Enhanced modelling of sustainable food and nutrition security: food consumption and nutrition behaviour of European households

Deliverable No. D9.2

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SUSFANS DELIVERABLES

This deliverable describes the enhanced modelling of food consumption and nutrition behaviour under constraints with a focus on European households and population health impacts of changes in diets. The demand side enhancements enable the analysis of SFNS over time and in response to (policy) shocks.

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TABLE OF CONTENT

DELIVERABLE SHORT SUMMARY FOR USE IN MEDIA

Assessing European diets in terms of sustainability and nutrition, the ambition of SUSFANS, takes on two major global challenges. With effects of climate change and unhealthy eating patterns becoming increasingly visible so does the need for interventions by government or other actors in the food supply chain. Marginal changes in the current food system will not suffice, therefore SUSFANS employs a set of well-established long run models (CAPRI, GLOBIOM and MAGNET) to explore leverage points for interventions addressing both sustainability and nutrition of consumption and its upstream implications in the food system, i.e. from fork to farm. To further enhance their ability to address the implications of European diets the long run models are further developed in the course of SUSFANS.

This report focuses on enhancements of MAGNET to better capture consumer demand in three major directions. First we focus on increasing socio-economic detail of consumers. We introduce two different types of households for the Czech Republic. Lacking the necessary data to do the same for the other three focus countries (Denmark, France and Italy) we outline an approach to use detailed micro level data either to define multiple representative households or for a direct link from the macro variables in MAGNET to micro level impacts. This connection will be developed further when building a link between MAGNET and the micro level diet model SHARP in upcoming SUSFANS work.

In the second part we switch from consumers to products, describing an increased differentiation of meat and fish products in the MAGNET database. This additional detail now allows a distinction between red and white meat, both in consumption and production systems. Furthermore detail has been added by splitting aquaculture and fish processing into dedicated sectors. Again this enhances the ability of MAGNET to capture diverging impacts of consumer purchases - increasing fish consumption (as is often recommended from a health perspective) through aquaculture has very different sustainability and resource implications than increasing wild catch fish.

Although the increased household and product detail improves MAGNET's capacity to analyse implications of changes in consumer demand, diet assessments require more detail than usefully included in a macro-economic model like MAGNET. The third and last part therefore focuses on connecting

MAGNET to a much more detailed database in terms of production, nutritional characteristics and demographic detail – the Global Expanded Nutrient Supply (GENuS) database. The newly developed GENuS nutrition module allows nutrition constraints on consumer purchases. Apart from imposing one or more of the 23 available macro or micro nutrient restrictions (e.g. calories, iron, sodium) the module also computes the majority of the SUSFANS food-based dietary guidelines all of which can be used to constrain the model. A first glimpse of the diet implications of adhering to the red meat guideline in the four European focus countries is provided. These results show the importance of coherence across Europe in imposing diet targets and of the choice of policy instruments for the overall diet pattern.

TEASER FOR SOCIAL MEDIA

The MAGNET model has been enhanced with meat and fish sectors as well as detailed data on products and nutritional profiles. Using the enhanced model for a first assessment of the diet implications of a red meat reduction shows the importance of coherence across Europe and choice of policy instruments.

Incentives and geographical scope of a red meat policy are critical for the impact on diets in European target countries and beyond.

ABSTRACT

The consumer side of the MAGNET model is enhanced in three main directions supporting assessment of sustainable and healthy diets in Europe (and beyond): (i) increasing socio-economic detail; (ii) increasing sector and product detail in MAGNET and (iii) establishing a link between macro-level MAGNET variables and micro-level diet data.

First the single representative household for Czech Republic is replaced by two different household types (farm and non-farm households). Date were derived from an existing national Social Accounting Matrix (SAM) and processed using an earlier developed data protocol. SAMs with the necessary household detail could however not be obtained for the other three SUSFANS focus countries. An approach is therefore outlined to increase socio-economic detail using micro-level data. Going through micro-level data would also facilitate a connection between MAGNET and the micro–level SHARP model.

The second part of the deliverable describes the introduction of ten new sectors in MAGNET increasing the detail in both demand and production meat and fish. These splits allow separate tracking of pig, poultry, cattle and other ruminant meat from fork to farm. Furthermore, different aquaculture sectors and a fish processing are introduced, allowing for example a more detailed assessment of the sustainability implications of an increase in fish consumption often advocated for health reasons.

The third part describes the Global Expanded Nutrient Supply (GENuS) database, providing a more detailed view on available products for consumption and their macro and micro nutritional content, both as a national average and by demographic group. This database is used to feed a newly developed nutrition module in MAGNET, connecting macro level changes to a more detailed product representation including macro and micro nutrient indicators. This GENuS nutritional module not only tracks developments in nutritional value of consumer purchases, it also allows the imposition of constraints. As a first illustrative example we simulate the reduction of red meat demand in the four SUSFANS countries.

We conclude by outlining the remaining challenges and connections to other work packages.

INTRODUCTION

Assessing European diets in terms of sustainability and nutrition, the ambition of SUSFANS, takes on two major global challenges. With effects of climate change and unhealthy eating patterns becoming increasingly visible so does the need for interventions by government or other actors in the food supply chain. Marginal changes in the current food system will not suffice, therefore SUSFANS employs a set of well-established long run models (CAPRI, GLOBIOM and MAGNET) to explore leverage points for interventions addressing both sustainability and nutrition of consumption and its upstream implications in the food system, i.e. from fork to farm. To further enhance their ability to address the implications of European diets the long run models are further developed in the course of SUSFANS.

The work reported in this deliverable focuses on improving the abilities of MAGNET to capture changing consumer diets. In addition to the planned work to increase socio-economic detail and the ability to impose diet constraints, we also increased animal product detail in MAGNET. This additional detail in both consumption, trade and production were deemed necessary for SUSFANS because of the importance of differentiating different types of meat from a diet as well as sustainability perspective. This additional detail now allows a distinction between red and white meat, both in consumption and production systems. Furthermore, detail has been added by splitting aquaculture and fish processing into dedicated sectors. Again this enhances the ability of MAGNET to capture the diverging impacts of consumer purchases - increasing fish consumption (as is often recommended from a health perspective) through aquaculture has very different sustainability and resource implications than increasing fishing.

The enhancements of MAGNET to better capture consumer demand are grouped in three part. The first two chapters take the consumer angle. Our ambition to add more household detail in the SUSFANS focus countries (Czech Republic, Denmark, France, Italy) based on national Social Accounting Matrices (SAMs) has been thwarted by lack of access to suitable SAMs. We only secured access to a SAM with multiple households for the Czech Republic. After a short presentation of the two new Czech household types in the first chapter the second chapter outlines an alternative approach for enhancing socio-economic detail using micro level data. Such a micro-data approach would also facilitate a connection between the macro level analyses in MAGNET and the micro level focus in SHARP, as aimed for part of Task 9.5.

The middle part of this deliverable then switches from consumers to products, describing how 10 new sectors and 11 products are added to MAGNET. This additional detail in modelling animal-based production greatly enhances the ability of MAGNET to contribute to the livestock case studies in WP5. Also the long run projections envisaged for WP10 will be enhanced by the increased scope to track consumption of products with different implications for both health and sustainability.

Although the increased household and product detail improves MAGNET's capacity to analyse implications of changes in consumer demand, diet assessments require more detail than usefully included in a macro-economic model like MAGNET. The third and last part therefore shifts to connecting MAGNET to a much more detailed database in terms of production, nutritional characteristics and demographic detail – the Global Expanded Nutrient Supply (GENuS) database. The original intent was to rely on the SHARP database for the four focus countries to add micro nutrient indicators to MAGNET. The SHARP data, however, have been considerably delayed and therefore an alternative has been sought. While there are clear limitations to the GENuS database, it has a similar structure in terms of detailed products, nutritional indicators and demographic detail. Code and insights developed while working with GENuS therefore directly benefit the inclusion of SHARP data once available. In addition GENuS has global coverage, complementing the European focus of SHARP. We first describe the construction of the GENuS database and some key indicators for EU member states using the dietary factors defined in WP2, to provide a sense of the scope and limitations of the GENuS database.

We then describes the newly developed GENuS nutrition module in MAGNET. This module allows nutrition constraints on consumer purchases. Apart from imposing macro or micro nutrient restrictions (e.g. calories, iron, sodium) the module also computes the majority of the SUSFANS food-based dietary guidelines (see D2.2) which also may be used to constrain the model. A first illustration focusing on diet implications is provided at the end of the chapter, exploring first diet implications of adhering to the red meat guideline in the four focus countries.

The concluding chapter outlines remaining challenges and next steps building on the work reported in this deliverable and how this work feeds into upcoming work in WP9 (toolbox development) and its connection to the case studies in WP5 and foresight analyses in WP10.

DECOMPOSING CZECH HOUSEHOLDS INTO SOCIOECONOMIC GROUPS

Sustainable food and nutrition security (SFNS) is most appropriately assessed at the individual or household level. The global CGE model MAGNET will be used for macro-economic assessments of European SFNS in a global context. Being based on the GTAP database (Narayanan, Aguiar, and McDougall 2015), household income and consumption data are available at an aggregate national level which limits its usability for SFNS assessments.

To enhance MAGNET's ability for SFNS assessments, we aimed to split national private consumption into multiple representative households types for the four focus countries using standardized protocols relying on national Social Accounting Matrix (SAM) data with multiple household types (Kuiper and Shutes 2014). This protocol has been developed and tested for several developing countries using SAMs made available through IFPRI. Obtaining access to suitable SAMs for European countries proved to be more of a challenge than anticipated – we only secured such data for Czech Republic.

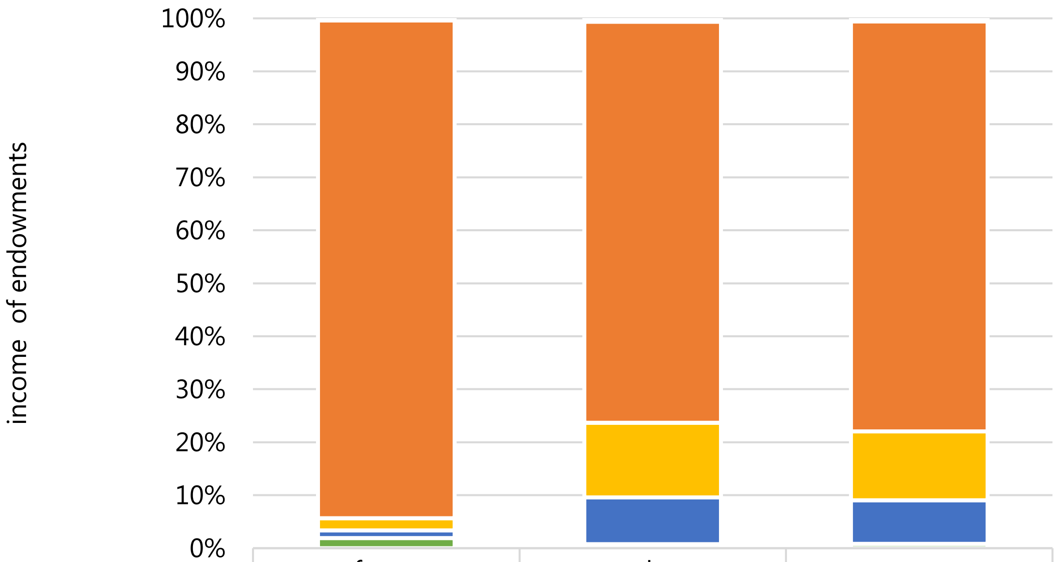
This chapter shortly describes the results of splitting the Czech single private household in the GTAP database (Aguiar, Narayanan, and McDougall 2016) into farm and non-farm households using data from Křístková (2012). We first look at income sources and expenditure patterns – particularly regarding food spending- before turning to nutrient availability according to the existing nutrition module in MAGNET[1].

Czech households' income and expenditure

Farm households receive 94% of their endowment income from capital while capital contributes 76% of non-farm household endowment income (***Figure 1***). These non-farm households rely more on income from (skilled) labour.

[1] Work on the GENuS nutrition module has only just finished to work around delays in the SHARP data and combination with the household module potentially exploiting the demographic detail in GENuS is still pending; also in light of the value-added of a household layer versus a top-down macro-micro link as discussed in the next chapter.

Figure 1: Distribution of income between endowment categories for different household types



	farms	other	average
Natural Resouces	0.4%	0.6%	0.6%
Capital	94.0%	75.7%	77.4%
Skilled labor	2.3%	14.1%	13.0%
Unskilled labor	1.4%	8.9%	8.2%
Land	1.9%	0.7%	0.8%

Source: MAGNET database

Table 1: Income sources by household types in Czech Republic (2011, USD)

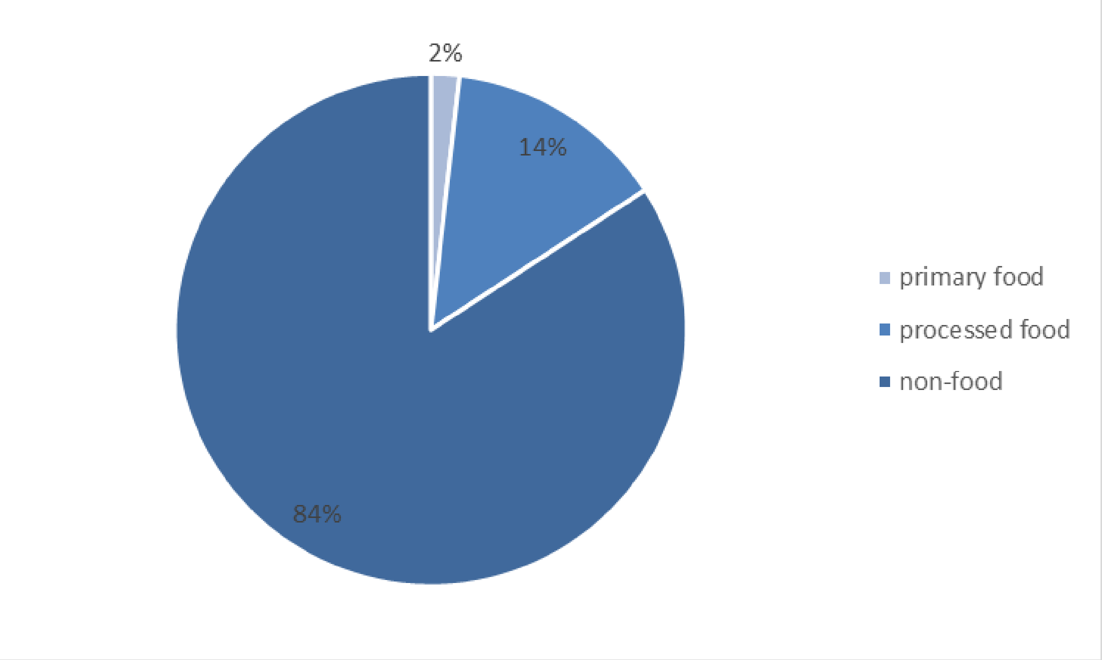
Income source	**Farm household**	**Non-farm household**
Endowments	13,525	140,208
From Government	-3,357	6,267
Depreciation capital	-3,317	-22,716
Transfers between households	36	62
Total income	*6,886*	*118,821*

Source: MAGNET database

The endowment income of farm households is tempered by net transfers paid to the government, while non-farm households receive extra income from the government (***Table 1***). Furthermore, farm households incur relatively higher depreciation on capital. At the end, the income from endowments is almost twice the final income as it is offset by transfers to the government and depreciation payments on capital. There are small positive transfers between both household types.

Households spend most of their disposable income on non-food items (***Figure 2***). There is hardly any difference between the household types between the expenditures on primary food, other food and non-food and therefore the national average is presented. This also holds for the separate commodities in the aggregated (non-food) groups. The expenditures on processed food are noticeably larger than on primary food items, as one would expect given the income levels in Czech Republic.

Figure 2: Relative household expenditures on food and non-food items



Source: MAGNET database

Nutrient availability

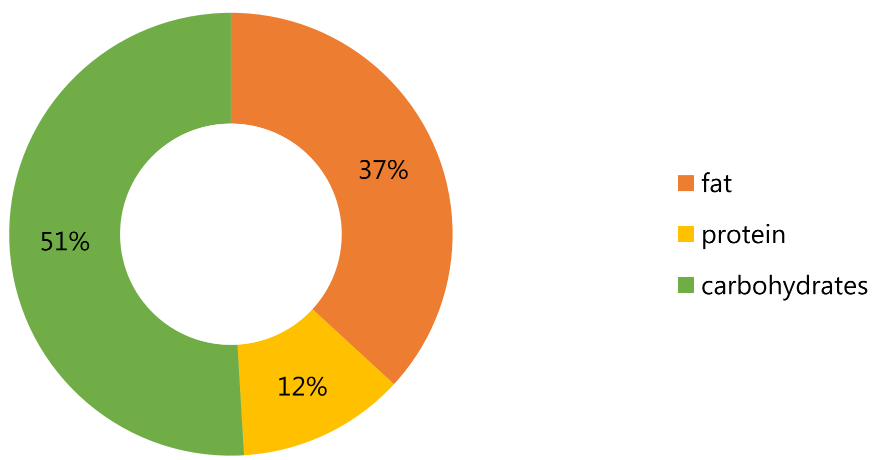
According to the MAGNET nutrition module, inhabitants of Czech Republic have, on average, 3221 kCal per capita available per day (***Table 2***). The macro nutrients are computed from the production side and refer to consumer food purchases. They do not capture actual consumption or intake which will be lower due to consumer food waste (see the discussion on the GENuS database below and the description of the MAGNET waste module in D9.4). The average Czech diet is high in protein and fat and average-to-high in terms of carbohydrate intake.

Table 2: Macro nutrient availability in Czech Republic (2011, person/day)

Food / Nutrient	Availability per person/ day	Unit
Calories	3221	kCal
Protein	100	g
Fat	134	g
Carbohydrates	416	g

Source: MAGNET database

Figure 3: Contribution of fat, protein and carbohydrates in total calorie availability per capita in Czech Republic

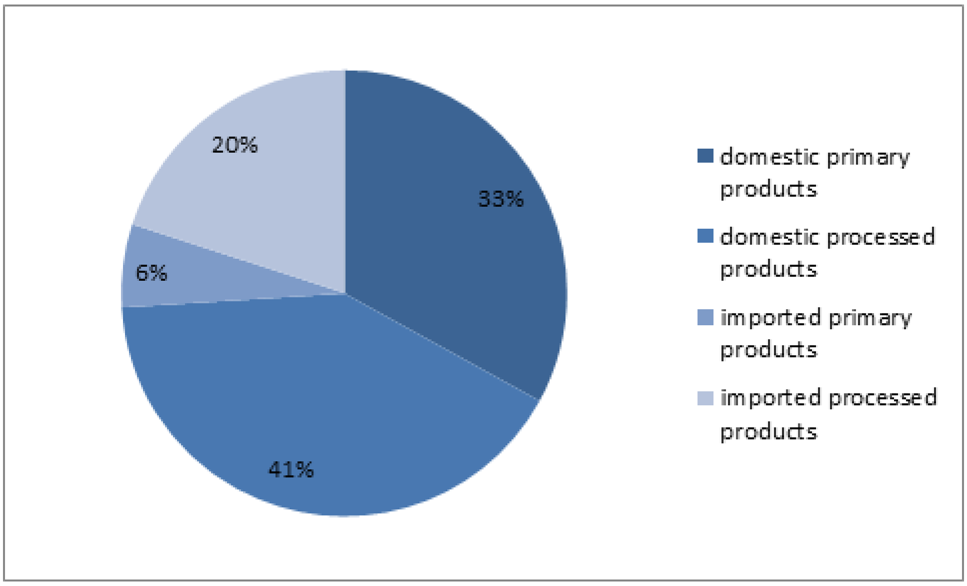


Source: MAGNET database

The share of fat in calorie intake is equal for both household types and is, according to the WHO (2015), too high. WHO recommends for a healthy diet a maximum contribution of fat of 30 percent exceeded (on average) by 7 percent points in the Czech Republic (***Figure 3***). It should of course be noted that the actual intake may be lower than these MAGNET numbers due to food waste.

The current MAGENT nutrition module traces macro nutrients associated with primary products from farm to fork (Rutten, Tabeau, and Godeschalk 2013). Using the data associated with this module we can therefore assess the country of origin of macro nutrients, which is not possible with, for example, the GENuS or SHARP nutrient data.

Figure 4: Share of origin of consumed calories in Czech Republic (2011)



Source: MAGNET database

For Czech Republic we find the main part of the calories (74%) derived from domestically sourced primary and processed products (***Figure 4***). Processed products clearly dominate the imported products, most likely due to a combination of perishability of primary products and higher valued added in processed foods making transport worthwhile. Of the calorie availability from primary products, 15 percent is imported compared to 30 percent for processed food. The main primary imported products are fish (64 percent) and vegetables and fruit (77 percent). This distribution is equal for farm-households as well as for non-farm households, due to similar consumption patterns already noted above.

Unsurprisingly, Czech Republic imports more than 90 percent of consumed processed rice, but consumed processed rice is only 1 percent of consumed processed food. More relevant processed food items are pork and chicken and other food (which encompasses a wide range of processed food items) - together they contribute around 40 % of calorie intake from processed food.

Contribution of the Czech household split to SFNS assessment

The detail on the two types of Czech household presented above show differences mainly on the income side. Farm households are heavily reliant on capital income whereas skilled labour forms a greater part of non-farm household income. This is relevant for scenario projections as changes in capital intensive industries will influence household incomes, particularly farm households, and changes to skilled-labour using industries will affect non-farm households more than farm-households.

The nutrition data suggest that the average diet in Czech Republic is high in protein and fat and average-to-high in carbohydrate intake. The similarities in household consumption patterns between the two household types carries over into nutrient intake patterns. Corroborating data are thus needed to understand further differences in consumption/nutrient patterns between the two households. In particular, the data as they stand give no insights into the demographic composition of the households which is needed for more detailed analysis of diets.

Both these points will be taken up in a more general context when discussing the value-added of the household layer as opposed to a direct top-down link from MAGNET to micro level data in SHARP in the next chapter.

SCOPE FOR ADDING SOCIOECONOMIC DETAIL WITH MICRO DATA

Difficulties in securing access to suitable SAMs for adding European household types to the MAGNET model prompted a search for alternative data sources, also keeping the upcoming link between SUSFANS models at different levels (task 9.5) in mind. The next step in SUSFANS model enhancement under WP9 is to establish links between the models. The most relevant as well as challenging is the link between the long run simulation models (CAPRI, GLOBIOM, MAGNET) and the SHARP diet model. The long run models operate at a very different scale (global, national or regional) from the micro (individual) level in SHARP.

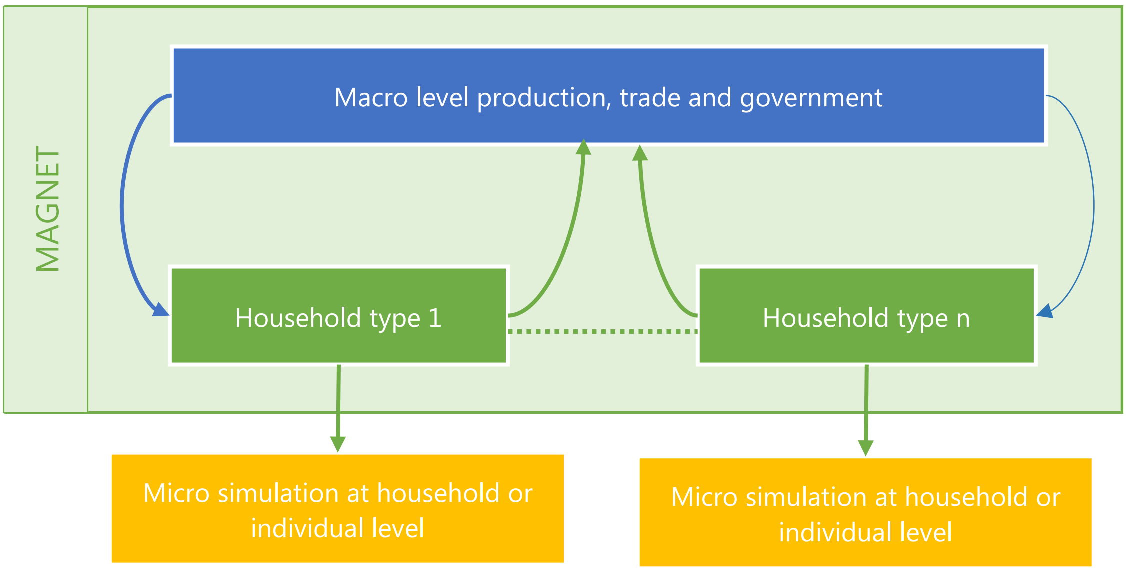
In terms of household consumption, the link between MAGNET and SHARP is key to capture how long run changes in incomes and prices may affect individual food intake and its nutritional consequences. Given limitations in data access and keeping the macro-micro link in mind we outline in this chapter an alternative protocol for increasing socio-economic detail in MAGNET. We start by a conceptual discussion on when adding a household layer adds additional value over a direct link top-down macro-micro link. We then outline a protocol for using micro level data to construct representative household types satisfying the accounting relationships as needed by a CGE model. The third and last part describes to what extent the Luxembourg Income Survey (LIS) database can be used to add socio-economic details for the SUSFANS focus countries and where additional detail from SHARP or other sources are needed to test whether a top-down macro-micro link would suffice or a household layer needs to be added.

When to add a household layer in MAGNET

Roughly speaking there are two options for adding socio-economic detail to MAGNET. The most straightforward in terms of model changes is a top-down link to micro data where changes in key variables endogenous in MAGNET (prices of endowments determining income and prices of commodities purchased by households) are sent to a microsimulation model translating these into household or even individual changes in demand and thus food consumption. The microsimulation can vary from very simple downscaling using fixed distributions to elaborate micro models included in a feedback loop with the macro CGE model. See van Ruijven et al. (2015) for a concise review of existing approaches to enhancing household detail CGE models.

Feedback loops between different models do not necessarily converge to a solution. Therefore a household module has been developed for MAGNET allowing the inclusion of multiple representative household types inside the model. This captures the feedback between household types and the rest of the economy, but at the cost of detail. While there are no conceptual limitations on the number of households (although there could potentially be computational issues), so far the data available only supported up to 20 household types. These representative households could then be linked to micro simulation models to arrive at the level of detail needed for nutritional detail. ***Figure 5*** presents a simplified presentation of combining representative households fully integrated in the MAGNET model with a micro-simulation model associated with each household type. With the household types taking care of the macro-economic feedback, their link to the micro-simulation models can be top-down, thus avoiding convergence issues.

Figure 5: Combining representative households and micro simulation



The income and expenditure of each household group is the average of the all households within the group, distributed around this mean. As such, the household group 'represents' the behaviour of all households within it that are assumed to respond in a similar way due to characteristics such as location or income sources. The greater the number of household groups within MAGNET, the more detailed the information that can be passed onto the micro-simulation model. For example, changes in the income of a single representative household, implies a shift in the mean of the distribution containing all households. In contrast, changes in the average income of 10 household groups computed endogenously within MAGNET, implies changes in the means of 10 household distributions, all with potentially different distributional characteristics.

The assumption underlying the approach in ***Figure 5*** and past work on including household types in MAGNET is that the feedback between the representative household types and the macro-model affects MAGNET results. If this would not be the case one could omit the representative household layer and link micro-simulation models directly to MAGNET.

In the absence of existing national SAMs with household detail, a considerable effort has to be invested in cleaning and combining micro-datasets to properly define the representative household layer. Before embarking on this task it therefore seems wise to carefully consider the conditions under which feedback from the household layer affects model outcomes. ***Figure 6*** schematically presents the interactions between the household layer and the rest of the model represented by production only for clarity of exposition.

Starting point is that household incomes differ due to different factor ownership (land, labour, capital etc.). These different income sources then feed into the demand system by household type (arrow 1). Depending on the demand system, diverging incomes may or may not affect the aggregate consumer demand (arrow 2). If households have a homothetic utility function the demand pattern in terms of relative shares of commodities in total expenditures is independent of the level of income. If then the demand systems for all household types have the same parameters, i.e. the same demand pattern, diverging household incomes have no impact on aggregate demand and there is thus no feedback to production nor the rest of the economy[2].

MAGNET employs either a Constant differences of Elasticities (CDE) demand system or a Linear Expenditure system (LES) which both are non-homothetic. This allows better capturing changes in demand pattern when incomes change as predicted by Engel's Law. Thus households with higher incomes will spend less on necessities like cereals and more luxurious items like meat. In the current context it implies that given the demand systems in MAGNET accounting for diverging household incomes will affect aggregate consumer demand and thus affect production.

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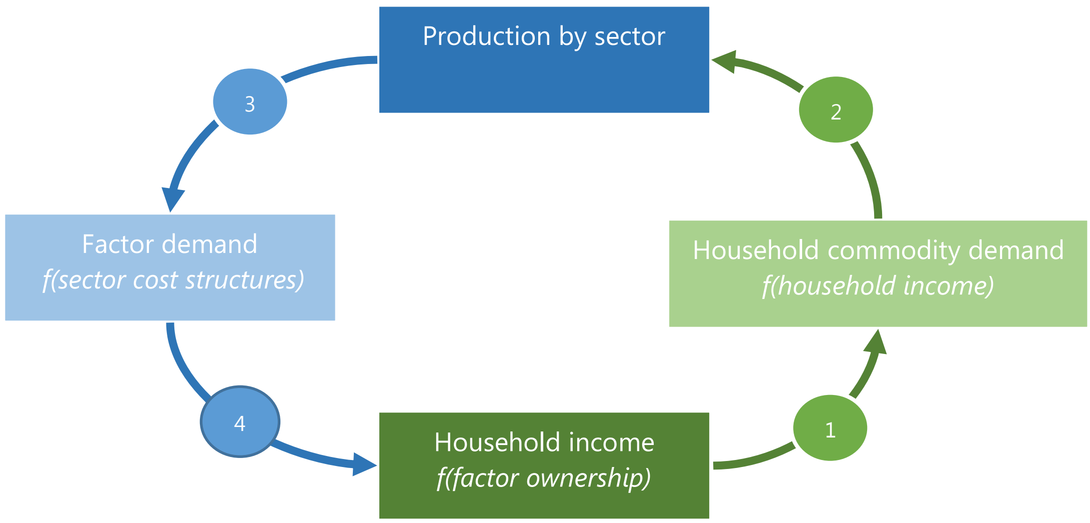
[2] We abstract from the possibility of household-specific commodity prices, for example due to household-specific consumption taxes, which would generate household-specific prices which could cause diverging demand patterns even with identical homothetic demand systems.

Figure 6: Influence of household layer on model outcomes



The next step in the feedback loop is the connection between production and factor demand (arrow 3). One may expect that a change in production, i.e. a shift from cereals to meat will result in a different factor demand and therefore diverging factor prices. This, however, critically depends on the number of factors distinguished and the data used to calibrate the cost structures. Pyatt and Round (2012) mathematically explore what they call the Stone Phenomenon: "'higher order (circular) effects of an exogenous change in final demand on the distribution of income and the structure of production were more or less independent of the sectoral composition of the initial injection" (Pyatt and Round 2012, 251). In other words, capturing diverging demand by introducing representative households may not affect the distribution of income.

It turns out this is not an oddity in a specific application but due to an imbalance between the amount of detail in sectors (many), households (varying from one to many) and factors (generally a few). The commonly limited amount of detail in factors (often restricted to land, labour and capital) effectively acts as a funnel. With only a few factors present changes in large number of sectors will quickly get lost once translated into changes in the few factors. While not referring to Pyatt and Round (2012), Balaskoa and Tourinho (2017) make a similar observation arguing that equal factor proportions in commodities demanded by households makes CGE models with multiple households surprisingly insensitive to income redistribution policies. Again, with fewer factors present factor proportions will quickly converge, muting the impact from diverging production on factor demand (arrow 3) and thus household income (arrow 4).

While for several of the developing countries both representative household types as multiple factors were added to the MAGNET database, the Czech SAM used to introduce the two household types did not allow further refining of the MAGNET factors. Furthermore, there is little differentiation in the expenditure pattern of these two households, likely due to their still aggregate character, which will mute the feedback from demand to production. While insightful in terms of different income developments, the inclusion of these two additional households for Czech Republic can be expected to add little additional feedback mechanisms to the MAGNET model.

In more general terms it makes most sense to add a household layer when the full feedback circle in ***Figure 6*** is functioning. With the non-homothetic demand systems in MAGNET supporting such feedback, relevance of including the feedback loop through the household layer depends on the structure of demand and production both governed by the data used to calibrate the model. Whether to add a household layer or make a direct connection to micro data thus becomes an empirical question. The remaining part of this chapter will outline a protocol to include a household layer based on micro data in cases supported by the empirical evidence, and shortly discuss available data sources in the SUSFANS project.

Protocol for adding representative households to MAGNET based on micro data

So far representative households have been added to MAGNET using national SAMs with household detail. While restrictive in terms of having to take the number of household types and factors as given, this approach requires limited resources using an earlier developed protocol described in Kuiper and Shutes (2014).

The proposed protocol for using micro databases to define representative households builds as much as possible on the existing SAM-based protocol. One key assumption we maintain is the use of GTAP data as control totals. In other words we take the GTAP national level income and expenditure data as given. This contrasts to the approach taken by MIRAGE which takes household survey data as control totals (Bouet et al. 2013).

The reason for taking the GTAP totals as given is that these are the result of an elaborative balancing procedure over several global datasets (Narayanan, Aguiar, and McDougall 2015). Although for a country-specific study it makes sense to meet country data as closely as possible, in a global dataset this implies adjusting data for other countries to maintain a globally balanced dataset with all bilateral trade flows accounted for. Experiments in MAGNET with adjusting production for the Netherlands in line with a Dutch SAM or adjusting cost structures for a few countries only have shown that such partial adjustments quickly cause implausible model results. All depends on the model aggregation and places/flows where the adjustments occur (i.e. if they disappear in large enough aggregates or not). The protocol outlined here focuses on splitting the households in the disaggregated GTAP database (141 countries in the current version 9 database) which are then be used in models of varying aggregations. We thus have no guarantee that global adjustments due to targeting micro data for a specific country get absorbed in a large enough aggregate. Taking the GTAP national data as control totals keeps all household-related adjustments restricted to the consumption accounts of the country of focus, thus minimizing the impact of the split on the remainder of the database.

Of course the analysis of micro data may give rise to valid concerns on the GTAP national level data. As part of the protocol we compare the structure of the micro level data to the GTAP data to identify any large discrepancies. If desired these can be then be addressed through a pre-simulation for a country specific study. By making the adjustment at more aggregate regional level as used in MAGNET model simulations implausible adjustments in other regions can be more easily be avoided (i.e. by assuring adjustments are made in a large enough aggregate to absorb the changes to avoid undesirable global impacts).

Taking the GTAP data as control totals facilitates the process of adjustment considerably by limiting it to adding details on income and expenditure by household types without having to adjusted production, trade nor total taxes. In the currently available protocol for adding household types this is made explicit by creating a satellite dataset detailing the households while maintaining the national level total private consumption in the core dataset.

The procedure used in MAGNET requires, at minimum, the data described in ***Table 3***. For the sake of exposition the table illustrates the approach in the case of two households (rural and urban) but the approach applies to any number of household types. When computing the household accounts ideally market (before tax) prices are used to avoid potential conflicts with GTAP tax rates used in MAGNET.

Table 3: Shares by household types needed to split the private household account in the GTAP database

		Rural	Urban	Sum of shares
Income sources[a]	Land	a_L	c_L	1
	Labour by type	a_B	c_B	1
	Capital	a_C	c_C	1
	Natural resources	a_N	c_N	1
	Sum of income shares	>1	>1	
Expenditures[b]	Primary commodities	b_a	d_a	1
	Processed food	b_p	d_p	1
	Manufacturing	b_m	d_m	1
	Services	b_s	d_s	1
	Sum of expenditure shares	>1	>1	

Note: [a] Multiple types of labour are distinguished in the GTAP database and for each a share is needed; [b] These are the broad types of commodities consumed by households within each category multiple commodities are distinguished.

Once income and expenditure accounts have been determined these can be converted into shares used to split the GTAP private household account. Use of shares avoids having to balance expenditures in different currencies and potentially for different years than used in the GTAP database. After this first step the total income over all household types will match for each endowment the GTAP private household total used as the control total (assured by the *a* and *c* share sum to 1 by endowment). Similarly the total expenditures over household types will match the GTAP private household expenditures by commodity. Given that the GTAP household account is balanced this first allocation of income and expenditures does not affect any other account in the SAM.

We then need to address the accounts by household type which should also balance. The existing protocol using data from national SAMs achieves this balance by adjusting the expenditure pattern across household types to match household income without changing the total expenditure pattern. This procedure thus preserves the relative factor endowments of households, a key factor in model simulations for diverging impacts across households. In the context of SUSFANS we are aiming to establish a link with the detailed intake data from SHARP and adjusting the consumption pattern of food therefore needs to be avoided. To accommodate this concern we propose to limit the adjustments across household types to manufacturing and service expenditures (together amounting to 86% of private household expenditures in the GTAP database). Apart from this adjustment the existing data processing protocol can be used to accommodate household splits based on micro-data. The resulting dataset preserves the pattern in factor income, total income and food expenditure from the national level sources as represented in the GTAP database.

Micro databases for adding socio-economic detail

As shown in ***Table 3*** we need data on income and expenditure by household type to compute the necessary shares to split the national private household accounts. Current household splits in MAGNET are based on national level SAMs taking the definition of household types as given. Starting from micro-data we can define a household typology suited our intended use. Note that we take the household, and not individuals, as the unit of analysis since incomes are pooled (at least to some extent) in households and buying decisions are also (to some extent) made at this level. We first motivate our choice of classification criteria before exploring the potential of these criteria to classify available micro level data.

Suitable household classification criteria from a CGE perspective

Currently we have household splits available for six countries. Three of these (Kenya, India, Indonesia) use income as a classification criterion alongside a rural urban distinction and in the case of Indonesia a land-ownership criterion for rural households. The other three use at least a rural-urban distinction (China) alongside a geographical indication (Ghana, Uganda) and an indication of whether farming provides the main source of income (Uganda).

A main use of MAGNET is to explore possible future developments using long run projections. Typically these involve large endogenous changes in income and economic structure. With endogenous and substantial income changes an initial income-based classification, as for example used for India, makes less sense when projecting forward. Similarly, with potentially large structural changes occurring in production structure of an economy using the key income sources as a classification mechanism may also make groups less relevant in the long run. The household classification criteria should thus not based on endogenous characteristics like income which changes considerably in (long run) projections.

The single shared criterion in the current available household groupings is a *rural-urban distinction*. This is a distinction often entering the policy debate, if only because of differences in political clout. From a CGE modelling perspective the distinction makes sense from a production and consumption side. Rural households are more reliant on agriculture, although urban farming can still be accommodated with a rural-urban divide. In terms of consumption urban households tend to consumer more processed (restaurant) foods while rural households may have access to their own primary production. Using a rural-urban distinction thus captures key differences in production and consumption without imposing a black-and-white separation quickly becoming meaningless when projecting forward.

Depending on the size of a country, its administrative organization, spatial variation in endowments and possible regional specialization in production makes a regional distinction very useful to capture differences in the households' environment which are key for determining their production and/or consumption decisions. As with the rural-urban distinction a *regional* criterion is not endogenous in MAGNET and does not impose a hard division on either sources of income or expenditures thus accommodating changes during model simulations.

MAGNET is often used for research questions linked to the bio-economy, like for example the impact of climate change on agricultural production or the potential for bio-based energy sources also claiming land. In these analyses land prices play a key role in determining the distribution of costs and benefits in the economy. Land is also a fixed endowment[3] both in terms of total quantity and location, potentially (depending on data availability) allowing a connection to the regional criterion. Land ownership generally is confined to a limited set of households making it useful to distinguish these from the landless. We may therefore use land ownership as the third criterion, having an important influence on production activities and income earning potential. The relevance of income from land, however, may be much less in a high-income European setting where only a small part of the population relies on land for their income.

[3] In MAGNET simulations agricultural land is endogenous but the total available land in a country is fixed.

Other potential criteria could be labour endowments, possibly by skill category or education levels. In long projections these are however changing due to demographic developments. With all people having their own labour at their disposal there is also no clear separation between households having labour and those without labour endowments. Furthermore, for linking to nutritional data aggregate household data do not suffice, but individual level data are needed. We thus do not include these in the household classification procedure but propose to set-up the data procedure such that a link to individual data (including education) can be maintained to facilitate the macro-micro link while capturing the individual impact of changes in education on income and consumption patterns.

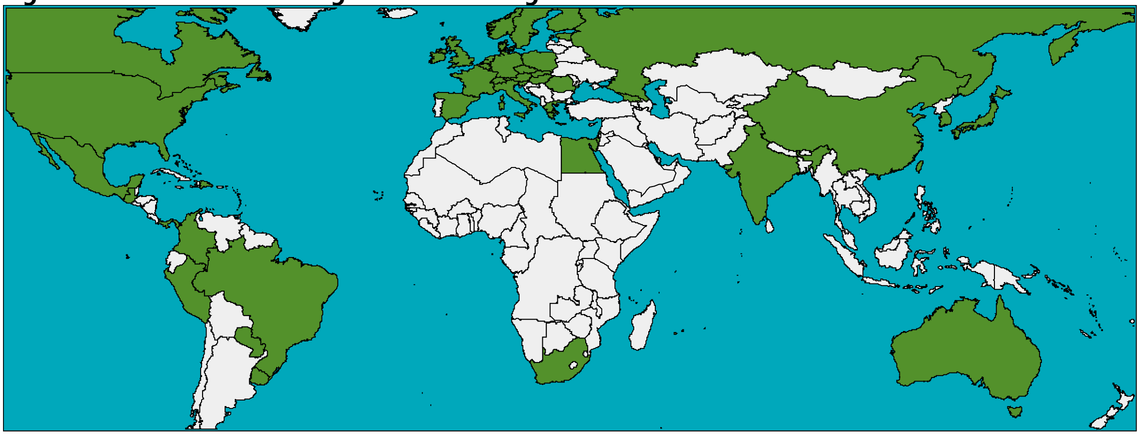
Finally we may consider capital ownership which could be expected to vary considerably depending on the income level of households. Capital endowments, however, change considerably in long run projections making it a less stable defining characteristic of households unless it is associated with a specific subset of households. This could therefore be explored when analysing income patterns in the micro-date.

Scope and limitations of the LIS micro data

The Luxemburg Income Survey (LIS) data[4] offer a promising source for adding socio-economic detail. Despite its name this database holds harmonized and publicly available micro-level data for many high- and middle income countries (see ***Figure 7***). Apart from providing a source of data for countries not generally covered by accessible household data from IFPRI or World Bank, it also offers the opportunity to link macro and micro-level data potentially enabling the link between macro and micro level models as aimed for in SUSFANS.

[4] The Luxembourg Income Study (LIS) Database can be accessed (after registration) via:, http://www.lisdatacenter.org

Figure 7: LIS database coverage of GTAP V9 regions



In the context of variables the LIS offers a tantalizing lists to characterize household types (see the variable listing in Annex 1). From these we made a first selection of household characteristic variables based on the classification considerations discussed above (see ***Table 4***). With consumption playing a key role in assessing diets we also looked at the data on consumption (C variables in the LIS overview) for the focus countries.

With respect to the classification variables only a regional distinction (varying by the country-specific administrative regions) is available for all focus countries. The rural-urban and urbanization variables are missing for Italy but available for the other three countries. There is thus scope for a classification of households by region. Coverage of data on farm households and land ownership is only available for France and therefore not a useful general classification criterion. Of course classification criteria may differ across countries, we could thus employ the more detailed data for France.

More concerning are the expenditure data which are only available for France. This implies that the LIS data do not provide the required data for adding household detail on the expenditure side for three of the four countries and additional data need to be found.

Table 4: LIS household characteristic usable for defining MAGNET household types

Name	Code	Definition	Comment
Region	*region_c*	Region of the residence of the household at the date of interview. Regions should refer to the administrative divisions of the country (at a level higher than the municipality) or geographical areas	In European countries, this will typically include the NUTS3 classification.
Rural area	*rural*	Dummy for rural area. The classification of geographical areas into urban and rural follows the country-specific guidelines (i.e. the urban/rural classification is not based on absolute numbers across all countries, but the cutoff point changes from country to country and can change within the same country from year to year in order to retain the individual country's classifications).	Please note that the definition of rural area used in this variable may differ substantially from dataset to dataset (even for the same country across years); please look at the dataset specific documentation (variable label and/or notes), as well as at the country-specific variables used for its construction (LOCSZ_C and AREA_C).
Size of locality of residence	*locsz_c*	Size of the locality: classification by number of inhabitants.	
Type of area	*area_c*	Other classifications of area such as type of area (metropolitan area, urban area, rural area), population density, degree of urbanization, size of locality of residence, or even linguistic region	
Farm household	*farm*	Dummy for farm household. A farm household is defined as a household who is running a farm and whose members are depending for their livelihood on agriculture (cultivating land and/or growing livestock).	This variable might not refer exclusively to households from rural areas. Please refer to the dataset-specific documentation for detailed information.
Ownership of agricultural land	*agriland*	Indication of the ownership and rental status of the agricultural land (arable land, permanent crops and permanent meadows and pastures).	The collective farming refers to the commonages entitlements on the land or other type of collective ownership of the land.
Farming activity	*farming*	Information on whether or not a household is actively involved in farming (defined as growing crops and/or breeding livestock) and their livelihood depends on it.	This variable is designed to capture the information about the household's agricultural activities in the agricultural areas (which are not necessarily a part of a rural area).

Table 5: LIS data availability for classification and consumption of focus countries

Name	Code	Czech Republic	Denmark	France	Italy
Descriptives	*Year*	2013	2013	2010	2014
	N	8053	87517	15797	8156
Region	*region_c*	14 regions	11 regions	13 regions	20 regions
Rural area	*rural*	37 % rural	11 % rural	18% rural	n.a.
Size of locality of residence	*locsz_c*	9 classes	13 classes	9 classes	4 classes
Type of area	*area_c*	3 degrees of urbanization	3 degrees of urbanization	11 degrees of urbanization	n.a.
Farm household	*farm*	n.a.	n.a.	0.7 % farm household	8% farm household
Ownership of agricultural land	*agriland*	n.a.	n.a.	0.6 % owns agricultural land	8% owns agricultural land
Farming activity	*farming*	n.a.	n.a.	3 types of farming activities	4% has a farming activity rest is missing
Expenditures	*C (total exp.)*	n.a.	n.a.	avaialble	n.a.
	Cfood	n.a.	n.a.	avaialble	n.a.

Connecting diets and incomes – improving SFNS assessments by linking LIS and SHARP databases

The limited data on expenditures from the LIS database could be supplemented by using GTAP expenditures shares for all households. This, however, removes household differentiation in the first feedback step from the household layer (arrow 1 in ***Figure 6***) thus not adding much insight compared to a top-down connection to the micro level.

Keeping the goal of assessing the diets of European consumers in mind a more promising avenue is to establish a link between the LIS and SHARP databases. Both are micro level datasets having age, sex and education variables which could allow construction of a combined dataset. While a substantial task not currently planned for in the context of SUSFANS, it holds substantial promises of enriching the analyses. It will add more socio-economic detail to the SHARP intake data which could help grouping of individual data for the modelling as well as offering scope for assessing a broader set of drivers of observed differences in diets. Establishing a connection between income sources from LIS and consumer intake data from SHARP can also enrich the linking of MAGNET to SHARP by accounting for changes in relative income flows when downscaling the macro MAGNET results to the SHARP micro level.

Once the LIS and SHARP are combined we can not only empirically assess whether total income has an impact on food consumption, but also explore whether the type of income sources affects intake. If clear patterns are found this could then inform a definition of a limited number of representative household types to capture feedback between diverging consumer decisions and the rest of the economy.

The SHARP database is restricted to food intake and thus will not provide diverging purchases on non-food items. Whether an introduction of a representative household layer based on these data adds an effective feedback loop through factor incomes (arrow 3 in ***Figure 6***) depends on the cost structures of the food sectors in MAGNET (these will be linked to the SHARP data) as well as the importance of food purchases in total expenditures (this governs the importance of diverging patterns in food only). There is quite some variation in production factor cost shares by food sector so differences in food consumption will change factor demand in food production. Whether this spread will lead to significant changes in factor payments given the relatively small share of food in total expenditures (16 to 11 percent across the four countries) is not easy to establish from the base data. If no additional data are available to also add differentiation in non-food expenditures across household types, the response of the MAGNET model to (exogenous) changes in food demand patterns needs to be assessed to determine the strength of a factor payment feedback channel driven by diverging food expenditures only. If this feedback channel proves to be insignificant the household layer can be omitted, establishing a direct (top down) link between MAGNET and the LIS-SHARP micro data to assess socio-economic differences in European diets.

Exploring the scope for building a combined LIS-SHARP dataset (potentially supplemented by additional micro data sources on non-food expenditures) would contribute to establishing a link between MAGNET and SHARP and may therefore be taken on the remaining toolbox work in WP9, resources permitting.

INCREASING FOOD DETAIL IN THE MAGNET DATABASE – MEAT AND FISH SPLITS

Shifting gear from the previous two chapters focussing on the increasing the level of consumer detail in MAGNET we now turn to increasing detail in terms of products. The current MAGNET database builds on the GTAP commodity classification which distinguishes 12 primary agricultural commodities and 8 processed food items[5]. The MAGNET database has an been extended in the past mostly in terms of adding more detailed coverage of bio-based sectors, like bioethanol and bio-plastics. Some of these extensions are relevant for diet assessments as well, for example separating oilcake out when modelling the process from oil seeds to vegetable oils.

In this chapter we describe several new additional splits enhancing the ability of MAGNET to capture shifts in diets in terms of health as well as sustainability. First we describe the procedure to increase the level of detail in terms of meat and meat products. The next section describes splits of the fishery sector, adding not only more types of fish but also a distinction between wild catch and aquaculture systems. Finally we shortly describe the 2011 base year implications of these splits for describing household food availability. It should be noted that given the economy-wide coverage of MAGNET, the splits increase the level of detail in modelling production and consumption previously encompassed inside more aggregate representations. In other words we thus do not expand the agricultural sector but increase the amount of detail in food production, trade and consumption.

Increasing MAGNET coverage of (processed) meat

So far MAGNET maintained the GTAP detail in terms of livestock sectors. In addition to the sectors listed in ***Table 6*** the GTAP database also includes separate sectors for both milk and wool (and silk) production. These are maintained as is in the MAGNET database and not discussed further.

Table 6: Link between new MAGNET and original GTAP livestock sectors

GTAP sectors	New MAGNET sectors

[5] See the GTAP website for a detailed description of the commodities included in each of the 57 standard GTAP sectors: (https://www.gtap.agecon.purdue.edu/databases/contribute/detailedsector.asp)

	Code	Name	Details	Code	Name
Primary	**ctl**	Bovine cattle, sheep and goats, horses	Cattle: cattle, sheep, goats, horses, asses, mules, and hinnies; and semen thereof	**ctl** **bfctl**	Other ruminants Cattle
	oap	Animal products nec	Other Animal Products: swine, poultry and other live animals; eggs, in shell (fresh or cooked), natural honey, snails (fresh or preserved) except sea snails; frogs' legs, edible products of animal origin n.e.c., hides, skins and furskins, raw , insect waxes and spermaceti, whether or not refined or coloured	**oap** **pltry**	Pig and other intensive livestock Poultry
Processed	**cmt**	Bovine meat products	Cattle Meat: fresh or chilled meat and edible offal of cattle, sheep, goats, horses, asses, mules, and hinnies. raw fats or grease from any animal or bird.	**cmt** **bfcmt**	Other bovine meat products Beef meat products
	omt	Meat products nec	Other Meat: pig meat and offal. preserves and preparations of meat, meat offal or blood, flours, meals and pellets of meat or inedible meat offal; greaves	**omt** **poum**	Pork and other meat products Poultry meat products

We define four new sectors of which two are processed and which are interrelated. First of all we separate cattle (bfctl) from other ruminants that remain in the MAGNET ctl sector[6]. Associated with this split is the separation of beef (bfcmt) from the ruminants processed meat sector (cmt). Similarly poultry (pltry) is split from the other intensive livestock primary sector (oap) which in is dominated by pig production. And at the processed side poultry meat (poum) is taken out of pork and other processed meat (omt).

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[6] The MAGNET protocol for splitting sectors always maintains the name of the original sector for ease of connection with other (non-GTAP) databases which are also included in the MAGNET database. Of course the content of the MAGNET sector will differ after the split from the original GTAP sector. When setting up a specific model names of all (aggregate) sectors can be changed by the user to better reflect its new composition.

The sector split protocol on MAGNET is based on a Social Accounting Matrix (SAM) representation of the database. Splitting data in a SAM format eases the consistency checks required for use of data in a CGE model like MAGNET, namely that all (monetary) flows need be accounted for. ***Figure 8*** provides an idea of the number of data points in the SAM that need to be adjusted to properly represent the new sectors in terms of production and trade. Note that this refers to the SAM for a single country – with MAGNET tracing all bilateral trade flows all bilateral imports and export pairs also need to be consistently adjusted as well (accounting for transport costs and trade barriers).

Figure 8: Production and trade related SAM entries adjusted for the livestock splits

			demand										
Supply	MCOM	DCOM	ACT				ww	tssm	tssd	hous	govt	cgds	total
			agri	fert	chem								
MCOM			Interm. import demand	Interm. import demand	Interm. import demand					Interm. import demand	Interm. import demand	Interm. import demand	
DCOM			Interm. domestic demand	Interm. domestic demand	Interm. domestic demand		export demand			Interm. domestic demand	Interm. domestic demand	Interm. domestic demand	
ACT		dom supply											
ENDW COMM			Factor input	Factor input	Factor input								
tmm	import levy												
tee		export levy											
tssm			import tax	Import tax	import tax					Import tax	Import tax	Import tax	
tssd			Dom. tax	Dom. tax	Dom. tax					Dom. Tax	Dom. Tax	Dom. Tax	
tfe			Factor tax	Factor tax	Factor tax								
dms			Factor dom. support	Factor dom. support	Factor dom. support								
trmm	transport margin												
ww	import supply												
RegHous								Import tax Revenue	Domestic tax Revenue				
prodtax			prod tax	prod tax	prod tax								
Total													

Data used for the livestock splits

The main focus of the increased livestock detail has been at the consumer side aiming to better capture diet diversity. In contrast to the fish split discussed below no additional data on production systems has been included in the current version of the database. This implies that in the base year the new sectors inherit the cost structure from their parent sector. Thus if the GTAP oap sectors uses no land (a standard modification to the GTAP database employed in MAGNET to capture the intensiveness of these sectors) neither will the poultry sector. Starting from the same initial cost structure, however, is less limiting than it may seem. First of all MAGNET allows the definition of sector-specific nested-CES production functions. It is therefore possible to define different nesting structures and substitution elasticities between inputs for each new sector. Furthermore, as demand and thus prices of the new sectors are likely to develop in different rates or even directions, the cost structures will respond accordingly since less profitable sectors cannot compete for scarce resources like land. The cost structures of new sectors will thus start diverge from their parent sector in long run projections.

Two data sources are used for both splits: BACI trade data and FAO production data. The BACI trade dataset (Gaulier and Zignago 2010) is a harmonized version of the COMTRADE database. It describes bilateral trade at HS 6-digits, i.e. at much more detail than the MAGNET database. The harmonization compared with the source data in COMTRADE mainly consists of assuring that bilateral flows are mirrored – exports from x to y are made equal to imports by y from x. This basic accounting relation is critical to maintain the balance in a SAM but not necessarily satisfied by the data as submitted by the individual countries. Annex 2 lists the mapping from the relevant HS 6 codes to the new MAGNET livestock sectors. With these mappings we can compute the value of bilateral trade between MAGNET countries and regions for the new sectors. From the FAOSTAT database[7] we use the country production data to compute production for each of the new sectors. Annex 3 lists the mapping between the FAO product definitions and the new livestock sectors. From both sources we use the 2011 values consistent with the current MAGNET base year. Having data on both production and trade, we compute demand as the residual.

Note that we do not use external data sources to adjust tax rates, including import tariffs, for the new sectors. If there are important differences critical for an analysis additional data on tax rates can either be included in the data procedure or through running the MAGNET model using the Altertax closure (Malcolm 1998). The latter has the advantage of being done at the model aggregation (typically 25 or less countries and regions) instead of for all 141 GTAP regions and therefore being much less data demanding.

In implementing the split the trade data are taken as leading, following the approach taken in the construction of the GTAP database. Trade data are a robust data source being derived from official records of commodities shipped around the world, while the production data are not based on a similarly well-

[7] Data are publicly available at: http://www.fao.org/faostat/en/#home

established global tracking system. Despite both data sources referring to the same year the data are also not fully consistent. For example there are some cases where BACI exports exceed production. To achieve consistency generic limits on shares are imposed or if serious consistency issues arise for a particular country only the procedure for that country is adjusted[8].

Increasing MAGNET coverage of fish types and production systems

The MAGNET database has been extended to include both wild catch fisheries, aquaculture and fish processing sectors. Where the livestock splits are a relatively straightforward division of existing GTAP sectors using production and trade data, the split of fisheries involves more fundamental changes to the database including additional detail in the endowments.

Figure 9 provides a schematic representation of the interactions between the new sectors. Interactions between aquaculture and fisheries, like fisheries providing fishmeal and fish seed to aquaculture, have been taken into account. Feed is explicitly modelled and attention is given to the competition between aquaculture and livestock sectors for available feed.

In the current MAGNET database the GTAP convention of fisheries using a generic natural resource endowment also use by for example oil and gas extraction has been followed. To better capture the dynamics of wild fish stocks the natural resource use by fisheries has been split in four types of fish stocks (diadromous fish, fresh fish, crustaceans and marine fish). All four stocks are harvested by a single fishing sector producing wild caught fish. We thus do not distinguish different types of wild caught fish in the model. In the case of aquaculture we do define five different types of systems, each with their own cost structure and product: diadromous fish, fresh fish, crustaceans, marine fish and molluscs.

[8] A detailed description of the implementation of the split including limits and country-specific adjustments is available from the MAGNET model documentation.

Figure 9: Interactions between new fish and aquaculture sectors in MAGNET

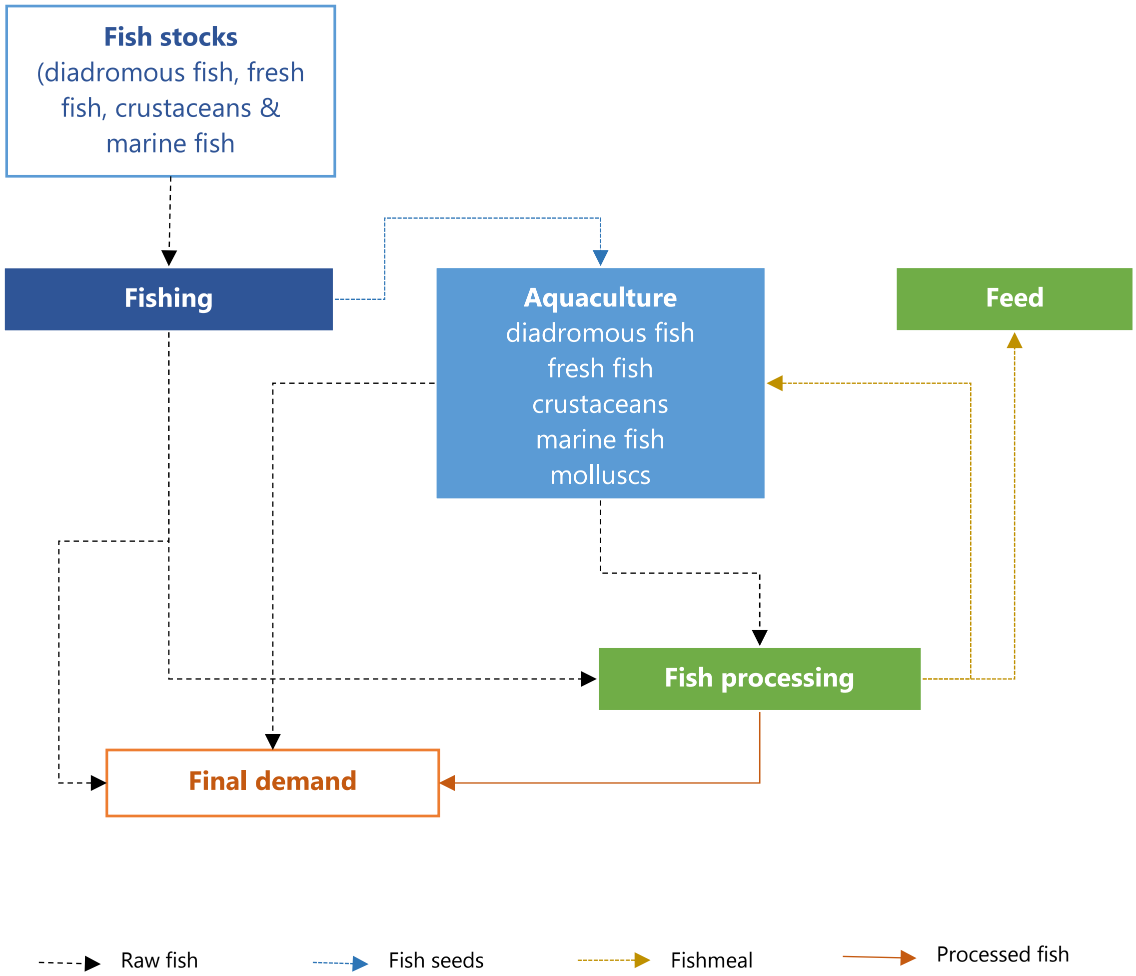

Table 7 summarizes the splits and mappings related to fish. It should be noted that fishmeal (used for feed) is not a stand-alone sector but a by-product of the processed fish sector. As with the livestock splits alongside the production and trade flows splits other entries in the SAM also need adjusting to capture intermediate demand, taxes, import tariffs and transport costs (see ***Figure 8*** above for an impression of the SAM entries that need to be adjusted in the course of the split).

Table 7: Link between new MAGNET and original GTAP fishery sectors

	GTAP sectors			New MAGNET sectors	
	Code	*Name*	*Details*	*Code*	*Name*
Primary	**fsh**	Fishing	Fishing: hunting, trapping and game propagation including related service activities, fishing, fish farms; service activities incidental to fishing	**fsh**	Fishing (wild catch)
				diad	Diadromous fish (aquaculture)
				fresh	Fresh fish (aquaculture)
				crust	Crustaceans (aquaculture)
				marin	Marine fish (aquaculture)
				molus	Molluscs (aquaculture)
Processed	**ofd**	Food products nec	Other Food: prepared and preserved fish or vegetables, fruit juices and vegetable juices, prepared and preserved fruit and nuts, all cereal flours, groats, meal and pellets of wheat, cereal groats, meal and pellets n.e.c., other cereal grain products (including corn flakes), other vegetable flours and meals, mixes and doughs for the preparation of bakers' wares, starches and starch products; sugars and sugar syrups n.e.c., preparations used in animal feeding, bakery products, cocoa, chocolate and sugar confectionery, macaroni, noodles, couscous and similar farinaceous products, food products n.e.c.	**ofd**	Food products nec
				fishp	Processed fish
				fishm	Fishmeal (by-product from fish processing so not a separate sector)

Note: in addition to above splits natural resource use in fishing has been split into crustaceans (cru_fsh), demersal fish (dem_fsh), pelagic fish (pela_fsh) and other fish (oth_fsh).

Databases used in the fish splits

In the case of fish (BACI) trade data are not detailed enough to be leading the split procedure. International trade statistics do not differentiate fish from aquaculture and other fish, nor do they distinguish between different types of fish. Lacking better data we thus maintain the bilateral trade patterns from the GTAP database and (detailed) production data become leading. For the fish production data we rely on the FAO landing statistics for fishing and FAO production data for the five aquaculture sectors. Note that in line with the monetary representations used in the MAGNET database we use the FAO monetary values of production for the splits.

Cost structures for the aquaculture sectors were synthesized from various literature sources into MAGNET compatible inputs. These aggregate costs structures vary by country depending on the importance of underlying species in each continent. With very limited data on cost structures of fish processing we construct a cost structure from the available data on fish processing for Europe (STECF 2013). The Scientific, Technical and Economic Committee for Fisheries (STECF) provides different cost structures for European countries. An average over these European countries has been applied as a cost structure for the rest of the world.

Using the (partly synthesized) cost structures, production levels and bilateral trade patterns the SAM can be adjusted to incorporate the new commodities and interactions between sectors[9].

European household food availability in the MAGNET database

Adding the new livestock and fish sectors to the MAGNET database enhances the ability of the model to trace the food system implications of changes in diets. With European consumers taking centre stage in SUSFANS we summarize the results of increased detail in the MAGNET database in terms of private food expenditures. Note that MAGNET nor GTAP uses intake data to quantify consumption. We can thus determine the private household expenditures on food, but not the actual intake of food which is likely to be lower due to food waste (see also D9.4 for a new MAGNET module capturing consumer food waste). A further limitation for nutritional assessments of the GTAP and thus MAGNET data is the expression of all flows in US dollars and not physical quantities. We will return to this point when describing the new GENuS nutrition module below.

[9] See the MAGNET documentation for more detail.

Table 8: Food and other expenditures in the MAGNET database by world regions (%)

		Low income	Lower middle income	Upper middle income	High income	EU28
	Private income (2011 US $/cap)	*533*	*1,276*	*3,538*	*27,053*	*20,778*
Cereals		**4.82**	**2.62**	**0.34**	**0.04**	**0.18**
	Paddy rice	0.64	0.61	0.03	0.00	0.00
	Wheat	1.10	0.52	0.10	0.02	0.14
	Cereal grains nec	3.08	1.49	0.21	0.03	0.05
Other crops		**8.16**	**8.58**	**2.41**	**0.81**	**0.94**
	Vegetables, fruit, nuts	5.99	6.70	2.02	0.66	0.72
	Oil seeds	0.56	0.87	0.04	0.02	0.02
	Sugar cane, sugar beet	0.16	0.08	0.04	0.00	0.00
	Crops nec	1.46	0.92	0.32	0.12	0.19
Livestock		**3.69**	**3.14**	**1.66**	**0.14**	**0.21**
	Cattle	1.06	0.18	0.07	0.01	0.00
	Other ruminants	0.42	0.17	0.03	0.01	0.00
	Pig and other intensive livestock	0.47	0.24	0.73	0.04	0.05
	Poultry	0.73	0.83	0.60	0.06	0.05
	Raw milk	1.01	1.72	0.23	0.02	0.11
Fish		**0.93**	**1.47**	**0.71**	**0.09**	**0.14**
	Fishing (wild catch)	0.88	1.20	0.48	0.08	0.12
	Diadromous fish (aquaculture)	0.04	0.18	0.12	0.01	0.01
	Fresh fish (aquaculture)	0.00	0.00	0.01	0.00	0.00
	Crustaceans (aquaculture)	0.01	0.08	0.06	0.00	0.00
	Marine fish (aquaculture)	0.00	0.02	0.01	0.00	0.01
	Molluscs (aquaculture)	0.00	0.00	0.03	0.00	0.01
Processed food		**21.24**	**20.18**	**16.88**	**7.10**	**10.09**
	Beef meat products	0.91	0.90	1.50	0.55	0.58
	Other bovine meat products	0.45	0.50	0.20	0.04	0.10
	Pork and other meat products	0.86	0.42	1.11	0.26	0.84
	Poultry meat products	0.60	0.52	0.81	0.32	0.49
	Dairy products	1.57	2.33	1.90	0.65	1.08
	Processed fish	0.31	0.53	0.54	0.21	0.08
	Processed rice	1.79	3.56	0.80	0.18	0.03
	Vegetable oils and fats	1.91	1.93	0.91	0.10	0.20
	Sugar	1.17	0.96	0.35	0.07	0.12
	Food products nec	6.56	5.48	5.24	2.75	3.36
	Beverages and tobacco products	5.11	3.06	3.50	1.98	3.20
Services and non-food		**61.15**	**64.01**	**78.00**	**91.81**	**88.44**
	Services	8.77	9.31	15.72	26.30	17.96
	Non-food	52.38	54.69	62.27	65.51	70.47

Table 9: Expenditure pattern by EU member state (%)

	Private income (2011 US $/cap)	*Cereals*	*Other crops*	*Livestock*	*Fish*	*Processed food*	*Services*	*Non-food*
Austria	28260	0.1	0.9	0.2	0.0	8.4	15.7	74.8
Belgium	26779	0.1	1.2	0.2	0.1	13.2	17.1	68.2
Bulgaria	4970	0.3	1.3	1.5	0.1	19.0	8.7	69.2
Cyprus	17491	0.2	1.3	0.4	0.0	12.4	16.4	69.4
Czech Republic	10492	0.6	1.0	0.2	0.0	13.9	34.0	50.3
Germany	25598	0.2	0.8	0.2	0.0	9.7	21.0	68.1
Denmark	29443	0.1	1.3	0.2	0.1	10.1	18.7	69.5
Spain	18712	0.2	0.6	0.1	0.5	9.7	16.0	72.9
Estonia	9818	0.2	2.6	0.9	0.1	21.0	7.7	67.5
Finland	27158	0.1	1.2	0.1	0.1	10.5	17.3	70.7
France	24058	0.0	0.9	0.1	0.1	10.9	16.8	71.2
United Kingdom	26326	0.1	0.8	0.3	0.0	6.8	17.3	74.8
Greece	20865	0.3	1.7	0.1	0.5	12.1	28.2	57.0
Croatia	9193	0.3	1.7	1.1	0.2	18.4	9.2	69.0
Hungary	8867	0.3	1.4	0.4	0.0	15.3	13.1	69.5
Ireland	19005	0.1	1.0	0.1	0.2	6.1	26.1	66.3
Italy	23174	0.3	0.9	0.2	0.3	9.2	15.5	73.7
Lithuania	10369	0.7	2.2	0.2	0.1	21.1	7.5	68.3
Luxembourg	61424	0.0	0.4	0.1	0.1	12.7	26.6	60.2
Latvia	9935	0.2	1.8	0.6	0.2	18.9	8.5	69.7
Malta	21843	0.1	1.0	0.5	0.3	10.0	16.5	71.6
Netherlands	22884	0.1	0.6	0.1	0.1	9.2	18.4	71.6
Poland	8705	0.4	1.6	0.9	0.0	15.8	14.8	66.4
Portugal	15096	0.1	1.0	0.1	0.5	12.0	23.7	62.6
Romania	6767	1.2	3.3	1.0	0.1	20.7	8.3	65.4
Slovakia	10754	0.5	1.3	0.4	0.0	14.8	22.1	60.9
Slovenia	15166	0.3	2.5	0.5	0.1	13.0	10.6	73.0
Sweden	27670	0.1	1.1	0.1	0.0	10.2	20.0	68.5
EU28	**20778**	**0.2**	**0.9**	**0.2**	**0.1**	**10.1**	**18.0**	**70.5**

Source: author's calculations from MAGNET database (data for 2011)

Table 8 describes the pattern in private expenditures from the MAGNET database expressed as percentages in total expenditures by major world region (for 2011, the MAGNET base year). The top row provides the income per capita in each of the regions, computed as the sum of total private expenditures[10]. It clearly shows the skewed global income distribution where low income countries have less than 1.5 dollar to spend per day. These are averages for each group and there will thus be regions with less than a dollar per day. Although below the high income average, an average citizen in the EU28 can still spend almost 57 dollar a day.

The spending patterns in the MAGNET database are in line with one of the few laws in economics, Engel's law. Poorer households spend more on food (39 percent of their income against 12 in the EU28 and 8 for the high income group). Expenditures of the poor on cheap starchy foods like cereals are also considerably higher than for households in richer regions. The richer regions, in contrast, spend more on processed foods. This difference is especially notable when looking at the new primary and processed livestock sectors. In the case of cattle and other ruminant livestock there are no noticeable expenditure shares in the EU28, the consumption of these types of meat run through the associated processed meat sectors. The additional primary livestock sectors, however, are relevant for low income regions.

Expenditures for fish take a low share in all regions, only for the lower middle income countries it reaches above 1 percent. Looking across the fish production systems aquaculture plays a very minor role. This could, however, change in the future and explicitly including aquaculture in the database allows an assessment for the scope of expanding fish consumption through aquaculture developments as opposed to increasing fishing. In terms of processed fish the EU28 has a noticeably lower expenditure share than the other regions.

For the EU28 we can zoom in further on the individual member states. For readability ***Table 9*** presents only shares by main categories by EU member state alongside the EU28 average already reported in ***Table 8***. To get a better view on the differences across the EU member states ***Figure 10*** shows these expenditure shares relative to the EU average (normalized at 1).

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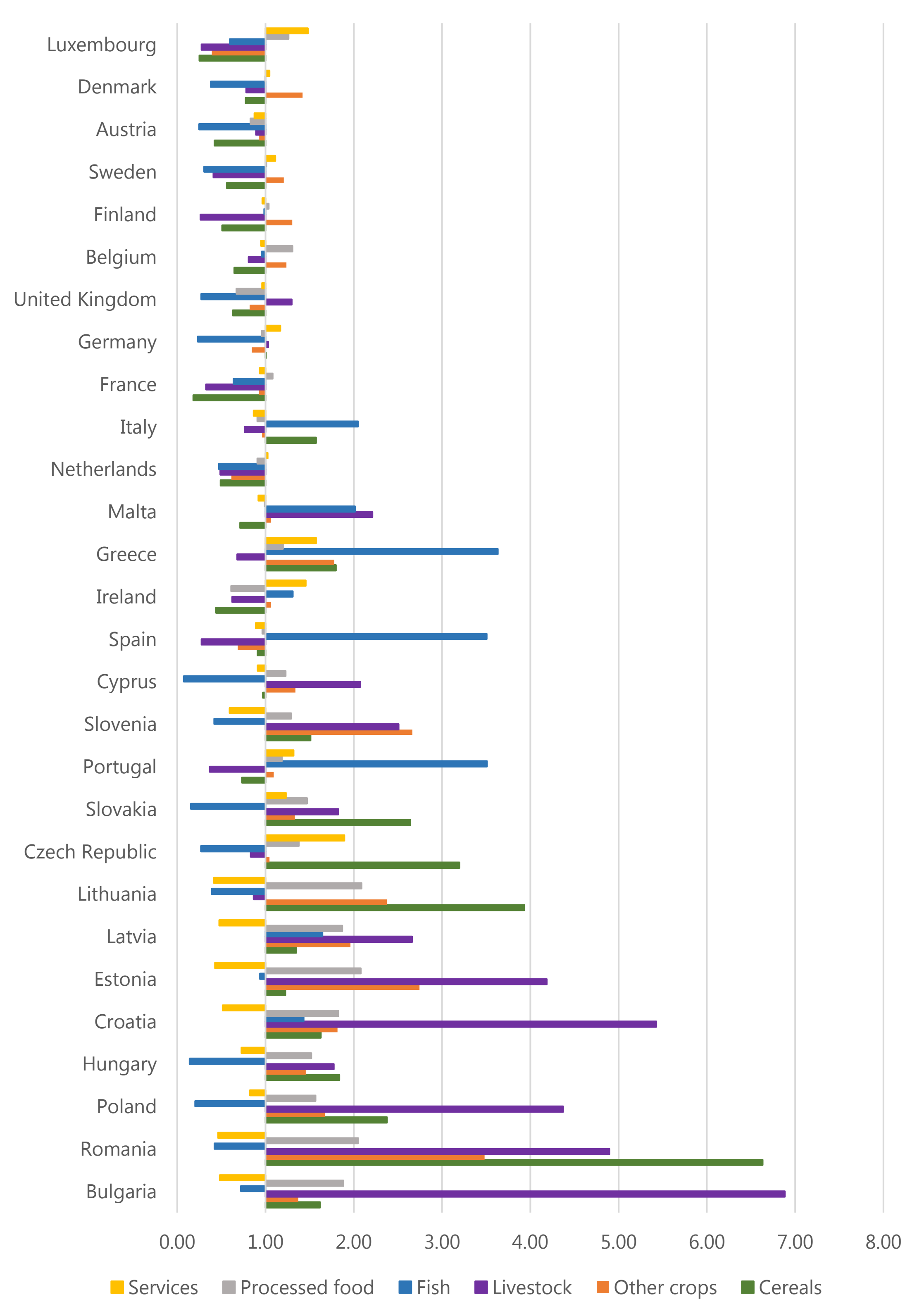
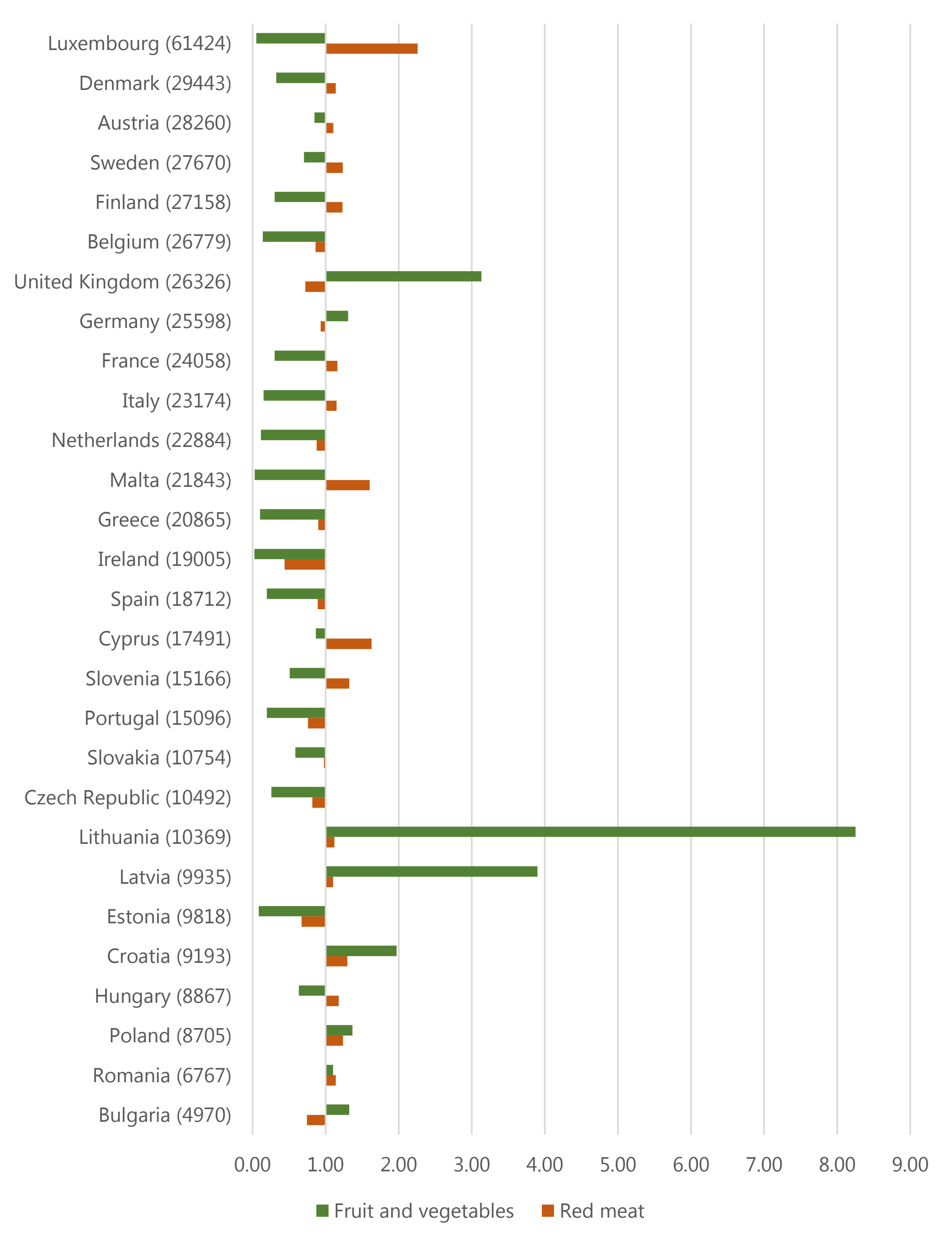
[10] This excludes savings which is in the standard GTAP set-up handled not by the private households but part of the regional household which allocates total national income (payments to endowments, taxes etc.) to savings, government and private household.

Figure 10: Relative expenditure shares by EU member state, ranked by income (2011, EU28 =1)



Source: author's calculations from MAGNET database

Figure 11: Normalized per capita member state expenditures on red meat, fruit and vegetables (2011, EU28 =1)



Note: income computed as total private expenditures per capita in brackets (US $)
Source: author's calculations from MAGNET database

Figure 10 clearly shows the variety in expenditures across the EU member states. Interestingly, Bulgaria has the lowest per capita income but not a much higher expenditure on cereals as one might expect given Engel's Law and does see for Romania. Instead its expenditure share for animal based products is close to 7 times the EU average. Service expenditures are included in ***Figure 10*** because it also includes food consumed out-of-home, for example in restaurants. The aggregated character covering many different types of services, however, makes it hard to derive a direct link to food consumption.

The new MAGNET sectors do allow a better assessment of diet components linked to increased disease risk from red meat. ***Figure 11*** presents per capita expenditures on red meat (beef, pork and other ruminants) by EU member state alongside the expenditures on fruit and vegetables which have a positive impact on health (Springmann, Mason-D'Croz, Robinson, Wiebe, et al. 2016; Springmann, Mason-D'Croz, Robinson, Garnett, et al. 2016). The EU internal market can be expected to prevent massive price differences across Europe and the variety in spending patterns observed in ***Figure 11*** will thus translate into differences in consumed quantities. Additional data supplementing the value based GTAP and MAGNET data are however needed to translate expenditures into quantity-based nutritional assessments. This challenge will be addressed in the last two chapters of this deliverable.

Contribution of the sector splits to SFNS assessments

Increasing detail in both livestock and fish production enhances the ability of MAGNET to assess the food system impacts of changes in diets or production systems. Specifically, these extensions facilitate the exploration of the macro-economic implications of the production side interventions in meat and fish planned for the case studies in WP5.

Given the limited data on which both sector splits are based, a comparison with the input structure and response of these sectors of comparable sectors in CAPRO and GLOBIOM during baseline development in WP10 seems useful. Given the very different nature of the models sector representations will differ, and the ambition is thus not to synchronize but become aware of key differences since they are likely to give rise to different responses in the foresight exercises. The comparison should not be limited to the production structures but extend to the demand side where in the price and income elasticities employed by the models will play a critical role in diet responses to change in the food system.

The data presented above on the variety in consumer expenditures across Europe is only the first piece of the puzzle. More detailed data on physical quantities need to be combined with these new meat and fish sectors and other purchases to be able to assess the nutritional implications of changes in consumer behaviour. For example, expenditures on read meat in high-income Luxembourg may be much higher due to higher quality (i.e. more expensive) types of meat which will not be captured by the very aggregate representation in MAGNET. Adding datasets with more product detail is the topic addressed in the next chapter describing a nutrition dataset that has been added the MAGNET database to feed a newly developed nutrition module.

INCREASING NUTRITION DETAIL – PRODUCTS AND MICRO NUTRIENTS

The current version of MAGNET includes a nutrition module delivering key macro-nutrients (calories, proteins, fats and carbohydrates) building on FAO food balance sheet data (Rutten, Tabeau, and Godeschalk 2013). Due to available data and design of this existing nutrition module data are only available at MAGNET sector aggregation and limited to macro nutrients. Experience gained while applying the module is that the limited product detail can generate difficult to interpret changes in nutrition indicators which are, at least in part, due regional differences in products aggregated into a homogeneous MAGNET commodity. A small change in regional composition of trade flows can then translate into very large changes in associated nutrition indicators. Apart from an ambition to expand the nutrition indicators to tracking of micro nutrients (as set out for task 9.2) we therefore also aim to increase the product detail used for nutritional assessments to better capture product variety obscured by the aggregate representation of products in MAGNET.

The original plan was to enhance the nutritional data for the EU focus countries using the SHARP database from WP7, which unfortunately have been delayed. To move forward we have turned to the Global Expanded Nutrients Supply (GENuS) Model by Smith et al. (2016). This database covers macro and micro nutrient data for 225 products in 152 counties, including the four SUSFANS focus countries. In addition it has an estimate of the nutritional availability by age and sex for each of these countries. Apart from the global coverage not available from the European focussed SHARP data, the GENuS data may also support the upscaling of the SHARP data from the four focus countries to European level by providing data on availability of products.

This chapter summarizes the construction and coverage of the GENuS dataset and describes the nutritional data it holds for the focus countries in a broader European perspective. The next chapter then describes the GENuS nutrition module in MAGNET which makes these data available for foresight analyses with the SUSFANS toolbox.

Construction of the GENuS nutrition database

The GENuS database combines the FAO food balance sheets with other data sources to construct a global and historical food and nutrient supply database[11]. The national level GENuS databases offer a time series of edible food supply from 1961 until 2011. For 2011 the nutritional value of the commodities by country are provided in a separate dataset (excluding fortification). Combining these two data sources thus provides a picture of the nutrient supply at national level.

To better understand the scope and limitations of the GENuS datasets we shortly describe the construction of each set of files. ***Figure 12*** outlines the construction of national level time series in edible foods. Starting point is the time series of food supply from the FAO Food Balance Sheets (FBS). Commodity detail is increased from 98 in the FBS to 221 using trade data supplemented by national census data to disaggregated trade classifications for fruit and vegetables. The latter adjustments is only possible for a subset of 152 countries. A transition from primary weight to edible or retail weight is made accounting for slaughtering, peeling of fruits and nuts and milling. To capture the rather different nutritional profile of flour an additional four commodities are added, resulting in 225 commodities in the final database of edible food supple (expressed in g/person/day).

The 2011 edible food supply is then used to compute the nutrient supply in 2011. In theory this entails a straightforward multiplication of the edible amounts of food (in g/person/day) with the nutrient density of each food item. In practice lack of data makes the translation much more complicated, as reflected by the steps towards the nutrient supply tables (***Figure 13***). First each region is mapped to a very limited set of existing regional specific food composition tables. If there is no regionally appropriate table, as is the case for Europe, the USDA table is used. A second issue is to map the 225 edible food commodities to the food items in each food composition table. In case a mapping to multiple items could be made all potential food items are taken along to the second step.

[11] The datasets are available (in csv format) at https://dataverse.harvard.edu/dataverse/GENuS

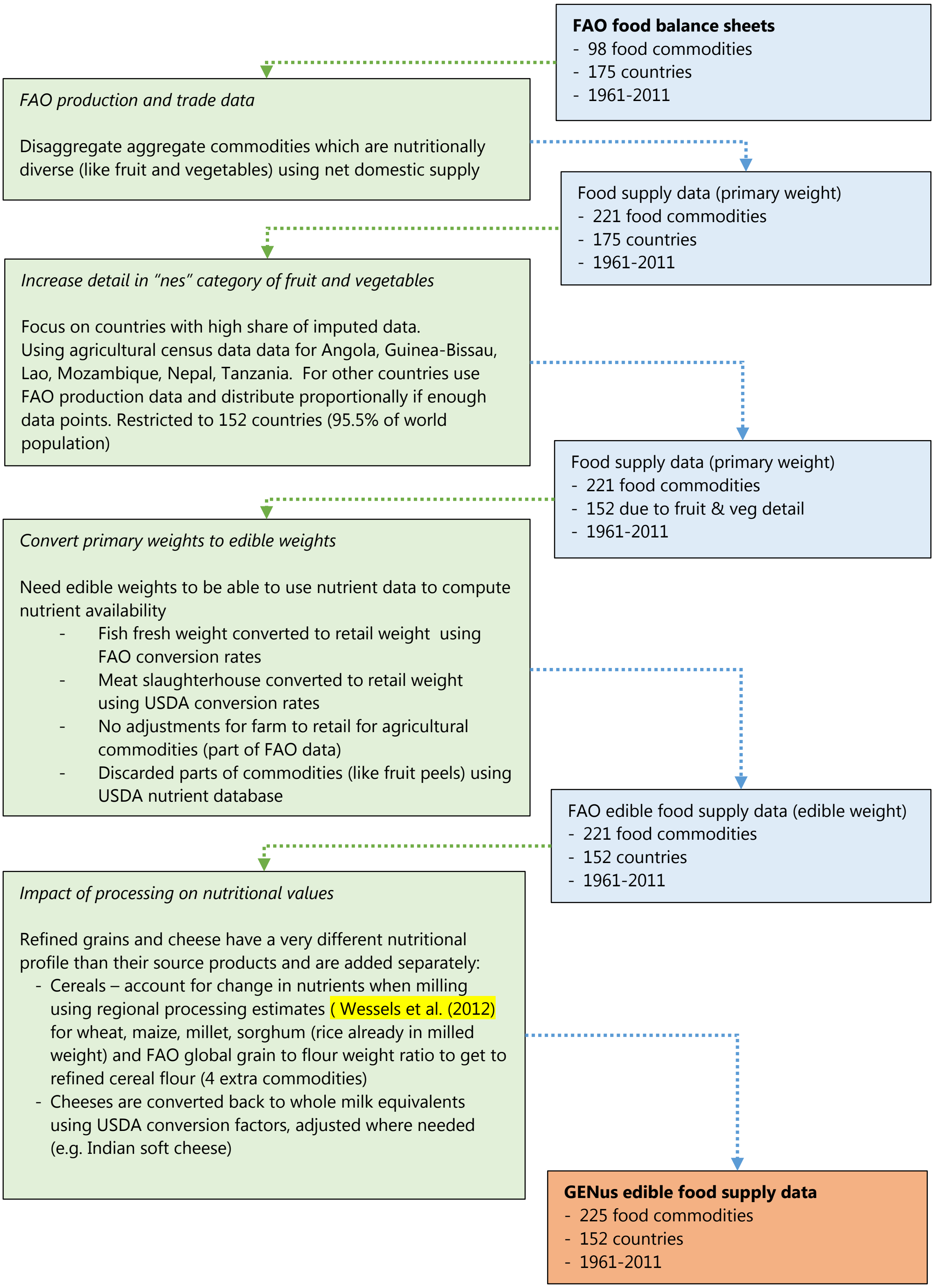


Figure 12: GENuS data procedure for the edible foods in g/person/day by country and year database (derived from Smith et al. (2016))

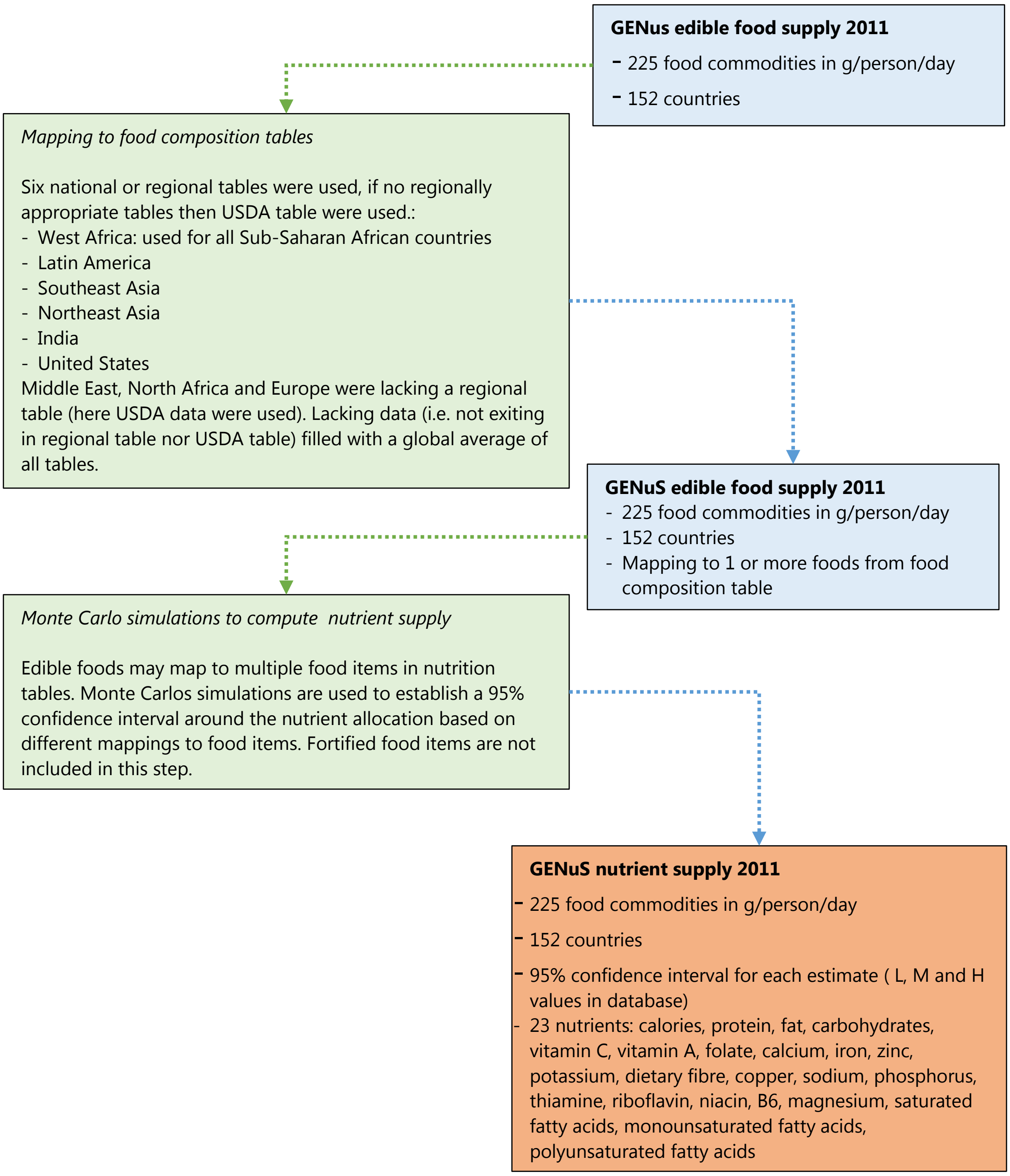


Figure 13: GENuS data procedure for determining the nutrients by person/day supplied in 2011, by food and country (derived from Smith et al. (2016))

This second step consists of accounting for the uncertainty in terms of nutritional content when assigning food items to the edible food commodities. Using 1000 Monte Carlo simulations of different choices for each nutrient a 95% confidence interval is constructed. These are labelled in the data by Low (L), Median (M) and H (estimates). The resulting dataset describes the supply per person per day in 2011 for the following 23 nutrients: calories, protein, fat, carbohydrates, vitamin C, vitamin A, folate, calcium, iron, zinc, potassium, dietary fibre, copper, sodium, phosphorus, thiamine, riboflavin, niacin, B6, magnesium, saturated fatty acids, monounsaturated fatty acids, and polyunsaturated fatty acids (see Annex 5 for their units of measurement). Compared to the macro nutrients covered by the current nutrition module this dataset greatly expands the scope of MAGNET for assessing the nutritional implications of the food supplied to households. In addition it has much greater commodity detail with 225 commodities, which can be used to address the aggregation issues in heterogeneous commodities faced by the current nutrition module.

In addition to the national level average availability of food and associated nutrients the GENuS database also contains data for 2011 on edible food and nutrients (with and without fortification) by age and sex. These data are obtained by matching the national averages to demographic food intake data in the Global Dietary Database (see for more details on the procedure Smith et al. 2016). While providing a tantalizing amount of detail to assess diets, the absence of socio-economic indicators like education or income, makes a connection to these data in long run projections less obvious. In essence each demographic class is treated as being representative of all people in that age-sex class, ignoring differences in socio-economic status which will affect diets both in the current situation and when projecting to a future point with different income developments.

The GENuS database provides information on edible food supply for 225 commodities for 175 countries from 1961 to 2011. For 2011 an allocation of national supply by age and sex is available. More specifically the following datasets are publicly available[12]:

- Time series of edible food supply at national level (1961-2011)
- Nutrient supply by food and country (2011)
- Edible food supply by age and sex (2011)
- Nutrient supply by age and sex, excluding fortification (2011)
- Nutrient supply by age and sex, including fortification (2011)

The first two datasets at national satisfy the minimal requirement to compute nutrient indicators with MAGNET, comparable to the national average macro nutrient indicators from the current nutrient module. The last three datasets

[12] The datasets are available (in csv format) at https://dataverse.harvard.edu/dataverse/GENuS

offer the possibility to compute a distribution of nutritional impacts across different population groups from the nation level changes resulting from MAGNET and to account for fortification.

Thus far we included edible food supply at national level for 2011 (the current MAGNET base year), the nutrient supply by food and country for 2011 and the edible food supply by age and sex for 2011. Applying the national level nutritional composition of food we compute the nutrient supply by age and sex, thus excluding fortification.

All GENuS data are expressed in quantities per person, per day. We combine the GENuS data with UN population statistics for 2011 (United Nations 2017) to compute population-weighted average person/ day nutrition availabilities for MAGNET (model) regions. Using the UN population data we can also compute the coverage of the 141 MAGNET regions by the GENuS database, which amounts to 93 percent of the world population (see Annex 4 of a coverage for the 141 MAGNET model regions). Within Europe all 28 EU member states are included in the GENuS database. We can therefore derive a complete picture of food and nutrient availability for the EU28 according to GENuS.

European diets according to GENuS – a national perspective

With 23 nutrition indicators, 225 products and 152 countries there are many ways to slice the GENuS data. To get a first handle on what it entails in terms of diets we start by looking at edible food availability. Note that the GENuS data are not derived from consumer intake surveys. Although care has been taken to account for losses due to peeling and slaughtering etc., the numbers from GENuS are expected to be higher than comparable numbers from consumer intake data. Once the SHARP data are available and connected to MAGNET a comparison with GENuS can be made, which may provide clues to consumer food waste and can possibly be used to fine tune the waste estimations in the new MAGNET waste module (described in D9.4).

The edible food availability allows us to assess the GENuS results in terms of the SUSFANS food based dietary guidelines for Europe defined in WP2, reported in D2.2 and summarized for quick reference in Table 10.

Table 10: SUSFANS food based dietary guidelines with cut-offs defined

Diet factor	Exposure definition	Minimum	Maximum
Vegetables	All kind of vegetables (including fresh, dried, tinned or canned vegetable products, but excluding vegetable juices and vegetables from soup, sauces and ready-to-eat products)	Minimum of 200 grams of vegetables a day	
Legumes	Legumes include kidney beans, pinto beans, white beans, black beans, garbanzo beans (chickpeas), lima beans (mature, dried), split peas, lentils, and edamame (green soybeans)	Minimum of 1 serving of legumes a week (135 grams a week ≈ 19 grams a day)	
Nuts and seeds	Walnuts, almonds, hazel, cashew, pistachio, macadamia, Brazil, pecan, pine nuts, flax seeds, sesame seeds, sunflower seeds, pumpkin seeds, poppy seeds, and peanut	Minimum of 15 grams of unsalted nuts or seeds a day	
Fruit	All kind of fruits (including fresh, dried, tinned or canned fruit products, but excluding fruit juice)	Minimum of 200 grams of fruit a day.	
Meat	Red meat: all mammalian muscle meat, including beef, veal, pork, lamb, mutton, horse and goat. Processed meat: meat that has been transformed through salting, curing, fermentations, smoking or other processed to enhance flavour or improve preservation (e.g. meat products as sandwich filling, ready-to-eat minced meat, sausages, etc.). White meat: meat from all kind of poultry.	Guideline on replacement of red and processed meat by white meat	Maximum of 500 grams of red meat (including processed meat) a week (≈71 grams a day)
Fish	All kind of fish and fish products	Minimum of 1 serving of fish a week (105 grams a week ≈ 15 grams a day)	
Milk and milk products	Food products produced from the milk of mammals, including milk, yoghurt, fresh cheese, quark, custard, milk puddings, cheese, butter, etc.	Minimum of 300 g of total dairy products a day	Maximum of 150 grams of cheese a week (≈21grams a day)
Sugar-sweetened beverages	Cold beverages with added sugars (sucrose, fructose or glucose), for example fruit juices, fruit nectars, soft drinks, ice teas, vitamin-water or sports drinks with added sugars, excluding 100% fruit juices without added sugars	Guideline on replacement of sugar-sweetened beverages by drinking water, coffee and tea.	Maximum of 500 mL of sugar-sweetened beverages a week (≈ 71 mL a day).
Alcoholic beverages	Alcohol beverages include beer and beer-like beverage, wine and wine-like beverage, mixed alcoholic drinks and unsweetened spirits and liqueurs. One serving of an alcoholic beverage contains 10 gram of alcohol equivalent to 250 mL of beer (5% alcohol), 100 mL of wine (12% alcohol) and 35 mL of liquor (35% alcohol)		Maximum of 1 serving of alcohol a day (1 serving contains 10 grams of alcohol equivalent to 13 mL of alcohol)
Salt	Salt present in foods and salt added during cooking and at the table.		Maximum of 6 grams of salt a day

Source: Mertens et al. (2016)

The SUSFANS dietary guidelines focus on factors important to either disease burden or health policy defining a cut-off pointy by category representing the minimum and/or maximum level of exposure to promote health and minimise disease risk. Cut-off points are derived from literature and national food-based dietary guidelines of the four focus countries taken to be representative for the EU diversity in food patterns (Scandinavia - Denmark, Central East Europe – Czech Republic, Mediterranean region - Italy and Western Europe - France). Note that the guidelines included in Table 10 are restricted to a subset of the diet factors identified by Mertens et al. (2016) with quantitative limits and thus usable for assessment with the GENuS data.

The two beverage categories are least straightforward to handle but for different reasons. Sugar-sweetened beverages are a processed food not captured as such in the GENuS database (see Annex 5 for a complete list of GENuS food products). For now only fruit juices are mapped to these beverages, which is a clear underestimation. GENuS does provide data on sugar, in various forms, but these are not straightforwardly connected to beverages.

In case of the alcoholic beverages the cut-off is based on serving size and will thus differ by alcoholic beverage depending on its alcohol percentage. Effectively this amounts to drink-specific cut-offs which could be explored in the future g/person/day in the GENuS data with some additional aggregation procedures.

Finally salt is both a separate commodity as well as a component of (processed) foods but not part of the GENuS food products. Sodium, the offending component of salt, is however part of the GENuS nutrition indicators. Sodium availability can thus be assessed both in total, referring to the salt cut-off above, and by food product. As the GENuS database refers to food available for consumption but not intake this will not capture any salt added during cooking.

Aggregating GENuS edible food availabilities into the diet factors in Table 10 we can hold the EU member state diets against the SUSFANS guidelines (***Table 11***). Cases where availability exceeds a minimum cut-off are marked green, cases exceeding a maximum amount marked red. Countries are ranked again based on income computed from MAGNET consumption expenditures (with Bulgaria being poorest and Luxembourg richest). There is no obvious relationship between average national income and adherence to the guidelines. Of course actual intake may be lower due to food waste and either higher or lower for specific socio-economic groups in each country. Nuts are by far the category where fewest countries meet the guidelines with only Greece barely making the cut-off by 1 gram. On the opposite side of the spectrum we find red meat availability exceed the recommended 71 grams per day in all EU member states.

Table 11: SUSFANS dietary guidelines and GENuS availability data (g/person/day)

	Vegetables	Legumes	Nuts	Fruits	Red meat	Fish	Diary
Cut-off	*> 200*	*> 19*	*> 15*	*> 200*	*<71*	*> 15*	*> 300*
Bulgaria	137	9	5	124	88	9	400
Romania	358	13	3	213	88	8	661
Poland	300	12	3	141	136	16	654
Hungary	143	27	2	186	127	7	404
Croatia	173	7	6	260	115	29	532
Estonia	247	12	4	145	82	17	942
Latvia	255	0	5	115	114	39	638
Lithuania	269	15	4	97	105	65	1410
Czech Rep.	153	9	5	142	126	13	493
Slovakia	191	6	4	131	106	11	338
Portugal	344	28	6	256	146	72	499
Slovenia	165	10	7	287	123	15	562
Cyprus	170	17	12	209	103	29	348
Spain	252	37	12	217	138	58	401
Ireland	167	11	6	278	116	28	1806
Greece	437	25	16	395	127	27	741
Malta	360	30	10	223	130	45	247
Netherlands	155	14	10	357	111	31	1644
Italy	256	24	10	338	144	36	593
France	186	27	7	214	138	48	1000
Germany	201	6	11	177	148	17	920
UK	180	21	8	246	102	22	537
Belgium	284	54	7	134	136	33	763
Finland	195	6	6	186	104	47	1141
Sweden	188	17	9	232	123	36	894
Austria	230	11	9	381	185	17	741
Denmark	241	10	7	223	115	41	1635
Luxembourg	231	3	1	357	141	37	881

Source: author's calculations from the GENuS database (Smith et al. 2016).

With vegetables, fruit and red meat being critical factors for disease burdens health (Springmann, Mason-D'Croz, Robinson, Wiebe, et al. 2016; Springmann, Mason-D'Croz, Robinson, Garnett, et al. 2016) we explore theses data a bit further with a spider diagram presentations of these data in ***Table 11***.

Vegetable availability is below the 200g/person/day in 13 of the member states (***Figure 14***). Given the perishable character of vegetables and thus likelihood of food waste, this does not bode well for vegetable consumption in about half the member states. Countries are ranked again based on income computed from MAGNET consumption expenditures (with Bulgaria being poorest and Luxembourg richest). ***Figure 14*** does not show an obvious relationship between income and vegetable availability. There is also no immediately obvious difference based on culturally or regionally defined diets, which may complicate the extrapolation from the four focus countries to the EU level.

Figure 15 presents the GENuS fruit availability by EU member state, where only 11 countries reach the minimum of 200 g/person/day. Comparing vegetable and fruit patterns does not show a clear correlation between the two. The aggregate MAGNET representation of fruit and vegetable in ***Figure 11*** thus obscures potentially diverging patterns for fruit and vegetables.

Figure 16 presents red meat availability showing the excess relative to the guideline of 71 grams at a glance. It is also immediately obvious that at national level income is not a determining factor for red meat purchases, all countries exceed the recommendation massively. Again this may be different for vulnerable socio-economic groups, but at national level there is an obvious rationale from a health perspective to reduce red meat consumption.

Next to red meat there is also a maximum advised for salt. Although GENuS does not include data on salt sodium availability by food item and region are included. Using the composition of table salt[13] 6 grams of salt corresponds to 2325 mg of sodium. Computing total national average sodium availability for EU member states results in numbers well below the advised 2.3 g/day (***Figure 17***). As discussed above GENuS includes median upper and lower estimates on nutrient availability due to the complexities of matching food composition tables to individual commodities. This uncertainty is visualized in ***Figure 17*** by the coloured area around the median estimate. There is a clear skewedness with more upwards uncertainty. But even using the much higher upper estimates only Ireland, Denmark and Luxembourg exceed the recommended 2325 mg a day.

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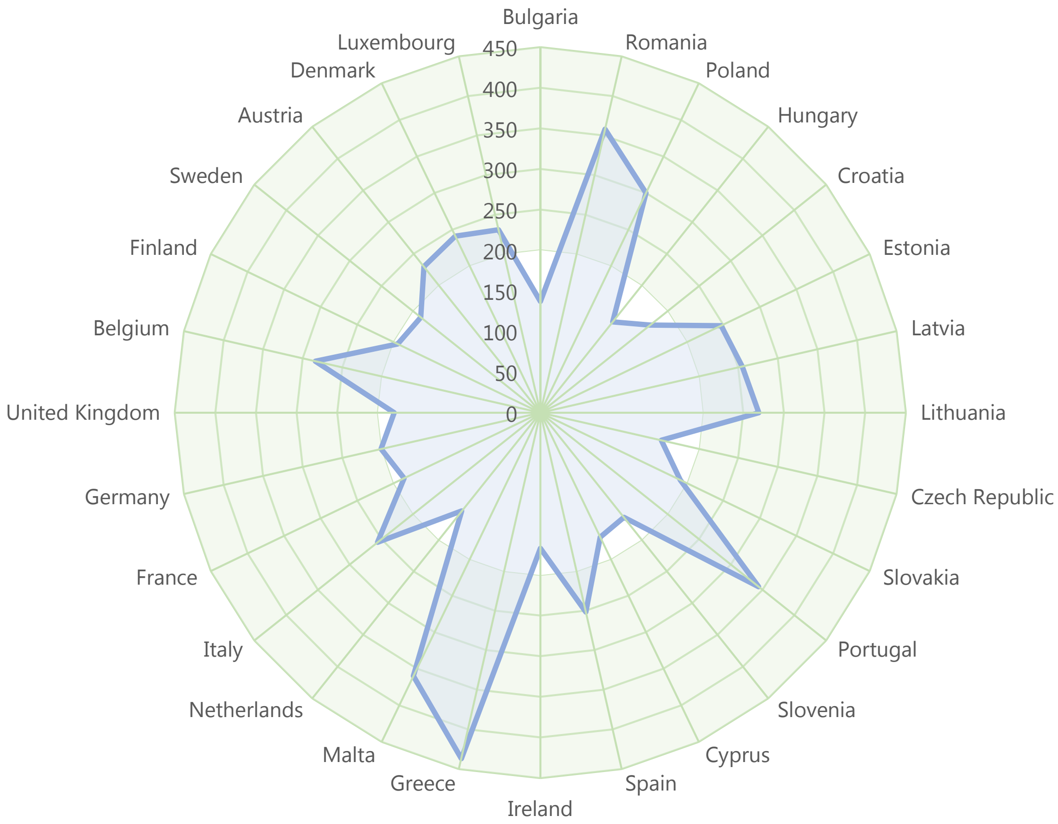
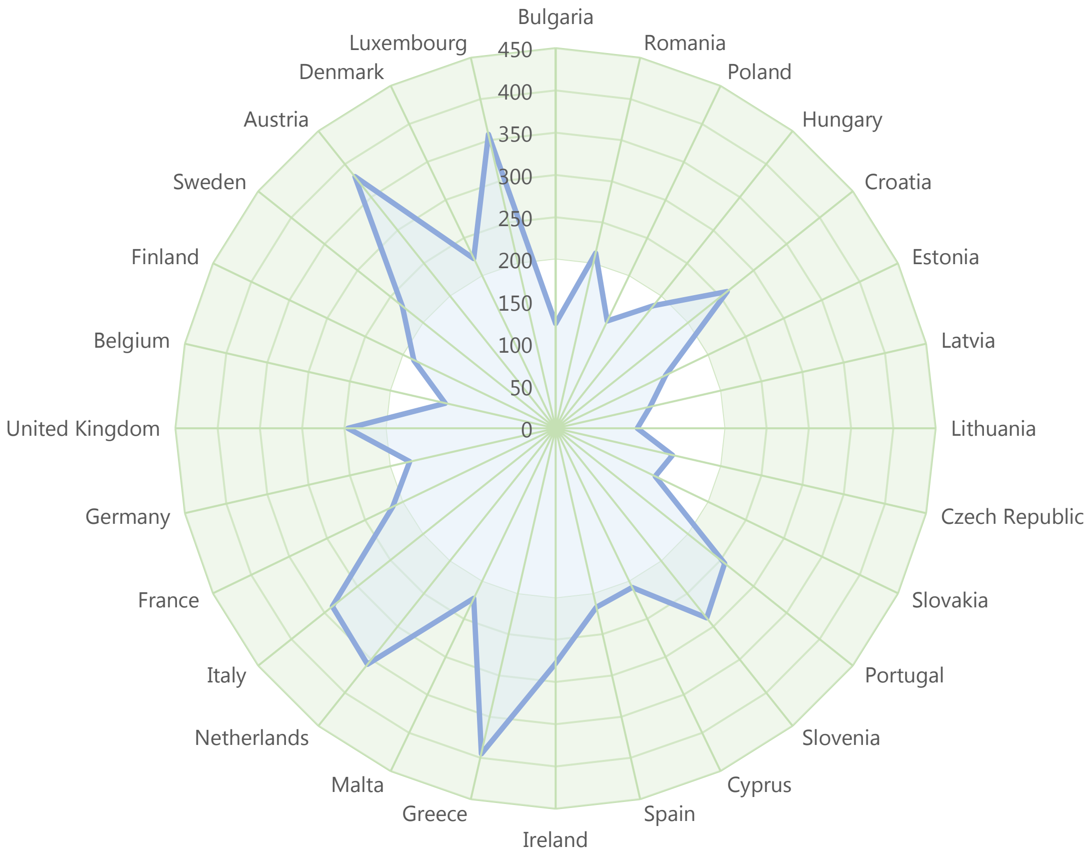
[13] "National Nutrient Database for Standard Reference, Basic Report: 02047, Salt, table". Agricultural Research Service, National Nutrient Database for Standard Reference, Release 27. United States Department of Agriculture. Accessible at: https://ndb.nal.usda.gov/ndb/search/list

Figure 14: GENuS vegetable availability by EU member state (g/person/day, 2011)



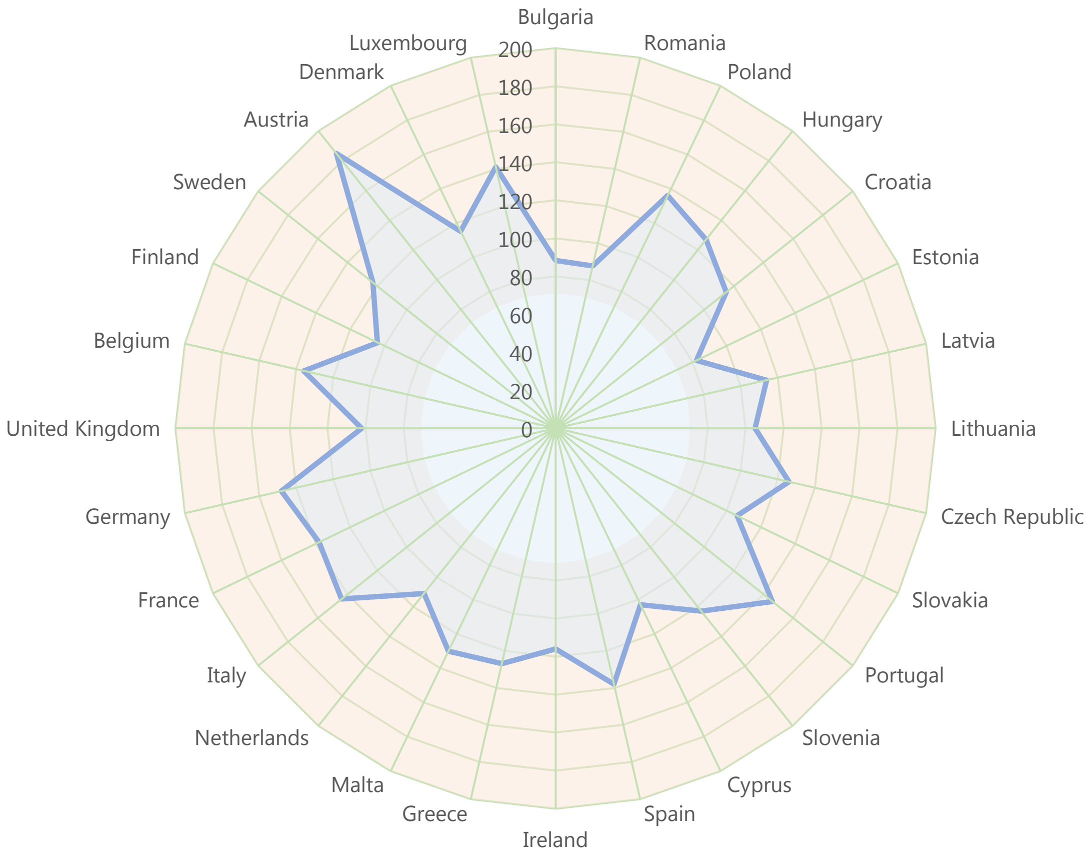
Note: SUSFANS food based dietary guideline for vegetables is a minimum of 200 g/person/day (green area).
Source: author's calculations from the GENuS database (Smith et al. 2016)

Figure 15: GENuS fruit availability by EU member state (g/person/day, 2011)



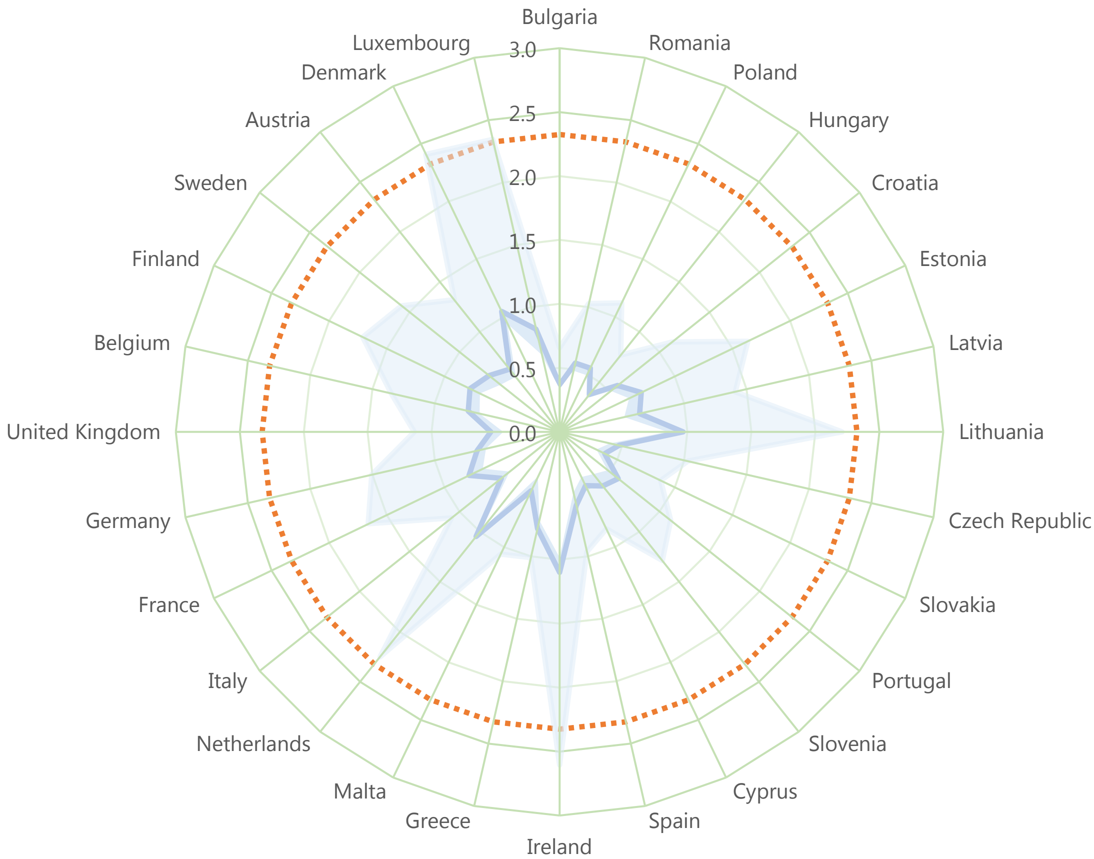
Note: the SUSFANS food based dietary guideline for fruit is a minimum of 200 g/person/day (green area).
Source: author's calculations from the GENuS database (Smith et al. 2016)

Figure 16: GENuS red meat availability by EU member state (g/person/day, 2011)



Note: the SUSFANS food based dietary guideline for red meat is a maximum of 71 g/person/day (red area).
Source: author's calculations from the GENuS database (Smith et al. 2016)

Figure 17: GENuS sodium availability by EU member state (g/person/day, 2011)



Note: the SUSFANS food based dietary guideline for salt is a maximum of 6 g/person/day, translating to 2325 mg/day for sodium (orange dotted line). The coloured area captures the lower and upper estimates of sodium availability.
Source: author's calculations from the GENuS database (Smith et al. 2016)

Concerns regarding excessive sodium consumption on which the dietary guideline for salt is based are thus not supported by the GENuS database. The most likely reason is the limited representation of processed foods in the GENuS database (see Annex 5 for a full description of the dataset). With salt not tracked as a primary commodity by itself, additions of salt during processing (for taste or preservation purposes) are missed by the GENuS data originating from the FAO primary production databases. This implies that for nutrients not linked to primary products covered by FAO but regularly added during processing the GENuS database will underestimate availability in products purchased by consumers.

GENuS database contribution to SFNS assessments

The GENuS database offers the opportunity to greatly enhance the ability of MAGNET for tracing (micro) nutrients in diets by offering a consistent global dataset. Furthermore the number of products distinguished in the dataset provides a much more detailed perspective than permitted by the MAGNET database, including the existing nutrition module defined on GTAP primary content (Rutten, Tabeau, and Godeschalk 2013). The GENuS data allow calculation of adherence to the European food-based dietary guidelines as defined in D2.2, and due to the scope of the data provide an assessment for all EU member states. It thus greatly enhances the scope for SFNS assessments.

Before turning to the inclusion of the GENuS nutrition data in MAGNET we need to be clear on the limitations of the GENuS data as well. The main limitation is the production focus of the nutrition values, i.e. the data refer to availability for private consumption but not actual intake. Given consumer food waste the GENuS data will overestimate the actual intake. Comparison with the SHARP database can provide an insight in the extent of this overestimation for the four SUSFANS focus countries, possibly by category of products knowing for example that fruit and vegetables are more perishable than flour.

A second key limitation of the GENuS database is its primary product focus with scant coverage of processed foods. This limitation plays out in different ways depending on the commodity concerned. For example, in the case of sugar all available sugar is represented in the database but its use in for example sugary drinks is not. GENuS can therefore estimate total sugar availability, but not the amount of sugary drinks (one of the SUSFANS diet factors). In contrast, for salt part of the availability will be missed because salt is not traced as a primary product. Any salt added during processed food not distinguished in GENuS will thus be ignored. The result is the underestimation of sodium availability in ***Figure 17***.

Finally, while the provision of data by age and sex groups offers a first tantalizing view of the sub-national distribution of food and assessing nutritional impacts taking into account different nutritional requirements by age and sex, these data do not capture any socio-economic differentiation. Adding such socio-economic detail would not only enhance the base year assessment of nutritional status knowing that diets vary by socio-economic status. If a link between key socio-economic characteristics and macro-economic developments can be established, for example a link to income developments, forward looking nutrition assessments would be greatly enhanced.

MAGNET FOODPRINT MODULE – TRACKING AND TARGETTING CONSUMPTION IMPACTS

The foodprint module in MAGNET aims to trace the impact of private consumption[14] on health and sustainability. Both these impacts tend to involve more detail, for example in terms of food items or spatial variety in impact, than captured by MAGNET. In many cases, increasing the level of detail in MAGNET does not make sense in that the data needed to calibrate the additional detail are not available, especially not with the global coverage required. An additional concern is the rapid explosion of the model dimensions increasing runtime and thus usability of the model.

For example, nutritional assessments are often made using thousands of products. Theoretically these could be included in MAGNET, requiring data on cost structures (i.e. which intermediate inputs and production factors are used in which quantities), consumer preferences (how does demand for each product change when relative prices or incomes change) and trade flows (most easily obtained of all three types of data). Lacking such data, commodities could be added in a synthetic fashion (e.g. using the cost structure of the original MAGNET sector to which they map). However, with such a synthetic approach the inclusion does not add interactions not already captured by the current aggregate representation and furthermore suggest an insight in, for example, substitution among commodities not backed by data. Finally including thousands of products in a model like MAGNET which traces all bilateral trade flows rapidly results in an explosion of the model dimensions.

Adding a huge amount of detail with very limited or no empirical backing does not exploit the core strength of MAGNET in connecting macro level interactions, quantifying trade-offs and synergies. At the same time moving beyond the national or average impact captured by MAGNET to more detailed assessments of either health or sustainability impacts of consumption is greatly enhances the policy relevance of results.

The foodprint module aims to provide such a bridge, allowing a connection to micro-level assessments. The ambition level of this connection can vary across different components of the foodprint module. At minimum there is a top-down

[14] MAGNET, being an economy-wide model, also includes government consumption which is not included in the foodprint module.

mapping from a MAGNET variables to multiple foodprint variables. For example, a percentage change in quantity of private purchases of ruminant meat from MAGNET is applied to the supply of edible quantities of different types of meat (cattle, sheep, goat etc.) by demographic group. Such a top-down mapping preserves the complete structure of the more detailed data, i.e. it assumes the pattern of consumption is not affected by the macro level changes.

A more refined approach would employ a reduced form take on adjusting the distribution of the micro data. For example, if it is known that an increase in income shifts consumption from sheep and goat towards cattle meat, then the shares of each type of meat in total ruminant meat can be adjusted. This would require the definition of a link between income per capita and the shares by type of ruminant meat. This is referred to as a reduced form approach because we do not fully model how the income changes feeds into a change in eating habits (which would require data on income sources, relative price changes etc.). Instead it is more of a black box approach using past trends to quantify the correlation between income per capita and types of meat purchased. Depending on the availability of data the connection can be made even more complex, for example tracing household specific changes in income and resulting diet patterns.

One may argue that a top-down mapping, however refined, does not need to be included in MAGNET but can be done ex-post outside of the model. It is, however, handy in practice to have all results from a scenario in a single file so one can easily move between macro level changes and micro level impacts. Furthermore, using the condensation possibilities in GEMPACK ex-post calculations do not need to slow the model down if they are only computed after a solution has been found. The dimensions of the foodprint module thus does not need to have an impact on the solution time. If any component would be so large as to affect the runtime it can easily be switched off if not relevant using the modular set-up of MAGNET.

There is a third, and more content-based, reason to include the foodprint module in MAGNET. It allows the inclusion of upward links, where aggregates computed from the detailed data do affect the model results. For example, if we have an exogenous change in consumption pattern defined at micro level we can shock the weights of each commodity when computing the aggregate calories in a MAGNET commodity. To continue on the ruminant meat example used above, a shift may be imposed away from cattle and towards sheep and goat meat. This change in weights may affect the total calorie content of ruminant meat at MAGNET level, as computed from these micro level data. If then the model closure is changed by fixing the total amount of private household calories, the shock on the micro level weights starts affecting the macro-economic interactions in MAGNET. Including the foodprint module in MAGNET thus facilitates assessing the macro-level impacts of micro-level shocks.

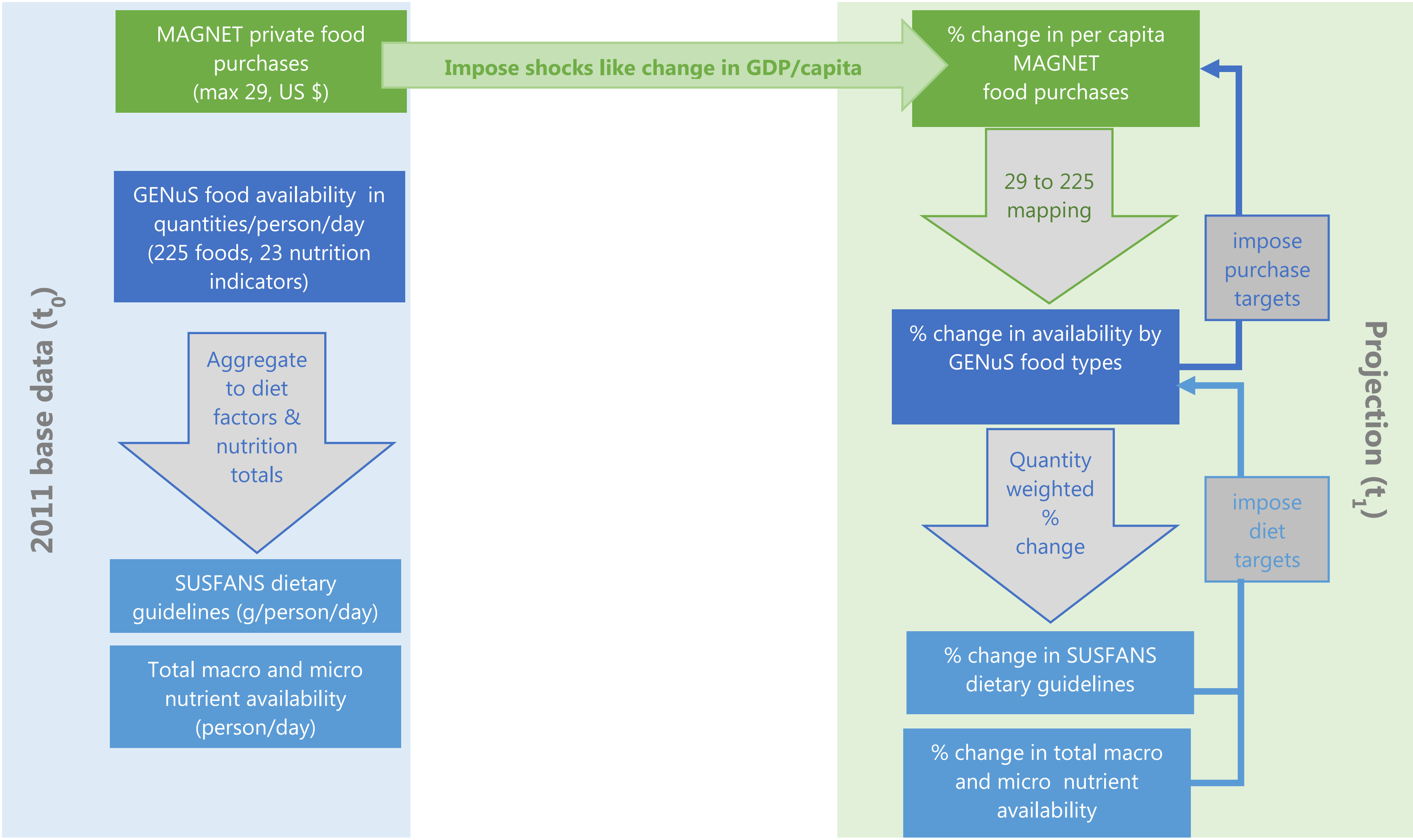
The aim of the foodprint module is two-fold. First of all to enhance the ability of MAGNET to take micro-level changes into account when assessing health and sustainability consequences of private consumption. Second, to ease the connection with complementary models which address specific topics in much more detail. For example, a SHARP foodprint module would allow an exchange with the SHARP model at their commodity and country level. This would ease the use of macro-level MAGNET changes in SHARP assessments, while insights from SHARP may be used in MAGNET. For example, if based on SHARP a correlation between income changes and consumption pattern can be established this could be added as an upward link in MAGNET. Another option would be to include a GLOBIOM module to connect insights from their detailed sustainability assessments with macro level changes in MAGNET. The remainder of this chapter discusses the GENuS nutrition module, the first component in the foodprint module, including some first simulation results.

The MAGNET GENuS nutrition module

The key challenge for the GENuS nutrition module is to connect the details of the data discussed in the previous chapter to the more aggregate representation in MAGNET. ***Figure 18*** presents a schematic overview of the link between the GENuS module and the rest of MAGNET. The left hand side shows the data in the base year from which the modelling starts. Here there is no consolidation or connection between the different data sources: the GTAP derived private expenditures in MAGNET are total national expenditures expressed in 2011 US $ while the GENuS data are in quantities per person per day (with quantity units varying by nutrient). The GENuS data are aggregated to the model regions using population weighted averages in case a MAGNET model region covers multiple GENuS countries.

From the GENuS data we can compute nutrition indicators like the SUSFANS dietary guidelines discussed in the previous chapter or total availability per person per day of macro and micro nutrients (like calories, vitamins, different types of fat etc.) . These indicators can be used both to assess current diets as well as to impose targets, as discussed below.

Figure 18: Schematic overview of the connection of the GENuS module to the rest of MAGNET



The MAGNET model can then be used to project forward or for comparative static analyses of changes in the food system from fork to farm. ***Figure 18*** presents the way in which the MAGNET model will be used in the foresight analyses, projecting from the 2011 base year to a future year (t_1). Common exogenous drivers are GDP and population changes, as indicated in the green arrow, which will generate in a change in the per capita food purchases relative to 2011 (as well as a host of other macro-economic changes in prices, production and trade which are ignored in the current exposition).

Using the mapping from GENuS to the commodities in the MAGNET database (see Annex 5) we can construct a mapping from the model's sector aggregation to the GENuS commodities[15]. Using this mapping we downscale the macro results to the GENuS commodities. The underlying assumption is that the composition of the GENuS food availability will not change. In other words, all GENuS commodities linked to the same MAGNET sector change by the same percentage thus preserving the base year detailed food pattern "inside" a MAGNET commodity. With MAGNET commodities changing at different rates the overall GENuS food pattern (across all MAGNET commodities) will change. While the uniform allocation of changes in MAGNET sectors to associated GENuS commodities is not very satisfactory, additional data are needed to modify this assumption.

Applying the percentage changes to the base year numbers we can compute the new quantities of GENuS commodities and re-compute the resulting nutrition indicators (both in percentage and quantity terms). Here the underlying assumption is that the nutritional content of the GENuS food commodities is fixed and all nutrition indices of a particular GENuS food thus change with the same percentage, Again, with additional data, this could be altered. A product reformulation, for example, could be captured by varying the percentage changes in the nutrition indices.

So far we only discussed the top-down transfer where the GENuS variables change with the rest of the model but do not affect the model solution. While very useful for tracking nutrition alongside all other (macro-economic) changes, one may also want to impose a diet target. This can be done by making one (or more) GENuS variables exogenous so they can be explicitly targeted. In this way

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[15] Over 70 commodities are potentially available in the MAGNET database which for computational reason are aggregated to a much smaller number of commodities in line with the research question at hand.

diet changes can be imposed and the food system response form fork to farm assessed.

MAGNET being a general equilibrium model endogenous variables can only be made exogenous if another variable (with matching dimensions) is made endogenous. Apart from the pure mathematical background of this variable swap[16] it forces one to be explicit on the instrument employed to reach the target. As the application below illustrates the choice of instrument is not trivial and will affect the model results.

Illustrative example of the GENuS nutrition module – red meat reduction

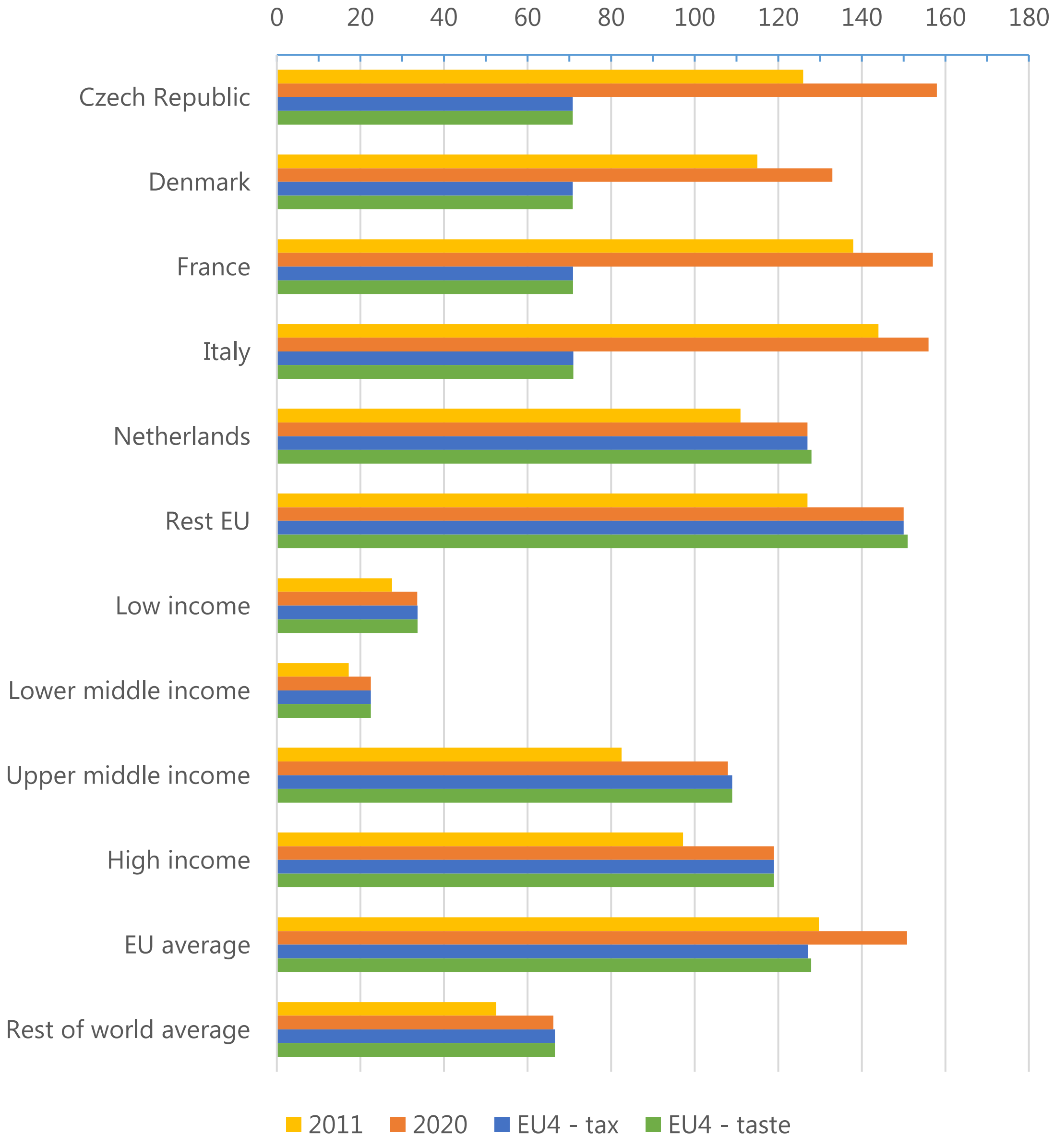
To test and illustrate the GENuS nutrition module, we run a simple scenario with a small MAGNET model (we aggregate most of the EU member states in an EU aggregate keeping the four focus countries and the Netherlands separate). We project from 2011 to 2020 using exogenous shocks on population and GDP taken from the Shared Socio-Economic Pathway number 2, "middle-of-the-road" projection (IIASA 2015). This simple baseline can then be compared to two alternative scenarios. Both scenarios restrict red meat purchases or demand in the four case study countries to 71 g/person/day, i.e. in line with the SUSFANS dietary guidelines discussed in the previous chapter. The scenarios differ, however, in the instrument employed. The first scenario introduces an endogenous consumer tax on red meat sectors in MAGNET while the second scenario uses an endogenous taste shift, i.e. the preferences of the consumers in the four countries are assumed to move away from red meat without any monetary incentive.

Figure 19 shows red meat demand by region in the 2011 base year, its baseline 2020 projection with GDP/capita changing and for the two alternative reduction scenarios in the four SUSFANS case study countries. The high 2011 European red meat availability discussed above (***Figure 16***) is expected to increase with rising incomes. Globally only the low and lower middle income countries are (significantly) below the European guideline of 71 g/day. Here the increases are

[16] MAGNET is large system of non-linear equations which is solved simultaneously. Mathematically this requires that the number of equations matches the number of endogenous variables.

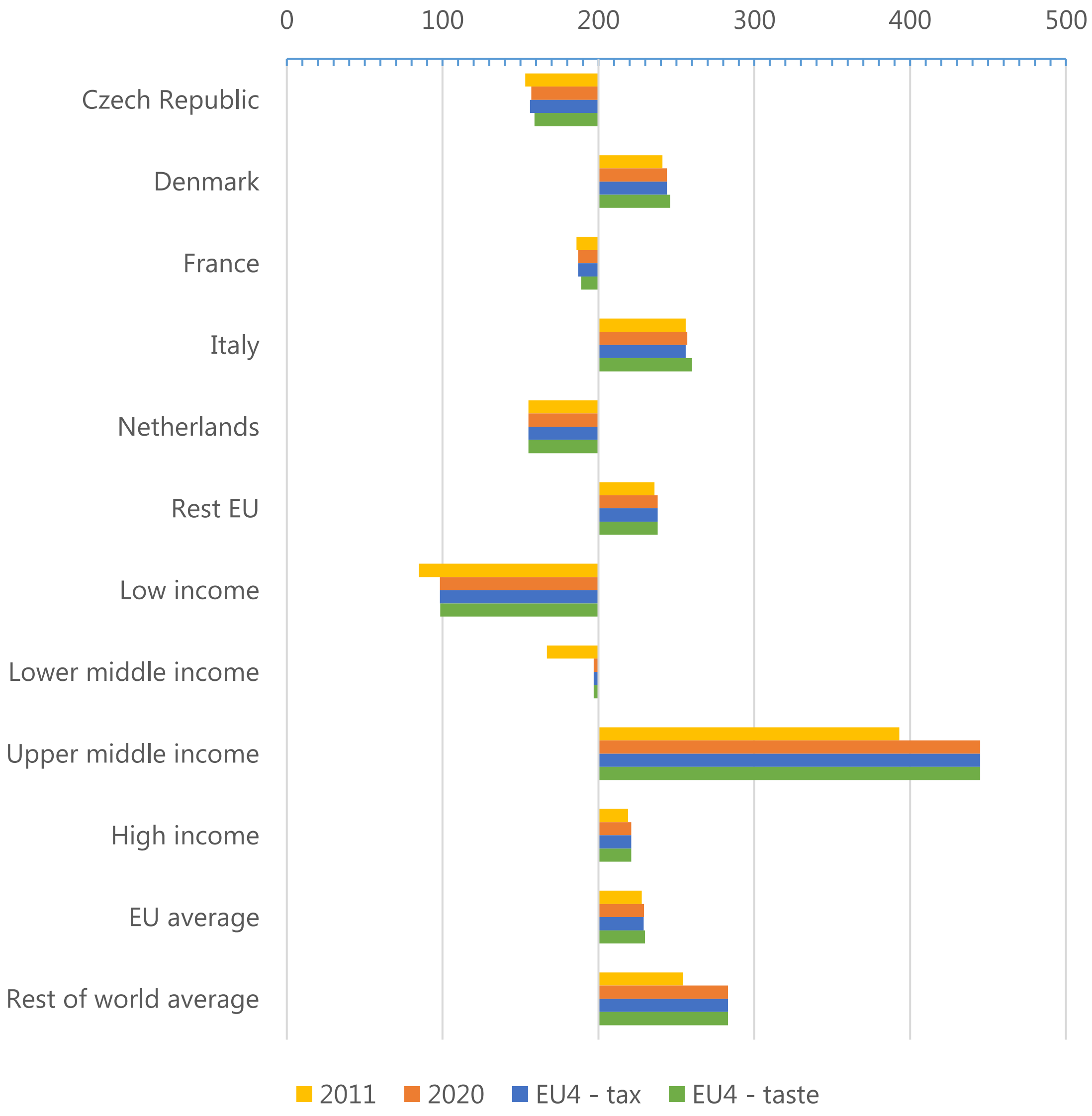
also much more modest. This is not due to a modest projected GDP growth (SSP2 assumes relatively high economic growth rates in low income regions to capture a catching-up process), but due to strong population growth making the GDP/capita growth more modest.

Figure 19: Red meat demand by region and scenario (g/person/day)



Source: MAGNET simulations

Figure 20: Vegetable availability by region and scenario (g/person/day)



Source: MAGNET simulations

SUSFANS focuses on four case study countries for which the SHARP model will be calibrated. It may therefore also be tempting to focus the foresight scenarios on these countries. ***Figure 19***, however, shows the risk of modelling interventions only in the four focus countries. The red meat target is only applied in the four countries, as immediately obvious from the stark reduction in red meat. Red meat demand in the Netherlands and Rest of EU, however, increases in both scenarios. The underlying economic reasoning is obvious: reduced demand in target regions lowers the meat price thus stimulating demand in regions without an exogenous target. Such opposing developments may not make sense from a European perspective, in which case SHARP diet recommendations need to be extrapolated to EU before being imposed in the long run models. The diverse pattern in red meat availability according to GENuS data (see ***Figure 16***) suggests that such an extrapolation may not be a straightforward exercise.

The two scenarios only target red meat but will affect other purchases and thus diet factors as well. To illustrate this ***Figure 20*** shows vegetable demand in each of the scenarios. Note that the link between MAGNET and GENuS allows for a more precise assessment of vegetables, which in MAGNET are combined with fruits. Furthermore the GENuS based assessment also picks up changes in processed vegetables which count towards vegetables according to the SUSFANS guidelines but are associated with the (very aggregated) other food category in MAGNET.

Adherence to a recommended 200 g/day varies across the focus countries with France being just and Czech Republic substantially below the recommendation. Low income countries consume least vegetables although with rising incomes it does increase.

Although not substantially different, the two alternative instruments to reach the same red meat target have opposing impacts on vegetable purchases. The increases in red meat from 2011 to 2020 are much larger than increases in vegetables in 2011-2020 period. According to MAGNET consumers thus have a stronger preference for red meat than vegetables. Considerably reducing their consumption to the 71 g/day recommendation thus requires a considerable tax, ranging from 117 percent in Denmark up to 401 percent in Czech Republic (without intervention Czech Republic exceeds the guideline by 2020 by much more than Denmark and thus require a higher tax rate to meet the target). Since in these simple examples we do not compensate the tax it takes away a substantial part of the available income and starts eating into the budget for vegetables.

The taste shifter in the second scenario operates in a very different way and can be thought of as consumers suddenly waking up in 2020 and preferring red meat less than they did in 2011. We do not include any costs associated with achieving this mind shift. The costless move away from red meat then releases budget spent on other food and non-food items. As a result vegetables increase slightly, not being a very preferred item.

In the context of imposing diet recommendations in the foresight analysis, this first example shows how the SHARP recommendations work through the assumptions on consumer behaviour in a long run model like MAGNET and affect dietary outcomes. Given the importance of the consumer response to the diet restrictions, comparing and assessing consumer behaviour in each of the long models when developing the baseline is recommended. It is likely to be an important source of diverging scores on comparable SUSFANS metrics from the different models.

Finally, to illustrate the richness of the GENuS module, ***Table 12*** shows iron availability for Czech females and males by scenario. Meat is an important source of iron and therefore changes in iron availability can be expected when red meat is reduced. As outlined in the chapter on the GENuS database linking data from food composition tables to food to compute nutrient content is not straightforward, This uncertainty is reflected in the GENuS database by lower, median and upper estimates for nutrients contained in the three panels with the lower estimate at the bottom and upper estimate in the top panel.

Despite both scenarios reaching the exact same red meat target, the changes in food purchases are different depending on the instrument employed as discussed above. This is reflected in the red meat reduction causing a reduced iron availability compared to the 2020 baseline results, but still (slightly) above the 2011 iron availability. To get a bit of a feel for the adequacy of iron, the European recommendation for the average population is 11 mg/day and 16 mg/day for menstruating women (EFSA Panel on Dietetic Products 2015). The female median estimates for availability are well below these recommendations suggesting inadequate iron intake. In contrast, the median estimate for the men are more in line with the recommendations.

There are of course numerous caveats with these numbers. Key is that they are not based on intake data at this detailed product level but done through downscaling using a diet model (see for details Smith et al. 2016). Furthermore the projections use the same simple link as for the commodities, assuming food items by age and sex group move by the same percentage as the national average. This preserves the initial diet pattern which, however, may change in response to income and price changes. Including a micro-simulation model capturing such changes would greatly enhance the assessments.

Table 12a: Iron availability by scenario in Czech republic, females (mg/person/day)

		0-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69
2011	Low	4.79	7.12	8.01	8.16	4.93	5.07	5.34	5.24	5.23	5.3	5.02	4.96	5.19	5.25
	Median	6.03	8.98	10.1	10.3	9.1	9.24	9.5	9.59	9.79	10	9.08	9.02	9.17	9.36
	High	9.21	13.7	15.4	15.7	20	20.1	20.3	20.8	21.4	21.9	19.4	19	19.3	19.8
2020	Low	5.43	8.08	9.09	9.25	5.58	5.73	6.04	5.94	5.93	5.99	5.68	5.6	5.86	5.92
	Median	6.89	10.2	11.5	11.7	10.4	10.5	10.8	10.9	11.1	11.4	10.3	10.2	10.4	10.6
	High	10.6	15.7	17.7	18	22.9	23.1	23.2	23.9	24.6	25.1	22.2	21.7	22	22.5
EU4 - tax	Low	4.96	7.39	8.31	8.47	5.15	5.28	5.56	5.47	5.43	5.52	5.26	5.23	5.49	5.57
	Median	6.26	9.32	10.5	10.7	9.43	9.57	9.84	9.94	10.1	10.4	9.46	9.44	9.63	9.85
	High	8.98	13.4	15	15.3	19.3	19.4	19.6	20.1	20.7	21.3	18.9	18.7	19	19.6
EU4 - taste	Low	5.04	7.49	8.43	8.59	5.22	5.36	5.64	5.55	5.51	5.6	5.34	5.3	5.57	5.65
	Median	6.35	9.45	10.6	10.8	9.56	9.7	9.98	10.1	10.3	10.6	9.59	9.57	9.77	9.99
	High	9.1	13.5	15.2	15.5	19.5	19.7	19.9	20.4	21	21.6	19.1	18.9	19.3	19.9

Table 13b: Iron availability by scenario in Czech republic, males (mg/person/day)

		0-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69
2011	Low	4.79	7.12	8.9	11.1	6.38	6.53	6.82	6.95	6.89	7.13	6.18	6.03	6.05	5.25
	Median	6.03	8.98	11.2	13.9	12.3	12.4	12.8	13	13.2	13.4	11.4	11	11.3	9.36
	High	9.21	13.7	17.1	21.3	27	27.3	27.8	28.1	29.2	29.7	24.8	24.1	24.7	19.8
2020	Low	5.43	8.08	10.1	12.5	7.26	7.43	7.76	7.91	7.82	8.09	7.02	6.84	6.85	5.92
	Median	6.89	10.2	12.8	15.9	14.1	14.3	14.6	14.9	15.1	15.3	13.1	12.6	12.9	10.6
	High	10.6	15.7	19.6	24.4	31.2	31.7	32.2	32.5	33.8	34.3	28.5	27.7	28.4	22.5
EU4 - tax	Low	4.96	7.39	9.23	11.5	6.59	6.74	7.04	7.18	7.13	7.4	6.44	6.31	6.36	5.57
	Median	6.26	9.32	11.6	14.5	12.6	12.7	13.1	13.3	13.5	13.8	11.8	11.4	11.8	9.85
	High	8.98	13.4	16.7	20.7	25.4	25.7	26.2	26.7	27.7	28.3	23.7	23.2	23.9	19.6
EU4 - taste	Low	5.04	7.49	9.37	11.6	6.68	6.83	7.14	7.28	7.23	7.51	6.53	6.41	6.45	5.65
	Median	6.35	9.45	11.8	14.7	12.7	12.9	13.2	13.5	13.7	14	12	11.6	11.9	9.99
	High	9.1	13.5	16.9	21	25.8	26.1	26.6	27	28.1	28.6	24.1	23.5	24.3	19.9

Contribution to SFNS assessments

The GENuS nutrition module adds a whole new set of micro nutrient indicators to MAGNET allowing a broader assessment of changes in nutrient availability alongside the environmental indicators already included in MAGNET (like agricultural land expansion, GHG emissions, fertilizer use). In addition to computing total nutrients, like calories or iron, we also added SUSFANS food-based dietary guidelines to the module which can either be tracked or used to impose constraints on the model. Maintaining the product detail of the GENuS dataset allows calculation of indicators that do not easily match the MAGNET aggregate sectors. For example, the SUSFANS dietary guideline for fruits covers fresh fruits linked to the fruit and vegetable sector in MAGNET as well as processed fruit linked to other food (a very diverse processed food sector).

While GENuS offers a global and consistent perspective on developments in nutrition availability, key limitations are that it holds no information on actual intake and lacks data on nutrients added during processing, as illustrated by the underestimation of sodium availability. Furthermore, lacking data on primary content or socio-economic details of the demographic groups, the connection from the macro level to the micro GENuS variables cannot respond to changes in the macro-economy.

Building on the experience gained with the GENuS data SHARP data will be combined with MAGNET in the context of establishing the SUSFANS toolbox. In part to prepare for this linking primary content is being added to the SHARP database, enabling a link with all three long run models (both CAPRI and GLOBIOM express demand in primary products equivalents). Compared to the MAGNET GENuS module a MAGNET SHARP module with primary content will allow for a more responsive link to MAGNET. It will allow us to take a change in primary content of MAGNET products (endogenous in the model) into account when translating macro to micro level changes. In other words, SHARP items linked to a specific MAGNET sector then do not need to move at the same rate but can move at diverging rates depending on their primary content.

Depending to the extent to which micro data on incomes can be linked to SHARP data (see also the discussion on the household layer), the connection between MAGNET and SHARP can be made even more responsive in terms of variations across the population. If a link between income sources and diets can be established, (endogenous) income developments from MAGNET can be taken into account when downscaling national averages to changes in individual intake.

REMAINING CHALLENGES

MAGNET has been enhanced in three dimensions – household types, product detail and micro nutrient data - to better capture consumer demand in the context of assessing sustainable and healthy diets. To conclude we outline the remaining challenges in each area.

Inability to secure national SAMs has resulted in only representative households being added for the Czech Republic. The Czech data, however, display limited differentiation in consumer demand patterns and therefore will not add substantial feedback through the household layer. Furthermore, the Czech data remain aggregated distinguishing only two types of households (farm and non-farm households). Looking ahead to the link with SHARP to be established in task 9.5, we developed a protocol for either adding representative households or (if not warranted by the data) create top-down link from MAGNET to SHARP. Access to an extensive micro data set, the Luxembourg Income Survey, has been secured but needs to be supplemented with micro data on expenditures and especially food expenditures to increase the socio-economic detail in the four focus countries. Combining and processing micro data sets requires substantial resources not originally planned for and may therefore be beyond the scope of SUSFANS.

Ten sectors and eleven commodities have been added to the MAGNET database to enhance its ability to track demand, trade and production of meat and fish including aquaculture. The data have been added in the disaggregated MAGNET database but will be used in a more aggregate model set-up both in terms of countries/regions and sectors. As part of the baseline development in WP10 these new sectors will need to be calibrated in the chosen model set-up. The choice set-up needs to be aligned with the type of questions to be addressed in WP5 (case studies) and WP10 (foresight).

A new nutrition module has been developed, building on the GENuS database, allowing much more detailed tracing of available food and macro and micro nutrients. The GENuS data are global in scope but not based on intake data. The GENuS module paves the way for a similar SHARP module. The SHARP data are similar in structure (number of products, nutritional detail) while being based on intake surveys offering more details on primary content and demographic characteristics, but are (in the context of SUSFANS) only available for the four European focus countries. Incorporating a link to SHARP data thus not only allows an exchange between MAGNET and SHARP, it also complements the new GENuS module with more details for the selected focus countries. This linking to

SHARP will be taken up in task 9.5 and will feed into both the case studies in WP5 and foresight analyses in WP10.

Including the new meat and fish sectors and GENuS nutrition module in baseline and foresight runs will provide a first assessment of future adherence to the SUSFANS food-based dietary guidelines and allows the imposition of diet-based constraints in the scenarios. The consumer-focussed enhancements discussed in this deliverable alongside the existing MAGNET modules tracking sustainability variables opens a window on trade-offs an synergies between sustainability and nutrition concerns for Europe in a global perspective.

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ANNEXES

Annex 1 – Variables in the Luxembourg Income Survey (LIS) database

A description of the LIS database coverage, including the variable list replicated below can be accessed at http://www.lisdatacenter.org/our-data/lis-database/

	H-FILE	P-FILE
TECHNICAL VARIABLES		
Identifiers		
unique unit identifier	HID	HID
person identifier		PID
unique country/year number	DID	DID
country/year identifier	DNAME	DNAME
country name	CNAME	CNAME
2-letter country abbreviation	ISO2	ISO2
reference year	YEAR	YEAR
data wave	WAVE	WAVE
File information		
household weight (normalised)	HWGT	
household weight (inflated)	HPOPWGT	
person weight (normalised)		PWGT
person weight (inflated)		PPOPWGT
additional household weight (for subsample)	HWGTA	
additional person weight (for subsample)		PWGTA
survey unit	SVYUNIT	
number of persons in survey unit	NPERS	
household member (dummy)		HHMEM
HOUSEHOLD CHARACTERISTICS VARIABLES		
Geographical characteristics		
region	REGION_C	
rural area (dummy)	RURAL	
size of locality of residence	LOCSZ_C	
type of area	AREA_C	
Dwelling characteristics		
owned/rented housing	OWN	
type of dwelling	DWELTYP	
value of dwelling	DWELVAL	
Farming characteristics		
farm household (dummy)	FARM	
ownership and rental of agricultural land	AGRILAND	
farming activity	FARMING	
Household composition		
household composition	HHTYPE	
head living with partner	HPARTNER	
number of household members	NHHMEM	
number of household members 65 or older	NHHMEM65	
number of household members 17 or younger	NHHMEM17	
number of household members 13 or younger	NHHMEM13	
numberof household members 5 or younger	NHHMEM5	
age of youngest household member	AGEYMEM	
number of household members with labour income	NEARN	

	H-FILE	P-FILE
SOCIO-DEMOGRAPHIC VARIABLES		
Living arrangements		
relationship to household head		RELATION
partner		PARTNER
living with parents		PARENTS
living with own children		CHILDREN
number of own children living in household		NCHILDREN
age of youngest own child living in household		AGEYOCH
Demographics		
age in years		AGE
sex		SEX
marital status		MARITAL
Immigration		
immigrant (dummy)		IMMIGR
citizenship		CITIZEN
country of birth		CTRYBRTH
years since arrived in country		YRSRESID
ethnicity/race		ETHNIC_C
previous place of residence		MIGRAT_C
other immigration characteristics		IMMIGR_C
Health		
disabled (dummy)		DISABLED
disability status		DISABL_C
chronic illness		ILLNESS_C
subjective health status		HEALTH_C
Education		
highest completed education level (3-category recode)		EDUC
highest education level		EDUC_C
currently enrolled in education		ENROLL
education level currently enrolled in		ENRLEV_C
age when completed education		EDCAGE
literate		LITERATE
education of mother		EDMOM_C
education of father		EDDAD_C
LABOUR MARKET VARIABLES		
Activity status		
employed (dummy)		EMP
mainly employed (dummy)		MAINEMP
unemployed (dummy)		UNEMP
retired (dummy)		RETIRED
current labour force status		CLFS
current main activity status		CMAS
usual activity status in income reference period		UMAS
in military (dummy)		MILIT
home production activities		HPROD_C

	H-FILE	P-FILE
irregular/casual/odd jobs for pay		ODDJOB_C
unofficial/non-registered/untaxed work		NOTOFF_C
duration of current unemployment spell		UNDUR
weeks unemployed last year		WEEKSUE
type of job search		JSEARCH
employment situation desired		EMPWANT
care for others affects employment		CAREWORK
type of long-term leave		LEAVE
Employment intensity		
full-year full-time (dummy)		FYFT
part-time in all jobs (dummy)		PTIME
weekly hours worked, any information		HOURS
weekly hours worked in all dependent jobs		HOURSD
weekly hours worked in all self-employment jobs		HOURSS
annual weeks worked, any information		WEEKS
annual weeks worked full-time in all jobs		WEEKSFT
annual weeks worked part-time in all jobs		WEEKSPT
multiple jobs holder (dummy)		SECJOB
number of jobs held		NJOBS
Job characteristics (job 1 / job 2)		
status in employment		STATUS1/2
industry (3-category recode)		INDA1/2
industry (9-category recode)		INDB1/2
industry (17-category ISIC 3.1 recode)		INDC1/2
industry (21-category ISIC 4 recode)		INDD1/2_C
industry		IND1/2_C
sector of employment		SECTOR1/2
number of persons in local unit (recode)		NEMP1/2
number of persons in local unit		NEMP1/2_C
occupation (3-category recode)		OCCA1/2
occupation (10-category ISCO recode)		OCCB1/2
occupation		OCC1/2_C
level of supervisory influence over others		SUPERV1/2
permanent employment		PERM1/2
part-time employment (dummy)		PTIME1/2
weekly hours worked		HOURS1/2
job tenure 5+ years (dummy)		TEN5YR1/2
job tenure in years		TENYR1/2
gross hourly wage		GROSS1/2
net hourly wage		NET1/2
Work experience		
ever worked in job or business (dummy)		EVERWORK
years of total work experience		WEXPTL
years of full-time work experience		WEXPFT
years of part-time work experience		WEXPPT
age when started working		EMPSTA

	Prefix						Suffix
	H-FILE			P-FILE			
	H	HM	HN	P	PM	PN	
CURRENT INCOME (I variables)							
total income	√	√	√	√	√	√	I
labour income	√	√	√	√	√	√	IL
paid employment income	√	√	√	√	√	√	ILE
regular paid employment income	√	√	√	√	√	√	ILER
basic wages and salaries	√	√	√	√	√	√	ILERB
wage supplements	√	√	√	√	√	√	ILERS
director wages	√	√	√	√	√	√	ILERD
casual paid employment income	√	√	√	√	√	√	ILEC
self-employment income	√	√	√	√	√	√	ILS
farm self-employment income	√	√	√	√	√	√	ILSF
non-farm self-employment income	√	√	√	√	√	√	ILSN
profit from business	√	√	√	√	√	√	ILSNB
household production activities	√	√	√	√	√	√	ILSNH
capital income	√	√		√	√		IC
interest and dividends	√	√					ICID
interest	√	√					ICIDI
dividends	√	√					ICIDD
voluntary individual pensions	√	√		√	√		ICVIP
rental income	√	√					ICREN
rental income from real estate	√	√					ICRENR
rental income from land	√	√					ICRENL
rental income from machinery	√	√					ICRENM
royalties	√	√		√	√		ICROY
transfer income	√	√	√	√	√	√	IT
social security transfers	√	√	√	√	√	√	ITS
work-related insurance transfers	√	√		√	√		ITSI
long-term insurance transfers	√	√		√	√		ITSIL
mandatory individual pensions	√	√		√	√		ITSILMIP
occupational pensions	√	√		√	√		ITSILO
employment-related public pensions	√	√		√	√		ITSILEP
old-age insurance public pensions	√	√		√	√		ITSILEPO
disability insurance public pensions	√	√		√	√		ITSILEPD
survivors insurance public pensions	√	√		√	√		ITSILEPS
work-injury pensions	√	√		√	√		ITSILWI
short-term insurance	√	√		√	√		ITSIS
sickness wage replacement	√	√		√	√		ITSISSI
maternity/parental wage replacement	√	√		√	√		ITSISMA
work-injury wage replacement	√	√		√	√		ITSISWI
unemployment wage replacement	√	√		√	√		ITSISUN
universal benefits	√	√		√	√		ITSU
old-age/disability/survivors universal pensions	√	√		√	√		ITSUP
old-age universal pensions	√	√		√	√		ITSUPO
disability universal pensions	√	√		√	√		ITSUPD
survivors universal pensions	√	√		√	√		ITSUPS
unemployment universal benefits	√	√		√	√		ITSUUN
disability universal benefits	√	√		√	√		ITSUDI
family/child universal benefits	√	√					ITSUFA
child allowances	√	√					ITSUFACA
advance maintenance	√	√					ITSUFAAM
non-work related child care benefits	√	√					ITSUFACC
education-related universal benefits	√	√		√	√		ITSUED
assistance benefits	√	√	√	√	√	√	ITSA
general social assistance	√	√					ITSAGEN
old-age/disability/survivors assistance pensions	√	√		√	√		ITSAP
old-age assistance pensions	√	√		√	√		ITSAPO
disability assistance pensions	√	√		√	√		ITSAPD
survivors assistance pensions	√	√		√	√		ITSAPS
unemployment assistance	√	√		√	√		ITSAUN
family/maternity/child assistance	√	√	√				ITSAFA
education assistance	√	√	√	√	√	√	ITSAED
housing assistance	√	√	√				ITSAHO
heating assistance	√	√	√				ITSAHE
food assistance	√	√	√				ITSAFO
medical assistance	√	√	√				ITSAME
private transfers	√	√	√	√	√	√	ITP
merit-based education transfers	√	√	√	√	√	√	ITPED
transfers from non-profit institutions	√	√	√				ITPNP
interhousehold transfers	√	√	√				ITPIH
alimony/child support	√	√	√				ITPIHA
remittances	√	√	√				ITPIHR
other family transfers	√	√	√				ITPIHFT
--- ADDITIONAL SET 1: TRANSFERS BY FUNCTION							
old-age transfers	√	√		√	√		IATOLD
disability transfers	√	√	√	√	√	√	IATDIS
survivors transfers	√	√		√	√		IATSUR
sickness transfers	√	√		√	√		IATSIC
family/children transfers	√	√	√	√	√	√	IATFAM
education transfers	√	√	√	√	√	√	IATEDU
unemployment transfers	√	√		√	√		IATUNE
housing transfers	√	√	√	√	√	√	IATHOU
--- ADDITIONAL SET 2: OTHER TRANSFER GROUPINGS							
civil servants pensions	√	√		√	√		IATCSP
work-injury compensation	√	√		√	√		IATWIC
care benefits	√	√	√	√	√	√	IATCAR
war victim/veterans benefits	√	√	√	√	√	√	IATVET
WINDFALL INCOME (W variables)							
windfall labour income	√	√		√	√		WL
windfall employee income	√	√		√	√		WLE
windfall self employment income	√	√		√	√		WLS
windfall capital income	√	√		√	√		WC
capital gains	√	√		√	√		WCG
insurance compensations	√	√		√	√		WCIC
windfall transfer income	√	√		√	√		WT
inheritances	√	√		√	√		WTIN
lottery winnings	√	√		√	√		WTLO
lump-sum retirement compensations	√	√		√	√		WTRC
NON-CONSUMPTION EXPENDITURE (X variables)							
income taxes and social security contributions	√	√	√	√	√	√	XIT
income taxes	√	√		√	√		XITI
income tax withholdings	√	√		√	√		XITIW
income tax adjustments	√	√		√	√		XITIA
social security contributions	√	√	√	√	√	√	XITS
social security contributions, self-paid	√	√		√	√		XITSS
social security contributions, paid on behalf o	√		√	√		√	XITSB
other taxes	√	√					XOT
property taxes	√	√					XOTP
other direct taxes	√	√					XOTD
voluntary contributions	√	√	√	√	√	√	XVC
voluntary contributions, self-paid	√	√		√	√		XVCS
voluntary contributions, paid by employer	√		√	√		√	XVCE
inter-household transfers paid	√	√					XIH
alimony/child support paid	√	√					XIHA
remittances paid	√	√					XIHR
other family transfers paid	√	√					XIHFT
donations to charity	√	√					XCH
interest paid	√	√					XINT
mortgage interest paid	√	√					XINTM
other interest paid	√	√					XINTO
CONSUMPTION (C variabels)							
total consumption	√	√	√				C
food and non-alcoholic beverages	√	√	√				CFOOD
alcohol and tobacco	√	√	√				CALCO
clothing and footwear	√	√	√				CAPP
housing and utilities	√	√	√				CHOUS
actual rent	√	√					CHOUSA
imputed rent	√		√				CHOUSI
housing equipment	√	√	√				CEQUIP
health	√	√	√				CMED
transport	√	√	√				CTRAN
communication	√	√	√				CCOMM
recreation and culture	√	√	√				CCULT
education	√	√	√				CEDUC
restaurants and hotels	√	√	√				CRESTO
miscellaneous goods and services	√	√	√				CMISC
--- ADDITIONAL BREAKDOWN OF NON-MONETARY CONSUMPTION							
home production for own use	√		√				CBOWN
goods produced for own consumption	√		√				CBOWNG
owner-occupied imputed rent	√		√				CBOWNIR
use value of durables	√		√				CBOWND
consumption of goods and services received	√		√				CBGIFT
from employment	√		√				CBGIFTE
from government	√		√				CBGIFTG
from others	√		√				CBGIFTO
ASSETS / LIABILITIES TRANSACTIONS (T variables)							
proceeds from sales	√	√		√	√		TS
sales of real estate	√	√		√	√		TSR
sales of financial products	√	√		√	√		TSF
sales of other non-consumption durables	√	√		√	√		TSO
inflows from loans	√	√		√	√		TIL
mortgage	√	√		√	√		TILM
other loans	√	√		√	√		TILO
repayments from borrowings	√	√		√	√		TILR
purchases	√	√		√	√		TP
purchase of real estate	√	√		√	√		TPR
purchase of financial products	√	√		√	√		TPF
purchase of other non-consumption durables	√	√		√	√		TPO
outflows from loans	√	√		√	√		TOL
mortgage repayments	√	√		√	√		TOLM
other loans repayments	√	√		√	√		TOLO
borrowings	√	√		√	√		TOLB

MAJOR AGGREGATES

DHI	disposable household income	HI - HXIT
DPI	cash disposable household income	HMI - HMXIT
FACTOR	factor income	HIL + HIC
SOCRED	social security redistribution	HITS
PRIVRED	private redistribution	HITP
PENSION	total pension income	HITSIL + HITSUP + HITSAP + HICVIP
PPENSION	individual total pension income	PITSIL + PITSUP + PITSAP + PICVIP

ADDITIONAL INFORMATION	H-FILE	P-FILE
currency units	CURRENCY	CURRENCY
deflation factor	DEFLATOR	DEFLATOR
gross/net income information	GROSSNET	GROSSNET
income imputation (dummy)	FHIMPU	FPIMPU
receipt of fringe benefits (dummy)	FHNILE	FPNILE
receipt of in-kind social benefits (dummy)	FHNITS	FPNITS
receipt of gifts (dummy)	FHNITP	FPNITP
payment of voluntary contributions by self (dummy)	FHMXVC	FPMXVC
payment of voluntary contributions by others (dummy)	FHNXVC	FPNXVC

Note: The variable name is made of a prefix and a suffix; the prefix is constructed in the following way:
- the first letter refers to the level of the file (**H** for household and **P** for person)
- the second letter refers to the nature of the item (**M** for monetary, **N** for non-monetary and absence of both M and N for the total)

The suffix begins with the main letter within the block (**I**, **W**, **X**, **C** and **T**); any following letters refer to further subcomponents.

Annex 2 – Mapping HS6 codes to new livestock sectors

The table below lists the mapping used to aggregate the BACI trade data (HS96-6) to match the new livestock sectors introduced in MAGNET.

MAGNET	HS6	Description
		OAP (GTAP)
PLTRY	010511	Live fowls of species Gallus domesticus, weighing not >185g
PLTRY	010512	Live turkeys, weighing not >185g
PLTRY	010511	Live fowls of species Gallus domesticus, weighing not >185g
PLTRY	010512	Live turkeys, weighing not >185g
PLTRY	010519	Live ducks/geese/guinea fowls, weighing not >185g
PLTRY	010592	Other :-- Fowls of the species Gallus domesticus, weighing not more than 2,000 g
PLTRY	010593	Other :-- Fowls of the species Gallus domesticus, weighing more than 2,000 g
PLTRY	010599	Live ducks/geese/turkeys/guinea fowls, weighing >185g
PLTRY	040700	Birds' eggs, in shell, fresh/preserved/cooked
PLTRY	050510	Feathers of a kind used for stuffing; down
PLTRY	050590	Skins & other parts of birds with feathers/down; feathers & parts of feathers (excl. of 0505.10), not further worked than cleaned, disinfected/treated for preservation; powder & waste of feathers/parts of feathers
OAP	010310	Live swine: pure-bred breeding animals
OAP	010391	Live swine other than pure-bred breeding animals, weighing < 50kg
OAP	010392	Live swine other than pure-bred breeding animals, weighing 50kg/more
OAP	010600	Other live animals.
OAP	020820	Frogs'legs
OAP	030760	Snails (excl. sea snails)
OAP	040900	Natural honey
OAP	041000	Edible products of animal origin, n.e.s.
OAP	050210	Pigs'/hogs'/boars' bristles & hair & waste thereof
OAP	050290	Badger hair & other brush making hair; waste of such bristles/hair
OAP	050400	Guts, bladders & stomachs of animals (other than fish), whole & pieces thereof, fresh/chilled/frozen/salted/in brine/dried/smoked
OAP	050610	Ossein & bones treated with acid
OAP	050690	Bones & horn-cores, unworked, defatted, simply prepared but not cut to shape, treated with acid/degelatinised (excl. of 0506.10); powder & waste of these products
OAP	050710	Ivory; ivory powder & waste
OAP	050790	Tortoise-shell, whalebone & whalebone hair, horns, antlers, hooves, nails, claws & beaks, unworked/simply prepared but not cut to shape; powder & waste of these products

OAP	051000	Ambergris, castoreum, civet & musk; cantharides; bile, whether/not dried; glands & other animal products used in the preparation of pharmaceutical products, fresh/chilled/frozen/othw. provisionally perserved
OAP	051199	Animal products not elsewhere specified/incld. (excl. of 0511.10); dead animals of Ch. 1, unfit for human consumption
OAP	152190	Beeswax, other insect waxes & spermaceti, whether/not refined/coloured
OAP	410110	Whole hides and skins of bovine animals, of a weight per skin not exceeding 8 kg when simply dried, 10 kg when dry-salted, or 14 kg when fresh, wet-salted otherwise preserved
OAP	410121	Other hides and skins of bovine animals, fresh or wet-salted :-- Whole
OAP	410122	Other hides and skins of bovine animals, fresh or wet-salted :-- Butts and bends
OAP	410129	Other hides and skins of bovine animals, fresh or wet-salted :-- Other
OAP	410130	Other hides and skins of bovine animals, otherwise preserved
OAP	410140	Hides and skins of equine animals
OAP	410210	Raw skins of sheep/lambs (fresh/salted/dried/limed/pickled/othw. preserved but not tanned/ parchment-dressed/further prepared), with wool on
OAP	410221	Raw skins of sheep/lambs, pickled but not tanned/ parchment-dressed/further prepared, without wool on
OAP	410229	Raw skins of sheep/lambs (fresh/salted/dried/limed/pickled/othw. preserved, but not tanned/ parchment-dressed/further prepared), split, other than those excld. by Note 1 (c) to this Ch..
OAP	410310	Of goats or kids
OAP	410320	Raw hides & skins of reptiles (fresh/salted/dried/limed/pickled/ othw. preserved,but not tanned/parchment-dressed/further prepared), whether/ not dehaired/split
OAP	410390	Raw hides&skins (fresh,/salted, dried, limed, pickled/othw. preserved, but not tanned, parchment-dressed/further prepared), whether/not dehaired/split, other than those excld. by Note 1 (b)
OAP	430110	Raw furskins, of mink, whole, with/without head/tail/paws
OAP	430120	Of rabbit or hare, whole, with or without head, tail or paws
OAP	430130	Raw furskins, of lamb: Astrakhan, Broadtail, Caracul, Persian & similar lamb, Indian/Chinese/Mongolian/Tibetan lamb, whole, with/without head/tail/paws
OAP	430140	Of beaver, whole, with or without head, tail or paws
OAP	430150	Of musk-rat, whole, with or without head, tail or paws
OAP	430160	Raw furskins, of fox, whole, with/without head/tail/paws
OAP	430170	Of seal, whole, with or without head, tail or paws
		OMT (GTAP)
POUM	020711	Meat of fowls of species Gallus domesticus, not cut in pieces, fresh/chilled
POUM	020712	Meat of fowls of species Gallus domesticus, not cut in pieces, frozen

POUM	020713	Cuts & edible offal of species Gallus domesticus, fresh/chilled
POUM	020714	Cuts & edible offal of species Gallus domesticus, frozen
POUM	020724	Meat of turkeys, not cut in pieces, fresh/chilled
POUM	020725	Meat of turkeys, not cut in pieces, frozen
POUM	020726	Cuts & edible offal of turkey, fresh/chilled
POUM	020727	Cuts & edible offal of turkey, frozen
POUM	020732	Meat of ducks/geese/guinea fowls, not cut in pieces, fresh/chilled
POUM	020733	Meat of ducks/geese/guinea fowls, not cut in pieces, frozen
POUM	020734	Fatty livers of ducks/geese/guinea fowls, fresh/chilled
POUM	020735	Meat & edible meat offal of ducks/geese/guinea fowls (excl. of 0207.32-0207.34), fresh/chilled
POUM	020736	Meat & edible meat offal of ducks/geese/guinea fowls (excl. of 0207.32-0207.34), frozen
POUM	160231	Prepared/preserved preparations of turkey (excl. homogenised preparations)
POUM	160232	Prepared/preserved preparations of fowls of the genus Gallus domesticus (excl. homogenised preparations)
POUM	160239	Prepared/preserved preparations of fowls of 01.05 (excl. turkey & fowls of the genus Gallus domesticus)
OMT	020311	Carcasses/half-carcasses of swine, fresh/chilled
OMT	020312	Hams, shoulders & cuts thereof , fresh/chilled, bone-in
OMT	020319	Meat of swine (excl. carcasses/half-carcasses/hams/shoulders & cuts thereof), fresh/chilled
OMT	020321	Carcasses/half-carcasses of swine, frozen
OMT	020322	Hams, shoulders & cuts thereof , frozen, bone-in
OMT	020329	Meat of swine (excl. carcasses/half-carcasses/hams/shoulders & cuts thereof), frozen
OMT	020810	Meat & edible meat offal of rabbits/hares, fresh/chilled/frozen
OMT	020890	Meat&edible meat offal, n.e.s., fresh/chilled/frozen
OMT	021011	Hams, shoulders & cuts thereof , of swine, salted/in brine/dried/smoked, bone-in
OMT	021012	Bellies (streaky) & cuts thereof , of swine, salted/in brine/dried/smoked
OMT	021019	Meat of swine (excl. hams/shoulders & cuts thereof & bellies (streaky) & cuts thereof), salted/in brine/dried/smoked
OMT	021020	Meat of bovine animals, salted/in brine/dried/smoked
OMT	021090	Other, including edible flours and meals of meat or meat offal
OMT	150300	Lard stearin, lard oil, oleostearin, oleo-oil & tallow oil, not emulsified/mixed/ othw. prepared
OMT	150410	Fish-liver oils & their fractions, whether/not refined but not chemically modified
OMT	150420	Fats & oils & their fractions, of fish, other than liver oils, whether/ not refined but not chemically modified
OMT	150430	Fats & oils & their fractions, of marine mammals, whether/ not refined but not chemically modified

OMT	150600	Animal fats & oils & fractions thereof (excl. of 1501.00-1505.00), whether/ not refined but not chemically modified
OMT	160100	Sausages & similar products, of meat/meat offal/blood; food preparations based on these products
OMT	160220	Prepared/preserved preparations of liver of any animal
OMT	160241	Hams & cuts thereof
OMT	160242	Shoulders of swine & cuts thereof
OMT	160249	Prepared/preserved preparations of swine (excl. of 1602.41, 1602.42 & homogenised preparations), incl. mixtures
OMT	160250	Prepared/preserved preparations of bovine animals (excl. homogenised preparations), incl. mixtures
OMT	160290	Preparations of prepared/preserved meat (excl. of 1602.10-1602.50), incl. preparations of blood of any animal
OMT	160300	Extracts & juices of meat/fish/crustaceans/molluscs/other aquatic invertebrates
OMT	230110	Flours, meals & pellets of meat/meat offal; greaves
		CTL (GTAP)
BFCTL	010210	Live bovine animals: pure-bred breeding animals
BFCTL	010290	Live bovine animals other than pure-bred breeding animals
CTL	010420	Live goats
CTL	010111	Horses :-- Pure-bred breeding animals
CTL	010119	Horses :-- Other
CTL	010120	Asses, mules and hinnies
CTL	010410	Live sheep
CTL	051110	Bovine semen
		CMT (GTAP)
BFCMT	020110	Carcasses/half-carcasses of bovine animals, fresh/chilled
BFCMT	020120	Meat of bovine animals, fresh/chilled (excl. of 0201.10), bone-in
BFCMT	020130	Meat of bovine animals, fresh/chilled, boneless
BFCMT	020210	Carcasses/half-carcasses of bovine animals, frozen
BFCMT	020220	Meat of bovine animals, frozen (excl. of 0202.10), bone-in
BFCMT	020230	Meat of bovine animals, frozen, boneless
CMT	020410	Carcasses/half-carcasses of lamb, fresh/chilled
CMT	020421	Carcasses/half-carcasses of sheep (excl. lamb), fresh/chilled
CMT	020422	Meat of sheep (excl. lamb & carcasses), fresh/chilled, bone-in
CMT	020423	Meat of sheep (excl. lamb), fresh/chilled, boneless
CMT	020430	Carcasses/half-carcasses of lamb, frozen
CMT	020441	Carcasses/half-carcasses of sheep (excl. lamb), frozen
CMT	020442	Meat of sheep (excl. lamb & carcasses), frozen, bone-in
CMT	020443	Meat of sheep (excl. lamb), frozen, boneless
CMT	020450	Meat of goats, fresh/chilled/frozen
CMT	020500	Meat of horses/asses/mules/hinnies, fresh/chilled/frozen
CMT	020610	Edible offal of bovine animals, fresh/chilled

CMT	020621	Tongues of bovine animals, frozen
CMT	020622	Livers of bovine animals, frozen
CMT	020629	Edible offal of bovine animals (excl. tongues & livers), frozen
CMT	020630	Edible offal of swine, fresh/chilled
CMT	020641	Livers of swine, frozen
CMT	020649	Edible offal of swine (excl. liver), frozen
CMT	020680	Edible offal, n.e.s., fresh/chilled
CMT	020690	Edible offal, n.e.s., frozen
CMT	020900	Pig fat (free of lean meat) & poultry fat (not rendered/othw. extracted), fresh/chilled/frozen/salted/in brine/dried/smoked
CMT	150100	Pig fat (including lard) and poultry fat
CMT	150200	Fats of bovine animals, sheep or goats, other than those of heading No. 15.03.
CMT	150510	Wool grease, crude
CMT	150590	Other

Annex 3 – Mapping FAO production to new livestock sectors

The table below lists the mapping used to aggregate the FAO production data to match the new livestock sectors introduced in MAGNET.

MAGNET	FAO	MAGNET	FAO
OAP (GTAP)		OAP	HairFine
PLTRY	Duck	OAP	HairCrsNes
PLTRY	Geese	OAP	Honey
PLTRY	Birdnes	OMT (GTAP)	
PLTRY	Turkey	POUM	Poultry
PLTRY	Chicken	OMT	Pigmeat
PLTRY	Rodents	OMT	meatOth
OAP	Pig	OMT	MeatMeal
OAP	Eggs	OMT	FishBodyO
OAP	Camel	OMT	FichLiverO
OAP	OtherCamel	CTL (GTAP)	
OAP	Rabbit	BFCTL	Cattle
OAP	Hides	BFCTL	Buffalo
OAP	KarakulSkins	CTL	Sheep
OAP	SkinRabbits	CTL	Goat
OAP	FineGoatHair	CTL	Horse
OAP	CesGoatHair	CTL	Ass
OAP	HairofHorses	CTL	Mule
OAP	RabbitsHares	CMT (GTAP)	
OAP	Beehives	BFCMT	BovineM
OAP	Naturalhoney	CMT	MGoatMeat
OAP	Beeswax	CMT	OffalsE

Annex 4 – Coverage of GENuS nutrition data

The table below summarizes the coverage of the GENuS nutrition data by MAGNET region. The number of ISO codes lists the total number of country codes that map to a MAGNET region, which can be small overseas territories. We therefore list not only the number of ISO country codes covered by GENuS but also the UN population of each country and the number of people covered by GENuS. The last column summarizes coverage by listing the percentage of population covered if less than 100%.

	MAGNET countries and regions		ISO codes	ISO covered	Population (UN)	Population covered (UN)	Coverage (%)
1	aus	Australia	5	1	22480	22480	-
2	nzl	New Zealand	1	1	4418	4418	-
3	xoc	Rest of Oceania	23	3	10104	1392	13.8
4	chn	China	1	1	1367480	1367480	-
5	hkg	Hong Kong	1	0	7066	0	0.0
6	jpn	Japan	1	1	128505	128505	-
7	kor	Korea	1	1	49745	49745	-
8	mng	Mongolia	1	1	2762	2762	-
9	twn	Taiwan	1	0	23185	0	0.0
10	xea	Rest of East Asia	2	0	25271	0	0.0
11	brn	Brunei Darussalam	1	1	394	394	-
12	khm	Cambodia	1	0	14538	0	0.0
13	idn	Indonesia	1	1	245708	245708	-
14	lao	Lao People's Democratic Rep	1	1	6333	6333	-
15	mys	Malaysia	1	1	28635	28635	-
16	phl	Philippines	1	1	95278	95278	-
17	sgp	Singapore	1	0	5176	0	0.0
18	tha	Thailand	1	1	67530	67530	-
19	vnm	Viet Nam	1	0	89437	0	0.0
20	xse	Rest of Southeast Asia	2	0	51685	0	0.0
21	bgd	Bangladesh	1	1	153912	153912	-
22	ind	India	1	1	1247236	1247236	-
23	npl	Nepal	1	1	27327	27327	-
24	pak	Pakistan	1	1	174184	174184	-
25	lka	Sri Lanka	1	1	20315	20315	-
26	xsa	Rest of South Asia	3	1	30825	375	1.2
27	can	Canada	1	1	34539	34539	-
28	usa	United States of America	1	1	311051	311051	-
29	mex	Mexico	1	1	119090	119090	-
30	xna	Rest of North America	3	0	0	0	-

	MAGNET countries and regions		ISO codes	ISO covered	Population (UN)	Population covered (UN)	Coverage (%)
31	arg	Argentina	1	1	41657	41657	-
32	bol	Bolivia	1	1	10078	10078	-
33	bra	Brazil	1	1	198687	198687	-
34	chl	Chile	1	1	17153	17153	-
35	col	Colombia	1	1	46407	46407	-
36	ecu	Ecuador	1	1	15177	15177	-
37	pry	Paraguay	1	1	6294	6294	-
38	per	Peru	1	1	29760	29760	-
39	ury	Uruguay	1	1	3386	3386	-
40	ven	Venezuela	1	1	29463	29463	-
41	xsm	Rest of South America	5	2	1522	1281	84.2
42	cri	Costa Rica	1	1	4600	4600	-
43	gtm	Guatemala	1	1	14949	14949	-
44	hnd	Honduras	1	1	8352	8352	-
45	nic	Nicaragua	1	1	5808	5808	-
46	pan	Panama	1	1	3708	3708	-
47	slv	El Salvador	1	1	6193	6193	-
48	xca	Rest of Central America	1	1	329	329	-
49	dom	Dominican Republic	1	1	10027	10027	-
50	jam	Jamaica	1	1	2829	2829	-
51	pri	Puerto Rico	1	0	3707	0	0.0
52	tto	Trinidad and Tobago	1	1	1335	1335	-
53	xcb	Caribbean	18	10	22839.7	22631.7	99.1
54	aut	Austria	1	1	8460	8460	-
55	bel	Belgium	1	1	11013	11013	-
56	cyp	Cyprus	1	1	1125	1125	-
57	cze	Czech Republic	1	1	10569	10569	-
58	dnk	Denmark	1	1	5583	5583	-
59	est	Estonia	1	1	1328	1328	-
60	fin	Finland	2	1	5389	5389	-
61	fra	France	4	1	65025	63344	97.4
62	deu	Germany	1	1	80934	80934	-
63	grc	Greece	1	1	11423	11423	-
64	hun	Hungary	1	1	9898	9898	-
65	irl	Ireland	1	1	4663	4663	-
66	ita	Italy	1	1	59760	59760	-
67	lva	Latvia	1	1	2092	2092	-
68	ltu	Lithuania	1	1	3080	3080	-
69	lux	Luxembourg	1	1	520	520	-
70	mlt	Malta	1	1	418	418	-

	MAGNET countries and regions		ISO codes	ISO covered	Population (UN)	Population covered (UN)	Coverage (%)
71	nld	Netherlands	1	1	16737	16737	-
72	pol	Poland	1	1	38321	38321	-
73	prt	Portugal	1	1	10625	10625	-
74	svk	Slovakia	1	1	5410	5410	-
75	svn	Slovenia	1	1	2053	2053	-
76	esp	Spain	1	1	46909	46909	-
77	swe	Sweden	1	1	9466	9466	-
78	gbr	United Kingdom	1	1	63812	63812	-
79	che	Switzerland	1	1	7930	7930	-
80	nor	Norway	2	1	4948	4948	-
81	xef	Rest of EFTA	2	1	323	323	-
82	alb	Albania	1	1	2927	2927	-
83	bgr	Bulgaria	1	1	7356	7356	-
84	blr	Belarus	1	1	9468	9468	-
85	hrv	Croatia	1	1	4313	4313	-
86	rou	Romania	1	1	20293	20293	-
87	rus	Russian Federation	1	1	143264	143264	-
88	ukr	Ukraine	1	1	45576	45576	-
89	xee	Rest of Eastern Europe	1	1	4077	4077	-
90	xer	Rest of Europe	13	4	15380	15380	-
91	kaz	Kazakhstan	1	1	16647	16647	-
92	kgz	Kyrgyzstan	1	1	5507	5507	-
93	tjk	Tajikistan	1	1	7816	7816	-
94	xsu	Rest of Former Soviet Union	2	1	34242	29068	84.9
95	arm	Armenia	1	1	2876	2876	-
96	aze	Azerbaijan	1	1	9146	9146	-
97	geo	Georgia	1	1	4171	4171	-
98	bhr	Bahrain	1	0	1278	0	0.0
99	irn	Iran Islamic Republic of	1	1	75492	75492	-
100	isr	Israel	1	1	7569	7569	-
101	jor	Jordan	1	1	7575	7575	-
102	kwt	Kuwait	1	1	3191	3191	-
103	omn	Oman	1	0	3237	0	0.0
104	qat	Qatar	1	0	1952	0	0.0
105	sau	Saudi Arabia	1	1	28238	28238	-
106	tur	Turkey	1	1	73409	73409	-
107	are	United Arab Emirates	1	1	8672	8672	-
108	xws	Rest of Western Asia	5	5	85610	85610	-
109	egy	Egypt	1	1	85898	85898	-
110	mar	Morocco	1	1	32859	32859	-

	MAGNET countries and regions		ISO codes	ISO covered	Population (UN)	Population covered (UN)	Coverage (%)
111	tun	Tunisia	1	1	10761	10761	-
112	xnf	Rest of North Africa	3	2	43502	43014	98.9
113	ben	Benin	1	1	9461	9461	-
114	bfa	Burkina Faso	1	1	16082	16082	-
115	cmr	Cameroon	1	1	20520	20520	-
116	civ	Cote d'Ivoire	1	1	20895	20895	-
117	gha	Ghana	1	1	25122	25122	-
118	gin	Guinea	1	1	11035	11035	-
119	nga	Nigeria	1	1	162877	162877	-
120	sen	Senegal	1	1	13301	13301	-
121	tgo	Togo	1	0	6679	0	0.0
122	xwf	Rest of Western Africa	9	6	50856	40174	79.0
123	xcf	Central Africa	6	2	24148	8989	37.2
124	xac	South Central Africa	2	1	90933	24219	26.6
125	eth	Ethiopia	1	1	90047	90047	-
126	ken	Kenya	1	1	42487	42487	-
127	mdg	Madagascar	1	1	21744	21744	-
128	mwi	Malawi	1	1	15628	15628	-
129	mus	Mauritius	1	1	1251	1251	-
130	moz	Mozambique	1	1	24939	24939	-
131	rwa	Rwanda	1	1	10516	10516	-
132	tza	Tanzania	1	1	47571	47571	-
133	uga	Uganda	1	0	35094	0	0.0
134	zmb	Zambia	1	0	14265	0	0.0
135	zwe	Zimbabwe	1	1	14387	14387	-
136	xec	Rest of Eastern Africa	9	2	73418.8	36033	49.1
137	bwa	Botswana	1	1	2051	2051	-
138	nam	Namibia	1	1	2216	2216	-
139	zaf	South Africa	1	1	52264	52264	-
140	xsc	Rest of South African Customs	2	1	3289	1225	37.2
141	xtw	Rest of the World	4	0	0	0	-

Annex 5 –GENuS commodities and nutrients

The first table presents an overview of the 225 GENuS food items at their mapping to the disaggregate MAGNET commodities. The second table presents the 24 GENuS food characteristics available for each of the 225 food items, including their unit of measurement.

nr	Code	Description	Code	Description
1	Wheat	Wheat	wht	Wheat
2	Rice_Mille	Rice (Milled Equivalent)	pdr	Paddy rice
3	Barley	Barley	gro	Cereal grains nec
4	Maize	Maize	gro	Cereal grains nec
5	Rye	Rye	gro	Cereal grains nec
6	Oats	Oats	gro	Cereal grains nec
7	Millet	Millet	gro	Cereal grains nec
8	Sorghum	Sorghum	gro	Cereal grains nec
9	Buckwheat	Buckwheat	gro	Cereal grains nec
10	Fonio	Fonio	gro	Cereal grains nec
11	Triticale	Triticale	gro	Cereal grains nec
12	Mixed_grai	Mixed grain	gro	Cereal grains nec
13	Cereals_ne	Cereals; nes	gro	Cereal grains nec
14	Popcorn	Popcorn	gro	Cereal grains nec
15	Quinoa	Quinoa	gro	Cereal grains nec
16	Canary_see	Canary seed	gro	Cereal grains nec
17	Cassava	Cassava	v_f	Vegetables, fruit, nuts
18	Potatoes	Potatoes	v_f	Vegetables, fruit, nuts
19	Sweet_Pota	Sweet Potatoes	v_f	Vegetables, fruit, nuts
20	Yams	Yams	v_f	Vegetables, fruit, nuts
21	Yautia_coc	Yautia (cocoyam)	v_f	Vegetables, fruit, nuts
22	Taro_cocoy	Taro (cocoyam)	v_f	Vegetables, fruit, nuts
23	Roots_and_	Roots and tubers; nes	v_f	Vegetables, fruit, nuts
24	Flour_of_r	Flour of roots and tubers	ofd	Food products nec
25	Sugar_Cane	Sugar Cane	c_b	Sugar cane, sugar beet
26	Sugar_Non_	Sugar; Non-Centrifugal	sgr	Sugar
27	Sugar_Raw_	Sugar (Raw Equivalent)	sgr	Sugar
28	Sweeteners	Sweeteners; Other	sgr	Sugar
29	Honey	Honey	oap	Animal products nec
30	Beans	Beans	v_f	Vegetables, fruit, nuts
31	Peas	Peas	v_f	Vegetables, fruit, nuts
32	Broad_bean	Broad beans; horse beans; dry	v_f	Vegetables, fruit, nuts
33	Chick_peas	Chick peas	v_f	Vegetables, fruit, nuts

nr	Code	Description	Code	Description
34	Cow_peas_d	Cow peas; dry	v_f	Vegetables, fruit, nuts
35	Pigeon_pea	Pigeon peas	v_f	Vegetables, fruit, nuts
36	Lentils	Lentils	v_f	Vegetables, fruit, nuts
37	Bambara_be	Bambara beans	v_f	Vegetables, fruit, nuts
38	Vetches	Vetches	ocr	Crops nec
39	Lupins	Lupins	ocr	Crops nec
40	Pulses_nes	Pulses; nes	v_f	Vegetables, fruit, nuts
41	Flour_of_p	Flour of pulses	ofd	Food products nec
42	Brazil_nut	Brazil nuts; with shell	v_f	Vegetables, fruit, nuts
43	Cashew_nut	Cashew nuts; with shell	v_f	Vegetables, fruit, nuts
44	Chestnuts	Chestnuts	v_f	Vegetables, fruit, nuts
45	Almonds_wi	Almonds; with shell	v_f	Vegetables, fruit, nuts
46	Walnuts_wi	Walnuts; with shell	v_f	Vegetables, fruit, nuts
47	Pistachios	Pistachios	v_f	Vegetables, fruit, nuts
48	Kolanuts	Kolanuts	v_f	Vegetables, fruit, nuts
49	Hazelnuts_	Hazelnuts; with shell	v_f	Vegetables, fruit, nuts
50	Areca_nuts	Areca nuts	v_f	Vegetables, fruit, nuts
51	Nuts_nes	Nuts; nes	v_f	Vegetables, fruit, nuts
52	Prepared_n	Prepared nuts (exc. groundnuts)	ofd	Food products nec
53	Soyabeans	Soyabeans	osd	Oil seeds
54	Groundnuts	Groundnuts (Shelled Eq)	osd	Oil seeds
55	SunflwrSd	Sunflowerseed	osd	Oil seeds
56	RapeMstrds	Rape and Mustardseed	osd	Oil seeds
57	CottnSd	Cottonseed	osd	Oil seeds
58	Coconuts_I	Coconuts - Incl Copra	osd	Oil seeds
59	SesameS	Sesameseed	osd	Oil seeds
60	Palmkrnls	Palmkernels	osd	Oil seeds
61	Olives	Olives	v_f	Vegetables, fruit, nuts
62	Oilcrp_Oth	Oilcrops; Other	osd	Oil seeds
63	Soyabean_O	Soyabean Oil	vol	Vegetable oils and fats
64	Groundnut_	Groundnut Oil	vol	Vegetable oils and fats
65	SunflwrSd_	Sunflowerseed Oil	vol	Vegetable oils and fats
66	RapeMstrd_	Rape and Mustard Oil	vol	Vegetable oils and fats
67	CottnSd_Oi	Cottonseed Oil	vol	Vegetable oils and fats
68	Palmkrnl_O	Palmkernel Oil	vol	Vegetable oils and fats
69	Palm_Oil	Palm Oil	vol	Vegetable oils and fats
70	Coconut_Oi	Coconut Oil	vol	Vegetable oils and fats
71	SesameS_Oi	Sesameseed Oil	vol	Vegetable oils and fats
72	Olive_Oil	Olive Oil	vol	Vegetable oils and fats
73	Ricebran_O	Ricebran Oil	vol	Vegetable oils and fats
74	Maize_Germ	Maize Germ Oil	vol	Vegetable oils and fats

nr	Code	Description	Code	Description
75	Oilcrp_Oil	Oilcrops Oil; Other	vol	Vegetable oils and fats
76	Tomatoes	Tomatoes	v_f	Vegetables, fruit, nuts
77	Onions	Onions	v_f	Vegetables, fruit, nuts
78	Cabbages_a	Cabbages and other brassicas	v_f	Vegetables, fruit, nuts
79	Artichokes	Artichokes	v_f	Vegetables, fruit, nuts
80	Asparagus	Asparagus	v_f	Vegetables, fruit, nuts
81	Lettuce_an	Lettuce and chicory	v_f	Vegetables, fruit, nuts
82	Spinach	Spinach	v_f	Vegetables, fruit, nuts
83	Cassava_le	Cassava leaves	v_f	Vegetables, fruit, nuts
84	Cauliflowe	Cauliflowers and broccoli	v_f	Vegetables, fruit, nuts
85	Pumpkins_s	Pumpkins; squash; and gourds	v_f	Vegetables, fruit, nuts
86	Cucumbers_	Cucumbers and gherkins	v_f	Vegetables, fruit, nuts
87	Eggplants_	Eggplants (aubergines)	v_f	Vegetables, fruit, nuts
88	Chillies_a	Chillies and peppers; green	v_f	Vegetables, fruit, nuts
89	Onions_inc	Onions (inc. shallots); green	v_f	Vegetables, fruit, nuts
90	Garlic	Garlic	ocr	Crops nec
91	Leeks_othe	Leeks; other alliaceous veg.	v_f	Vegetables, fruit, nuts
92	Beans_gree	Beans; green	v_f	Vegetables, fruit, nuts
93	Peas_green	Peas; green	v_f	Vegetables, fruit, nuts
94	Leguminous	Leguminous vegetables; nes	v_f	Vegetables, fruit, nuts
95	String_bea	String beans	v_f	Vegetables, fruit, nuts
96	Carrots_an	Carrots and turnips	v_f	Vegetables, fruit, nuts
97	Okra	Okra	v_f	Vegetables, fruit, nuts
98	Maize_gree	Maize; green	gro	Cereal grains nec
99	Mushrooms_	Mushrooms and truffles	v_f	Vegetables, fruit, nuts
100	Chicory_ro	Chicory roots	v_f	Vegetables, fruit, nuts
101	Veg_fresh_	Vegetables; fresh; nes	v_f	Vegetables, fruit, nuts
102	Veg_dried_	Vegetables; dried; nes	v_f	Vegetables, fruit, nuts
103	Veg_dehydr	Vegetables; dehydrated	v_f	Vegetables, fruit, nuts
104	Veg_in_vin	Vegetables in vinegar	ofd	Food products nec
105	Veg_preser	Vegetables; preserved; nes	ofd	Food products nec
106	Veg_frozen	Vegetables; frozen	v_f	Vegetables, fruit, nuts
107	Veg_in_tem	Vegetables in tem. preservatives	ofd	Food products nec
108	Veg_prepar	Vegetables prepared or preserved; frozen	ofd	Food products nec
109	Homogenous	Homogenous vegetables prepared	ofd	Food products nec
110	Watermelon	Watermelons	v_f	Vegetables, fruit, nuts
111	Other_melo	Other melons (inc. cantaloupes)	v_f	Vegetables, fruit, nuts
112	Coffee_sub	Coffee substitutes; cont. coffee	b_t	Beverages and tobacco products
113	Oranges_Ma	Oranges; Mandarines	v_f	Vegetables, fruit, nuts
114	Lemons_Lim	Lemons; Limes	v_f	Vegetables, fruit, nuts

nr	Code	Description	Code	Description
115	Grapefruit	Grapefruit	v_f	Vegetables, fruit, nuts
116	Citrus_Oth	Citrus; Other	v_f	Vegetables, fruit, nuts
117	Bananas	Bananas	v_f	Vegetables, fruit, nuts
118	Plantains	Plantains	v_f	Vegetables, fruit, nuts
119	Apples	Apples	v_f	Vegetables, fruit, nuts
120	Pineapples	Pineapples	v_f	Vegetables, fruit, nuts
121	Dates	Dates	v_f	Vegetables, fruit, nuts
122	Grapes	Grapes	v_f	Vegetables, fruit, nuts
123	Pears	Pears	v_f	Vegetables, fruit, nuts
124	Quinces	Quinces	v_f	Vegetables, fruit, nuts
125	Apricots	Apricots	v_f	Vegetables, fruit, nuts
126	Sour_cherr	Sour cherries	v_f	Vegetables, fruit, nuts
127	Cherries	Cherries	v_f	Vegetables, fruit, nuts
128	Peaches_an	Peaches and nectarines	v_f	Vegetables, fruit, nuts
129	Plums_and_	Plums and sloes	v_f	Vegetables, fruit, nuts
130	Stone_frui	Stone fruit; nes	v_f	Vegetables, fruit, nuts
131	Pome_fruit	Pome fruit; nes	v_f	Vegetables, fruit, nuts
132	Strawberri	Strawberries	v_f	Vegetables, fruit, nuts
133	Raspberrie	Raspberries	v_f	Vegetables, fruit, nuts
134	Gooseberri	Gooseberries	v_f	Vegetables, fruit, nuts
135	Currants	Currants	v_f	Vegetables, fruit, nuts
136	Blueberrie	Blueberries	v_f	Vegetables, fruit, nuts
137	Cranberrie	Cranberries	v_f	Vegetables, fruit, nuts
138	Berries_ne	Berries; nes	v_f	Vegetables, fruit, nuts
139	Figs	Figs	v_f	Vegetables, fruit, nuts
140	Mangos_man	Mangos; mangosteens; guavas	v_f	Vegetables, fruit, nuts
141	Avocados	Avocados	v_f	Vegetables, fruit, nuts
142	Persimmons	Persimmons	v_f	Vegetables, fruit, nuts
143	Cashewappl	Cashewapple	v_f	Vegetables, fruit, nuts
144	Kiwi_fruit	Kiwi fruit	v_f	Vegetables, fruit, nuts
145	Papayas	Papayas	v_f	Vegetables, fruit, nuts
146	Fruit_trop	Fruit; tropical fresh; nes	v_f	Vegetables, fruit, nuts
147	Fresh_frui	Fresh fruit; nes	v_f	Vegetables, fruit, nuts
148	Fruit_drie	Fruit dried; nes	v_f	Vegetables, fruit, nuts
149	Fruit_juic	Fruit juice; nes	ofd	Food products nec
150	Fruit_prep	Fruit; prepared; nes	ofd	Food products nec
151	Homogenize	Homogenized; cooked fruit prepared	ofd	Food products nec
152	Coffee	Coffee	ocr	Crops nec
153	Cocoa_Bean	Cocoa Beans	ocr	Crops nec
154	Tea	Tea	ocr	Crops nec
155	Pepper	Pepper	v_f	Vegetables, fruit, nuts

nr	Code	Description	Code	Description
156	Pimento	Pimento	v_f	Vegetables, fruit, nuts
157	Cloves	Cloves	ocr	Crops nec
158	Vanilla	Vanilla	ocr	Crops nec
159	Cinnamon_c	Cinnamon (canella)	ocr	Crops nec
160	Nutmeg_mac	Nutmeg; mace; and cardamoms	ocr	Crops nec
161	Anise_badi	Anise; badian; fennel; coriander	ocr	Crops nec
162	Ginger	Ginger	ocr	Crops nec
163	Spices_nes	Spices; nes	ocr	Crops nec
164	Wine	Wine	b_t	Beverages and tobacco products
165	Beer	Beer	b_t	Beverages and tobacco products
166	Bevrg_Ferm	Beverages; Fermented	b_t	Beverages and tobacco products
167	Bevrg_Alco	Beverages; Alcoholic	b_t	Beverages and tobacco products
168	Bovine_Mea	Bovine Meat	bfcmt	Beef processed meat
169	Mutton_Goa	Mutton & Goat Meat	cmt	Meat: cattle,sheep,goats,horse
170	Pigmeat	Pigmeat	omt	Meat products nec
171	Poultry_Me	Poultry Meat	poum	Poultry processed meat
172	Bird_meat_	Bird meat; nes	poum	Poultry processed meat
173	Horse_meat	Horse meat	omt	Meat products nec
174	Meat_of_as	Meat of asses	omt	Meat products nec
175	Meat_of_mu	Meat of mules	omt	Meat products nec
176	Camel_meat	Camel meat	omt	Meat products nec
177	Rabbit_mea	Rabbit meat	omt	Meat products nec
178	OMeat_rode	Meat of other rodents	omt	Meat products nec
179	OMeat_came	Meat of other camelids	omt	Meat products nec
180	Game_meat	Game meat	omt	Meat products nec
181	Meat_dried	Meat; dried; nes	cmt	Meat: cattle,sheep,goats,horse
182	Meat_nes	Meat; nes	cmt	Meat: cattle,sheep,goats,horse
183	Snails_not	Snails; not sea	oap	Animal products nec
184	OffL_of_ca	Offals of cattle; edible	bfcmt	Beef processed meat
185	OffL_of_sh	Offals of sheep; edible	cmt	Meat: cattle,sheep,goats,horse
186	OffL_of_go	Offals of goats; edible	cmt	Meat: cattle,sheep,goats,horse
187	OffL_of_pi	Offals of pigs; edible	omt	Meat products nec
188	OffL_Lvr_c	Offals; liver; chicken	poum	Poultry processed meat
189	OffL_Lvr_g	Offals; liver; geese	poum	Poultry processed meat
190	OffL_Lvr_d	Offals; liver; duck	poum	Poultry processed meat
191	OffL_nes	Offals; nes	cmt	Meat: cattle,sheep,goats,horse
192	Butter_cow	Butter; cow milk	mil	Dairy products
193	Ghee_butte	Ghee; butteroil of cow milk	mil	Dairy products
194	Butter_of_	Butter of buffalo milk	mil	Dairy products
195	Ghee_oil_o	Ghee oil of buffalo milk	mil	Dairy products
196	Butter_ghe	Butter; ghee of sheep milk	mil	Dairy products

nr	Code	Description	Code	Description
197	Cream	Cream	mil	Dairy products
198	Fats_Anima	Fats; Animals; Raw	cmt	Meat: cattle,sheep,goats,horse
199	Fish_Body_	Fish; Body Oil	fsh	Fishing
200	Fish_Lvr_O	Fish; Liver Oil	fsh	Fishing
201	Hen_eggs_i	Hen eggs; in shell	poum	Poultry processed meat
202	Eggs_liqui	Eggs; liquid	poum	Poultry processed meat
203	Eggs_dried	Eggs; dried	poum	Poultry processed meat
204	Other_bird	Other bird eggs; in shell	poum	Poultry processed meat
205	Cow_milk_w	Cow milk; whole; fresh	rmk	Raw milk
206	Buffalo_mi	Buffalo milk; whole; fresh	rmk	Raw milk
207	Sheep_milk	Sheep milk; whole; fresh	rmk	Raw milk
208	Goat_milk_	Goat milk; whole; fresh	rmk	Raw milk
209	Camel_milk	Camel milk; whole; fresh	rmk	Raw milk
210	Product_of	Product of natural milk constit.	mil	Dairy products
211	Ice_cream_	Ice cream and edible ice	ofd	Food products nec
212	Freshwater	Freshwater Fish	fsh	Fishing
213	Demersal_F	Demersal Fish	fsh	Fishing
214	Pelagic_Fi	Pelagic Fish	fsh	Fishing
215	Marine_Fis	Marine Fish; Other	fsh	Fishing
216	Crustacean	Crustaceans	fsh	Fishing
217	Cephalopod	Cephalopods	fsh	Fishing
218	Molluscs_O	Molluscs; Other	fsh	Fishing
219	Aquatic_An	Aquatic Animals; Others	fsh	Fishing
220	Aquatic_Pl	Aquatic Plants	fsh	Fishing
221	Miscellane	Miscellaneous + (Total)	ofd	Food products nec
222	Wheat_Flou	Wheat Flour	ofd	Food products nec
223	Corn_Flour	Corn Flour	ofd	Food products nec
224	Millet_Flo	Millet Flour	ofd	Food products nec
225	Sorghum_Fl	Sorghum Flour	ofd	Food products nec

No.	Code	Description
1	EdFd	Edible food availability by country 2011 (g/person/day)
2	Calorie	Calorie availability by country 2011 (kcal/person/day)
3	Protein	Protein availability by country 2011 (g/person/day)
4	Fat	Fat availability by country 2011 (g/person/day)
5	Carb	Carbohydrates availability by country 2011 (g/person/day)
6	VitC	Vitamin C availability by country 2011 (mg/person/day)
7	VitA	Vitamin A availability by country 2011 (microgram RAE/person/day)
8	Folate	Folate availability by country 2011 (microgram/person/day)
9	Calcium	Calcium availability by country 2011 (mg/person/day)
10	Iron	Iron availability by country 2011 (mg/person/day)
11	Zinc	Zinc availability by country 2011 (mg/person/day)
12	Potas	Potassium availability by country 2011 (mg/person/day)
13	Fiber	Dietary fiber availability by country 2011 (g/person/day)
14	Copper	Copper availability by country 2011 (mg/person/day)
15	Sodium	Sodium availability by country 2011 (mg/person/day)
16	Phosph	Phosphorus availability by country 2011 (mg/person/day)
17	Thiamin	Thiamine availability by country 2011 (mg/person/day)
18	Ribofl	Robiflavin availability by country 2011 (mg/person/day)
19	Niacin	Niacin availability by country 2011 (mg/person/day)
20	B6	B6 availability by country 2011 (mg/person/day)
21	Magnsm	Magnesium availability by country 2011 (mg/person/day)
22	SatFat	Saturated fatty acids availability by country 2011 (g/person/day)
23	MonoUSF	Monounsaturated fatty acids avail. by country 2011 (g/person/day)
24	PolyUSF	Polyunsaturated fatty acids avail. by country 2011 (g/person/day)