken, while de Vries also included horses, fur animals and other poultry. Our results are lower because we did not include these species. An upcoming version of Geo-SOL could include this manure using the de Vries excretion rate and the most recent livestock population statistics. Secondly, our calculation does not yet include nitrogen deposition; this parameter is being added in the upcoming version of Geo-SOL as this deposition is dependent on the ammonia deposition that is being modelled in a spatially explicit way and is being added to assess the impact of livestock on biodiversity. Finally, the nitrogen calculation approach also includes the losses from nitrogen application not included in the de Vries calculation. This difference explains why our nitrogen input is much lower than de Vries.

On the nitrogen offtake side, we find spatial patterns very similar to de Vries; the slight variation can be attributed to our use of more recent crop data, which reflects higher yields and increased nitrogen removal.

The difference with de Vries is obvious but can be explained by the difference in the calculating approach of the soil nitrogen balance. Yet the spatial pattern is similar to de Vries', suggesting that the method developed for Geo-SOL is robust and comparable to established approaches like de Vries' model.

Like the results of de Vries, results of Geo-SOL show that most of Europe is not circular and experiences a nitrogen surplus. This surplus is particularly high in regions like Benelux and the UK. Intensive livestock farming and high artificial fertiliser use in these areas produce excess nitrogen inputs over outputs. The imbalance is driven by high animal densities and concentrated manure production, which is not spread over a wide enough area to spread the nitrogen load adequately. Whilst crop yields are often high in these regions, mineral fertiliser is still the dominant nutrient source. Therefore, high nutrient loads combined with nitrogenous losses to the environment lead to water and air pollution.

7 Conclusion

In this deliverable, we presented the methodology and results of the Geo-SOL baseline for estimating nitrogen excretion rates and soil nitrogen balances. Through comparison with de Vries (2021), we validated our approach, finding similar spatial patterns in nitrogen inputs and outputs. Differences are explained by using more recent crop data and livestock assumptions. With the baselines established and validated, we believe the model can reflect agricultural system changes outlined within the scenarios developed in WP2, such as Efficiency First, Feed No Food, Rural Renaissance, and High Animal Agency. This modelling approach will, therefore, provide valuable insights into future animal husbandry pathways.

Appendix

3.1 List of crops in the Geo-SOL baseline

CODE_DIFF	name
C1110	Common wheat and spelt
C1120	Durum wheat
C1200	Rye and winter cereal mixtures (maslin)
C1300	Barley
C1410	Oats
C1420	Spring cereal mixtures (mixed grain other than maslin)
C1500	Grain maize and corn-cob-mix
C1600	Triticale
C1700	Sorghum
C1900	Other cereals n.e.c. (buckwheat, millet, canary seed, etc.)
C2000	Rice
F1110	Apples
F1120	Pears
F1190	Other pome fruits n.e.c.
F1210	Peaches
F1220	Nectarines
F1230	Apricots
F1240	Cherries
F1250	Plums
F1290	Other stone fruits n.e.c
F2100	Figs
F2200	Kiwis
F2300	Avocados
F2400	Bananas
F2900	Other fruits from subtropical and tropical climate zones n.e.c.
F3000	Berries (excluding strawberries)
F4100	Walnuts
F4200	Hazelnuts
F4300	Almonds
F4400	Chestnuts
F4900	Other nuts n.e.c.
G1000	Temporary grasses and grazings
G2100	Lucerne
G2900	Other leguminous plants harvested green n.e.c.

G3000	Green maize
G9100	Other cereals harvested green (excluding green maize)
G9900	Other plants harvested green from arable land n.e.c.
I1110	Rape and turnip rape seeds
I1120	Sunflower seed
I1130	Soya
I1140	Linseed (oilflax)
I1150	Cotton seed
I1190	Other oilseed crops n.e.c.
I2100	Fibre flax
I2200	Hemp
I2300	Cotton fibre
I2900	Other fibre crops n.e.c.
I3000	Tobacco
I4000	Hops
I5000	Aromatic, medicinal and culinary plants
I6000	Energy crops n.e.c.
I9000	Other industrial crops n.e.c.
J0000	Permanent grassland
O1100	Olives for table use
O1910	Olives for oil
P1100	Field peas
P1200	Broad and field beans
P1300	Sweet lupins
P9000	Other dry pulses and protein crops n.e.c.
R1000	Potatoes (including seed potatoes)
R2000	Sugar beet (excluding seed)
R9000	Other root crops n.e.c.
S0000	Strawberries
T1000	Oranges
T2000	Small citrus fruits
T3000	Lemons and acid limes
T4000	Pomelos and grapefruit
T9000	Other citrus fruits n.e.c.
V1100	Cauliflower and broccoli
V1200	Brussels sprouts
V1300	Cabbages
V1900	Other brassicas n.e.c
V2100	Leeks
V2200	Celery

V2300	Lettuces
V2300S	Lettuces under glass or high accessible cover
V2400	Endives
V2500	Spinach
V2600	Asparagus
V2710	Chicory for fresh consumption
V2720	Chicory for processing
V2800	Artichokes
V2900	Other leafy or stalked vegetables n.e.c.
V3100	Tomatoes
V3200	Cucumbers
V3300	Gherkins
V3410	Eggplants
V3420	Courgettes and marrows
V3430	Gourds and pumpkins
V3510	Muskmelons
V3520	Watermelons
V3600	Peppers (capsicum)
V3900	Other vegetables cultivated for fruit n.e.c.
V4100	Carrots
V4210	Onions
V4220	Shallots
V4300	Beetroot
V4400	Celeriac
V4500	Radishes
V4600	Garlic
V4900	Other root, tuber and bulb vegetables n.e.c.
V5100	Fresh peas
V5200	Fresh beans
V5900	Other fresh pulses n.e.c.
V9000	Other fresh vegetables n.e.c.
W1000	Grapes

n.e.c. = not elsewhere classified

7.1 Dairy cattle production characteristics

SOL_name	system	**start_weight**	**end_weight**	**weight gain**	**alive_weight**	**milk_yield**	**fat_content**	**dressing**	**days**	**slaugher_age**
bovine_dairy_cow	DC_MAIZE_HIGH	700	700	0	700	8000	4	45	365	
bovine_dairy_cow	DC_MAIZE_PG	700	700	0	700	9000	4	45	365	
bovine_dairy_cow	DC_MAIZE_TG	700	700	0	700	10000	4	45	365	
bovine_dairy_cow	DC_TG	700	700	0	700	9000	4	45	365	
bovine_dairy_cow	DC_MAIZE_MIX	700	700	0	700	8500	4	45	365	
bovine_dairy_cow	DC_GRASS_NIT	600	600	0	600	5800	4	48	365	
bovine_dairy_cow	DC_GRASS_LARGE	600	600	0	600	6500	4	48	365	
bovine_dairy_cow	DC_GRASS_SEM	600	600	0	600	3000	4	48	365	
bovine_dairy_cow	DC_MOUNTAIN	650	650	0	650	6000	4	48	365	
bovine_dairy_cow	DC_MED_INT	700	700	0	700	10000	4	45	365	
bovine_dairy_cow	DC_MED_PROF	700	700	0	700	7000	4	46	365	
bovine_dairy_cow	DC_MED_SMALL	650	650	0	650	6000	4	48	365	
bovine_dairy_cow	DC_SUBS	600	600	0	600	5000	4	48	365	
bovine_dairy_cow	DC_UNDEFINED	700	700	0	700	7000	4	46	365	

bovine_dairy_replacement_calf_female	DC_MAIZE_HIGH	74	375.437995	0.82585752	225				365	
bovine_dairy_replacement_heifer	DC_MAIZE_HIGH	375.437995	676.875989	0.82585752	526				365	
bovine_dairy_replacement_heifer2	DC_MAIZE_HIGH	676.875989	700	0.82585752	688				28	
bovine_dairy_replacement_calf_male	DC_MAIZE_HIGH	74	387	0.857534247	231				365	
bovine_dairy_replacement_ youngbull	DC_MAIZE_HIGH	387	700	0.857534247	544				365	
bovine_dairy_replacement_calf_female	DC_MAIZE_PG	74	375.437995	0.82585752	225				365	
bovine_dairy_replacement_heifer	DC_MAIZE_PG	375.437995	676.875989	0.82585752	526				365	
bovine_dairy_replacement_heifer2	DC_MAIZE_PG	676.875989	700	0.82585752	688				28	
bovine_dairy_replacement_calf_male	DC_MAIZE_PG	74	387	0.857534247	231				365	
bovine_dairy_replacement_ youngbull	DC_MAIZE_PG	387	700	0.857534247	544				365	
bovine_dairy_replacement_calf_female	DC_MAIZE_TG	74	375.437995	0.82585752	225				365	
bovine_dairy_replacement_heifer	DC_MAIZE_TG	375.437995	676.875989	0.82585752	526				365	
bovine_dairy_replacement_heifer2	DC_MAIZE_TG	676.875989	700	0.82585752	688				28	
bovine_dairy_replacement_calf_male	DC_MAIZE_TG	74	387	0.857534247	231				365	
bovine_dairy_replacement_ youngbull	DC_MAIZE_TG	387	700	0.857534247	544				365	
bovine_dairy_replacement_calf_female	DC_TG	74	375.437995	0.82585752	225				365	
bovine_dairy_replacement_heifer	DC_TG	375.437995	676.875989	0.82585752	526				365	

bovine_dairy_replacement_heifer2	DC_TG	676.875989	700	0.82585752	688				28	
bovine_dairy_replacement_calf_male	DC_TG	74	387	0.857534247	231				365	
bovine_dairy_replacement_ youngbull	DC_TG	387	700	0.857534247	544				365	
bovine_dairy_replacement_calf_female	DC_MAIZE_MIX	74	375.437995	0.82585752	225				365	
bovine_dairy_replacement_heifer	DC_MAIZE_MIX	375.437995	676.875989	0.82585752	526				365	
bovine_dairy_replacement_heifer2	DC_MAIZE_MIX	676.875989	700	0.82585752	688				28	
bovine_dairy_replacement_calf_male	DC_MAIZE_MIX	74	387	0.857534247	231				365	
bovine_dairy_replacement_ youngbull	DC_MAIZE_MIX	387	700	0.857534247	544				365	
bovine_dairy_replacement_calf_female	DC_GRASS_NIT	74	327.28496	0.693931398	201				365	
bovine_dairy_replacement_heifer	DC_GRASS_NIT	327.28496	580.569921	0.693931398	454				365	
bovine_dairy_replacement_heifer2	DC_GRASS_NIT	580.569921	600	0.693931398	590				28	
bovine_dairy_replacement_calf_male	DC_GRASS_NIT	74	387	0.857534247	231				365	
bovine_dairy_replacement_ youngbull	DC_GRASS_NIT	387	700	0.857534247	544				365	
bovine_dairy_replacement_calf_female	DC_GRASS_LARGE	74	327.28496	0.693931398	201				365	
bovine_dairy_replacement_heifer	DC_GRASS_LARGE	327.28496	580.569921	0.693931398	454				365	
bovine_dairy_replacement_heifer2	DC_GRASS_LARGE	580.569921	600	0.693931398	590				28	
bovine_dairy_replacement_calf_male	DC_GRASS_LARGE	74	387	0.857534247	231				365	

bovine_dairy_replacement_ youngbull	DC_GRASS_LARGE	387	700	0.857534247	544				365	
bovine_dairy_replacement_calf_female	DC_GRASS_SEM	74	327.28496	0.693931398	201				365	
bovine_dairy_replacement_heifer	DC_GRASS_SEM	327.28496	580.569921	0.693931398	454				365	
bovine_dairy_replacement_heifer2	DC_GRASS_SEM	580.569921	600	0.693931398	590				28	
bovine_dairy_replacement_calf_male	DC_GRASS_SEM	74	387	0.857534247	231				365	
bovine_dairy_replacement_ youngbull	DC_GRASS_SEM	387	700	0.857534247	544				365	
bovine_dairy_replacement_calf_female	DC_MOUNTAIN	74	351.361478	0.759894459	213				365	
bovine_dairy_replacement_heifer	DC_MOUNTAIN	351.361478	628.722955	0.759894459	490				365	
bovine_dairy_replacement_heifer2	DC_MOUNTAIN	628.722955	650	0.759894459	639				28	
bovine_dairy_replacement_calf_male	DC_MOUNTAIN	74	387	0.857534247	231				365	
bovine_dairy_replacement_ youngbull	DC_MOUNTAIN	387	700	0.857534247	544				365	
bovine_dairy_replacement_calf_female	DC_MED_INT	74	375.437995	0.82585752	225				365	
bovine_dairy_replacement_heifer	DC_MED_INT	375.437995	676.875989	0.82585752	526				365	
bovine_dairy_replacement_heifer2	DC_MED_INT	676.875989	700	0.82585752	688				28	
bovine_dairy_replacement_calf_male	DC_MED_INT	74	387	0.857534247	231				365	
bovine_dairy_replacement_ youngbull	DC_MED_INT	387	700	0.857534247	544				365	
bovine_dairy_replacement_calf_female	DC_MED_PROF	74	375.437995	0.82585752	225				365	

bovine_dairy_replacement_heifer	DC_MED_PROF	375.437995	676.875989	0.82585752	526				365	
bovine_dairy_replacement_heifer2	DC_MED_PROF	676.875989	700	0.82585752	688				28	
bovine_dairy_replacement_calf_male	DC_MED_PROF	74	387	0.857534247	231				365	
bovine_dairy_replacement_ youngbull	DC_MED_PROF	387	700	0.857534247	544				365	
bovine_dairy_replacement_calf_female	DC_MED_SMALL	74	351.361478	0.759894459	213				365	
bovine_dairy_replacement_heifer	DC_MED_SMALL	351.361478	628.722955	0.759894459	490				365	
bovine_dairy_replacement_heifer2	DC_MED_SMALL	628.722955	650	0.759894459	639				28	
bovine_dairy_replacement_calf_male	DC_MED_SMALL	74	387	0.857534247	231				365	
bovine_dairy_replacement_ youngbull	DC_MED_SMALL	387	700	0.857534247	544				365	
bovine_dairy_replacement_calf_female	DC_SUBS	74	327.28496	0.693931398	201				365	
bovine_dairy_replacement_heifer	DC_SUBS	327.28496	580.569921	0.693931398	454				365	
bovine_dairy_replacement_heifer2	DC_SUBS	580.569921	600	0.693931398	590				28	
bovine_dairy_replacement_calf_male	DC_SUBS	74	387	0.857534247	231				365	
bovine_dairy_replacement_ youngbull	DC_SUBS	387	700	0.857534247	544				365	
bovine_dairy_replacement_calf_female	DC_UNDEFINED	74	375.437995	0.82585752	225				365	
bovine_dairy_replacement_heifer	DC_UNDEFINED	375.437995	676.875989	0.82585752	526				365	
bovine_dairy_replacement_heifer2	DC_UNDEFINED	676.875989	700	0.82585752	688				28	

bovine_dairy_replacement_calf_male	DC_UNDEFINED	74	387	0.857534247	231				365	
bovine_dairy_replacement_ youngbull	DC_UNDEFINED	387	700	0.857534247	544				365	
bovine_dairy_fattening_calf_forslaughter	DC_MAIZE_HIGH	74	221	1.348623853	148			57	109	109
bovine_dairy_fattening_calf	DC_MAIZE_HIGH	74	497.932292	1.161458333	286				365	0
bovine_dairy_fattening_heifer_forslaugther	DC_MAIZE_HIGH	497.932292	520	1.161458333	509			57	19	384
bovine_dairy_fattening_heifer	DC_MAIZE_HIGH	221	517.272265	0.811704835	369				365	0
bovine_dairy_fattening_heifer2_forslaughter	DC_MAIZE_HIGH	517.272265	540	0.811704835	529				28	0
bovine_dairy_fattening_youngbull_forslaughter	DC_MAIZE_HIGH	74	520	1.161458333	297			57	19	384
bovine_dairy_fattening_calf_forslaughter	DC_MAIZE_PG	74	221	1.348623853	148			57	109	109
bovine_dairy_fattening_calf	DC_MAIZE_PG	74	497.932292	1.161458333	286				365	0
bovine_dairy_fattening_heifer_forslaugther	DC_MAIZE_PG	497.932292	520	1.161458333	509			57	19	384
bovine_dairy_fattening_heifer	DC_MAIZE_PG	221	517.272265	0.811704835	369				365	0
bovine_dairy_fattening_heifer2_forslaughter	DC_MAIZE_PG	517.272265	540	0.811704835	529				28	0
bovine_dairy_fattening_youngbull_forslaughter	DC_MAIZE_PG	74	520	1.161458333	297			57	19	384
bovine_dairy_fattening_calf_forslaughter	DC_MAIZE_TG	74	221	1.348623853	148			57	109	109
bovine_dairy_fattening_calf	DC_MAIZE_TG	74	497.932292	1.161458333	286				365	0
bovine_dairy_fattening_heifer_forslaugther	DC_MAIZE_TG	497.932292	520	1.161458333	509			57	19	384

bovine_dairy_fattening_heifer	DC_MAIZE_TG	221	517.272265	0.811704835	369				365	0
bovine_dairy_fattening_heifer2_forslaughter	DC_MAIZE_TG	517.272265	540	0.811704835	529				28	0
bovine_dairy_fattening_youngbull_forslaughter	DC_MAIZE_TG	74	520	1.161458333	297			57	19	384
bovine_dairy_fattening_calf_forslaughter	DC_TG	74	221	1.348623853	148			57	109	109
bovine_dairy_fattening_calf	DC_TG	74	497.932292	1.161458333	286				365	0
bovine_dairy_fattening_heifer_forslaugther	DC_TG	497.932292	520	1.161458333	509			57	19	384
bovine_dairy_fattening_heifer	DC_TG	221	517.272265	0.811704835	369				365	0
bovine_dairy_fattening_heifer2_forslaughter	DC_TG	517.272265	540	0.811704835	529				28	0
bovine_dairy_fattening_youngbull_forslaughter	DC_TG	74	520	1.161458333	297			57	19	384
bovine_dairy_fattening_calf_forslaughter	DC_MAIZE_MIX	74	221	1.348623853	148			57	109	109
bovine_dairy_fattening_calf	DC_MAIZE_MIX	74	497.932292	1.161458333	286				365	0
bovine_dairy_fattening_heifer_forslaugther	DC_MAIZE_MIX	497.932292	520	1.161458333	509			57	19	384
bovine_dairy_fattening_heifer	DC_MAIZE_MIX	221	517.272265	0.811704835	369				365	0
bovine_dairy_fattening_heifer2_forslaughter	DC_MAIZE_MIX	517.272265	540	0.811704835	529				28	0
bovine_dairy_fattening_youngbull_forslaughter	DC_MAIZE_MIX	74	520	1.161458333	297			57	19	384
bovine_dairy_fattening_calf_forslaughter	DC_GRASS_NIT	74	221	1.348623853	148			57	109	109
bovine_dairy_fattening_calf	DC_GRASS_NIT	74	497.932292	1.161458333	286				365	0

bovine_dairy_fattening_heifer_forslaugther	DC_GRASS_NIT	497.932292	520	1.161458333	509			57	19	384
bovine_dairy_fattening_heifer	DC_GRASS_NIT	221	517.272265	0.811704835	369				365	0
bovine_dairy_fattening_heifer2_forslaughter	DC_GRASS_NIT	517.272265	540	0.811704835	529				28	0
bovine_dairy_fattening_youngbull_forslaughter	DC_GRASS_NIT	74	520	1.161458333	297			57	19	384
bovine_dairy_fattening_calf_forslaughter	DC_GRASS_LARGE	74	221	1.348623853	148			57	109	109
bovine_dairy_fattening_calf	DC_GRASS_LARGE	74	497.932292	1.161458333	286				365	0
bovine_dairy_fattening_heifer_forslaugther	DC_GRASS_LARGE	497.932292	520	1.161458333	509			57	19	384
bovine_dairy_fattening_heifer	DC_GRASS_LARGE	221	517.272265	0.811704835	369				365	0
bovine_dairy_fattening_heifer2_forslaughter	DC_GRASS_LARGE	517.272265	540	0.811704835	529				28	0
bovine_dairy_fattening_youngbull_forslaughter	DC_GRASS_LARGE	74	520	1.161458333	297			57	19	384
bovine_dairy_fattening_heifer	DC_GRASS_SEM	221	517.272265	0.811704835	369				365	0
bovine_dairy_fattening_heifer2_forslaughter	DC_GRASS_SEM	517.272265	540	0.811704835	529				28	0
bovine_dairy_fattening_youngbull_forslaughter	DC_GRASS_SEM	74	520	1.161458333	297			57	19	384
bovine_dairy_fattening_calf_forslaughter	DC_GRASS_SEM	74	221	1.348623853	148			57	109	109
bovine_dairy_fattening_calf	DC_GRASS_SEM	74	497.932292	1.161458333	286				365	0
bovine_dairy_fattening_heifer_forslaugther	DC_GRASS_SEM	497.932292	520	1.161458333	509			57	19	384
bovine_dairy_fattening_heifer	DC_MOUNTAIN	221	559.066158	0.926208651	390				365	0

bovine_dairy_fattening_heifer2_forslaughter	DC_MOUNTAIN	559.066158	585	0.926208651	572			57	28	0
bovine_dairy_fattening_youngbull_forslaughter	DC_MOUNTAIN	74	520	1.161458333	297			52	19	384
bovine_dairy_fattening_calf_forslaughter	DC_MOUNTAIN	74	221	1.348623853	148			57	109	109
bovine_dairy_fattening_calf	DC_MOUNTAIN	74	497.932292	1.161458333	286				365	0
bovine_dairy_fattening_heifer_forslaugther	DC_MOUNTAIN	497.932292	520	1.161458333	509			57	19	384
bovine_dairy_fattening_heifer	DC_MED_INT	221	600.860051	1.040712468	411				365	0
bovine_dairy_fattening_heifer2_forslaughter	DC_MED_INT	600.860051	630	1.040712468	615			57	28	0
bovine_dairy_fattening_youngbull_forslaughter	DC_MED_INT	74	520	1.161458333	297			52	19	384
bovine_dairy_fattening_calf_forslaughter	DC_MED_INT	74	221	1.348623853	148			57	109	109
bovine_dairy_fattening_calf	DC_MED_INT	74	497.932292	1.161458333	286				365	0
bovine_dairy_fattening_heifer_forslaugther	DC_MED_INT	497.932292	520	1.161458333	509			57	19	384
bovine_dairy_fattening_heifer	DC_MED_PROF	221	600.860051	1.040712468	411				365	0
bovine_dairy_fattening_heifer2_forslaughter	DC_MED_PROF	600.860051	630	1.040712468	615			57	28	0
bovine_dairy_fattening_youngbull_forslaughter	DC_MED_PROF	74	520	1.161458333	297			52	19	384
bovine_dairy_fattening_calf_forslaughter	DC_MED_PROF	74	221	1.348623853	148			57	109	109
bovine_dairy_fattening_calf	DC_MED_PROF	74	497.932292	1.161458333	286				365	0
bovine_dairy_fattening_heifer_forslaugther	DC_MED_PROF	497.932292	520	1.161458333	509			57	19	384

bovine_dairy_fattening_heifer	DC_MED_SMALL	221	559.066158	0.926208651	390				365	0
bovine_dairy_fattening_heifer2_forslaughter	DC_MED_SMALL	559.066158	585	0.926208651	572			57	28	0
bovine_dairy_fattening_youngbull_forslaughter	DC_MED_SMALL	74	520	1.161458333	297			52	19	384
bovine_dairy_fattening_calf_forslaughter	DC_MED_SMALL	74	221	1.348623853	148			57	109	109
bovine_dairy_fattening_calf	DC_MED_SMALL	74	497.932292	1.161458333	286				365	0
bovine_dairy_fattening_heifer_forslaugther	DC_MED_SMALL	497.932292	520	1.161458333	509			57	19	384
bovine_dairy_fattening_heifer	DC_SUBS	221	517.272265	0.811704835	369				365	0
bovine_dairy_fattening_heifer2_forslaughter	DC_SUBS	517.272265	540	0.811704835	529				28	0
bovine_dairy_fattening_youngbull_forslaughter	DC_SUBS	74	520	1.161458333	297			57	19	384
bovine_dairy_fattening_calf_forslaughter	DC_SUBS	74	221	1.348623853	148			57	109	109
bovine_dairy_fattening_calf	DC_SUBS	74	497.932292	1.161458333	286				365	0
bovine_dairy_fattening_heifer_forslaugther	DC_SUBS	497.932292	520	1.161458333	509			57	19	384
bovine_dairy_fattening_heifer	DC_UNDEFINED	221	517.272265	0.811704835	369				365	0
bovine_dairy_fattening_heifer2_forslaughter	DC_UNDEFINED	517.272265	540	0.811704835	529				28	0
bovine_dairy_fattening_youngbull_forslaughter	DC_UNDEFINED	74	520	1.161458333	297			57	19	384
bovine_dairy_fattening_calf_forslaughter	DC_UNDEFINED	74	221	1.348623853	148			57	109	109
bovine_dairy_fattening_calf	DC_UNDEFINED	74	497.932292	1.161458333	286				365	0

bovine_dairy_fattening_heifer_forslaugther	DC_UNDEFINED	497.932292	520	1.161458333	509			57	19	384
bovine_dairy_fattening_heifer	DC_UNDEFINED	221	517.272265	0.811704835	369				365	0
bovine_dairy_bull	DC_MAIZE_HIGH	700	700	0	700			54	365	
bovine_dairy_bull	DC_MAIZE_PG	700	700	0	700			54	365	
bovine_dairy_bull	DC_MAIZE_TG	700	700	0	700			54	365	
bovine_dairy_bull	DC_TG	700	700	0	700			54	365	
bovine_dairy_bull	DC_MAIZE_MIX	700	700	0	700			54	365	
bovine_dairy_bull	DC_GRASS_NIT	700	700	0	700			54	365	
bovine_dairy_bull	DC_GRASS_LARGE	700	700	0	700			54	365	
bovine_dairy_bull	DC_GRASS_SEM	700	700	0	700			54	365	
bovine_dairy_bull	DC_MOUNTAIN	700	700	0	700			54	365	
bovine_dairy_bull	DC_MED_INT	700	700	0	700			54	365	
bovine_dairy_bull	DC_MED_PROF	700	700	0	700			54	365	
bovine_dairy_bull	DC_MED_SMALL	700	700	0	700			54	365	
bovine_dairy_bull	DC_UNDEFINED	700	700	0	700			54	365	

7.2 Suckler cattle production characteristics

SOL_name	system	**start_weight**	**end_weight**	**weight gain**	**alive_weight**	**milk_yield**	**dressing**	**days in system**
bovine_suckler_cow	SC_MOUNTAIN	650	650	0	650	2500	52	365
bovine_suckler_cow	SC_PG_SMALL	650	650	0	650	2500	52	365
bovine_suckler_cow	SC_PG_LARGE	650	650	0	650	2500	52	365
bovine_suckler_cow	SC_MED1	650	650	0	650	2500	52	365
bovine_suckler_cow	SC_MED2	650	650	0	650	2500	52	365
bovine_suckler_cow	SC_MED3	650	650	0	650	2500	52	365
bovine_suckler_cow	SC_TG	650	650	0	650	2500	52	365
bovine_suckler_cow	SC_MAIZE_TG	650	650	0	650	2500	52	365
bovine_suckler_cow	SC_MAIZE_BEET	650	650	0	650	2500	52	365
bovine_suckler_cow	SC_UNDEFINED	650	650	0	650	2500	53	365
bovine_suckler_replacement_calf_female	SC_MOUNTAIN	50	350	0.82191781	200			365
bovine_suckler_replacement_heifer	SC_MOUNTAIN	350	650	0.82191781	500			365
bovine_suckler_replacement_heifer2	SC_MOUNTAIN	650	650	#DIV/0!	650			0
bovine_suckler_replacement_calf_male	SC_MOUNTAIN	74	437	0.99452055	256			365
bovine_suckler_replacement_youngmale	SC_MOUNTAIN	437	800	0.99452055	619			365
bovine_suckler_replacement_calf_female	SC_PG_SMALL	74	362	0.7890411	218			365
bovine_suckler_replacement_heifer	SC_PG_SMALL	362	650	0.7890411	506			365
bovine_suckler_replacement_heifer2	SC_PG_SMALL	650	650	#DIV/0!	650			0
bovine_suckler_replacement_calf_male	SC_PG_SMALL	74	437	0.99452055	256			365
bovine_suckler_replacement_youngmale	SC_PG_SMALL	437	800	0.99452055	619			365
bovine_suckler_replacement_calf_female	SC_PG_LARGE	74	362	0.7890411	218			365
bovine_suckler_replacement_heifer	SC_PG_LARGE	362	650	0.7890411	506			365

bovine_suckler_replacement_heifer2	SC_PG_LARGE	650	650	#DIV/0!	650			0
bovine_suckler_replacement_calf_male	SC_PG_LARGE	74	437	0.99452055	256			365
bovine_suckler_replacement_youngmale	SC_PG_LARGE	437	800	0.99452055	619			365
bovine_suckler_replacement_calf_female	SC_MED1	74	362	0.7890411	218			365
bovine_suckler_replacement_heifer	SC_MED1	362	650	0.7890411	506			365
bovine_suckler_replacement_heifer2	SC_MED1	650	650	#DIV/0!	650			0
bovine_suckler_replacement_calf_male	SC_MED1	74	437	0.99452055	256			365
bovine_suckler_replacement_youngmale	SC_MED1	437	800	0.99452055	619			365
bovine_suckler_replacement_calf_female	SC_MED2	74	362	0.7890411	218			365
bovine_suckler_replacement_heifer	SC_MED2	362	650	0.7890411	506			365
bovine_suckler_replacement_heifer2	SC_MED2	650	650	#DIV/0!	650			0
bovine_suckler_replacement_calf_male	SC_MED2	74	437	0.99452055	256			365
bovine_suckler_replacement_youngmale	SC_MED2	437	800	0.99452055	619			365
bovine_suckler_replacement_calf_female	SC_MED3	74	362	0.7890411	218			365
bovine_suckler_replacement_heifer	SC_MED3	362	650	0.7890411	506			365
bovine_suckler_replacement_heifer2	SC_MED3	650	650	#DIV/0!	650			0
bovine_suckler_replacement_calf_male	SC_MED3	74	437	0.99452055	256			365
bovine_suckler_replacement_youngmale	SC_MED3	437	800	0.99452055	619			365
bovine_suckler_replacement_calf_female	SC_TG	74	362	0.7890411	218			365
bovine_suckler_replacement_heifer	SC_TG	362	650	0.7890411	506			365
bovine_suckler_replacement_heifer2	SC_TG	650	650	#DIV/0!	650			0
bovine_suckler_replacement_calf_male	SC_TG	74	437	0.99452055	256			365
bovine_suckler_replacement_youngmale	SC_TG	437	800	0.99452055	619			365
bovine_suckler_replacement_calf_female	SC_MAIZE_TG	74	362	0.7890411	218			365
bovine_suckler_replacement_heifer	SC_MAIZE_TG	362	650	0.7890411	506			365
bovine_suckler_replacement_heifer2	SC_MAIZE_TG	650	650	#DIV/0!	650			0

bovine_suckler_replacement_calf_male	SC_MAIZE_TG	74	437	0.99452055	256			365
bovine_suckler_replacement_youngmale	SC_MAIZE_TG	437	800	0.99452055	619			365
bovine_suckler_replacement_calf_female	SC_MAIZE_BEET	74	362	0.7890411	218			365
bovine_suckler_replacement_heifer	SC_MAIZE_BEET	362	650	0.7890411	506			365
bovine_suckler_replacement_heifer2	SC_MAIZE_BEET	650	650	#DIV/0!	650			0
bovine_suckler_replacement_calf_male	SC_MAIZE_BEET	74	437	0.99452055	256			365
bovine_suckler_replacement_youngmale	SC_MAIZE_BEET	437	800	0.99452055	619			365
bovine_suckler_replacement_calf_female	SC_UNDEFINED	74	362	0.7890411	218			365
bovine_suckler_replacement_heifer	SC_UNDEFINED	362	650	0.7890411	506			365
bovine_suckler_replacement_heifer2	SC_UNDEFINED	650	650	#DIV/0!	650			0
bovine_suckler_replacement_calf_male	SC_UNDEFINED	74	437	0.99452055	256			365
bovine_suckler_replacement_youngmale	SC_UNDEFINED	437	800	0.99452055	619			365
bovine_suckler_fattening_calf_forslaughter	SC_MOUNTAIN	50	418	1.22666667	234		57	300
bovine_suckler_fattening_calf	SC_MOUNTAIN	50	470	1.15068493	260			365
bovine_suckler_fattening_heifer_forslaughter	SC_MOUNTAIN	470	508.9038	0.8	489		57	209
bovine_suckler_fattening_heifer	SC_MOUNTAIN	470	634	0.8	552			365
bovine_suckler_fattening_heifer2_forslaughter	SC_MOUNTAIN	634	666	0.8	650		57	40
bovine_suckler_fattening_youngmale_forslaughter	SC_MOUNTAIN	470	508.9038	0.8	489		57	209
bovine_suckler_fattening_calf_forslaughter	SC_PG_SMALL	50	418	1.22666667	234		57	300
bovine_suckler_fattening_calf	SC_PG_SMALL	50	470	1.15068493	260			365
bovine_suckler_fattening_heifer_forslaughter	SC_PG_SMALL	470	466.3439	0.8	468		57	155
bovine_suckler_fattening_heifer	SC_PG_SMALL	470	634	0.8	552			365
bovine_suckler_fattening_heifer2_forslaughter	SC_PG_SMALL	634	666	0.8	650		57	40
bovine_suckler_fattening_youngmale_forslaughter	SC_PG_SMALL	470	466.3439	0.8	468		57	155
bovine_suckler_fattening_calf_forslaughter	SC_PG_LARGE	50	418	1.22666667	234		57	300
bovine_suckler_fattening_calf	SC_PG_LARGE	50	470	1.15068493	260			365

bovine_suckler_fattening_heifer_forslaughter	SC_PG_LARGE	470	466.3439	0.8	468		57	155
bovine_suckler_fattening_heifer	SC_PG_LARGE	470	634	0.8	552			365
bovine_suckler_fattening_heifer2_forslaughter	SC_PG_LARGE	634	666	0.8	650		57	40
bovine_suckler_fattening_youngmale_forslaughter	SC_PG_LARGE	470	466.3439	0.8	468		57	155
bovine_suckler_fattening_calf_forslaughter	SC_MED1	50	418	1.22666667	234		57	300
bovine_suckler_fattening_calf	SC_MED1	50	496	1.22191781	273			365
bovine_suckler_fattening_heifer_forslaughter	SC_MED1	496	587.1774	1.2	542		57	83
bovine_suckler_fattening_heifer	SC_MED1	496	634	0.8	565			365
bovine_suckler_fattening_heifer2_forslaughter	SC_MED1	634	666	0.8	650		57	40
bovine_suckler_fattening_youngmale_forslaughter	SC_MED1	496	587.1774	1.2	542		57	83
bovine_suckler_fattening_calf_forslaughter	SC_MED2	50	418	1.22666667	234		57	300
bovine_suckler_fattening_calf	SC_MED2	50	470	1.15068493	260			365
bovine_suckler_fattening_heifer_forslaughter	SC_MED2	470	513.1005	0.8	492		57	214
bovine_suckler_fattening_heifer	SC_MED2	470	634	0.8	552			365
bovine_suckler_fattening_heifer2_forslaughter	SC_MED2	634	666	0.8	650		57	40
bovine_suckler_fattening_youngmale_forslaughter	SC_MED2	470	513.1005	0.8	492		57	214
bovine_suckler_fattening_calf_forslaughter	SC_MED3	50	418	1.22666667	234		57	300
bovine_suckler_fattening_calf	SC_MED3	50	470	1.15068493	260			365
bovine_suckler_fattening_heifer_forslaughter	SC_MED3	470	444.8244	0.8	457		57	129
bovine_suckler_fattening_heifer	SC_MED3	470	634	0.8	552			365
bovine_suckler_fattening_heifer2_forslaughter	SC_MED3	634	666	0.8	650		57	40
bovine_suckler_fattening_youngmale_forslaughter	SC_MED3	470	444.8244	0.8	457		57	129
bovine_suckler_fattening_calf_forslaughter	SC_TG	50	418	1.22666667	234		57	300
bovine_suckler_fattening_calf	SC_TG	50	496	1.22191781	273			365
bovine_suckler_fattening_heifer_forslaughter	SC_TG	496	587.1774	1.2	542		57	83
bovine_suckler_fattening_heifer	SC_TG	496	634	0.8	565			365

bovine_suckler_fattening_heifer2_forslaughter	SC_TG	634	666	0.8	650		57	40
bovine_suckler_fattening_youngmale_forslaughter	SC_TG	496	587.1774	1.2	542		57	83
bovine_suckler_fattening_calf_forslaughter	SC_MAIZE_TG	50	418	1.22666667	234		57	300
bovine_suckler_fattening_calf	SC_MAIZE_TG	50	496	1.22191781	273			365
bovine_suckler_fattening_heifer_forslaughter	SC_MAIZE_TG	496	654.9038	1.2	575		57	139
bovine_suckler_fattening_heifer	SC_MAIZE_TG	496	634	0.8	565			365
bovine_suckler_fattening_heifer2_forslaughter	SC_MAIZE_TG	634	666	0.8	650		57	40
bovine_suckler_fattening_youngmale_forslaughter	SC_MAIZE_TG	496	654.9038	1.2	575		57	139
bovine_suckler_fattening_calf_forslaughter	SC_MAIZE_BEET	50	418	1.22666667	234		57	300
bovine_suckler_fattening_calf	SC_MAIZE_BEET	50	496	1.22191781	273			365
bovine_suckler_fattening_heifer_forslaughter	SC_MAIZE_BEET	496	654.9038	1.2	575		57	139
bovine_suckler_fattening_heifer	SC_MAIZE_BEET	496	634	0.8	565			365
bovine_suckler_fattening_heifer2_forslaughter	SC_MAIZE_BEET	634	666	0.8	650		57	40
bovine_suckler_fattening_youngmale_forslaughter	SC_MAIZE_BEET	496	654.9038	1.2	575		57	139
bovine_suckler_fattening_calf_forslaughter	SC_UNDEFINED	50	418	1.22666667	234		57	300
bovine_suckler_fattening_calf	SC_UNDEFINED	50	483	1.18630137	267		0	365
bovine_suckler_fattening_heifer_forslaughter	SC_UNDEFINED	483	560.040477	1	522		57	145
bovine_suckler_fattening_heifer	SC_UNDEFINED	483	634	0.8	559		0	365
bovine_suckler_fattening_heifer2_forslaughter	SC_UNDEFINED	634	666	0.8	650		57	365
bovine_suckler_fattening_youngmale_forslaughter	SC_UNDEFINED	483	560.040477	1	522		57	365
bovine_suckler_steer	SC_MOUNTAIN	800	800	0	800		54	365
bovine_suckler_steer	SC_PG_SMALL	800	800	0	800		54	365
bovine_suckler_steer	SC_PG_LARGE	800	800	0	800		54	365
bovine_suckler_steer	SC_MED1	800	800	0	800		54	365
bovine_suckler_steer	SC_MED2	800	800	0	800		54	365
bovine_suckler_steer	SC_MED3	800	800	0	800		54	365

bovine_suckler_steer	SC_TG	800	800	0	800		54	365
bovine_suckler_steer	SC_MAIZE_TG	800	800	0	800		54	365
bovine_suckler_steer	SC_MAIZE_BEET	800	800	0	800		54	365
bovine_suckler_steer	SC_UNDEFINED	800	800	0	800		54	365

7.3 Dairy feed ratio

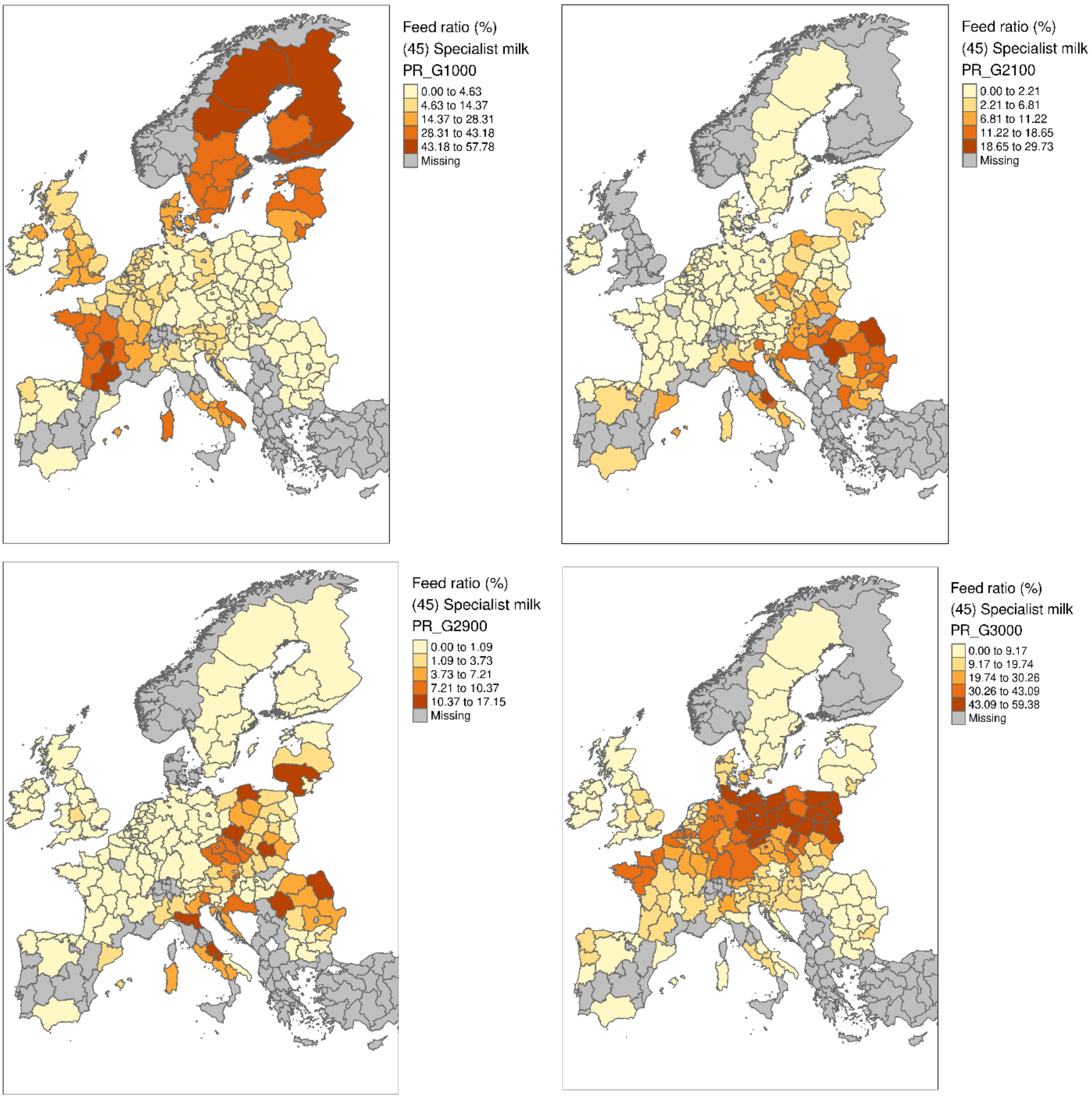

Figure 14 : dairy feed ratio temporary grasslands (G1000) top left, alfalfa (G2100) top right, other leguminous plants harvested green (G2900) bottom left, and maize harvested green (G3000) bottom right

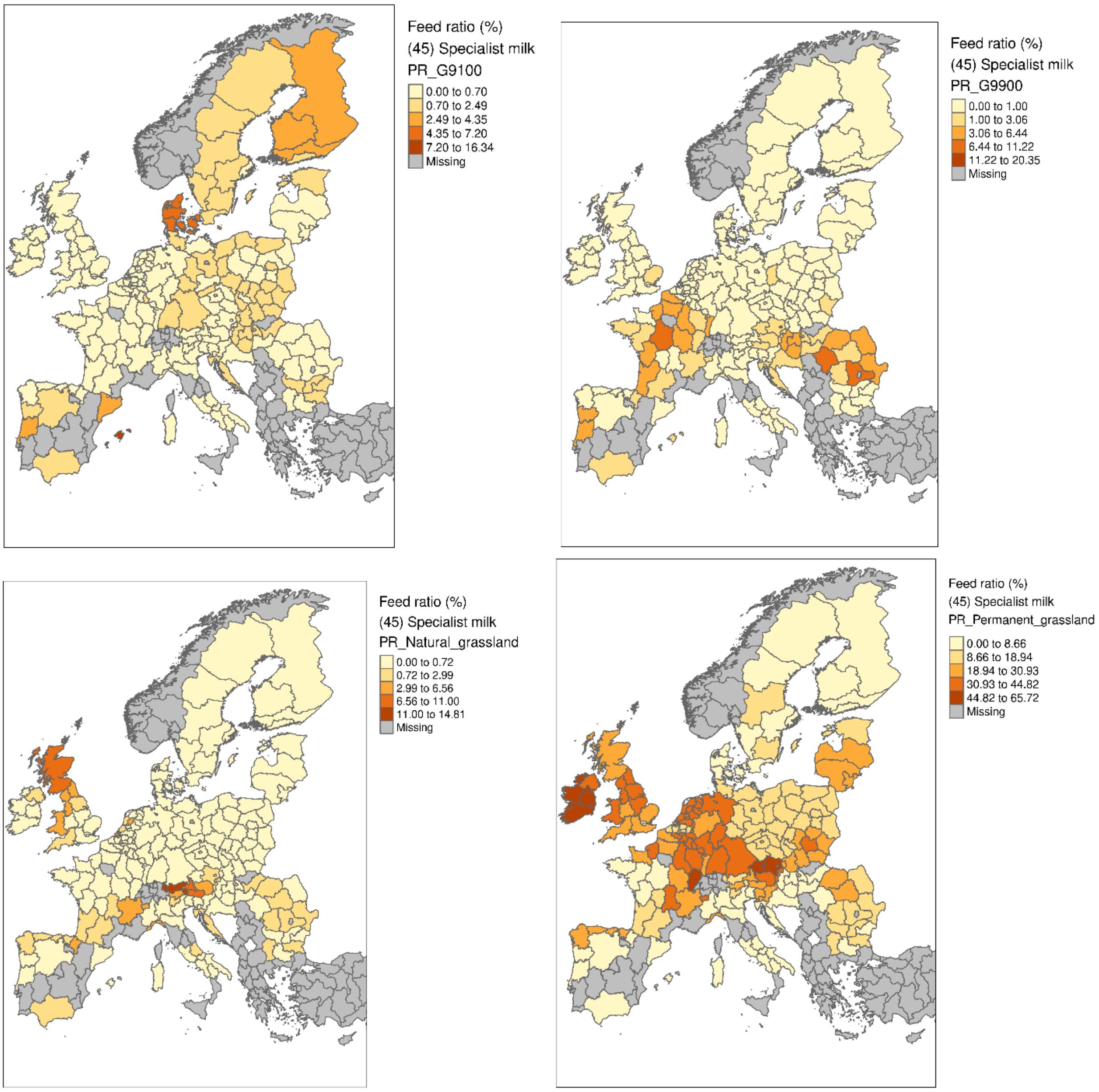

Figure 15 : dairy feed ratio other cereals harvested green (excluding green maize) (G9100) top left, other plants harvested green from arable land (G9900) top right, natural permanent grasslands bottom left, and managed permanent grasslands bottom right

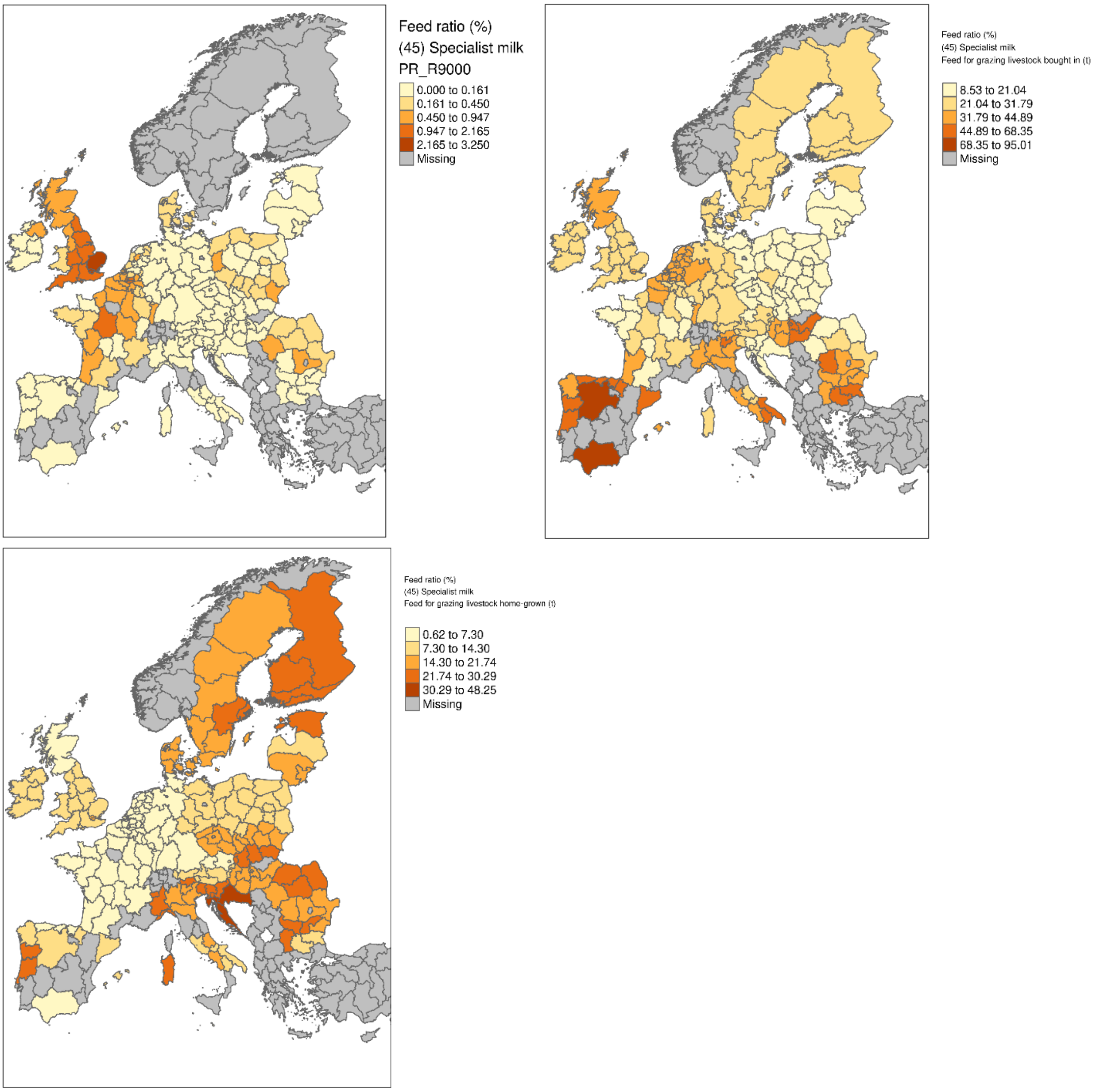

Figure 16 : dairy feed ratio other fodder root (R9000) top left, bough in concentrate (top right), home-grown concentrate (bottom left).

7.4 Other cattle feed ratio

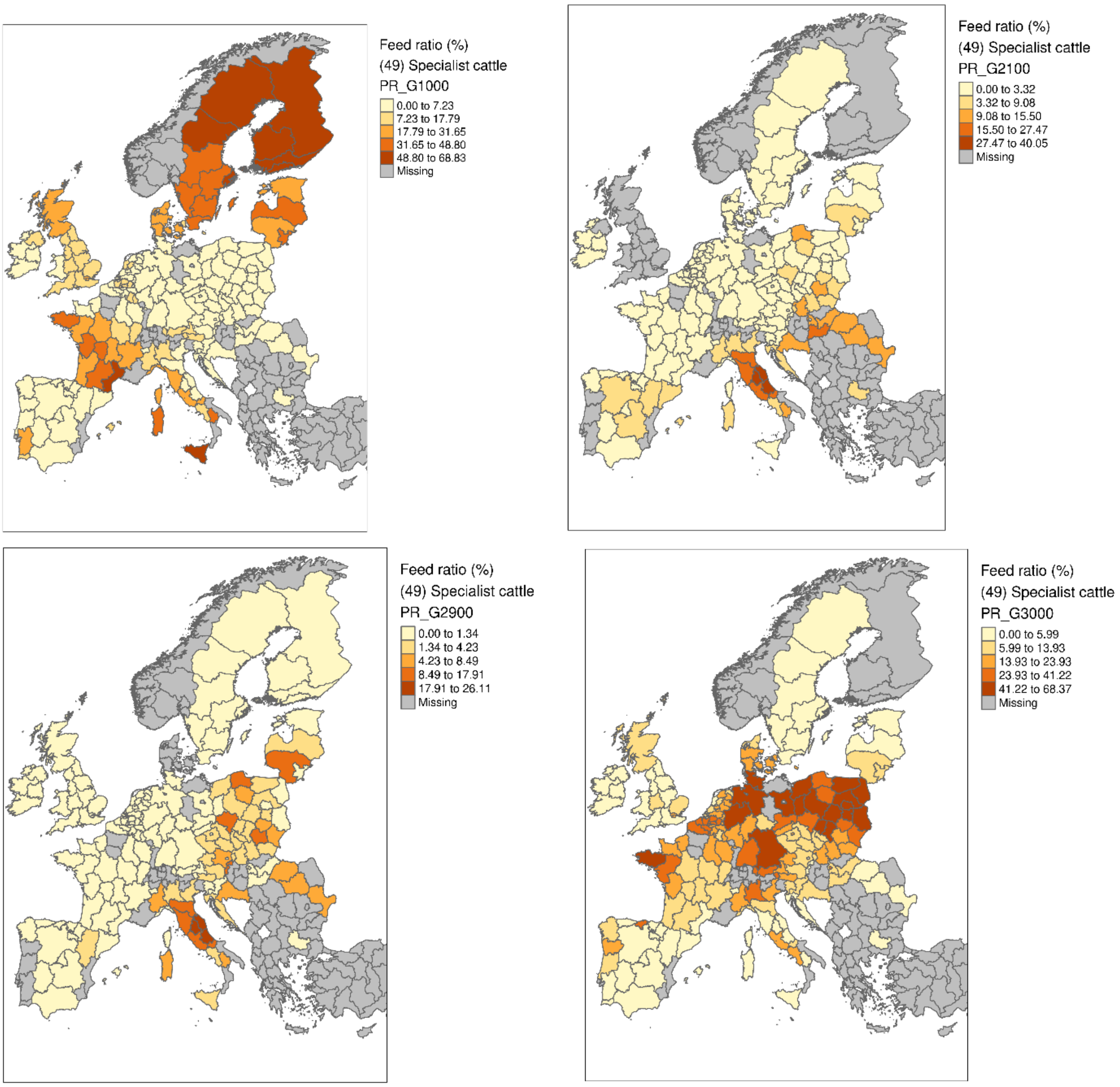

Figure 17 : other cattle feed ratio temporary grasslands (G1000) top left, alfalfa (G2100) top right, other leguminous plants harvested green (G2900) bottom left, and maize harvested green (G3000) bottom right

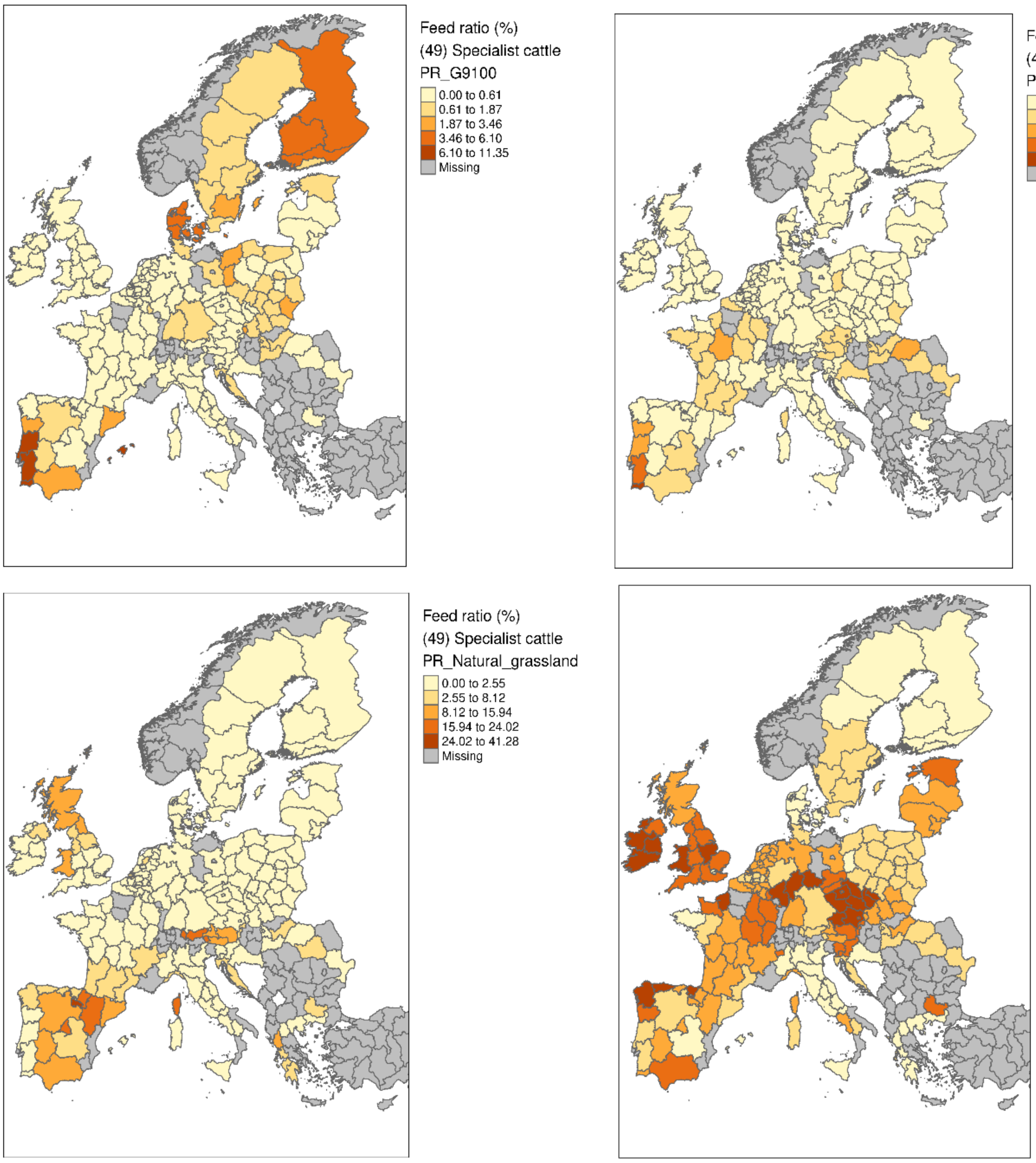

Figure 18 : other cattle feed ratio other cereals harvested green (excluding green maize) (G9100) top left, other plants harvested green from arable land (G9900) top right, natural permanent grasslands bottom left, and managed permanent grasslands bottom right

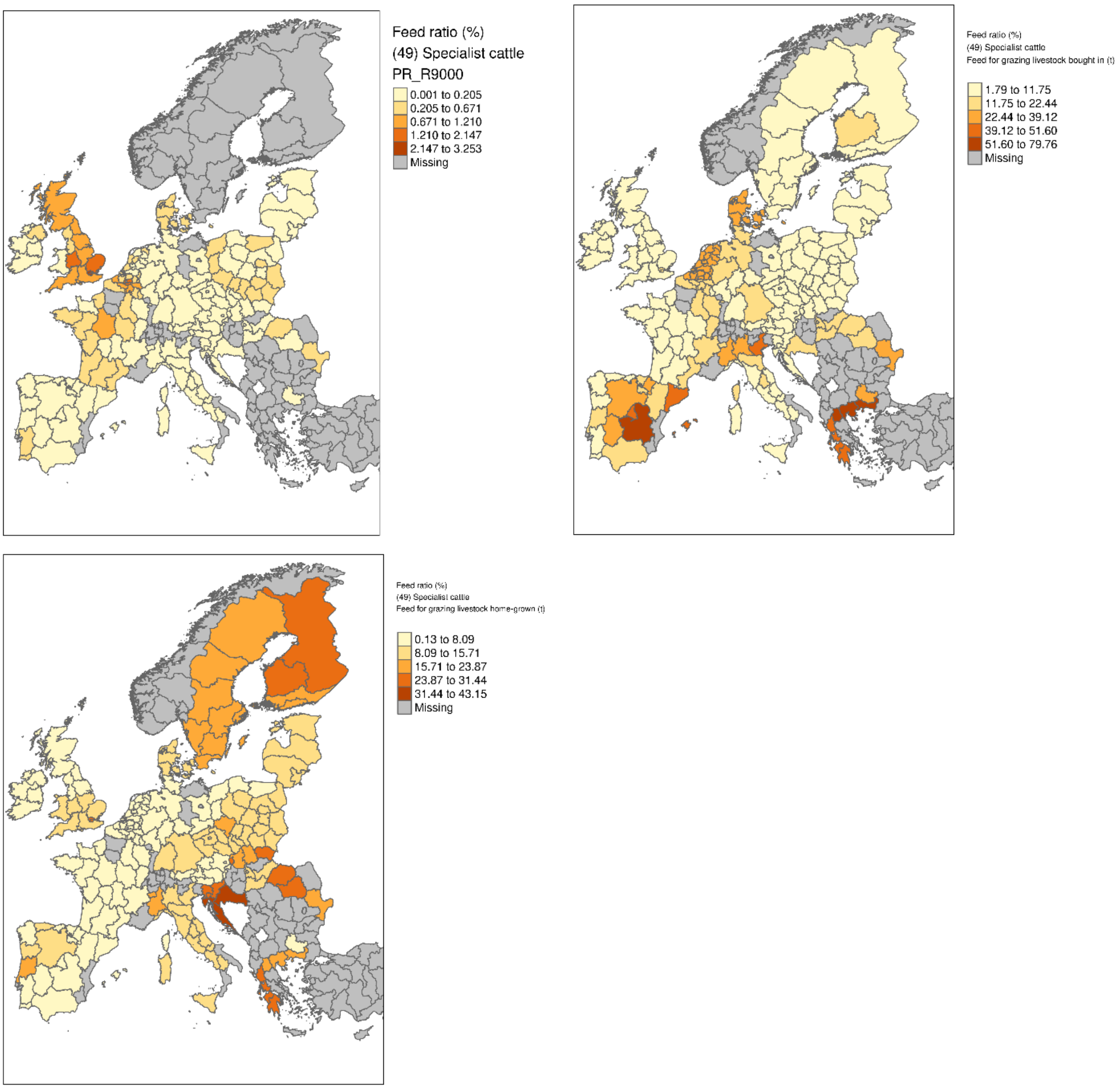

Figure 19 : other cattle feed ratio other fodder root (R9000) top left, bough in concentrate (top right), home-grown concentrate (bottom left).

7.5 Sheep and goat feed ratio

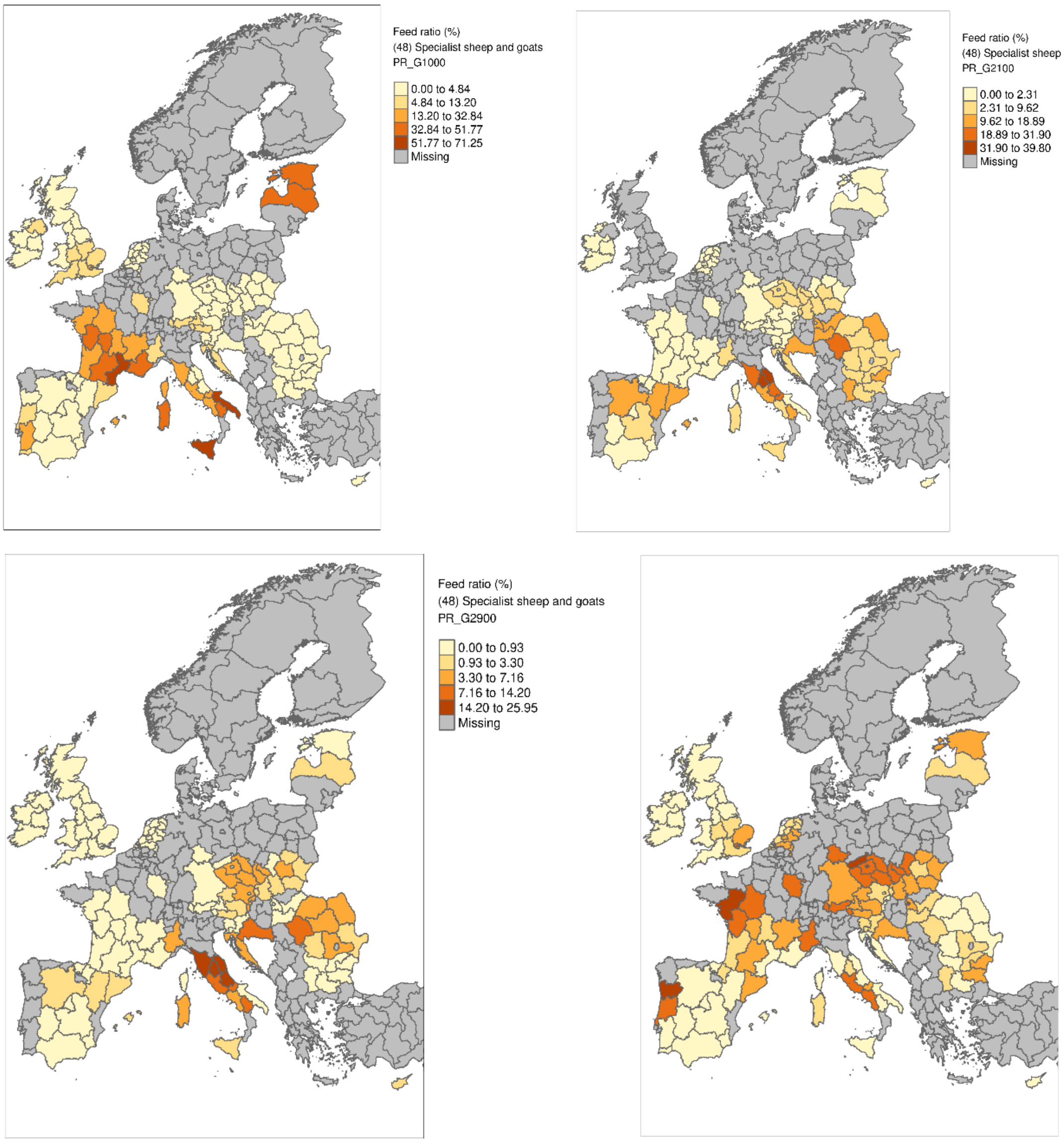

Figure 20: sheep and goat feed ratio temporary grasslands (G1000) top left, alfalfa (G2100) top right, other leguminous plants harvested green (G2900) bottom left, and maize harvested green (G3000) bottom right

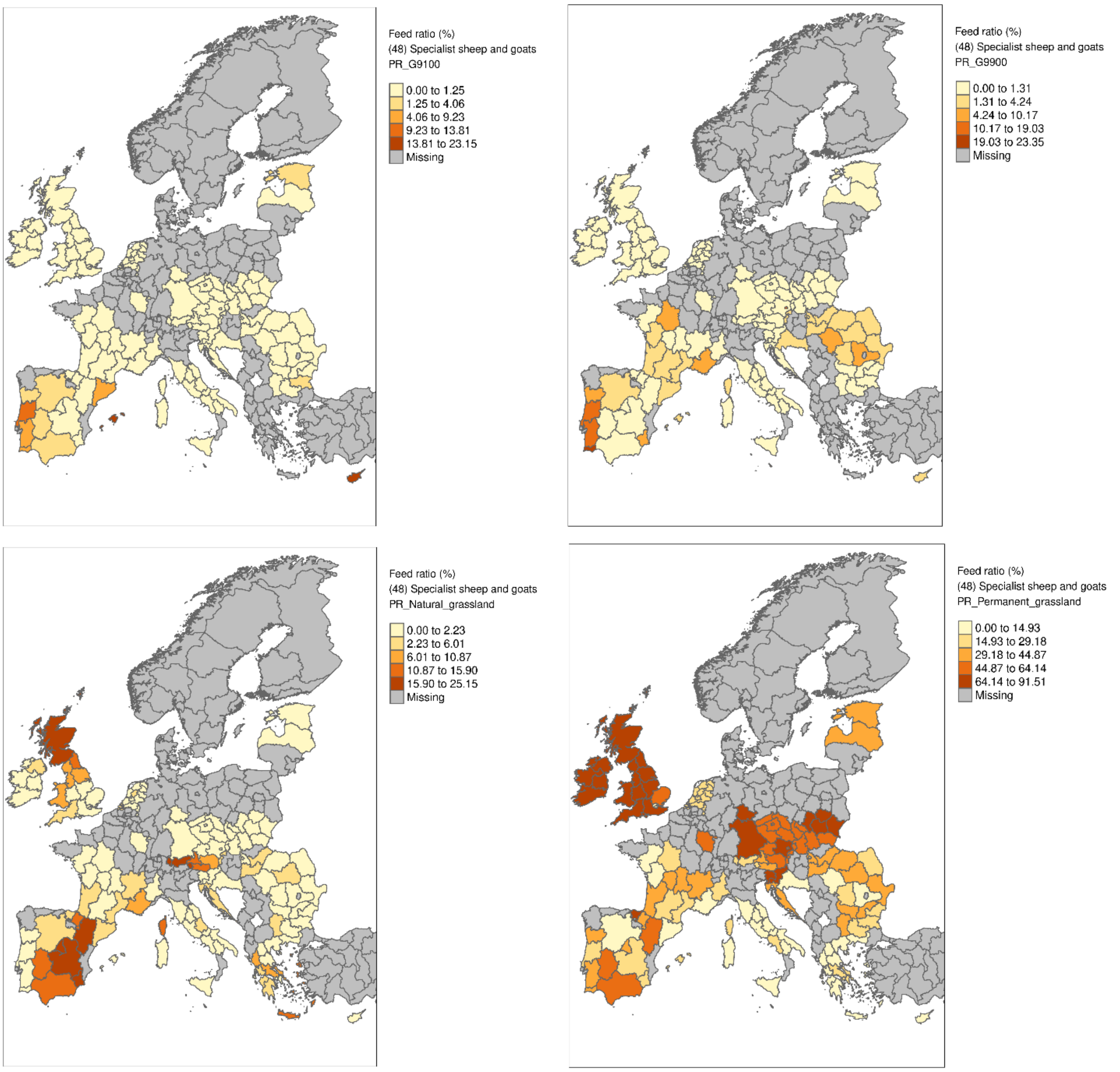

Figure 21 : sheep and goat feed ratio other cereals harvested green (excluding green maize) (G9100) top left, other plants harvested green from arable land (G9900) top right, natural permanent grasslands bottom left, and managed permanent grasslands bottom right

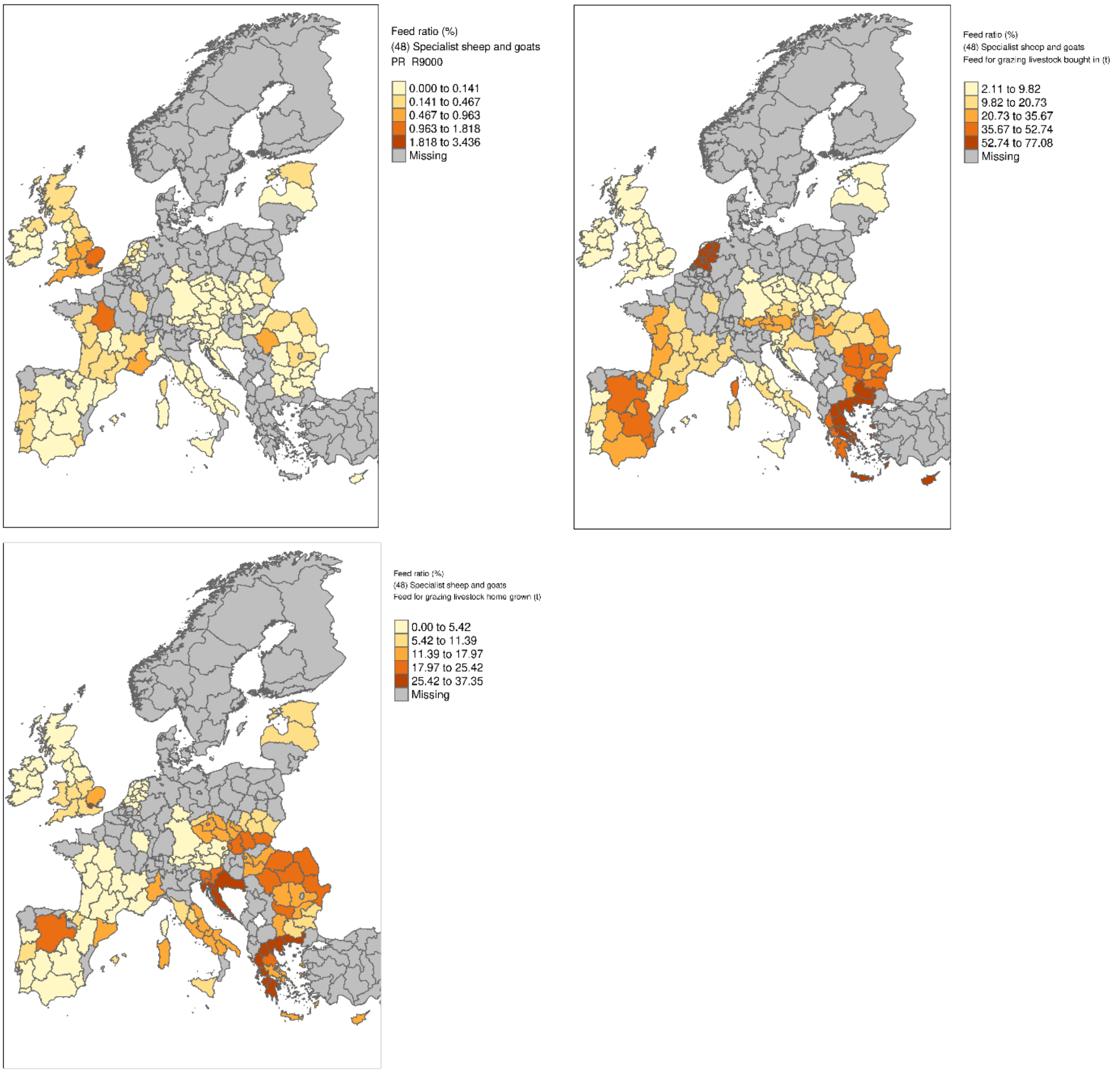

Figure 22 : dairy feed ratio other fodder root (R9000) top left, bough in concentrate (top right), home-grown concentrate (bottom left).