EUROPEAN COMMISSION

Community research

COMET

(Contract Number: Fission-2012-3.4.1-604794)

DELIVERABLE (IRA-Human-D3)

Sets of improved parameter values for Nordic and Mediterranean ecosystems for Cs-134/137, Sr-90, I-131 with justification text

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Date of issue of this report: 06/04/16

Start date of project: 01/06/2013 Duration: 48Months

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Project co-funded by the European Commission under the Seventh Euratom Framework Programme for Nuclear Research &Training Activities		
Dissemination Level		
PU	Public	PU
RE	Restricted to a group specified by the partners of the [COMET] project	
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Executive Summary

The two standard European Decision Support Systems ARGOS and JRODOS use German default parameters in their integrated "Terrestrial Food Chain and Dose Module" (FDMT). Since many of the parameters used in FDMT are region-specific, many of the default parameters may not be appropriate for other regions in Europe. The aim of this Deliverable was to derive updated human food chain parameter values that are appropriate for Nordic and Mediterranean terrestrial ecosystems. Based on recommendations regarding regional updating developed within the JRODOS or ARGOS communities (and to lesser extent on available sensitivity analyses), important parameters in relation to regional adaptation have been identified. These parameters may be divided in four broad groups: Contamination of plants due to direct deposition, animal parameters, human habits and uptake from soil. Each country (Finland, Norway, Spain) have decided on the specific parameters within those broad categories to update. The parameters chosen are based on the identified needs in each country – and where we expect the updating to give the most significant reduction in uncertainty related to the activity concentrations in foodstuffs and internal doses to humans. Consequently, the focus of this report is on: (1) parameters of relevance to growing season and harvest periods of crops and grass including seasonal development of leaf area indices (LAI) (i.e. agricultural calendars), (2) animal feeding practice and (3) human consumption of foodstuffs. Together with updated regionalised parameter values from Finland, Norway and Spain, relevant model default parameter values have been included in separate tables. Since the French modelling platform SYMBIOSE will be run using the regionally updated parameters from Finland, Norway and Spain in the next part of this project, we have also included relevant French default parameters in this Deliverable.

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1. Introduction

Region-specific parameters are lacking for many countries leading to rather uncertain predictions of doses from the human food chain following radioactive fallout, from for example nuclear power plant accidents. Generally, the Mediterranean area has been understudied so far, and the derivation of region-specific values would greatly improve the prediction capability. The Nordic countries have climatic conditions, and agricultural and grazing practices that differ significantly from the central European ones. Therefore, parameterisation of region-specific values is necessary to provide sound predictions on food contamination over time and consequent doses to humans.

To study the effect of regional, and to some extent generic parameter updates, two scenarios were specified within the present project: a dry deposition scenario and a wet deposition scenario with a specified amount of rainfall. For both scenarios the deposition date was set to 1 August[1]. Four radionuclides were included: Cs-134, Cs-137, Sr-90 and I-131 at 1000 Bq m^{-2} deposition of each. Two models were applied in this project:

- The Terrestrial Food Chain and Dose Module (FDMT) by Finland, Spain and Norway
- SYMBIOSE by France

At this stage, both models have been run using default parameters focusing on priority foodstuffs identified by each participating country (Table 1.1).

Table 1.1: Products considered. Relevant food items / product for each participating country.

Food item / product	Finland	France	Norway	Spain
Cow milk (fresh)	X	X	X	X
Cow milk (canned)		X		
Goat milk		X	X	X
Lamb meat		X	X	X
Leafy vegetables (fresh)	X	X	X	X
Leafy vegetables (canned)		X		
Beef (cow)	X	X	X	X
Pork	X	X	X	X
Winter wheat (flour)	X	X	X	X

For the part of the project described in this Deliverable, the aim is to derive human food chain parameter values that are appropriate for Nordic and Mediterranean ecosystems.

[1] Other dates could be considered at a later stage.

2. Model descriptions

2.1 The Terrestrial Food Chain and Dose Module (FDMT)

FDMT is used in the two standard European Decision Support Systems ARGOS and JRODOS to predict transfer of radioactive substances in food chains following radioactive fallout (concentrations in various products and doses to the population are calculated). FDMT is based on the ECOSYS dynamic model developed in the early 1990s (Müller and Pröhl, 1993). A large number of adjustable parameters are included in the module, where some are dependent on site and situation, whereas others have a more general validity. In the broadest sense, parameters in FDMT can be categorised (based on Raskob et al 2000; Pröhl and Müller, 2005) as being either:

- **Element-independent**: food products, plant growing and harvesting times, animal feeding characteristics, human consumption habits.
- **Element dependent**: Translocation factors, soil leaching/fixation, soil-plant transfer factors, transfer factors to animal products, processing of feed-/foodstuffs.
- **Nuclide-dependent**: Physical half-lives, various dose factors.

For a detailed description of FDMT parameters including default values we refer to Müller et al. (2004).

2.2 SYMBIOSE

SYMBIOSE is a modelling platform developed by IRSN and co-funded by EDF (Electricité De France, the French operator). SYMBIOSE models the fate and transport of radioactive substances in environmental systems to assess their risks to humans, accounting for uncertainty and variability (Gonze et al., 2011; Simon-Cornu et al., 2015). This platform can be used in a wide range of situations for assessing risks induced by radioactive releases from nuclear facilities under normal operation, accidental or decommissioning conditions. Environmental models in SYMBIOSE address atmospheric, terrestrial, freshwater and marine systems as well as the major transfer processes at their interfaces. The modelled exposure pathways are external radiation (in the plume and outside of the plume) and internal contamination (inhalation, percutaneous transfer for tritium, accidental ingestion of sea sand and sea water, ingestion of foodstuffs, including drinking water, leafy vegetables, potatoes, cow milk, beef, hen eggs, river fish, sea fish, etc.). Thus, it is appropriate for dealing with the scenario of accidental atmospheric release defined in COMET WP3 IRA "human food chain". Since IRSN is both the developer and the user of SYMBIOSE, uncertainty and sensitivity analyses of the model can be performed (which is not the case for the users of FDMT).

3. Regional update of FDMT

One of the limitations of the FDMT model (as currently implemented) is that most default parameters are based on southern German values that may not be appropriate for other regions in Europe. However, regional adaptation of parameters has been updated for seven eastern European countries within RODOS (Raskob et al. 2000; Slavik et al. 2001). In addition, regional updating of Nordic countries (Hansen et al. 2010; Andersson et al. 2011) and Ireland (RPII, 2007) is also available.

Recommendations regarding adaptation of FDMT parameters for specific regions or sites have been developed within the JRODOS or ARGOS communities, for instance in connection with the updating work done in Eastern Europe (as mentioned above). These recommendations are largely based on expert judgment from the developers of ECOSYS or other experienced users of FDMT (Pröhl and Müller, 2005; Raskob et al 2000; Raskob, 2014). Generally, parameters are rated as being of high, moderate or low priority in relation to regional updating.

Based on recommendations regarding regional updating (Pröhl and Müller, 2005), and to a lesser extent on sensitivity analyses (Müller et al., 1993), important parameters in relation to regional adaptation have been identified (Table 2.1). Except for the category "Uptake from soil" (which is element-specific), they all belong to the "element-independent" category. All nuclide-specific parameters are considered low priority in relation to regional updating (i.e. they have general validity).

Table 2.1: Summary of important parameters in relation to regional adaptation. Note that each parameter may require specification of several sub-parameters (these are identified during the actual regional adaptation)

Category	Parameter
Contamination of plants due to direct deposition	• Relevant growth periods • Leaf area indices (LAI) • Yields • Period of preparing winter feed
Animal parameters	• Animal specific feeding rations
Human habits	• Age-dependent consumption rates • Seasonality of consumption rates (if relevant)
Uptake from soil	• Transfer factors • Migration rates (if necessary)

Each country (Finland, Norway and Spain) has decided on which of these parameters to update (see following sections). The parameters chosen are based on the identified needs in each country and where we expect the updating to give the most significant reduction in uncertainty related to the activity concentrations in foodstuffs and internal doses to humans.

3.1 Finland

It was found that regionalised Finnish data are currently available only for certain general (but important) parameters such as consumption of foodstuffs, crop yields and harvesting periods. Many important parameters, such as those related to soil type, are simply not available, and are therefore not changed. Also, some of the parameter values presented here are not "really national" but are based on or judged from the values referring to other Nordic countries.

The following sections 3.1.1–3.1.4 show the JRODOS default parameter values and the modified Finnish data for the consumption of foodstuffs, leaf area indices, crop yields, harvesting periods and animal feeding as well as the data for hay and grass.

The main difficulties faced are summarised in section 3.1.5.

3.1.1 Foodstuffs consumption

Diets and consumption of various foodstuffs may vary significantly between different countries. Furthermore, the consumption figures in a country also change more or less over time. This trend was apparent in the Finnish data collected now versus a decade ago.

There are a couple of problems related to the customisation of the foodstuff consumption parameters of FDMT and comparing them with those in JRODOS:

- In JRODOS there are five age groups included in the Central European default parameters: one year, five years, ten years, fifteen years and adults. In Finland, there exists relevant foodstuff consumption statistics only for adults and children of one, two, three, four and six years. Furthermore, the detailed classification of various foodstuffs in the adult diet study differs somewhat from that used in the children's diet study.
- The available Finnish data is in some respects limited. Therefore, different kinds of assumptions and approximations have to be made.

Table 3.1 shows the consumption rates of various foodstuffs as given currently in JRODOS (Central European parameters) and table 3.2 those referring to the Finnish conditions. The Finnish parameters are based on:

- Adults: Data were collected by 48-hour dietary recall from 1295 participants (age 25–64 years) as a part of the *FINDIET 2012 survey* (FINDIET, 2013). 48-hour dietary recalls were done between Mondays and Fridays and data thus includes week and weekend days. The number of Thursdays and Saturdays is about half compared with other days and data on Fridays are lacking because of the study design.
- Children: Food diaries (2535 three-day diaries in all) of children born 1998–2003 were collected between the years 2003–2005 using the data from the national *Type 1 Diabetes Prediction and Prevention (DIPP) Nutrition Study* (DIPP, 2008). Age groups in the study were one, two, three, four and six years.

Comparison of tables 3.1 and 3.2 suggests that there exist “major” differences concerning e.g. vegetables, some cereals, meat and drinking water. Some of these are real but some may be caused by the differences in the basis of the statistics used (the origin of the default consumption rates in JRODOS is not known well by STUK).

Table 3.1: Average food consumption (absolute intake g/day) for various age groups in JRODOS.

Product	**1 y**	**5 y**	**10 y**	**15 y**	**Adults**
Winter wheat					
• Whole	6	13	16	18	23
• Flour	35	73	91	100	130
• Bran	0	0	0	0	0
Spring wheat					
• Whole	0.7	1.4	1.8	2	2.6
• Flour	3.9	8.1	10	12	15
• Bran	0	0	0	0	0
Rye					
• Whole	2.2	4.8	6	6.9	8.7
• Flour	9.3	19	24	28	35
• Bran	0	0	0	0	0
Oats	2.9	3.1	3.9	4.4	5.6
Potatoes	45	35	60	83	160
Leafy vegetables	58	74	79	86	94
Root vegetables	21	24	29	33	33
Fruit vegetables	12	36	41	46	47
Fruits	150	72	91	100	120
Berries	0	10	12	14	14
Milk	560	140	180	210	230
Condensed milk	0	11	14	16	18
Cream	0	9.6	13	14	16
Butter	0	6.1	9.5	12	18
Cheese (ren.)	0	10	14	19	26
Cheese (acid)	0	6.6	8.9	12	17
Sheep milk	0	0	0	0	0
Goat’s milk	0	0	0	0	0
Beef (cow)	1.5	18	19	23	27
Beef (bull)	3	35	38	46	55
Veal	0.2	1.4	1.5	1.8	2.2
Pork	3.9	72	78	90	108
Lamb	0	0	0	0	0.6
Chicken	0	1.1	1.2	1.3	1.7
Eggs	5	18	25	36	43
Beer	0	0	12	130	610
Drinking water	640	800	1000	1600	1600
Fish	0	7.5	10	11	18

Table 3.2: Average food consumption (absolute intake g/day) for various age groups in Finland

Product	1 y	5 y[a]	10 y[a]	15 y[a]	Adults (25-64 years)
Winter wheat[b]					
• Whole	n	n	n	n	n
• Flour[c]	1.5	4.6	5.0	4.9	4.8
• Bran	n	n	n	n	n
Spring wheat[b]					
• Whole	n	n	n	n	n
• Flour[c]	18	53	57	56	55
• Bran	n	n	n	n	n
Rye					
• Whole	n	n	n	n	n
• Flour[c]	5	13	21	28	42
• Bran	n	n	n	n	n
Oats[d]	21	13	13	14	8.2
Potatoes	70	80	82	79	73
Leafy vegetables	4[e]	6.5[e]	11[e]	16[e]	19
Root vegetables	36	28	30	31	34
Fruit vegetables	15[e]	24[e]	41[e]	62[e]	72
Fruits[f]	55	61	80	101	145
Berries[f]	14	16	17	19	22
Milk	267	485	448	390	272
Condensed milk	ns	ns	ns	ns	ns
Cream[g]	3.5	11	15	15	17
Butter	1	5	8	10	16
Cheese (rennet)[h]	3.5	14	20	26	39
Cheese (acid)[h]	n	n	n	n	n
Sheep milk	ns	ns	ns	ns	ns
Goat's milk	ns	ns	ns	ns	ns
Beef (cow)[i]	15	16	19	21	24
Beef (bull)[i]	n	n	n	n	n
Veal	n	n	n	n	n
Pork	13	18	21	24	29
Lamb	n	n	n	n	1.4[j]
Chicken	n	n	n	n	33[k]
Eggs	2.5	11	14	16	20
Beer	0	0	0	0	268[l]
Drinking water	71	118	259	437	791
Fish[m]	5	11	16	21	30

n = Not known.

ns = Not known but probably very small.

[a] Consumption figures are based in many cases on interpolation between age groups.

[b] Only the total consumption of wheat is known. Consumption of winter wheat is clearly smaller than that of spring wheat. The divisions between winter wheat and spring wheat given here are average values based on the 2010-2013 crop yields and fractions of harvests that are of milling quality (TIKE, 2014).

[c] All consumption is assumed to be flour.

[d] Consumption is not known precisely. Figures are rough estimates based on the consumption of oats and barley together.

[e] Very rough estimates based on the data on the total consumption of other vegetables than root vegetables and on using consumption ratios given for adults.

[f] Does not include juices.

[g] Includes also milks > 2 % fat.

[h] Due to lack of data all cheese is assumed to be rennet coagulation cheese.

[i] Only total consumption of beef is known. It is assumed to be cow beef.

[j] Estimated on the basis of total consumption and population over 15 years.

[k] Poultry meat.

[l] Estimated on basis of total consumption and population over 15 years.

[m] Fish and shellfish.

3.1.2 Leaf area indices, yields and harvesting data (southern Finland)

The Finnish and JRODOS data are shown in tables 3.3–3.5. The Finnish leaf-area-index data are taken from the report PARDNOR (2009) and harvesting data from an internal memorandum (Kostiainen E., 2013). The crop yields are 2010-2013 averages taken from the official statistics (TIKE, 2014).

It must be understood that the yields, growth season and harvesting season vary from year to year; changes of one to two weeks in the given dates are customary (in some years the changes may be even bigger).

The Finnish leaf-area indices in PARDNOR (2009) represent whole months. JRODOS however requires that the times are input as specific dates, and therefore an interpretation is made here that the index data (normal fertilization conditions) in PARDNOR (2009) refer to the date in the middle of the corresponding month.

The beginning dates of the Finnish growth seasons shown in the tables are only estimates based on one hand on the fact that the thermal growth period starts usually in the end of April (in southern Finland) and on the other hand on the data of leaf area indices. In cases where the beginning of the growth season determined in this way refers to a later date than the JRODOS Central European value the latter is chosen to also represent the Finnish conditions.

There is a minor problem concerning the yields of vegetables that are in JRODOS divided into leafy vegetables, fruit vegetables and root vegetables. There is no information about which vegetables actually belongs to each vegetable group or on how the average yields are estimated. Furthermore, common vegetables such as cauliflower, onions and peas do not seem to belong to any of the above-mentioned groups.

The Finnish vegetable group yields in table 3.4 are weighted according to the cultivated areas of the vegetables belonging to the group in question (the names of the vegetables considered in each group are given in the table).

3.1.3 Grass and hay data (southern Finland)

The grass and hay data for Finland and JRODOS are given in tables 3.6 and 3.7. The Finnish total yields (in table 3.6) are 2010-2013 averages taken from the official statistics (TIKE, 2014). The yields at different dates are estimated on the basis of the total yields, leaf area indices (PARDNOR, 2009) and the Central European data. Harvesting data is mostly based on the mentioned internal memorandum (Kostiainen E., 2013), while the beginning of the growth season is simply taken to be one month later than that in JRODOS.

The Finnish values of growth dilution factors for grass and hay (table 3.7) are slightly modified JRODOS values and are only rough estimates.

3.1.4 Feedstuffs and animal feeding regimes

Table 3.8 shows the JRODOS default data. Apart from the water consumption figures (MTT, 2006), the Finnish data in table 3.9 are the same as in PARDNOR (2008) and refer to typical main constituents of fodder. In practice, there are variations, of course. For example, the annual average feed consumption rates of cows are substantially lower than those for

lactating cows. On the other hand, during thedry period of the cows (about two months) the consumption rates are smaller than the annual average values.

There is one major difference between the JRODOS default data and the Finnish data. In Finland grass silage plays an important role as a feedstuff but JRODOS does not include it. Therefore a new feedstuff item was created assuming that the minimum delay between harvest and use as feed is 10 days; the actual delay depends on the type of inoculant used and on the moisture content, and may vary from a few days to one or two months. Grass silage is also included in the above-mentioned table 3.6 (grass and hay data).

Table 3.3: Leaf area indices, yields and harvesting data for rye, spring wheat, spring barley and oats.

STUK (Finland)				**JRODOS default** (Central Europe)			
Leaf are index				**Leaf area index**			
Rye		Spring wheat		Rye		Spring wheat	
Julian day	Index	Julian day	Index	Julian day	Index	Julian day	Index
0	0.5	0	0	0	0.1	0	0
75	0.5	105	0	79	1	105	0
105	0.5	135	1.4	140	6	171	6
135	5	166	5	213	1	227	1
196	5	196	5	214	0	228	0
235	2.1	235	2	288	0	365	0
236	0.3	236	0.3	365	0.1		
257	0	365	0				
288	0.5						
365	0.5						
Spring barley		Oats		Spring barley		Oats	
Julian day	Index	Julian day	Index	Julian day	Index	Julian day	Index
0	0	0	0	0	0	0	0
105	0	105	0	105	0	105	0
135	2.3	135	2.3	166	5	171	5
166	5	166	5	217	1	222	1
196	5	196	5	218	0	223	0
235	2	238	2	365	0	365	0
236	0.3	239	0.3				
365	0	365	0				
Yield ($kg \cdot m^{-2}$)				**Yield** ($kg \cdot m^{-2}$)			
• Rye 0.27				• Rye 0.4			
• Spring wheat 0.37				• Spring wheat 0.5			
• Spring barley 0.35				• Spring barley 0.4			
• Oats 0.33				• Oats 0.4			
Growing and harvesting seasons (Julian day)				**Growing and harvesting seasons** (Julian day)			
Rye		Spring wheat		Rye		Spring wheat	
Begin of growth	Harvest[a]	Begin of growth	Harvest[a]	Begin of growth	Harvest	Begin of growth	Harvest
288	235	120	235	288	212	105	227
Spring barley		Oats		Spring barley		Oats	
Begin of growth	Harvest[a]	Begin of growth	Harvest[a]	Begin of growth	Harvest	Begin of growth	Harvest
120	235	120	238	105	217	105	222

[a] The harvesting dates given refer to the average dates (as apparently also in JRODOS) of the harvesting periods: rye, spring wheat and spring barley 227–243, oats 232–243

Table 3.4: Leaf area indices, yields and harvesting data for potatoes, outdoor leafy vegetables, outdoor fruit vegetables and outdoor root vegetables.

STUK (Finland)				**JRODOS default** (Central Europe)			
Leaf are index				**Leaf area index**			
Potatoes		Leafy vegetables[a]		Potatoes		Leafy vegetables	
Julian day	Index	Julian day	Index	Julian day	Index	Julian day	Index
0 105 135 166 196 227 288 365	0 0 0.6 3.3 5 4.7 0 0	0 105 135 166 196 227 258 288 304 365	0 0 3 5 5 3.5 3 2 0 0	0 140 182 213 258 365	0 0 4 4 0 0	0 365	5 5
Fruit vegetables[b]		Root vegetables[c]		Fruit vegetables		Root vegetables	
Julian day	Index	Julian day	Index	Julian day	Index	Julian day	Index
0 105 135 166 196 227 243 365	0 0 0.2 5 2.8 2.5 0 0	0 105 135 166 196 227 258 304 365	0 0 0.02 1.2 4.6 5 5 0 0	0 105 182 274 305 365	0 0 5 5 0 0	0 105 182 274 305 365	0 0 5 5 0 0
Yield (kg·m^{-2})				**Yield** (kg·m^{-2})			
• Potatoes 2.6 • Leafy vegs. 2.5 • Fruit vegs. 4.4 • Root vegs. 3.9				• Potatoes 3.0 • Leafy vegs. 2.0 • Fruit vegs. n • Root vegs. n			
Growing and harvesting seasons (Julian day)				**Growing and harvesting seasons** (Julian day)			
Potatoes		Leafy vegs.		Potatoes		Leafy vegs.	
Begin of growth	Harvest (begin, end)	Begin of growth	Harvest (begin, end)	Begin of growth	Harvest (begin, end)	Begin of growth	Harvest (begin, end)
140	244 274	120	182 273	140	227 267	71	121 304
Fruit vegs.		Root vegs.		Fruit vegs.		Root vegs.	
Begin of growth	Harvest (begin, end)	Begin of growth	Harvest (begin, end)	Begin of growth	Harvest (begin, end)	Begin of growth	Harvest (begin, end)
120	196 227	120	244 288	n	n	n	n

n = not known or not given.

[a] Includes cabbage (white cabbage, sprouting broccoli, Chinese cabbage), crisphead lettuce and leek. Note that if cauliflower is classified as a leaf vegetable the average outdoor vegetable yield is 2.2 kg/m^2.

[b] Includes gherkin, pumpkin and courgette.

[c] Includes carrot, red beet, swede and celeriac. Note that if onions are classified as root vegetables the average yield is 3.3 kg/m^2.

Table 3.5: Leaf area indices, yields and harvesting data for beet, fruits, berries and winter wheat.

STUK (Finland)				**JRODOS default** (Central Europe)			
Leaf are index				**Leaf area index**			
Beet		Fruits		Beet		Fruits	
Julian day	Index	Julian day	Index	Julian day	Index	Julian day	Index
0	0	0	0	0	0	0	0
105	0	135	0	130	0	105	0
135	0.8	166	3.5	171	1	182	5
166	5	196	5	213	4	274	5
227	5	227	5	305	3	305	0
305	0	258	4	306	0	365	0
365	0	288	0	365	0		
		365	0				
Berries		Winter wheat		Berries		Winter wheat	
Julian day	Index	Julian day	Index	Julian day	Index	Julian day	Index
0	0	0	0.5	0	0	0	0.1
135	0	105	0.5	105	0	110	1
166	4.4	135	2.4	182	5	161	7
196	5	166	5	274	5	217	1
258	5	196	5	305	0	218	0
288	3.5	227	2.1	365	0	298	0
319	0	228	0.3			365	0.1
365	0	258	0				
		288	0.5				
		365	0.5				
Yield (kg·m^{-2})				**Yield** (kg·m^{-2})			
• Beet 4.0 • Fruits 0.7 • Berries 0.26 • W. wheat 0.40				• Beet 5.0 • Fruits n • Berries n • W. wheat 0.5			
Growing and harvesting seasons (Julian day)				**Growing and harvesting seasons** (Julian day)			
Beet		Fruits		Beet		Fruits	
Begin of growth	Harvest (begin, end)	Begin of growth	Harvest (begin, end)	Begin of growth	Harvest (begin, end)	Begin of growth	Harvest (begin, end)
130	274 304	135	227 288	130	263 304	n	n
Berries		Winter wheat		Berries		Winter wheat	
Begin of growth	Harvest (begin, end)	Begin of growth	Harvest[a]	Begin of growth	Harvest (begin, end)	Begin of growth	Harvest
135	182 243	273	227	n	n	298	217

n = not known or not given.

[a] The harvesting date given refers to the average date (as apparently in JRODOS) of the harvesting period 213-243.

Table 3.6: Grass and hay data.
Note that "grass" in this table refers to green fodder.

STUK (Finland)				**JRODOS default** (Central Europe)			
Yield				**Yield**			
Grass intensive (Grass silage: values in brackets)		Grass extensive		Grass intensive		Grass extensive	
Julian day	Yield ($kg \cdot m^{-2}$)	Julian day	Yield ($kg \cdot m^{-2}$)	Julian day	Yield ($kg \cdot m^{-2}$)	Julian day	Yield ($kg \cdot m^{-2}$)
0	0.01 (0.01)	0	0.01	0	0.01	0	0.01
105	0.05 (0.05)	105	0.05	74	0.05	74	0.05
135	0.8 (1.2)	182	0.8	135	1.5	182	1.5
166	1.1 (1.6)	213	1.1	304	1.5	304	1.5
257	1.1 (1.6)	257	1.1	305	0.05	305	0.01
258	0.05 (0.05)	258	0.05	365	0.01	365	0.01
335	0.01 (0.01)	335	0.01				
365	0.01 (0.01)	365	0.01				
Hay intensive		Hay extensive		Hay intensive		Hay extensive	
Julian day	Yield ($kg \cdot m^{-2}$)	Julian day	Yield ($kg \cdot m^{-2}$)	Julian day	Yield ($kg \cdot m^{-2}$)	Julian day	Yield ($kg \cdot m^{-2}$)
0	0.01	0	0.01	0	0.01	0	0.01
105	0.05	105	0.05	74	0.05	74	0.05
135	0.25	182	0.25	135	1.5	182	1.5
166	0.35	213	0.35	304	1.5	304	1.5
257	0.35	257	0.35	305	0.05	305	0.05
258	0.05	258	0.05	365	0.01	365	0.01
335	0.01	335	0.01				
365	0.01	365	0.01				
Max yield ($kg \cdot m^2$)				**Max yield** ($kg \cdot m^2$)			
• Grass 1.1 • Grass silage 1.6 • Hay 0.35				• Grass 1.5 • Hay 1.5			
Growing and harvesting seasons (Julian day)				**Growing and harvesting seasons** (Julian day)			
Grass intensive (Grass silage: values in brackets)		Grass extensive		Grass intensive		Grass extensive	
Begin of growth	105 (105)	105		Begin of growth	74	74	
Begin of harvest	166 (161)	166		Begin of harvest	121	121	
End of harvest	257 (215)	257		End of harvest	304	304	
End of first period	196 (191)	196		End of first period	196	196	
Hay intensive		Hay extensive		Hay intensive		Hay extensive	
Begin of growth	105	105		Begin of growth	74	74	
Begin of harvest	176	176		Begin of harvest	136	136	
End of harvest	243	243		End of harvest	258	258	
End of first period	196	196		End of first period	196	196	

Table 3.7: Growth dilution factors for grass and hay.

Month	**STUK** (Finland)		**JRODOS default** (Central Europe)	
	Growth dilution factors (1/d)		Growth dilution factors (1/d)	
	Grass/Hay intensive	Grass/Hay extensive	Grass/Hay intensive	Grass/Hay extensive
January	0	0	0	0
February	0	0	0	0
March	0	0	0.077	0.058
April	0.077	0.058	0.029	0.029
May	0.029	0.029	0.035	0.015
June	0.035	0.015	0.035	0.012
July	0.035	0.012	0.035	0.012
August	0.035	0.012	0.035	0.012
September	0.023	0.008	0.023	0.008
October	0.017	0.006	0.017	0.006
November	0	0	0	0
December	0	0	0	0

Table 3.8: JRODOS data of feedstuffs for animal products (kg fresh weight per day, Central Europe).

Animal product, Julian day	**Grass (intensive)**	**Grass (extensive)**	**Hay (intensive)**	**Hay (extensive)**	**Other**	**Feeding water**
Cow's milk						
111	0	0	14	0	0	75
131	70	0	0	0	0	75
294	70	0	0	0	0	75
314	0	0	14	0	0	75
365	0	0	14	0	0	75
Beef (cow)						
111	0	0	14	0	0	75
131	70	0	0	0	0	75
294	70	0	0	0	0	75
314	0	0	14	0	0	75
365	0	0	14	0	0	75
Beef (bull)						
365	0	0	0	0	28[a]	40
Pork						
365	0	0	0	0	3[b]	8
Lamb						
111	0	0	0	1	0	4
131	0	5	0	0	0	4
294	0	5	0	0	0	4
314	0	0	0	1	0	4
365	0	0	0	1	0	4
Chicken						
365					0.09[c]	0.2

[a] Maize.
[b] Winter barley.
[c] Winter wheat.

Table 3.9: Finnish data of feedstuffs for animal products (kg fresh weight per day).

Animal product and Julian day	Grass silage (intensive)	Fresh grass (intensive)	Fresh grass (extensive)	Hay (intensive)	Hay (extensive)	Spring barley/ Oats	Winter wheat	Feeding water
Cow's milk								
151	41	0	0	2	0	4	0	100
152	0	38	0	0	0	3.5	0	100
258	0	38	0	0	0	3.5	0	100
259	41	0	0	2	0	4	0	100
365	41	0	0	2	0	4	0	100
Beef cattle								
1	20	0	0	0	0	3	0	45
365	20	0	0	0	0	3	0	45
Pork								
365	0	0	0	0	0	3.5[a]	0	7
Lamb								
1	4	0	0	0	0.1	0	0	6
32	5	0	0	0	0.1	0.2	0	6
60	5	0	0	0	0.1	0.4	0	6
91	6.5	0	0	0	0.1	1.2	0	6
152	0	0	7.5	0	0	0	0	6
275	4	0	0	0	0	0	0	6
288	4	0	0	0	0.1	0.2	0	6
305	4	0	0	0	0.1	0	0	6
365	4	0	0	0	0.1	0	0	6
Chicken								
1	0	0	0	0	0	0.05	0.05	0.2
365	0	0	0	0	0	0.05	0.05	0.2

[a] Spring barley.

3.1.5 Conclusions

During the current localisation process, two major problems arose:

- The documentation of JRODOS is partly insufficient. If one is assumed to perform comparison calculations the origin of the Central European data should be known better and the foodstuffs in different groups should be clearly identified. For example, the public JRODOS documentation does not include lists of the vegetables assumed to belong to different vegetable groups.

- The basis of the statistical and other available Finnish data are in certain cases not identical to that used in JRODOS. Therefore some rough interpolations and approximations (and also educated guesses) were needed.

3.2 Norway

This part of the report deals with ARGOS FDMT regional updates for Norway. We have put emphasis on:

- Parameters of relevance to growing season and harvest periods of crops and grass including seasonal development of leaf area indices (LAI) (section 3.2.1)
- animal feeding regimes (section 3.2.2)
- human consumption of foodstuffs (section 3.2.3)

Due to limited time, we have decided not to include updates in radionuclide soil-plant transfer factors as a topic in the present report, even though this parameter is important for the long-term trends of e.g. Cs-137 in Norway.

3.2.1 Leaf area indices, yields and harvest data

The adaptation here is to some extend based on the work performed within the NKS-PARDNOR project, where three growing zones were specified for Norway. These zones, entitled Z1, Z2 and Z3, were based on the start of the growing season, defined here as the approximate time the average temperature in a specified region exceeds 5°C. For more information about the derivation of growing zones, we refer to PARDNOR (2009).

For the present work, we have identified which types of agricultural products are relevant within each zone, and their importance in relation to total production in Norway. Updated calculations of LAI development for different crops have been made since the available data within PARDNOR (2009) was insufficient for Norway. In addition, some inaccuracies have been identified and corrected. The same LAI database for different crops as used within PARDNOR (2009) was applied for the present update (i.e. Olesen, 2006). To be able to use the database, key variables such as sowing time, soil temperature development during the growing season[2] and harvest time had to be specified for various crops. Values for normal fertilisation were used in all cases.

LAIs for fruits, berries and leafy vegetables were not available through Olesen (2006). Consequently, we have simply adopted the Danish values given in PARDNOR (2009), since there are only minor differences in temperature development during the growing season between Denmark and Norway Z1.

[2] Temperature sum (TSum) – summation of days multiplied by the average day soil temperatures (degree days)

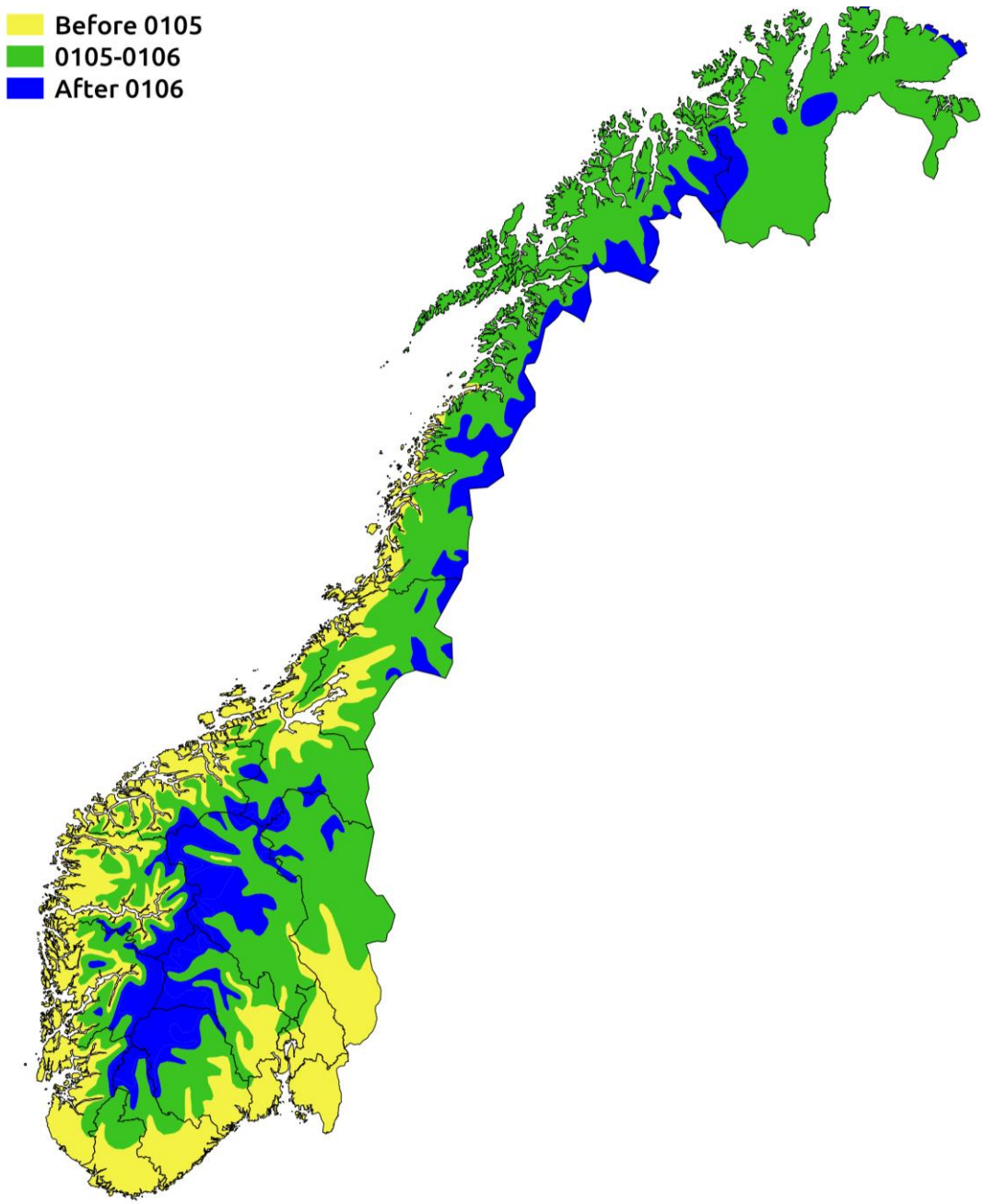

Figure 3.1: Start of growing season – approximate time when average temperature passes 5 °C in regions Z1 (yellow), Z2 (green) and Z3 (blue) (map by Tanya H. Hevrøy based on PARDNOR, 2009).

Cereals

The ARGOS German defaults and the updated Norwegian values are shown in tables 3.10 and 3.11, respectively. We have only included LAI data for Z1 in table 3.11, since more than 90 % of the national production of cereals occurs in this area. The Norwegian yields are 2010-2014 averages taken from the official statistics[3].

Table 3.10: Leaf area indices, yields and harvesting data for cereals (ARGOS default)

Spring barley		Spring wheat		Oats		Rye		Winter wheat	
Date	LAI	Date	LAI	Date	LAI	Date	LAI	Date	LAI
15.4.	0	15.4.	0	15.4.	0	1.1.	0.1	1.1.	0.1
15.6.	5	20.6.	6	20.6.	5	20.3.	1	20.4.	1
5.8.	1	15.8.	1	10.8.	1	20.5.	6	10.6.	7
6.8.	0	16.8.	0	11.8.	0	1.8.	1	5.8.	1
						2.8.	0	6.8.	0
						15.10.	0	25.10.	0
						31.12.	0.1	31.12.	0.1

Product	Start of growth	Harvest	Yield
Spring barley	15.4.	5.8.	0.4
Spring wheat	15.4.	15.8.	0.5
Oats	15.4.	10.8.	0.4
Rye	15.10.	31.7.	0.4
Winter wheat	25.10.	5.8.	0.5

Table 3.11: Leaf area indices, yields and harvesting data for cereals/grain (Norway)

Spring barley Z1		Spring wheat Z1		Oats Z1		Rye Z1		Winter wheat Z1	
Date	LAI	Date	LAI	Date	LAI	Date	LAI	Date	LAI
20.4.	0	20.4.	0	20.4.	0	1.1.	0.5	1.1.	0.5
4.5.	0	4.5.	0	4.5.	0	1.3.	0.5	1.3.	0.5
13.5.	0.41	13.5.	0.3	13.5.	0.41	7.4.	0.5	7.4.	0.5
23.5.	1.16	23.5.	0.8	23.5.	1.16	21.4.	1.6	21.4.	1
1.6.	2.53	1.6.	1.6	1.6.	2.53	2.5.	5	3.5.	2.2
8.6.	5	8.6.	2.9	8.6.	5	22.7.	5	13.5.	5
21.7.	5	14.6.	5	25.7.	5	15.8.	2	22.7.	5
15.8.	2	22.7.	5	15.8.	2	16.8.	0.3	16.8.	2
16.8.	0	18.8.	2	16.8.	0	5.9.	0	17.8.	0.3
		19.8.	0			14.9.	0	5.9.	0
						10.10.	0.5	14.9.	0
						31.12.	0.5	10.10.	0.5
								31.12.	0.5

Product	Start of growth Z1	Harvest Z1	Harvest N*	Yield
Spring barley	4.5.	15.8.	15.8.–15.9.	0.34
Spring wheat	4.5.	18.8.	15.8.–15.9.	0.40
Oats	4.5.	15.8.	1.9.–15.9.	0.40
Rye**	14.9.	15.8.	15.8.–31.8.	0.41
Winter wheat**	14.9.	16.8.	1.8.–15.8.	0.40

*Estimated harvest period (PARDNOR, 2009)

[3] Statistics Norway see http://www.ssb.no/

**Data from Denmark

Vegetables, fruits and berries

The vegetables in ARGOS FDMT are divided in leafy vegetables, fruit vegetables and root vegetables, and – as is also the case for JRODOS – no clear definition of what these umbrella categories actually represent is provided. Consequently, we have specified which products we have included for our update (see table 3.13 for details). Large differences in yield between various countries is likely to be due to the actual types of vegetables included in each category. Similar arguments apply to fruits and berries. As was the case for cereals, we have only included LAI data for Zone 1 in table 3.13, since the main production occurs here.

Table 3.12: Leaf area indices, yields and harvesting data for vegetables, fruit and berries (ARGOS default)

Potatoes		Leafy v.		Root v.		Fruit v.		Fruit		Berries	
Date	LAI	Date	LAI	Date	LAI	Date	LAI	Date	LAI	Date	LAI
20.5.	0	1.1.	5	15.4.	0	15.4.	0	15.4.	0	15.4.	0
1.7.	4	31.12.	5	1.7.	5	1.7.	5	1.7.	5	1.7.	5
1.8.	4			1.10.	5	1.10.	5	1.10.	5	1.10.	5
15.9.	0			1.11.	0	1.11.	0	1.11.	0	1.11.	0

Product	Start of growth	Harvest	Yield
Potatoes	20.5.	15.8.–24.9.	3.0
Leafy vegetables	n	1.1.–31.12.	2.0
Root vegetables	n	1.8.–31.10.	2.0
Fruit vegetables	n	1.8.–15.10.	1.5
Fruit	n	1.7.–15.10.	2.0
Berries	n	1.7.–15.10.	1.5

n = not known or given

Table 3.13: Leaf area indices, yields and harvesting data for vegetables, fruit and berries (Norway)

Potatoes Z1		Leafy v. Z1*		Root v. Z1		Fruit v. Z1		Fruit Z1*		Berries Z1*	
Date	LAI	Date	LAI	Date	LAI	Date	LAI	Date	LAI	Date	LAI
20.4.	0	10.4.	0	20.4.	0	20.4.	0	1.5.	0	1.4.	0
22.5.	0	1.5.	1	22.5.	0	8.5.	0	15.5.	0.5	10.4.	1
31.5.	0.6	1.6.	5	1.6.	0	1.6.	0.2	1.6.	4	1.5.	3
7.6.	1	15.9.	4	7.6.	0.1	7.6.	1.1	15.7.	5	20.6.	5
14.6.	1.5	31.10.	2.5	14.6.	0.3	14.6.	3.9	1.10.	4	15.8.	5
20.6.	2.2	15.11.	0	20.6.	0.5	15.6.	5	31.10.	0	15.9.	0
27.6.	3.3			27.6.	1.2	1.7.	5				
3.7.	5			10.7.	2	5.8.	2.5				
15.8.	5			3.8.	5	1.9.	0				
4.9.	1			01.11.	0						
16.10.	0										

*Danish data used (PARDNOR, 2009)

Product	Start of growth Z1	Harvest N	Yield
Potatoes	22.5.	15.9.–15.10	2.5
Leafy vegetables[a)]	10.4.	1.6. –31.10.	2.4
Root vegetables[b)]	1.6.	1.10.–31.10.	2.4
Fruit vegetables[c)]	8.5.	1.7.–15.8.	2.8
Fruit[d)]	1.5.	15.9.–15.10.	0.51
Berries[e)]	1.4.	20.6.–15.8.	0.35

[a)] Various cabbage and lettuce plus leek and Brussels sprout (2010–2014, Statistics Norway).
[b)] Swede, carrot, beetroot, onion, celeriac and turnip (2010–2014, Statistics Norway)
[c)] Gherkin (2010–2014, Statistics Norway)

[d] Apples, pears and plums (2010–2014, Statistics Norway)
[e] Cherries, blackcurrant, strawberries, raspberries, blueberries and other berries (2010–2014, Statistics Norway)

Grass

The ARGOS German defaults and the updated Norwegian values are shown in tables 3.14 and 3.15, respectively. In table 3.15, we have included all three zones, but particularly Z1 and Z2 are important in relation to lamb and cow related grass productions.

For Finland, the beginning of growth season was simply taken to be one month later than the JRODOS default, leading to a one month delay of reaching maximum yield. A different approach was used for Norway: For the sake of simplicity, we assume the same LAI model for all three zones ("grass for harvest"). In contrast to the FDMT defaults, no difference is assumed for the development of grass Intensive and grass Extensive in Norway due to lack of relevant data (for ARGOS defaults grass E reaches the mid-season stage 6 weeks later than grass I, as shown in table 3.14). Norwegian yields (kg/m^2) were estimated from LAI.

Table 3.14: Yields and harvesting data for grass (ARGOS default)

Grass intensive (I)		**Grass extensive**	
Date	Yield	Date	Yield
1.1.	0.01	1.1.	0.01
15.3.	0.05	15.3.	0.05
15.5.	1.5	1.7.	1.5
31.10.	1.5	31.10.	1.5
1.11.	0.05	1.11.	0.05

	Grass I and E
Start of growth	15.3.
Harvest	1.5.-31.10.
End of first period	15.7.

Table 3.15: Yields and harvesting data for grass (Norway)

Grass Z1		**Grass Z2**		**Grass Z3**	
Date	Yield	Date	Yield	Date	Yield
1.1.	0.01	1.1.	0.01	1.1.	0.01
1.3.	0.01	1.3.	0.01	1.3.	0.01
15.4.	0.05	19.5.	0.05	3.6.	0.05
29.4.	0.4	1.6.	0.4	12.6.	0.4
9.5.	0.8	9.6.	0.8	21.6.	0.8
13.5.	1.5	12.6.	1.5	25.6.	1.5
30.9.	1.5	15.9.	1.5	31.8.	1.5
15.10.	0.01	1.10.	0.01	1.10.	0.01

	Z1	**Z2**	**Z3**
Start of growth	15.4.	19.5.	3.6.
Harvest	1.6.-30.9.	1.7.-15.9.	15.7.-31.8.
End of first period	15.7.	15.8.	31.8.

3.2.2 Animal feeding regimes

The ARGOS German defaults and the updated Norwegian values are shown in tables 3.16 and 3.17, respectively.

Table 3.16: Feedstuffs for animals (kg fresh weight per day) (ARGOS default)

Animal	Date	Grass I	Grass E	Hay I	Hay E	Maize	W. barley	W. wheat	Feed water
Lactating cow	21.4.			14					75
	11.5.	70							75
	21.10.	70							75
	10.11.			14					75
	31.12.			14					75
Lactating goat	21.4.				2.6				6
	11.5.		13						6
	21.10.		13						6
	10.11.				2.6				6
	31.12.				2.6				6
Beef cattle	1.1.					28			40
	31.12.					28			40
Pig	1.1.						3		8
	31.12.						3		8
Lamb	21.4.				1				4
	11.5.		5						4
	21.10.		5						4
	10.11.				1				4
	31.12.				1				4
Chicken	1.1.							0.09	0.2
	31.12.							0.09	0.2
Laying hen	1.1.							0.09	0.2
	31.12.							0.09	0.2

Most data for table 3.17 are derived from PARDNOR (2008). Corrections from dry weight to fresh weight have been made using the following conversion factors:

- Grass and silage: 5
- Hay: 1.25
- Cereals: 1.11

As for Finland, grass silage plays an important role as a feedstuff in Norway, but it is not included as such in ARGOS FDMT. It is estimated that only 5–10% of grass conservation in Norway is as hay (Eriksen, 2015). Nevertheless, for the update we have omitted that problem and recalculated the silage to hay equivalents. Consequently, the table shows “hay” when we actually should read “grass silage”.

Grazing characteristics are particularly important for the possible contamination of meat and milk. We have modified the pasture period in accordance with the growing seasons in the respective zones. These modifications are based on “expert” judgement (discussion among people at NRPA with experience on this topic).

Table 3.17: Feedstuffs for animals (kg fresh weight per day) (Norway)

Zone 1:

Animal	Date	Grass I	Grass E	Hay I	S. barley	W. wheat	Oats
Lactating cow Z1	1.1.			12	3.1		1.2
	15.5.	50			2.0		0.78
	14.9.	50			2.0		0.78
	15.9.			12	3.1		1.2
	31.12.			12	3.1		1.2
Lactating goat Z1	1.1.			1.4	0.33		0.16
	15.5.		6.0		0.22		0.11
	14.9.		6.0		0.22		0.11
	15.9.			1.4	0.33		0.16
	31.12.			1.4	0.33		0.16
Lamb Z1	15.5.		2.5				
	15.8.		3.5				
	15.9.		5.0				

Zone 2:

Animal	Date	Grass I	Grass E	Hay I	S. barley	W. wheat	Oats
Lactating cow Z2	1.1.			12	3.1		1.2
	1.6.	50			2.0		0.78
	14.9.	50			2.0		0.78
	15.9.			12	3.1		1.2
	31.12.			12	3.1		1.2
Lactating goat Z2	1.1.			1.4	0.33		0.16
	1.6.		6.0		0.22		0.11
	14.9.		6.0		0.22		0.11
	15.9.			1.4	0.33		0.16
	31.12.			1.4	0.33		0.16
Lamb Z2	1.6.		2.5				
	15.8.		3.5				
	15.9.		5.0				

Zone 3:

Animal	Date	Grass I	Grass E	Hay I	S. barley	W. wheat	Oats
Lactating cow Z3	1.1.			12	3.1		1.2
	20.6.	50			2.0		0.78
	14.9.	50			2.0		0.78
	31.8.			12	3.1		1.2
	31.12.			12	3.1		1.2
Lactating goat Z3	1.1.			1.4	0.33		0.16
	20.6.		6.0		0.22		0.11
	14.9.		6.0		0.22		0.11
	31.8.			1.4	0.33		0.16
	31.12.			1.4	0.33		0.16
Lamb Z3	20.6.		2.5				
	15.8.		3.5				
	31.8.		5.0				

Dates not zone dependent:

Animal	Date	Grass I	Grass E	Hay I	S. barley	W. wheat	Oats
Beef cattle	1.1.			7.1	0.67	0.67	0.89
	31.12.			7.1	0.67	0.67	0.89
Pig	1.1.				1.8	0.33	0.89
	31.12.				1.8	0.33	0.89
Chicken	1.1.					0.041	0.0078
	31.12.					0.041	0.0078
Laying hen	1.1.					0.034	0.0227
	31.12.					0.034	0.0227

*Feed water not considered for Norway – defaults used

Challenges in relation to regional updating

The feed consumption estimates given here represent an average or “common practice”. However, in Norway a minor but still considerable fraction of the milking cows are on rough mountain or outfield grazing during summer. For these animals the Grass E category is more relevant than Grass I (which is both used in the German defaults and in the updated Norwegian average grazing). This is important, particularly when focusing on the long-term perspective after radioactive fallout, as clearly demonstrated by the persistently high levels of Cs-137 in milk from certain areas of Norway 30 years after the Chernobyl accident.

There is a clear seasonality of lamb/sheep production in Norway. The lambs are born in March–May, released on mountain or outfield pastures during May–June and collected in September (as indicated in table 3.17). The slaughter period is generally September–October (which covers most of the meat used for human consumption in the following year as well). This is the reason why only parts of a yearly diet of lamb is included in table 3.17. Finally, there seems to be an increasing trend towards more intensive lamb production in some parts of Norway. In such cases, the summer diet should be changed to Grass I.

We have decided to include concentrates in the table 3.17, even though these feedstuffs are usually purchased from commercial producers. Imported feed such as maize and soya (as being part of concentrates in PARDNOR (2008) has been excluded from the table. It is a matter of discussion whether other feedstuffs than grass/hay/silage should be included since concentrates are usually not locally produced. Nevertheless, we have kept them here for the purpose of conservativeness.

3.2.3 Foodstuffs consumption

Table 3.18 shows the consumption rates of various foodstuffs as currently given in ARGOS FDMT (German default). These data were initially presented in Müller and Pröhl (1993) based on sources from the 1980s.

Table 3.18: Average food consumption (g/day) for various age groups (Argos default)

Category	Product*	ARGOS (default)				
		1 y	5 y	10 y	15 y	Adults
Cereals	Spring wheat, whole grain	0.7	1.4	1.8	2	2.6
	Spring wheat, flour	3.9	8.1	10	12	15
	Winter wheat, whole grain	6	13	16	18	23
	Winter wheat, flour	35	73	91	100	130
	Rye, whole grain	2.2	4.8	6	6.9	8.7
	Rye, flour	9.3	19	24	28	35
	Oats	2.9	3.1	3.9	4.4	5.6
Vegetables	Potatoes	45	35	60	83	160
	Leafy vegetables	58	74	79	86	94
	Root vegetables	21	24	29	33	33
	Fruit vegetables	12	36	41	46	47
Fruit and berries	Fruit	150	72	91	100	120
	Berries	0	10	12	14	14
Milk products	Milk	560	140	180	210	230
	Condensed milk	0	11	14	16	18
	Cream	0	9.6	13	14	16
	Butter	0	6.1	9.5	12	18
	Cheese (rennet)	0	10	14	19	26
	Cheese (acid)	0	6.6	8.9	12	17
Meat	Beef (cow)	1.5	18	19	23	27
	Beef (cattle)	3	35	38	46	55
	Veal	0.2	1.4	1.5	1.8	2.2
	Pork	3.9	72	78	90	108
	Lamb	2.2	2.2	3.7	3.9	3.9
	Chicken	1.5	11	12	14	17
Other	Eggs	5	18	25	36	43
	Beer	0	0	12	130	610

Table 3.19 includes the updated Norwegian diets. There are three main statistical sources relevant for food consumption in Norway: food supplies, household consumptions and dietary surveys (Johansson, 2000). For the present work, we have generally used data from dietary surveys, and supplied with information from the other two types of sources when necessary. This approach is in accordance with PARDNOR (2008). However, updated estimates of dietary intake were considered necessary for our investigation. This was mainly due to:

- New available statistical data of relevance – particularly the NORKOST 3 dietary survey (NORKOST 3, 2012) covering adults 18–70 years.
- Need for a more "refined" method of converting broad dietary categories such as "bread" to the highly specific cereals required by ARGOS FDMT. Including better estimates on the use of whole meal flour (not considered by PARNOR, 2008).
- Inclusion of age-groups 1 y and 4 y (not part of PARDNOR, 2008).

In addition to NORKOST 3, the following dietary surveys were the main sources used for different age groups:

- Spedkost 2006-2007: 1 year old children (Spedkost, 2009).
- Ungkost 2000: 4 year old children (Ungkost, 2002a).
- Ungkost 2000: 9 year old children and 13 years old teenagers (Ungkost, 2002b).

As evident from the information above, the age groups available from the dietary surveys does not exactly match those considered by ARGOS FDMT (see table 3.18). However, the groups are fairly close to the defaults (generally within a couple of years). Diets are assumed to be the same for the whole country, and the comparability of results from the different surveys was not considered. For details regarding derivation of data for different FDMT food products, see supplementary text in table 3.19.

As dealt with in section 3.2.2, the production of lamb meat in Norway is very dependent of season, and this certainly influences the consumption pattern over the year, with higher intake in the “lamb season” from September to December. Outside this season, the lamb meat consumed is generally from September-October the year before.

Table 3.19: Average food consumption (g/day) for various age groups (Norway). * assumed to be zero

Category	Product	Norway (updated)				
		1 y	4y	9 y	13 y	>18 y
Cereals[a)]	Spring wheat, whole grain	21	35	47	48	72
	Spring wheat, flour	23	65	91	99	96
	Winter wheat, whole grain	0*	0*	0*	0*	0*
	Winter wheat, flour	0*	0*	0*	0*	0*
	Rye, whole grain	1.8	3.2	4.2	4.3	6.5
	Rye, flour	1.8	3.2	4.2	4.3	6.5
	Oats	5.3	6.6	8.7	8.8	13
Vegetables[b)]	Potatoes	25	35	47	53	67
	Leafy vegetables	0*	10	12	13	28
	Root vegetables	16	19	23	25	53
	Fruit vegetables	16	21	26	29	56
Fruit and berries[c)]	Fruit	57	73	69	51	140
	Berries	19	7	7	5	14
Milk products[d)]	Milk	246	373	415	360	317
	Condensed milk	0*	0*	0*	0*	0*
	Cream	2	17	24	27	22
	Butter	1	1.5	1	1	5.5
	Cheese (rennet)	7.6	12	19	27	34
	Cheese (acid)	1.0	1.3	1.7	2.2	4.4
Meat[e)]	Beef (cow)	2.3	6.7	10	12	15
	Beef (cattle)	3.7	11	16	19	24
	Veal	0.2	0.4	0.7	0.8	1.0
	Pork	8.2	23	36	42	53
	Lamb	1.7	4.6	6.9	7.9	11
	Chicken	6.3	18	26	30	41
Other	Eggs	2	9	10	9	26
	Beer	0	0	0	0	85

[a)] Intake of grain products based on consumption of bread, cereals and cake from dietary surveys. Flour content in bread etc., from Matvaretabellen.no (2015). Type of flour used – wheat, rye, barley and oats – based on production for human consumption statistics 2009–2013. Fraction of whole meal flour in bread is assumed using findings from SIFO (2008).

[b)] Intake of fresh vegetables from dietary surveys – weighting between categories leafy, root and fruit vegetables based on data from Statistics Norway (2013). Leafy vegetables include cabbage. Root vegetables include mushrooms and onions. Vegetables from industrially made food not considered for age group 1 y.

[c)] Only fresh (or frozen) fruits and berries included here. Data from Statistics Norway (2013) were used to separate between fruit and berries in most cases. Fruit and berries from industrially made food were not considered for age group 1 y.

[d)] Milk for age category 1 y include cow milk and breast-milk substitute (not breast-milk). Contributions from industrially made porridge are not considered. Division between rennet and acid cheese has been made based upon data from Melk.no (2014). Brown whey cheese is not included.

[e)] Total meat consumption available from dietary surveys was split up in FDMT meat categories using data from production statistics 2010-2014 (Statistics Norway, 2015). Meat from industrially made food was not considered for age group 1 y.

3.3 Spain

The parameter values taken are the following: foodstuffs consumption rates, crop yields, harvesting periods, leaf area indices (LAI), feedstuffs and animal feeding regimes. For the first three items, there are complete sets of National statistics values, and assumptions have been needed to adapt this extensive and detailed information to the database structure and set of parameters considered in JRODOS.

In the case of the feedstuffs and animal feeding regime, several assumptions have been made in order to adapt the complex regime system in Spain, with important differences between the North and the South of the country due to climatic conditions, which needed to be simplified to meet the requirements of the JRODOS databases. Finally, for the estimation of the LAI, different growing cycle models have been used, as well as several technical literature data and assumptions.

Sections 3.3.1–3.3.3 show the Spanish values and the assumptions made when necessary, as well as the JRODOS default parameter values. The conclusions and main difficulties faced are summarised in section 3.3.4.

3.3.1 Foodstuffs consumption

The Spanish parameter values on food consumption rates used have been obtained from the National Food Survey ENALIA[4], carried out by the Spanish Food Safety and Nutrition Agency (AECOSAN). It is an individual survey, which includes children and adolescents aged from 6 months to 17 years, as well as adults. The survey allows knowing the type of food and the quantities consumed, essential data for nutrient intake assessment and also for scientific research on exposure assessment to contaminants through the food chain.

All the activities of the survey, from the design itself, have been conducted according to a harmonized and agreed approach in Europe, provided by the European Food Safety Agency (EFSA, 2009a). The parameter values and databases have therefore a common structure along the European countries, facilitating comparison purposes. The statistics on food consumption are reported in grams per day (g/day) per person as finally consumed, according to the level of food aggregation considered by the EFSA approach.

Five age groups are included in ENALIA: 3-11 months, 1-3 years, 4-9 years, 10-18 years and adults. These groups are very similar to the age groups considered in JRODOS, the main difference being that the latter considers an age group of 5 years old whereas ENALIA considers a slightly younger age group, between 1-3 years. Given the close similarity it is assumed that the age groups of ENALIA are representative of those in JRODOS.

The foodstuff selection considered for JRODOS has been kept, although some of the products are not so important in the whole of the Mediterranean diet, for instance cream or condensed milk, while others, such as sheep and goat milk are mainly produced for cheese manufacturing

[4] http://www.aecosan.msssi.gob.es/AECOSAN/web/seguridad_alimentaria/subdetalle/enalia.shtml

and not for direct consumption. More specific Mediterranean foodstuffs are missing such as rice, legumes, wine and olive oil. In order to match the JRODOS foodstuff selection to the Mediterranean foodstuffs, several assumptions have been necessary. For comparison purposes, table 3.20 shows the average food consumption rates (Central European parameter values) for the JRODOS foodstuffs and the five age groups considered.

Table 3.20: Average food consumption (absolute intake (g/day) for various age groups in JRODOS.

Product	1 y	5 y	10 y	15 y	Adults
Winter wheat					
• Whole	6	13	16	18	23
• Flour	35	73	91	100	130
• Bran	0	0	0	0	0
Spring wheat					
• Whole	0.7	1.4	1.8	2	2.6
• Flour	3.9	8.1	10	12	15
• Bran	0	0	0	0	0
Rye					
• Whole	2.2	4.8	6	6.9	8.7
• Flour	9.3	19	24	28	35
• Bran	0	0	0	0	0
Oats	2.9	3.1	3.9	4.4	5.6
Potatoes	45	35	60	83	160
Leafy vegetables	58	74	79	86	94
Root vegetables	21	24	29	33	33
Fruit vegetables	12	36	41	46	47
Fruits	150	72	91	100	120
Berries	0	10	12	14	14
Milk	560	140	180	210	230
Condensed milk	0	11	14	16	18
Cream	0	9.6	13	14	16
Butter	0	6.1	9.5	12	18
Cheese (ren.)	0	10	14	19	26
Cheese (acid)	0	6.6	8.9	12	17
Sheep milk	0	0	0	0	0
Goat's milk	0	0	0	0	0
Beef (cow)	1.5	18	19	23	27
Beef (bull)	3	35	38	46	55
Veal	0.2	1.4	1.5	1.8	2.2
Pork	3.9	72	78	90	108
Lamb	0	0	0	0	0.6
Chicken	0	1.1	1.2	1.3	1.7
Eggs	5	18	25	36	43
Beer	0	0	12	130	610
Drinking water	640	800	1000	1600	1600
Fish	0	7.5	10	11	18

Table 3.21 shows the Spanish food consumption rates, where the values for the first four age groups, come from the most recent ENALIA published data (2013), while the values for adults have been obtained from EFSA's Comprehensive Food Consumption Database (2009b), as ENALIA´s are not yet published (publication date foreseen, May 2016). The values are given in mean absolute intake (g/day)

Table 3.21: Average food consumption (absolute intake (g/day) for various age groups in Spain

Product	6-11 m	1-3 y	4-9 y	10-18 y	Adults
Winter wheat					
• Whole[1]	30.22	20.78	27.71	33.31	21.15
• Flour	0.04	1.57	5.74	8.77	6.84
• Bran	nc	nc	nc	nc	N
Spring wheat					
• Whole[2]	7.58	47.45	119.20	165.68	133.86
• Flour[3]	n	n	n	n	n
• Bran	nc	nc	nc	nc	nc
Rye					
• Whole[4]	n	0.01	0.14	0.03	n
• Flour	nc	nc	nc	nc	nc
• Bran	nc	nc	nc	nc	nc
Oats	n	n	n	n	N
Rice[5]	1.23	6.94	12.41	13.30	
Potatoes	81.30	54.49	50.44	60.67	76.13
Leafy vegetables[6]	10.39	10.19	17.84	27.47	134.88
Root vegetables	21.36	18.98	17.61	21.32	29.47
Fruit vegetables	17.93	17.35	23.80	37.06	94.06
Fruits[7]	142.43	131.19	148.70	168.87	179.41
Berries[8]	n	n	n	n	6.35
Milk[9]	81.74	301.14	419.96	556.12	352.48
Condensed milk	0	0	0.04	0.05	1.17
Cream	0	0.05	0.80	1.31	1.81
Butter	0	0.25	0.77	0.69	1.06
Cheese (rennet)[10]	5.68	11.33	10.65	4.83	n
Cheese (acid)[11]	0.33	15.24	14.79	19.41	22.03
Sheep milk	nc	nc	nc	nc	nc
Goat's milk	0	0.94	1.59	0	nc
Beef (cow)	10.80	13.91	19.28	26.88	116.61
Beef (bull)	n	n	n	n	n
Veal[12]	n	n	n	n	n
Pork[13]	0.22	22.04	46.85	64.35	19.18
Lamb	0.59	0.69	0.55	1.52	n
Chicken	24.48	28.31	38.66	42.96	40.85
Eggs	1.42	12.66	18.66	24.22	8.54
Beer	0	0	0	0	37.42
Drinking water	61.42	260.82	449.50	521.77	547.29
Fish[14]	12.24	39.47	46.57	52.08	75.17

nc = Not considered in the statistics
n= Not given separately
1-14 = see explanations in the text.

Several kinds of assumptions have been made to match the Spanish data to the JRODOS foodstuffs database. To begin with, Spanish statistics do not consider separately the consumption of different types of cereals, as they compose different foodstuffs, for which consumption rates are available. The only exception is the rice, not considered in JRODOS, but very important in the Mediterranean diet. Taking advantage of the RODOS food chain module, that facilitates the inclusion of up to three new foodstuffs, the parameter values for rice have been specifically included in table 3.21. The products not covered in the Spanish statistics, such as bran and direct consumption of sheep milk are conveniently indicated (nc) as well as those not given separately (n).

In other cases it has been necessary to group different type of products. Having no information on the type of grouping made in the JRODOS foodstuffs database, the following assumptions have been made:

1. Whole winter wheat data refers to pasta and breakfast cereals; the consumption rate is the sum of both.
2. Whole spring wheat data refers to bread and fine bakery wares; the consumption rate is the sum of both.
3. Flour data refers to winter wheat, as no distinction is made between winter and spring wheat.
4. Whole rye refers to the consumption of other types of cereals, without specifying.
5. Rice has been included as a new foodstuff in the database due to its importance in the Mediterranean diet.
6. Leafy vegetables, it is assumed that this group includes, following the National agricultural statistics (2014) on crop yields and production, leafy and stem vegetables, therefore, data on their consumption considers both.
7. Fruits include fresh and processed fruits.
8. Berries are included in the Fruit group.
9. Milk includes cow milk, fermented milk and dairy desserts; it does not include condensed milk, cream and goat milk, which are addressed elsewhere, in the case of 6-11m and 1-3 y age groups it does not include breastmilk.
10. Rennet cheese refers exclusively to fresh cheese.
11. Acid cheese refers to the other types of cheese, not fresh cheese.
12. Veal data is included in cow meat data.
13. Pork data includes ham and other cold cuts.
14. Fish data refers to fish and shellfish.

3.3.2 Leaf area indices, yields and harvesting data

The Spanish and JRODOS parameter values are shown in tables 3.22–3.24. To derive the Spanish values, the following assumptions have been made:

Dates for sowing and harvesting

The National crop calendar (1993) has been the source of data for sowing and harvesting dates. Although the calendar is updated every five years, the latest available edition in electronic format dates from 1992, and has been the one used. The calendar includes the distribution of the monthly mean percent of harvested and marketed production of each crop as well as the sowing surfaces of herbaceous crops and surfaces under flowering of permanents crops. There are data at province level (NUTS 3) and the mean figures at National level. A total of 148 crops and varieties are included according to the National classification used in the National agricultural statistics (2014).

For the purpose of this task, the mean national data have been used, obtaining the most representative values for sowing and harvesting dates and the mean growing period (days) of each crop or group of crops as indicated in the JRODOS databases.

- The month with the maximum percent of seeded surface is taken as **beginning of growth** season for each type and variety of crop. In case of grouping of crops, the most likely value (modal value) or, in default case, the minimum value among the crops of the group is used. The date ($\mathbf{D_S}$), in Julian days, is put as the first day of the month.
- The **mean period of growing (MPG),** in days, between the first day of the month with the maximum seeded surface and the last day of the month with the maximum harvested production has been estimated for each crop. Again, in case of grouping, the mean value is used.
- The **date of harvest** ($\mathbf{D_H}$) is put in Julian days at the last day of the period of growth.

Yields

The Spanish yields are taken from the National agricultural statistics (2014). These data are classified among types of crops, being the yield given on dry and irrigated surfaces, but no seasonality is considered. For assessment purposes using JRODOS, the mean dry yields at National level have been used (kg/m^2), with the following assumptions:

- Winter wheat, is assumed to be Durum wheat (for pasta production), the rest being spring wheat.
- Winter barley Six-row barley (mainly for malt production) is considered winter barley and the two-row barley as spring barley.
- Potatoes show four growing cycles: very early potato, early potato, mid-season potato and late potato, the mid-season potato has been taken as reference.

Concerning the vegetables, as has been previously mentioned, there is no information available on how the grouping of the leafy, fruit and root vegetables has been made in JRODOS, nor how the average yields of these groups, have been estimated. Therefore, we have used the grouping defined by the Spanish National agricultural statistics (2014), that is:

- Leafy vegetables include leafy and stem vegetables: cabbage (green, Savoy, red, Brussels sprouts), asparagus, celery, lettuce, endive, spinach, chard and thistle.
- Fruit vegetables include: watermelon, melon, pumpkin, courgette, cucumber, aubergine and tomato.
- Root vegetables include: garlic, onion, leek, red beet, carrot, radish, and turnip.

Flower vegetables such as artichoke, broccoli and cauliflower and green legumes have not been considered.

The yield value (kg/m^2) representing each vegetable group has been estimated by the weighted sum of the individual yields of each crop belonging to that group, with its cultivated area.

Leaf Area Index

The leaf area development, described as the Leaf Area Index (LAI), is a function of the plant´s growing season. The data for the Spanish crops have been estimated from LAI normalised curves, the value of the maximum LAI and the representatives' dates along the growing season.

The normalised LAI curves defining curve *shapes* (Figure 3.2), represent the fraction of the plant´s maximum LAI (fr_{LAImx}) corresponding to a given fraction of the potential heat units (fr_{PHU}) required for plant maturity. The fr_{PHU} is directly related to timing of the plant development (Neitsch et al., 2009). Therefore, parameters of these curves can be adapted among the varieties and the regions studied, knowing the value of the maximum LAI and the representative dates of the crop growing season.

The parameters describing the LAI normalised curves and the maximum LAI value for the crops considered in the study have been extracted from the plant growth database of the SWAT model (Arnold et al., 2013).

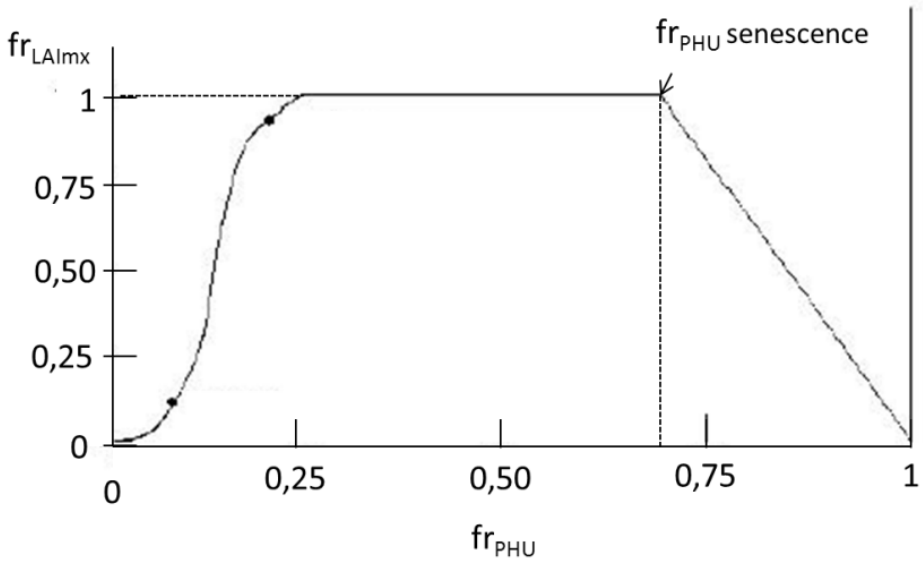

Figure 3.2: Fraction of the maximum LAI as a function of growing season (Adapted Neitsch et al., 2009).

In order to obtain the representative dates of the growing season, the total growing period has been divided into 4 growth stages (see Figure 3.3):

1. **The initial stage (L_{ini}):** this is the period from sowing or transplanting until the crop covers about 10% of the ground.

2. **The crop development stage (L_{dev}):** this period starts at the end of the initial stage and lasts until the full ground cover has been reached (ground cover 70-80%); it does not necessarily mean that the crop is at its maximum height.

3. The **mid - season stage (L_{mid}):** this period starts at the end of the crop development stage and lasts until maturity; it includes flowering and grain-setting.

4. The **late season stage (L_{lat}):** this period starts at the end of the mid-season stage and lasts until the last day of the harvest; it includes ripening.

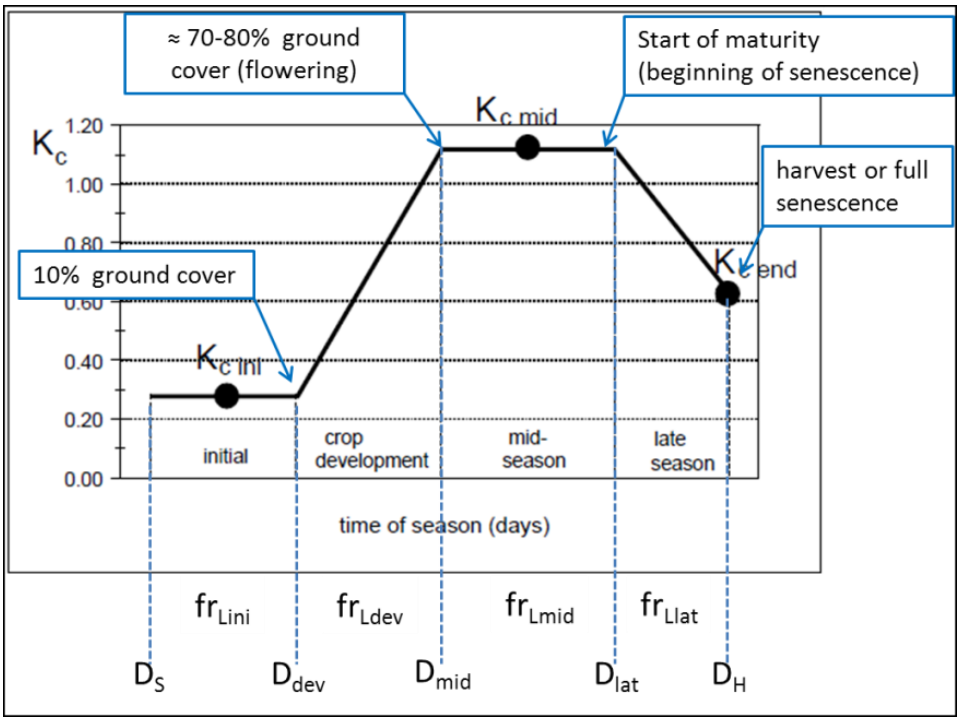

Figure 3.3: Typical curve of the temporal evolution of crop growing (in this case, represented by the Crop coefficient Kc). The different growth stages, with the fraction of length and representatives dates are pointed out, being **D_S**, the sowing date and **D_H** the harvest date (modified from FAO 56; Allen et al., 2006).

The duration (as fraction of the total growing season) of the various growth stages for the Mediterranean crops of concern, has been extracted from values compiled in the report FAO 56 (Allen et al., 2006). Applying these fractions to the values of MPG of the Spanish crops and beginning from the D_S, the dates D_{dev}, D_{mid}, D_{lat} are established. The respective values for the LAI are calculated for these dates, intermediate point of the sigmoid part of the curve (crop development stage) and intermediate point of the descending straight line (last season stage). The LAI for the days of year (DOY) 0 and 365 are also included.

Table 3.22: Leaf area indices, yields and harvesting data for winter and spring wheat and winter and spring barley.

CIEMAT (Spain)				**JRODOS default** (Central Europe)			
Leaf are index				**Leaf area index**			
Winter wheat		Spring wheat		Winter wheat		Spring wheat	
Julian day	Index	Julian day	Index	Julian day	Index	Julian day	Index
0	2.71	0	1.89	0	0.1	0	0
35	3.99	6	2.31	110	1	105	0
102	4	94	4	161	7	171	6
140	4	116	2	217	1	227	1
154	2	138	0	218	0	228	0
168	0	305	0	298	0	365	0
305	0	334	0.19	365	0.1		
334	0.83	353	0.89				
365	2.66	365	1.81				
Winter barley		Spring barley		Winter barley		Spring barley	
Julian day	Index	Julian day	Index	Julian day	Index	Julian day	Index
0	0.52	0	0	0	0.1	0	0
25	2.53	32	0	91	1	105	0
62	3.94	59	0.1	145	6	166	5
134	4	76	0.12	196	1	217	1
159	2	93	0.97	197	0	218	0
183	0	174	4	278	0	365	0
305	0	194	2	365	0.1		
354	0.15	214	0				
365	0.47	365	0				
Yield ($kg \cdot m^{-2}$)				**Yield** ($kg \cdot m^{-2}$)			
• Winter wheat 0.27 • Spring wheat 0.38 • Winter barley 0.28 • Spring barley 0.37				• Winter wheat 0.5 • Spring wheat 0.5 • Winter barley 0.5 • Spring barley 0.4			
Growing and harvesting seasons (Julian day)				**Growing and harvesting seasons** (Julian day)			
Winter wheat		Spring wheat		Winter wheat		Spring wheat	
Begin of growth	Harvest	Begin of growth	Harvest	Begin of growth	Harvest	Begin of growth	Harvest
305	168	305	138	298	217	105	227
Winter barley		Spring barley		Winter barley		Spring barley	
Begin of growth	Harvest	Begin of growth	Harvest	Begin of growth	Harvest	Begin of growth	Harvest
305	183	32	214	278	196	105	217

Table 3.23: Leaf area indices, yields and harvesting data for rye, maize, rice and oats.

CIEMAT (Spain)				**JRODOS default** (Central Europe)			
Leaf are index				**Leaf area index**			
Rye		Maize		Rye		Maize	
Julian day	Index	Julian day	Index	Julian day	Index	Julian day	Index
0	1.58	0	0	0	0.1	0	0
5	1.87	121	0	79	1	135	0
46	3.80	158	0.36	140	6	171	1
128	4	183	1.73	213	1	213	5
156	2	207	2.76	214	0	288	4
183	0	269	3	288	0	289	0
274	0	288	1.5	365	0.1	365	0
329	0.13	306	0				
365	1.51	365	0				
Rice		Oats		Rice		Oats	
Julian day	Index	Julian day	Index	Julian day	Index	Julian day	Index
0	0	0	2.66			0	0
121	0	31	3.8			105	0
146	0.85	104	4			171	5
158	1.86	129	2			222	1
171	3.02	153	0			223	0
220	4.88	274	0			365	0
233	2.5	323	0.23				
245	0	359	2.17				
365	0	365	2.59				
Yield ($kg \cdot m^{-2}$)				**Yield** ($kg \cdot m^{-2}$)			
Rye	0.25			Rye	0.4		
Maize	1.11			Maize	1.5		
Rice	0.78			Rice			
Oats	0.22			Oats	0.4		
Growing and harvesting seasons (Julian day)				**Growing and harvesting seasons** (Julian day)			
Rye		Maize		Rye		Maize	
Begin of growth	Harvest	Begin of growth	Harvest	Begin of growth	Harvest	Begin of growth	Harvest
274	183	121	306	288	212	135	288
Rice		Oats		Rice		Oats	
Begin of growth	Harvest	Begin of growth	Harvest	Begin of growth	Harvest	Begin of growth	Harvest
121	245	274	153			105	222

Table 3.24: Leaf area indices, yields and harvesting data for potatoes, outdoor leafy vegetables, outdoor fruit vegetables and outdoor root vegetables.

CIEMAT (Spain)				**JRODOS default** (Central Europe)			
Leaf are index				**Leaf area index**			
Potatoes		Leafy vegetables[a]		Potatoes		Leafy vegetables	
Julian day	Index	Julian day	Index	Julian day	Index	Julian day	Index
0	0	0	0	0	0	0	5
60	0	182	0	140	0	365	5
98	0.15	215	0.83	182	4		
121	1.42	239	3.36	213	4		
143	3.48	264	3.61	258	0		
207	4	296	3.62	365	0		
226	2	305	1.81				
245	0	313	0				
365	0	365	0				
Fruit vegetables[b]		Root vegetables[c]		Fruit vegetables		Root vegetables	
Julian day	Index	Julian day	Index	Julian day	Index	Julian day	Index
0	0	0	0	0	0	0	0
91	0	91	0	105	0	105	0
122	0.38	130	0.11	182	5	182	5
143	1.83	157	1.33	274	5	274	5
165	2.65	184	2.40	305	0	305	0
214	2.78	246	2.50	365	0	365	0
226	1.39	260	1.25				
238	0	273	0				
365	0	365	0				
Yield (kg·m^{-2})				**Yield** (kg·m^{-2})			
Potatoes	2.83			Potatoes	3.0		
Leafy vegs.	2.39			Leafy vegs.	2.0		
Fruit vegs.	6.06			Fruit vegs.	n		
Root vegs.	3.59			Root vegs.	n		
Growing and harvesting seasons (Julian day)				**Growing and harvesting seasons** (Julian day)			
Potatoes		Leafy vegs.		Potatoes		Leafy vegs.	
Begin of growth	Harvest (begin, end)	Begin of growth	Harvest (begin, end)	Begin of growth	Harvest (begin, end)	Begin of growth	Harvest (begin, end)
60	245	182	313	140	227 267	71	121 304
Fruit vegs.		Root vegs.		Fruit vegs.		Root vegs.	
Begin of growth	Harvest (begin, end)	Begin of growth	Harvest (begin, end)	Begin of growth	Harvest (begin, end)	Begin of growth	Harvest (begin, end)
91	238	91	273	n	n	n	n

n = not known or not given.

[a] Includes cabbage (green, Savoy, red, Brussels sprouts), asparagus, celery, lettuce, endive, spinach, chard and thistle.

[b] Includes watermelon, melon, pumpkin, courgette, cucumber, aubergine and tomato.

[c] Includes garlic, onion, leek, red beet, carrot, radish, and turnip.

3.3.3 Feedstuffs and animal feeding regimes

Feed resources for animals are set out in National statistics under the headings of forage crops, grassland and grazed forest and shrub land.

The feeding of livestock may be through fodder, meaning those products that are mowed, conditioned and spread throughout the year, and grass, defined as what the cattle grazes directly from the field.

In the first case, it is necessary to differentiate the fodder obtained from the proper forage crops, including gramineous, legumes as single species forage crop, temporal meadows, roots and others.

The term grass includes the feed obtained directly by cattle from stubble (the product remaining after the harvest of certain arable agricultural products), from land for fodder crops, mainly gramineous, single species forage crops such as alfalfa and temporal meadows. It also includes grazing of semi-natural grasslands and woodlands.

On the other hand, depending on the feeding regimen, intensive and extensive systems are distinguished. The former is constituted of a diet based on forage and pastures of agricultural origin and in an indoor regime, while the latter is an outdoor diet based on natural pastures.

In this task, a rough approach has been assumed as representative of livestock production in the Mediterranean Spain: the semi-extensive and extensive systems of grazing are the feeding basis of the livestock for meat, including beef cattle, pork, lamb and goat and the intensive systems are mainly for production of cow's milk.

The data of alfalfa and temporal meadows (National agricultural statistics, 2014) are considered as representative of intensive regime. The green yield is divided in "grass intensive", with data from harvested production for fresh and dehydrated use and "hay intensive", with data of production for hay and silage.

The data from natural meadows for the extensive regime, and all the yield is referred as "grass extensive".

The feeding diets, as daily intake rate throughout the year, have been estimated taking into account the nutritional needs of an animal-type, under each specific feeding regime, the distribution of the forage and grass production along the year and the stocking capacity of the grazing areas (Díaz Gaona et al., 2006; San Miguel Ayanz, 2006; Álvarez Sánchez-Arjona, 2010).

According to these approximations and taking an educated guess in some cases, the Spanish data are shown in tables 3.25–3.28. Data for intake rate for pork, lamb, goat and chicken are still under analysis and at this stage have been not yet changed.

Table 3.25: Grass and hay data.

CIEMAT (Spain)				**JRODOS default** (Central Europe)			
Yield				**Yield**			
Grass intensive[a]		Grass extensive[b]		Grass intensive		Grass extensive	
Julian day	Yield ($kg \cdot m^{-2}$)	Julian day	Yield ($kg \cdot m^{-2}$)	Julian day	Yield ($kg \cdot m^{-2}$)	Julian day	Yield ($kg \cdot m^{-2}$)
0	0	0	0	0	0.01	0	0.01
31	0.01	31	0.01	74	0.05	74	0.05
59	0.02	59	0.10	135	1.5	182	1.5
90	0.05	90	0.29	304	1.5	304	1.5
120	0.17	120	0.36	305	0.05	305	0.01
151	0.45	151	0.34	365	0.01	365	0.01
181	0.70	181	0				
212	0.69	212	0				
243	0.63	243	0				
273	0.47	273	0				
304	0.20	304	0.01				
334	0.04	334	0.10				
365	0	365	0.04				
Hay intensive[c]		Hay extensive		Hay intensive		Hay extensive	
Julian day	Yield ($kg \cdot m^{-2}$)	Julian day	Yield ($kg \cdot m^{-2}$)	Julian day	Yield ($kg \cdot m^{-2}$)	Julian day	Yield ($kg \cdot m^{-2}$)
0	0	0	0	0	0.01	0	0.01
31	0	31	0	74	0.05	74	0.05
59	0.01	59	0	135	1.5	182	1.5
90	0.02	90	0	304	1.5	304	1.5
120	0.06	120	0	305	0.05	305	0.05
151	0.17	151	0	365	0.01	365	0.01
181	0.27	181	0				
212	0.26	212	0				
243	0.24	243	0				
273	0.18	273	0				
304	0.08	304	0				
334	0.01	334	0				
365	0	365	0				
Max leaf area index				**Max leaf area index**			
Grass 4				Grass 7			
Hay 4				Hay 7			
Growing and harvesting seasons (Julian day)				**Growing and harvesting seasons** (Julian day)			
Grass intensive		Grass extensive		Grass intensive		Grass extensive	
Begin of growth	60	1		Begin of growth	74	74	
Begin of harvest	91	60		Begin of harvest	121	121	
End of harvest	154	365		End of harvest	304	304	
End of first period	122	181		End of first period	196	196	
Hay intensive		Hay extensive		Hay intensive		Hay extensive	
Begin of growth	60	0		Begin of growth	74	74	
Begin of harvest	91	0		Begin of harvest	136	136	
End of harvest	154	0		End of harvest	258	258	
End of first period	122	0		End of first period	196	196	

[a] Is assumed to refer to green yield of the harvested production of alfalfa for fresh and dehydrated use, yield= 3,41 kg m^{-2}

[b] is assumed to refer to natural meadows, yield= 1,25 kg m^{-2}

[c] is assumed to refer to green yield of the harvested production of alfalfa for hay and silage, yield= 1,17 kg m-2

Table 3.26: Growth dilution factors for grass and hay.

Month	**CIEMAT** (Spain) Growth dilution factors (1/d)		**JRODOS default** (Central Europe) Growth dilution factors (1/d)	
	Grass/Hay intensive	Grass/Hay extensive	Grass/Hay intensive	Grass/Hay extensive
January	0	0	0	0
February	0	0.058	0	0
March	0	0.029	0.077	0.058
April	0.077	0.015	0.029	0.029
May	0.029	0.012	0.035	0.015
June	0.035	0.008	0.035	0.012
July	0.035	0.006	0.035	0.012
August	0.035	0	0.035	0.012
September	0.035	0	0.023	0.008
October	0.023	0.058	0.017	0.006
November	0.017	0.029	0	0
December	0	0.012	0	0

Table 3.27: JRODOS data of feedstuffs for animal products (kg fresh weight per day, Central Europe).

Animal product, Julian day	**Grass (intensive)**	**Grass (extensive)**	**Hay (intensive)**	**Hay (extensive)**	**Other**	**Feeding water**
Cow's milk						
111	0	0	14	0	0	75
131	70	0	0	0	0	75
294	70	0	0	0	0	75
314	0	0	14	0	0	75
365	0	0	14	0	0	75
Beef (cow)						
111	0	0	14	0	0	75
131	70	0	0	0	0	75
294	70	0	0	0	0	75
314	0	0	14	0	0	75
365	0	0	14	0	0	75
Beef (bull)						
365	0	0	0	0	28[a]	40
Pork						
365	0	0	0	0	3[b]	8
Lamb						
111	0	0	0	1	0	4
131	0	5	0	0	0	4
294	0	5	0	0	0	4
314	0	0	0	1	0	4
365	0	0	0	1	0	4
Chicken						
365					0.09[c]	0.2

[a] Maize.
[b] Winter barley.
[c] Winter wheat.

Table 3.28: Spanish data of feedstuffs for animal products (kg fresh weight per day).

Animal product, Julian day	Grass (intensive)	Grass (extensive)	Hay (intensive)	Hay (extensive)	Winter cereals	Other	Feeding water
Cow's milk							
0	0	0	0	0	0	0	150
31	0	0	21	0	0	0	150
59	3	0	20	0	0	0	150
90	8	0	19	0	0	0	150
120	31	0	14	0	0	0	150
151	75	0	3	0	0	0	150
181	75	0	3	0	0	0	150
212	75	0	3	0	0	0	150
243	75	0	3	0	0	0	150
273	63	0	6	0	0	0	150
304	37	0	12	0	0	0	150
334	7	0	19	0	0	0	150
365	0	0	21	0	0	0	150
Beef (cow)							
0	0	0	0	0	0	0[a]	100
31	0	8	0	0	30	0	100
59	0	63	0	0	0	0	100
90	0	63	0	0	0	0	100
120	0	63	0	0	0	0	100
151	0	63	0	0	0	0	100
181	0	0	0	0	17	7	100
212	0	0	0	0	17	7	100
243	0	0	0	0	17	7	100
273	0	0	0	0	17	7	100
304	0	8	0	0	30	0	100
334	0	63	0	0	0	0	100
365	0	25	0	0	23	0	100
Pork							
365	0	0	0	0		3[b]	8
Lamb							
111	0	0	0	1		0	4
131	0	5	0	0		0	4
294	0	5	0	0		0	4
314	0	0	0	1		0	4
365	0	0	0	1		0	4
Chicken							
365						0.09[c]	0.2

[a] Stubble
[a] Maize.
[b] Winter barley.
[c] Winter wheat.

3.3.4 Conclusions

The parameters selected for updating the Spanish values were the foodstuffs consumption rates, the crop yields, the harvesting periods, the leaf area indices and the feedstuffs and animal feeding regimes.

The derivation of the parameter values has encountered some difficulties, related to both the structure and the parameters considered in the JRODOS databases. These have been resolved as accurately as possible, through various assumptions.

The structure of the database, as it is right now, is not flexible and not only prevents the incorporation of new parameters, for example foodstuffs, it also makes difficult to modify some of the parameters considered. This is the case, for example, of the intensive grass regime parameterization, which in real conditions can achieve five or six cuts of grass, whereas the database only considers two.

Regarding the parameters included in the database, there is not sufficient information on how their selection and grouping has been made, neither how the parameter values have been estimated. This has made it necessary to make some assumptions and "educated guesses" in order to solve the problems encountered.

Section 3.3 has summarized the rough estimations made to parameterise Mediterranean areas. A more detailed exercise would need a new and more flexible structure of the database.

4. Comparison with SYMBIOSE (France)

In this project, SYMBIOSE will be run using regionally updated parameters from Finland, Norway and Spain (given above) and default values (for France conditions), which are therefore provided in the present chapter.

To be consistent with earlier chapters, we have put emphasis on:

- Agricultural calendars regarding crops, including growing season and harvest periods (section 4.1),
- animal feeding regimes (section 4.2) and,
- human consumption of foodstuffs (section 4.3)

4.1. Modelling of crops and agricultural calendar

In SYMBIOSE, 10 annual crops are defined; two of them provide food for the human diet (potatoes and winter cereals for flour), whereas all of the other crops provide feed for animal diets (various cereals, maize silage, fodder…). For each of the annual crops, Julian days are defined for 3 events: ploughing, germination (assumed to be comparable with start of growth in FDMT) and harvest. These days are provided in table 4.1. Yields and leaf are indexes are not explicitly modelled, and the values of aerial interception factor by dry and/or wet pathway (in m^2 per fresh kilogram) are tabulated as a function of the "deposition - harvest" time and the daily rainfall height or daily irrigation height.

Pasture grass (for animal grazing) is modelled in SYMBIOSE under the assumption that it is mature, i.e. that the start of calculation is by far posterior to the germination. The default value for yield is 0.7 kg fresh weight/m^2 but this parameter is not used in modelling the foliar pathway. Leaf area indexes (LAI) are not explicitly modelled, and the values of aerial interception factor by dry and/or wet pathway (in m^2 per fresh kilogram) are tabulated as a function of the daily rainfall height. Default values for this interception factor are constant whatever the "deposition - harvest" time and can be modified by the user.

Vegetables (leafy vegetables, root vegetables and fruit vegetables) are modelled all year long. Indeed, these types of plants are supposed to be sowed/harvested continuously all year, possibly in green houses during winter (typically from November to March). Yields and leaf area indexes (LAI) are not explicitly modelled, and the values of aerial interception factor by dry and/or wet pathway (in m^2 per fresh kilogram) are tabulated as a function of the daily rainfall height. Default values for this interception factor are constant whatever the Julian day, but this can be modified by the user.

Fruits and berries are not (yet) modelled in the current version of SYMBIOSE, to be used in the framework of COMET. Next version of SYMBIOSE (planned to be released end of 2016) will include fruits but this is too late to be used in COMET calculations.

Table 4.1 summarizes main information introduced above.

Table 4.1: French data (SYMBIOSE default) for germination and harvest Julian days

Product	Germination	Harvest
Leafy vegetables	All year long	
Root vegetables	All year long	
Fruit vegetables	All year long	
Fruit	Not yet modelled in SYMBIOSE	
Berries	Not yet modelled in SYMBIOSE	
Potatoes	359	324
Winter cereals (for flour)	293	223
Crops for animal feed	223, 293 or 359	166, 201, 213, 274 or 298
Pasture grass	All year long	

In conclusion, there are differences in modelling choices between SYMBIOSE and FDMT, independently of regional considerations. For the between-region comparisons to be done in the next step, parameters will be specifically recalculated to be comparable under the assumption that the deposition is on 1st of August.

4.2. Animal feeding regimes

The feeding diets are modelled in a similar way between SYMBIOSE and FDMT. Tables 4.2 and 4.3 provide default values in SYMBIOSE for daily intake rate throughout the year.

Table 4.2: SYMBIOSE data of feedstuffs for animal products (kg fresh weight per day, France).

Animal product, Julian day	Grass (grazing)	Maize silage	Fodder	Cereals	Feeding water
Cow milk					
1	0	40	2	0	100
91	50	0	0	0	100
288	0	40	2	0	100
Beef					
1	0	25	12	0	50
91	45	0	0	0	50
305	0	25	12	0	50
Sheep					
1	0	0	8	0	10
91	0	5	0	0	10
274	0	0	8	0	10

Table 4.3: SYMBIOSE data of feedstuffs for animal products (kg fresh weight per day, France).

Animal product, All year long	Grass (grazing)	Maize silage	Fodder	Cereals	Feeding water
Hen (eggs)	0	0	1	0.15	0.3
Pork (meat)	0	0	2	2.5	10
Chicken (meat)	0	0	0	0.15	0.1

In conclusion, comparison between North and south European regions can be done using the season at which lactating cows are outside grazing, with an obvious north to south gradient:

- from end of May to mid-September in Finland
- starting between mid-May and mid-June depending on the zone in Norway (Z1, Z2 or Z3), ending mid-September
- from mid-May to mid-October in Central Europe
- from end of March to mid-October in France (SYMBIOSE default)
- from end of February to end of November in Spain.

4.3. Foodstuffs consumption

SYMBIOSE default parameter values on food consumption rates are assumed to be representative of the French population, and were derived from French diet surveys (INSEE, 1991). Six age groups are considered in SYMBIOSE. Foodstuffs considered in table 4.4 are those also modelled by FDMT. Foodstuffs not considered in this Table are those:

- not (yet) modelled in SYMBIOSE : fruits, berries, rice, condensed milk, butter…
- modelled in SYMBIOSE but with nil default consumption data: ewe milk, goat milk…
- modelled in SYMBIOSE but out of the scope of this document : river fishes, sea fishes, sea molluscs, seaweeds…

Table 4.4: Average food consumption (absolute intake g/day) for various age groups in SYMBIOSE

Product	0-1 y	1-2 y	2-7 y	7-12 y	12-17 y	adults
Flour (winter cereals)	22	45	110	140	160	200
Potatoes	11	29	26	45	62	120
Leafy vegetables	16	37	68	73	79	87
Canned leafy vegetables	11	7.1	12	12	14	15
Root vegetables	16	37	31	38	43	43
Canned root vegetables	11	7.1	11	13	15	15
Fruit vegetables	16	37	41	46	52	53
Canned fruit vegetables	16	32	16	18	21	21
Milk (cow)	0	0	57	73	86	94
Canned milk (cow)	650	410	110	140	170	180
Fermented cheese (cow)	1.6	12	15	21	290	39
Butter	2.2	9.1	6	9.4	12	18
Beef meat	12	18	34	37	44	53
Chicken meat	12	18	43	46	54	66
Pork meat	13	26	44	48	55	67
Sheep meat	0	0	4.4	4.8	5.8	6.9
Eggs (hen)	2.8	13	12	17	24	29
Drinking water	700	700	1100	1100	1700	1700

In conclusion, between-regional comparison can be done on the example of the consumption by adults of leafy vegetables, again with a gradient from north to south.

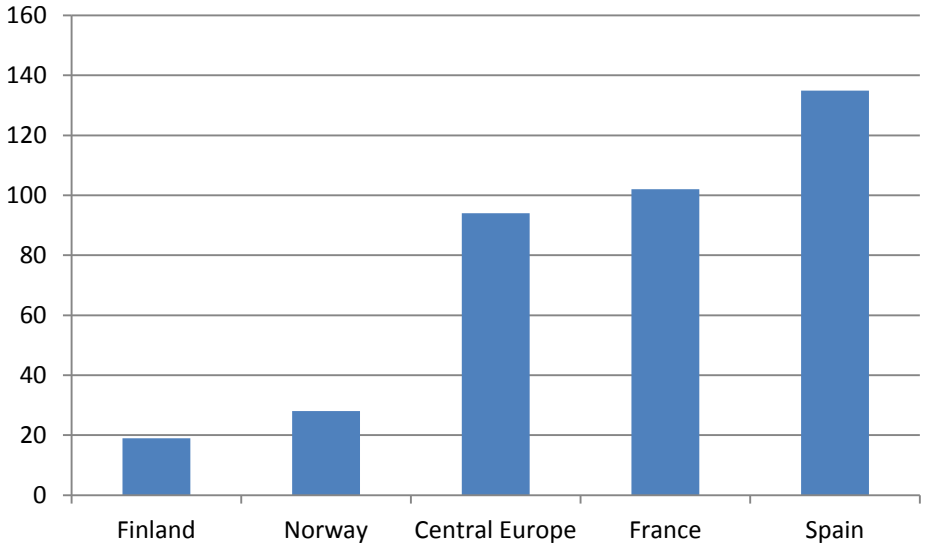

Figure 4.1: Between-country comparison average food consumption (absolute intake g/day) of leafy vegetables by adults

5. Conclusions and further work

- Updated parameter values of relevance to growing season and harvest periods of crops and grass including seasonal development of leaf area indices (LAI), animal feeding regimes and human consumption of foodstuffs have been provided for the Mediterranean (Spain) and Nordic (Finland, Norway) areas.

- Relevant FDMT and SYMBIOSE default values have been included for comparison purposes.

- For the forthcoming Milestone IRA Human M3 (due in autumn 2016), each country will run the same scenarios as described in Chapter 1 with their respective updated parameter values and compare the results with the rounds performed earlier with FDMT default values. In addition, SYMBIOSE will be run using the regionally updated parameters from Finland, Norway and Spain.

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