Food Balance Sheets

TO DO

Important Tasks

- We need to include proteins/fats/calories
- We should include an example where the primary product is eaten as such.
- Implement calculation for tourist element.
- Implement calculation for industrial element.
- Implement calculation for feed element.
- Implement calculation for residual element.
- Review trade portion from Alex and incorporate into this document.
- Discuss trade for countries with access to customs and without.
- Balancing algorithm: determine a good way to choose the tolerance automatically. It's manually tuned in this example, and that clearly won't work for general food balance sheet processes.
- Add text/content to the document to provide more explanation of each example.
- Round printed values. If there are only 1 or 2 digits, the final value should be the closest multiple of 5. If 3 digits, a multiple of 10, 4 to 7 digits a multiple of 100, and 8+ digits then 4 significant digits.

Minor Tasks

- Loss module: clean up the functions in the one script and put them into individual files with roxygen-style documentation (even if very sparse at the moment). This is crucial for transferring this work back to an R module on the system.
- All modules: clean up hard-coded numbers, column names, etc.
- The trade figures I quote here are based on the US data, but not exactly. We have HS6 trade data, and I can map that to CPC. However, some HS6 codes map to many CPC codes. My understanding is that the historical approach has been to not use split factors and to simply map the quantity straight into one of the CPC codes. For this simple example, I map the HS data to CPC and randomly split it.
- The commodity trees used are derived based on the FCL commodity tree. They will likely need to be updated, but for now I just simply map the FCL elements to their corresponding CPC codes. At the least, it would be good to have a tree for processing and a tree for standardization (some elements, for example beer, bran, etc. don't standardize up to the same thing they were processed from).

Wheat

For this example, we'll first consider the full process for creating a food balance sheet for wheat. We start off with an empty table:

Name	Production	Imports	Exports	StockChange	Food	Food Processing	Feed	Waste	Seed	Industrial	Tourist	Residual
Wheat	0	0	0	0	0	0	0	0	0	0	0	0
Wheat flour	0	0	0	0	0	0	0	0	0	0	0	0
Bulgur	0	0	0	0	0	0	0	0	0	0	0	0
Breakfast cereals	0	0	0	0	0	0	0	0	0	0	0	0
Wheat starch	0	0	0	0	0	0	0	0	0	0	0	0
Wheat bran	0	0	0	0	0	0	0	0	0	0	0	0

Production

For production data, we first fill in the table with any available official figures. To impute production, we must also consider yield and area harvested data as yield is defined as production divided by area harvested (and thus with any two elements the third is uniquely defined). Suppose we have the following official data:

Name	Area Harvested	Yield	Production
Wheat	18496174	0	0
Wheat flour	NA	NA	18652048

In this case, the production value is only known for wheat flour (it is missing for wheat), and for wheat we are also missing the yield value. The first step in the imputation process is to impute the yield, using the previously described production imputation methodology.

Name	Area Harvested	Yield	Production
Wheat	18496174	2.9422	0
Wheat flour	NA	NA	18652048

Now, we have enough information to impute the production data:

Name	Area Harvested	Yield	Production
Wheat	18496174	2.9422	54418808
Wheat flour	NA	NA	18652048

Name	Area Harvested	Yield	Production

Now, we fill in the table with our production values. Production is only imputed for primary products, and so in this case no additional values are filled in.

Name	Production	Imports	Exports	StockChange	Food	Food Processing	Feed	Waste	Seed	Industrial	Tourist	Residual
Wheat	**54418808**	0	0	0	0	0	0	0	0	0	0	0
Wheat flour	**18652048**	0	0	0	0	0	0	0	0	0	0	0
Bulgur	**-**	0	0	0	0	0	0	0	0	0	0	0
Breakfast cereals	**-**	0	0	0	0	0	0	0	0	0	0	0
Wheat starch	**-**	0	0	0	0	0	0	0	0	0	0	0
Wheat bran	**-**	0	0	0	0	0	0	0	0	0	0	0

Trade

For the next example, we'll show how the imputation, mirroring and balancing works. In this case, we just take the country totals and insert into this table.

Name	Production	Imports	Exports	StockChange	Food	Food Processing	Feed	Waste	Seed	Industrial	Tourist	Residual
Wheat	54418808	**1999076**	**32789894**	0	0	0	0	0	0	0	0	0
Wheat flour	18652048	**341529**	**572794**	0	0	0	0	0	0	0	0	0
Bulgur	-	**182485**	**524471**	0	0	0	0	0	0	0	0	0
Breakfast cereals	-	**307172**	**217289**	0	0	0	0	0	0	0	0	0
Wheat starch	-	**624947**	**224528**	0	0	0	0	0	0	0	0	0
Wheat bran	-	**258937**	**2343712**	0	0	0	0	0	0	0	0	0

Stock Changes

We now estimate the stock changes. Note that for most products, we assume that countries do not hold stocks. Generally, stocks will only be held for primary level products, and not even all of these products. The numbers below represent the estimated stock changes (by the stock imputation methodology described previously) for the example country we're considering.

Name	Production	Imports	Exports	StockChange	Food	Food Processing	Feed	Waste	Seed	Industrial	Tourist	Residual
Wheat	54418808	1999076	32789894	**-230630**	0	0	0	0	0	0	0	0

Name	Production	Imports	Exports	StockChange	Food	Food Processing	Feed	Waste	Seed	Industrial	Tourist	Residual
Wheat flour	18652048	341529	572794	**-**	0	0	0	0	0	0	0	0
Bulgur	-	182485	524471	**-**	0	0	0	0	0	0	0	0
Breakfast cereals	-	307172	217289	**-**	0	0	0	0	0	0	0	0
Wheat starch	-	624947	224528	**-**	0	0	0	0	0	0	0	0
Wheat bran	-	258937	2343712	**-**	0	0	0	0	0	0	0	0

Food

The allocation to food, on the other hand, can potentially be considered at any processing level, although some commodities (such as wheat) are assumed to not be eaten as such. We impute food consumption numbers for the example country and update the FBS table below.

Name	Production	Imports	Exports	StockChange	Food	Food Processing	Feed	Waste	Seed	Industrial	Tourist	Residual
Wheat	54418808	1999076	32789894	-230630	0	0	0	0	0	0	0	0
Wheat flour	18652048	341529	572794	-	**18539484**	0	0	0	0	0	0	0
Bulgur	-	182485	524471	-	**3684**	0	0	0	0	0	0	0
Breakfast cereals	-	307172	217289	-	**98131**	0	0	0	0	0	0	0
Wheat starch	-	624947	224528	-	0	0	0	0	0	0	0	0
Wheat bran	-	258937	2343712	-	0	0	0	0	0	0	0	0

Losses

Name	Production	Imports	Exports	StockChange	Food	Food Processing	Feed	Waste	Seed	Industrial	Tourist	Residual
Wheat	54418808	1999076	32789894	-230630	0	0	0	**560306**	0	0	0	0
Wheat flour	18652048	341529	572794	-	18539484	0	0	**-**	0	0	0	0
Bulgur	-	182485	524471	-	3684	0	0	**-**	0	0	0	0
Breakfast cereals	-	307172	217289	-	98131	0	0	**-**	0	0	0	0
Wheat starch	-	624947	224528	-	0	0	0	**-**	0	0	0	0
Wheat bran	-	258937	2343712	-	0	0	0	**-**	0	0	0	0

```
## Warning: Standard error for loss data is currently just 10% of loss value,
## it is not estimated in any way.
```

Feed

Feed allocation must be done at this phase in order to ensure that we have reduced the feed demand by the corresponding amounts of feed products (i.e. wheat bran, wheat germ, etc.).

Seed

Name	Production	Imports	Exports	StockChange	Food	Food Processing	Feed	Waste	Seed	Industrial	Tourist	Residual
Wheat	54418808	1999076	32789894	-230630	0	0	0	560306	**1904246**	0	0	0
Wheat flour	18652048	341529	572794	-	18539484	0	0	-	**-**	0	0	0
Bulgur	-	182485	524471	-	3684	0	0	-	**-**	0	0	0
Breakfast cereals	-	307172	217289	-	98131	0	0	-	**-**	0	0	0
Wheat starch	-	624947	224528	-	0	0	0	-	**-**	0	0	0
Wheat bran	-	258937	2343712	-	0	0	0	-	**-**	0	0	0

Industrial Utilization

Work in progress. . .

Tourist Consumption

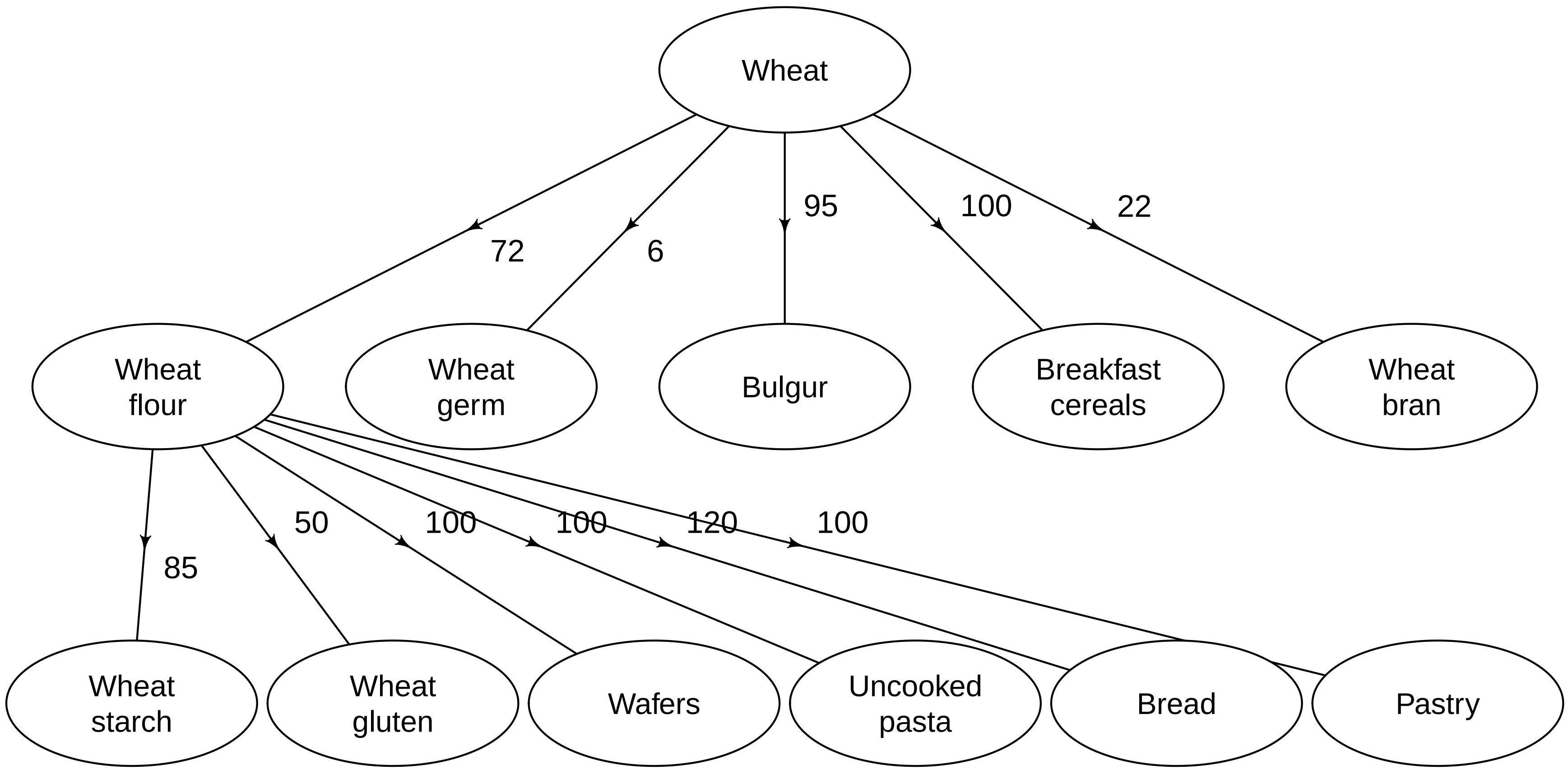
The tourist consumption estimation approach uses tourist data from the WTO as well as last year's consumption patterns to estimate the impact of tourism on local consumption. Note that tourist consumption can be negative; as an extreme example consider a case where many nationals travel abroad but no tourists enter. In this case, that country will certainly have a negative "tourist consumption" because more calories will be assumed abroad than locally.

Residual Other Uses

Work in progress. . .

Standardization and Balancing

Now, suppose we have the following commodity tree:



We first start with the pre-standardized table:

Name	Production	Imports	Exports	StockChange	Food	Food Processing	Feed	Waste	Seed	Industrial	Tourist	Residual
Wheat	54418808	1999076	32789894	-230630	0	0	0	560306	1904246	0	0	0
Wheat flour	18652048	341529	572794	-	18539484	0	0	-	-	0	0	0
Bulgur	-	182485	524471	-	3684	0	0	-	-	0	0	0
Breakfast cereals	-	307172	217289	-	98131	0	0	-	-	0	0	0
Wheat starch	-	624947	224528	-	0	0	0	-	-	0	0	0
Wheat bran	-	258937	2343712	-	0	0	0	-	-	0	0	0

We then compute the required "production" of each of the processed products to satisfy any deficits due to exports or consumption (note that we can allow production to be zero if supply exceeds utilization).

Name	Production	Imports	Exports	StockChange	Food	Food Processing	Feed	Waste	Seed	Industrial	Tourist	Residual
Wheat	54418808	1999076	32789894	-230630	0	0	0	560306	1904246	0	0	0
Wheat flour	18652048	341529	572794	-	18539484	0	0	-	-	0	0	0
Bulgur	**345670**	182485	524471	-	3684	0	0	-	-	0	0	0
Breakfast cereals	**8247**	307172	217289	-	98131	0	0	-	-	0	0	0
Wheat starch	**0**	624947	224528	-	0	0	0	-	-	0	0	0
Wheat bran	**2084775**	258937	2343712	-	0	0	0	-	-	0	0	0

Since wheat starch is produced from wheat flour, we would first need to ensure the wheat flour "food to processing" can cover any deficits of wheat starch. However, since wheat starch imports exceed exports plus food, we don't have to worry about this requirement. Instead, we can just standardize all the first processed level products back to food to processing of wheat.

Name	Production (processed)	SD(Production)	Wheat Equivalent	SD(Wheat Equivalent)
Wheat flour	18652048	0	25905622	0
Bulgur	345670	884	363863	931
Breakfast cereals	8247	1481	8247	1481
Wheat bran	2084775	0	9476252	0

Now, we wish to compute the distribution for food to processing for wheat. The main requirement is in the wheat flour, and it should be noted that the 9 million kilogram requirement for wheat bran will automatically be satisfied if the 26 million kilogram requirement for wheat flour is satisfied (as they are by-products). Thus, the food to processing element for wheat has a mean of 26,198 thousand kilograms (the sum of the first three) and a standard deviation of 63 thousand kilograms (the square-root of the sum of the squares of the first three standard deviations). Thus, we now have the following table:

Now, we must balance this table. To do this, we need to extract the computed **standard deviations (is this the word we're using???)** of each element. The table below shows the expected value and estimated **standard deviation** for each of the elements for wheat:

Variable	Production	Imports	Exports	StockChange	Food	Food Processing	Feed	Waste	Seed	Industrial	Tourist	Residual
Mean	54418808	1999076	32789894	-230630	0	26277929	0	560306	1904246	0	0	0
Standard Dev.	326513	0	0	89854	0	1724	0	56031	1129	0	0	0

Note that in this case, the standard deviation for food for processing is very small; this is because it's mostly determined by the production of wheat flour, and this value is an official figure.

Variable	Production	Imports	Exports	StockChange	Food	Food Processing	Feed	Waste	Seed	Industrial	Tourist	Residual
Mean	59091496	1999076	32789894	-481490	0	26277117	0	600614	1904492	0	0	0
Standard Dev.	326513	0	0	89854	0	1724	0	56031	1129	0	0	0

Now, when balancing, we find that food is adjusted down slightly. This adjustment to food of wheat implies that the production of children commodities must also be updated (and hence their food values as well).

Name	Production (processed)	SD(Production)	Wheat Equivalent	SD(Wheat Equivalent)	Adjustment
Wheat flour	18652048	0	25905622	0	0
Bulgur	345452	884	363633	931	-230
Breakfast cereals	7665	1481	7665	1481	-582
Wheat bran	2084775	0	9476252	0	0

We can now update the production numbers for each of the first level primary elements. Note that in the process of creating flour, we also create bran and germ. The amount of bran and germ created, in this case, is determined by the amount of flour we need to create (as that was our most stringent requirement). Thus, we have:

Name	Production	Imports	Exports	StockChange	Food	Food Processing	Feed	Waste	Seed	Industrial	Tourist	Residua
Wheat	59091496	1999076	32789894	-481490	0	26277117	0	600614	1904492	0	0	0
Wheat flour	18652048	341529	572794	-	18539484	0	0	-	-	0	0	0
Wheat germ	**-**	-	-	-	-	-	-	-	-	0	0	0
Bulgur	**345451**	182485	524471	0	**3466**	0	0	0	0	0	0	0
Breakfast cereals	**7666**	307172	217289	0	**97549**	0	0	0	0	0	0	0
Wheat starch	0	624947	224528	-	0	0	0	-	-	0	0	0
Wheat bran	**5699282**	258937	2343712	0	0	0	**3614507**	0	0	0	0	0

Our food balance sheet is nearly completed, except that some commodities haven't been handled yet. In particular, wheat starch had imports exceeding exports and so we have not balanced that commodity yet; also, wheat flour has official production and so we haven't modified that commodity either. These unbalanced elements must be updated, and since the production is already fixed (either because it's an official figure or because it's 0) the balancing is very straight-forward: the uncertainty will be entirely allocated to food (or, in general, to either food or feed).

Name	Production	Imports	Exports	StockChange	Food	Food Processing	Feed	Waste	Seed	Industrial	Tourist	Residua
Wheat	59091496	1999076	32789894	-481490	-54	26277117	0	600614	1904492	0	0	
Wheat flour	18652048	341529	572794	-	**18420783**	0	0	-	-	0	0	
Wheat germ	-	-	-	-	-	-	-	-	-	0	0	
Bulgur	345451	182485	524471	0	3466	0	0	0	0	0	0	
Breakfast cereals	7666	307172	217289	0	97549	0	0	0	0	0	0	
Wheat starch	0	624947	224528	-	**400420**	0	0	-	-	0	0	
Wheat bran	5699282	258937	2343712	0	0	0	3614507	0	0	0	0	

Now, the final step is aggregating this full table back into primary equivalent. For most elements, this is trivial: for example, the final stock change for wheat will simply be the current stock change because there is no stock change for processed products. However, there are three elements that must be handled differently: imports, exports, and food. Note that the final value for wheat equivalent production is simply the current value for wheat production: this is because "production" of flour (or any other processed product) isn't really production in the sense that the flour is acquired from a different commodity (whereas production of wheat is truly a production as it is not derived from anything else). Also, food processing will not be standardized as it is more of an accounting variable that specifies how much of a commodity at one level should be processed into a different commodity.

To standardize trade and food, we can simply aggregate the trade and food of the children commodities up into their primary equivalent by dividing by the extraction rate. We add these primary equivalents to the current value of trade/food of wheat, and we have our final, primary equivalent trade/food of wheat. Also, feed is not standardized back into wheat equivalent as it is accounted for **???**.

Name	Production	Imports	Exports	StockChange	Food	Food Processing	Feed	Waste	Seed	Industrial	Tourist	Residual
Wheat	59091496	3993871	34721681	-481490	26340070	26277117	0	600614	1904492	0	0	0

We can also compute calories, fats, and proteins at this point. First, we apply a calorie/fat/protein content factor to each individual element:

Name	Quantity	Energy	Protein	Fat
Wheat	-54.41744	1420.937	12.3400	1.86500
Wheat flour	18420783.17000	1472.172	11.0475	1.33875
Bulgur	3465.57586	NA	NA	NA
Breakfast cereals	97548.92610	NA	NA	NA
Wheat starch	400419.70300	NA	NA	NA
Wheat bran	0.00000	NA	NA	NA

Standardization is trivial: all the commodities here are purely additive, so the standardized calories/fats/proteins are simply the sum of the total calories/fats/proteins for each element:

Energy (millions)	Protein (millions)	Fat (millions)
27118.49	203.5	24.66

Cattle Meat

Name	Production	Imports	Exports	StockChange	Food	Food Processing	Feed	Waste	Seed	Industrial	Tourist	Residual
Meat of cattle	0	0	0	0	0	0	0	0	0	0	0	0
Meat of cattle boneless	0	0	0	0	0	0	0	0	0	0	0	0
Bovine meat	0	0	0	0	0	0	0	0	0	0	0	0
Extracts of meat	0	0	0	0	0	0	0	0	0	0	0	0
Butcher fat	0	0	0	0	0	0	0	0	0	0	0	0

Production

For production data, we first fill in the table with any available official figures. To impute production, we must also consider yield and area harvested data as yield is defined as production divided by area harvested (and thus with any two elements the third is uniquely defined). Suppose we have the following official data:

Name Area Harvested Yield Production —– ————— —— ———

In this case, the production value is only known for cattle flour (it is missing for cattle), and for cattle we are also missing the yield value. The first step in the imputation process is to impute the yield, using the previously described production imputation methodology.

Name Area Harvested Yield Production —– ————— —— ———

Now, we have enough information to impute the production data:

Name Area Harvested Yield Production —– ————— —— ———

Now, we fill in the table with our production values. Production is only imputed for primary products, and so in this case no additional values are filled in.

Name	Production	Imports	Exports	StockChange	Food	Food Processing	Feed	Waste	Seed	Industrial	Tourist	Residual
Meat of cattle	**11921102**	0	0	0	0	0	0	0	0	0	0	0
Meat of cattle boneless	**-**	0	0	0	0	0	0	0	0	0	0	0
Bovine meat	**-**	0	0	0	0	0	0	0	0	0	0	0
Extracts of meat	**-**	0	0	0	0	0	0	0	0	0	0	0
Butcher fat	**-**	0	0	0	0	0	0	0	0	0	0	0

Trade

For the next example, we'll show how the imputation, mirroring and balancing works. In this case, we just take the country totals and insert into this table.

Name	Production	Imports	Exports	StockChange	Food	Food Processing	Feed	Waste	Seed	Industrial	Tourist	Residual
Meat of cattle	11921102	**71866**	**185535**	0	0	0	0	0	0	0	0	0
Meat of cattle boneless	-	**84689**	**27085**	0	0	0	0	0	0	0	0	0
Bovine meat	-	**-**	**-**	0	0	0	0	0	0	0	0	0
Extracts of meat	-	**-**	**-**	0	0	0	0	0	0	0	0	0
Butcher fat	-	**19637**	**267121**	0	0	0	0	0	0	0	0	0

Stock Changes

We now estimate the stock changes. Note that for most products, we assume that countries do not hold stocks. Generally, stocks will only be held for primary level products, and not even all of these products. The numbers below represent the estimated stock changes (by the stock imputation methodology described previously) for the example country we're considering.

Name	Production	Imports	Exports	StockChange	Food	Food Processing	Feed	Waste	Seed	Industrial	Tourist	Residual
Meat of cattle	11921102	71866	185535	**-1431**	0	0	0	0	0	0	0	0
Meat of cattle boneless	-	84689	27085	**-**	0	0	0	0	0	0	0	0
Bovine meat	-	-	-	**-**	0	0	0	0	0	0	0	0
Extracts of meat	-	-	-	**-**	0	0	0	0	0	0	0	0
Butcher fat	-	19637	267121	**-**	0	0	0	0	0	0	0	0

Food

The allocation to food, on the other hand, can potentially be considered at any processing level, although some commodities (such as cattle) are assumed to not be eaten as such. We impute food consumption numbers for the example country and update the FBS table below.

Name	Production	Imports	Exports	StockChange	Food	Food Processing	Feed	Waste	Seed	Industrial	Tourist	Residual
Meat of cattle	11921102	71866	185535	-1431	0	0	0	0	0	0	0	0
Meat of cattle boneless	-	84689	27085	-	**7793721**	0	0	0	0	0	0	0
Bovine meat	-	-	-	-	**98**	0	0	0	0	0	0	0
Extracts of meat	-	-	-	-	**949**	0	0	0	0	0	0	0

Name	Production	Imports	Exports	StockChange	Food	Food Processing	Feed	Waste	Seed	Industrial	Tourist	Residual
Butcher fat	-	19637	267121	-	0	0	0	0	0	0	0	0

Losses

Name	Production	Imports	Exports	StockChange	Food	Food Processing	Feed	Waste	Seed	Industrial	Tourist	Residual
Meat of cattle	11921102	71866	185535	-1431	0	0	0	**22766**	0	0	0	0
Meat of cattle boneless	-	84689	27085	-	7793721	0	0	-	0	0	0	0
Bovine meat	-	-	-	-	98	0	0	-	0	0	0	0
Extracts of meat	-	-	-	-	949	0	0	-	0	0	0	0
Butcher fat	-	19637	267121	-	0	0	0	-	0	0	0	0

```
## Warning: Standard error for loss data is currently just 10% of loss value,
## it is not estimated in any way.
```

Feed

Feed allocation must be done at this phase in order to ensure that we have reduced the feed demand by the corresponding amounts of feed products.

Seed

Name	Production	Imports	Exports	StockChange	Food	Food Processing	Feed	Waste	Seed	Industrial	Tourist	Residual
Meat of cattle	11921102	71866	185535	-1431	0	0	0	22766	-	0	0	0
Meat of cattle boneless	-	84689	27085	-	7793721	0	0	-	-	0	0	0
Bovine meat	-	-	-	-	98	0	0	-	-	0	0	0
Extracts of meat	-	-	-	-	949	0	0	-	-	0	0	0
Butcher fat	-	19637	267121	-	0	0	0	-	-	0	0	0

Industrial Utilization

Work in progress…

Tourist Consumption

The tourist consumption estimation approach uses tourist data from the WTO as well as last year's consumption patterns to estimate the impact of tourism on local consumption. Note that tourist consumption can be negative; as an extreme example consider a case where many nationals travel abroad but no tourists enter. In this case, that country will certainly have a negative "tourist consumption" because more calories will be assumed abroad than locally.

Residual Other Uses

Work in progress…

Standardization and Balancing

Now, suppose we have the following commodity tree:

We first start with the pre-standardized table:

Name	Production	Imports	Exports	StockChange	Food	Food Processing	Feed	Waste	Seed	Industrial	Tourist	Residual
Meat of cattle	11921102	71866	185535	-1431	0	0	0	22766	-	0	0	0
Meat of cattle boneless	-	84689	27085	-	7793721	0	0	-	-	0	0	0
Bovine meat	-	-	-	-	98	0	0	-	-	0	0	0
Extracts of meat	-	-	-	-	949	0	0	-	-	0	0	0
Butcher fat	-	19637	267121	-	0	0	0	-	-	0	0	0

We then compute the required "production" of each of the processed products to satisfy any deficits due to exports or consumption (note that we can allow production to be zero if supply exceeds utilization).

Name	Production	Imports	Exports	StockChange	Food	Food Processing	Feed	Waste	Seed	Industrial	Tourist	Residual
Meat of cattle	**11921102**	71866	185535	-1431	0	0	0	22766	-	0	0	0
Meat of cattle boneless	**7736116**	84689	27085	-	7793721	0	0	-	-	0	0	0
Bovine meat	**98**	-	-	-	98	0	0	-	-	0	0	0
Extracts of meat	**949**	-	-	-	949	0	0	-	-	0	0	0
Butcher fat	**247484**	19637	267121	-	0	0	0	-	-	0	0	0

Since wheat starch is produced from wheat flour, we would first need to ensure the wheat flour "food to processing" can cover any deficits of wheat starch. However, since wheat starch imports exceed exports plus food, we don't have to worry about this requirement. Instead, we can just standardize all the first processed level products back to food to processing of wheat.

Now, we wish to compute the distribution for food to processing for wheat The main requirement is in the wheat flour, and it should be noted that the 9 million kilogram requirement for wheat bran will automatically be satisfied if the 26 million kilogram requirement for wheat flour is satisfied (as they are by-products). Thus, the food to processing element for wheat has a mean of 26,198 thousand kilograms (the sum of the first three) and a standard deviation of 63 thousand kilograms (the square-root of the sum of the squares of the first three standard deviations). Thus, we now have the following table:

Now, we must balance this table. To do this, we need to extract the computed **standard deviations (is this the word we're using???)** of each element. The table below shows the expected value and estimated **standard deviation** for each of the elements for wheat:

Note that in this case, the standard deviation for food for processing is very small; this is because it's mostly determined by the production of wheat flour, and this value is an official figure.

Now, when balancing, we find that food is adjusted down slightly. This adjustment to food of wheat implies that the production of children commodities must also be updated (and hence their food values as well).

We can now update the production numbers for each of the first level primary elements. Note that in the process of creating flour, we also create bran and germ. The amount of bran and germ created, in this case, is determined by the amount of flour we need to create (as that was our most stringent requirement). Thus, we have:

Our food balance sheet is nearly completed, except that some commodities haven't been handled yet. In particular, wheat starch had imports exceeding exports and so we have not balanced that commodity yet; also, wheat flour has official production and so we haven't modified that commodity either. These unbalanced elements must be updated, and since the production is already fixed (either because it's an official figure or because it's 0) the balancing is very straight-forward: the uncertainty will be entirely allocated to food (or, in general, to either food or feed).

Name	Production	Imports	Exports	StockChange	Food	Food Processing	Feed	Waste	Seed	Industrial	Tourist	Residual
Meat of cattle	11921102	71866	185535	-1431	2110930	9675166	0	22766	-	0	0	0
Meat of cattle boneless	7736116	84689	27085	-	7793721	0	0	-	-	0	0	0
Bovine meat	98	-	-	-	98	0	0	-	-	0	0	0
Extracts of meat	949	-	-	-	949	0	0	-	-	0	0	0
Butcher fat	247484	19637	267121	-	0	0	0	-	-	0	0	0

Now, the final step is aggregating this full table back into primary equivalent. For most elements, this is trivial: for example, the final stock change for wheat will simply be the current stock change because there is no stock change for processed products. However, there are three elements that must be handled differently: imports, exports, and food. Note that the final value for wheat equivalent production is simply the current value for wheat production: this is because "production" of flour (or any other processed product) isn't really production in the sense that the flour is acquired from a different commodity (whereas production of wheat is truly a production as it is not derived from anything else). Also, food processing will not be standardized as it is more of an accounting variable that specifies how much of a commodity at one level should be processed into a different commodity.

To standardize trade and food, we can simply aggregate the trade and food of the children commodities up into their primary equivalent by dividing by the extraction rate. We add these primary equivalents to the current value of trade/food of wheat, and we have our final, primary equivalent trade/food of wheat. Also, feed is not standardized back into wheat equivalent as it is accounted for **???**.

Name Production Imports Exports StockChange Food Food Processing Feed Waste Seed Industrial Tourist Residual —— ———— ——— ——— ———— —— ————- —— ——— —— ———— ——— ———

We can also compute calories, fats, and proteins at this point. First, we apply a calorie/fat/protein content factor to each individual element:

Name	Quantity	Energy	Protein	Fat
NA	-11632359.05300	NA	NA	NA
Meat of cattle	2110930.37259	NA	NA	NA
Meat of cattle boneless	7793720.98280	NA	NA	NA
Bovine meat	97.99503	1165.2400	32.15	13.77000
Extracts of meat	948.95184	497.6538	9.16	4.27125
Butcher fat	0.00000	NA	NA	NA

Standardization is trivial: all the commodities here are purely additive, so the standardized calories/fats/proteins are simply the sum of the total calories/fats/proteins for each element:

Energy (millions)	Protein (millions)	Fat (millions)
0.59	0.01	0.01

Palm Oil

```
## Warning in rm(palmData): object 'palmData' not found
```

Sugar

Now, let's consider the full process for creating a food balance sheet for sugar. We start off with an empty table:

Name	Production	Imports	Exports	StockChange	Food	Food Processing	Feed	Waste	Seed	Industrial	Touris
Sugar Beet	0	0	0	0	0	0	0	0	0	0	
Sugar Cane	0	0	0	0	0	0	0	0	0	0	
Sugar and Syrups nes	0	0	0	0	0	0	0	0	0	0	

Name	Production	Imports	Exports	StockChange	Food	Food Processing	Feed	Waste	Seed	Industrial	Touris
Beet sugar	0	0	0	0	0	0	0	0	0	0	
Refined sugar	0	0	0	0	0	0	0	0	0	0	
Molasses (from beet, cane and maize)	0	0	0	0	0	0	0	0	0	0	
Undenatured ethyl alcohol (>80%)	0	0	0	0	0	0	0	0	0	0	
Undenatured ethyl alcohol (<=80%)	0	0	0	0	0	0	0	0	0	0	
Other non-alcoholic caloric beverages n.e.c	0	0	0	0	0	0	0	0	0	0	

Production

For production data, we first fill in the table with any available official figures. In this case, the production value is known for all the primary products and thus no imputation is done. We also have production data for some of the processed commodities:

Name	Production	Imports	Exports	StockChange	Food	Food Processing	Feed	Waste	Seed	Industrial	Touris
Sugar Beet	**26214040**	0	0	0	0	0	0	0	0	0	
Sugar Cane	**26511598**	0	0	0	0	0	0	0	0	0	
Sugar and Syrups nes	**-**	0	0	0	0	0	0	0	0	0	
Beet sugar	**4561000**	0	0	0	0	0	0	0	0	0	
Refined sugar	**-**	0	0	0	0	0	0	0	0	0	
Molasses (from beet, cane and maize)	**2075000**	0	0	0	0	0	0	0	0	0	
Undenatured ethyl alcohol (>80%)	**-**	0	0	0	0	0	0	0	0	0	
Undenatured ethyl alcohol (<=80%)	**-**	0	0	0	0	0	0	0	0	0	
Other non-alcoholic caloric beverages n.e.c	**-**	0	0	0	0	0	0	0	0	0	

Trade

For the next example, we'll show how the imputation, mirroring and balancing works. In this case, we just take the country totals and insert into this table.

Name	Production	Imports	Exports	StockChange	Food	Food Processing	Feed	Waste	Seed	Industrial	Tou
Sugar Beet	26214040	**194543**	**304**	0	0	0	0	0	0	0	
Sugar Cane	26511598	**9725**	**861**	0	0	0	0	0	0	0	
Sugar and Syrups nes	-	**387899**	**2766095**	0	0	0	0	0	0	0	
Beet sugar	4561000	**9**	**194806**	0	0	0	0	0	0	0	
Refined sugar	-	**1275232**	**111184**	0	0	0	0	0	0	0	

Name	Production	Imports	Exports	StockChange	Food	Food Processing	Feed	Waste	Seed	Industrial	Tou
Molasses (from beet, cane and maize)	2075000	**464181**	**236516**	0	0	0	0	0	0	0	
Undenatured ethyl alcohol (>80%)	-	**965161**	**867423**	0	0	0	0	0	0	0	
Undenatured ethyl alcohol (<=80%)	-	**-**	**-**	0	0	0	0	0	0	0	
Other non-alcoholic caloric beverages n.e.c	-	**1314304**	**1075983**	0	0	0	0	0	0	0	

Stock Changes

We now estimate the stock changes. Note that for most products, we assume that countries do not hold stocks. Generally, stocks will only be held for primary level products, and not even all of these products. The numbers below represent the estimated stock changes (by the stock imputation methodology described previously) for the example country we're considering.

Name	Production	Imports	Exports	StockChange	Food	Food Processing	Feed	Waste	Seed	Industrial	Touris
Sugar Beet	26214040	194543	304	**-**	0	0	0	0	0	0	
Sugar Cane	26511598	9725	861	**-**	0	0	0	0	0	0	
Sugar and Syrups nes	-	387899	2766095	**-**	0	0	0	0	0	0	
Beet sugar	4561000	9	194806	**-**	0	0	0	0	0	0	
Refined sugar	-	1275232	111184	**79498**	0	0	0	0	0	0	
Molasses (from beet, cane and maize)	2075000	464181	236516	**-**	0	0	0	0	0	0	
Undenatured ethyl alcohol (>80%)	-	965161	867423	**193313**	0	0	0	0	0	0	
Undenatured ethyl alcohol (<=80%)	-	-	-	**-**	0	0	0	0	0	0	
Other non-alcoholic caloric beverages n.e.c	-	1314304	1075983	**-**	0	0	0	0	0	0	

Food

The allocation to food, on the other hand, can potentially be considered at any processing level, although some commodities (such as wheat) are assumed to not be eaten as such. We impute food consumption numbers for the example country and update the FBS table below.

Name	Production	Imports	Exports	StockChange	Food	Food Processing	Feed	Waste	Seed	Industrial	To
Sugar Beet	26214040	194543	304	-	0	0	0	0	0	0	
Sugar Cane	26511598	9725	861	-	0	0	0	0	0	0	
Sugar and Syrups nes	-	387899	2766095	-	**22953**	0	0	0	0	0	
Beet sugar	4561000	9	194806	-	0	0	0	0	0	0	
Refined sugar	-	1275232	111184	79498	**8800000**	0	0	0	0	0	
Molasses (from beet, cane and maize)	2075000	464181	236516	-	0	0	0	0	0	0	

Name	Production	Imports	Exports	StockChange	Food	Food Processing	Feed	Waste	Seed	Industrial	To
Undenatured ethyl alcohol (>80%)	-	965161	867423	193313	0	0	0	0	0	0	
Undenatured ethyl alcohol (<=80%)	-	-	-	-	**2014156**	0	0	0	0	0	
Other non-alcoholic caloric beverages n.e.c	-	1314304	1075983	-	**238505**	0	0	0	0	0	

Losses

Name	Production	Imports	Exports	StockChange	Food	Food Processing	Feed	Waste	Seed	Industrial	T
Sugar Beet	26214040	194543	304	-	0	0	0	**205504**	0	0	
Sugar Cane	26511598	9725	861	-	0	0	0	**213257**	0	0	
Sugar and Syrups nes	-	387899	2766095	-	22953	0	0	**-**	0	0	
Beet sugar	4561000	9	194806	-	0	0	0	**-**	0	0	
Refined sugar	-	1275232	111184	79498	8800000	0	0	**-**	0	0	
Molasses (from beet, cane and maize)	2075000	464181	236516	-	0	0	0	**-**	0	0	
Undenatured ethyl alcohol (>80%)	-	965161	867423	193313	0	0	0	**-**	0	0	
Undenatured ethyl alcohol (<=80%)	-	-	-	-	2014156	0	0	**-**	0	0	
Other non-alcoholic caloric beverages n.e.c	-	1314304	1075983	-	238505	0	0	**-**	0	0	

```
## Warning: Standard error for loss data is currently just 10% of loss value,
## it is not estimated in any way.
```

Feed

Feed allocation must be done at this phase in order to ensure that we have reduced the feed demand by the corresponding amounts of feed products (i.e. wheat bran, wheat germ, etc.).

Seed

Name	Production	Imports	Exports	StockChange	Food	Food Processing	Feed	Waste	Seed	Industrial	To
Sugar Beet	26214040	194543	304	-	0	0	0	205504	**-**	0	
Sugar Cane	26511598	9725	861	-	0	0	0	213257	**-**	0	
Sugar and Syrups nes	-	387899	2766095	-	22953	0	0	-	**-**	0	
Beet sugar	4561000	9	194806	-	0	0	0	-	**-**	0	

Name	Production	Imports	Exports	StockChange	Food	Food Processing	Feed	Waste	Seed	Industrial	To
Refined sugar	-	1275232	111184	79498	8800000	0	0	-	-	0	
Molasses (from beet, cane and maize)	2075000	464181	236516	-	0	0	0	-	-	0	
Undenatured ethyl alcohol (>80%)	-	965161	867423	193313	0	0	0	-	-	0	
Undenatured ethyl alcohol (<=80%)	-	-	-	-	2014156	0	0	-	-	0	
Other non-alcoholic caloric beverages n.e.c	-	1314304	1075983	-	238505	0	0	-	-	0	

```
## Warning: Standard error for seed data is currently just 10% of seed value,
## it is not estimated in any way.
```

Industrial Utilization

Work in progress…

Tourist Consumption

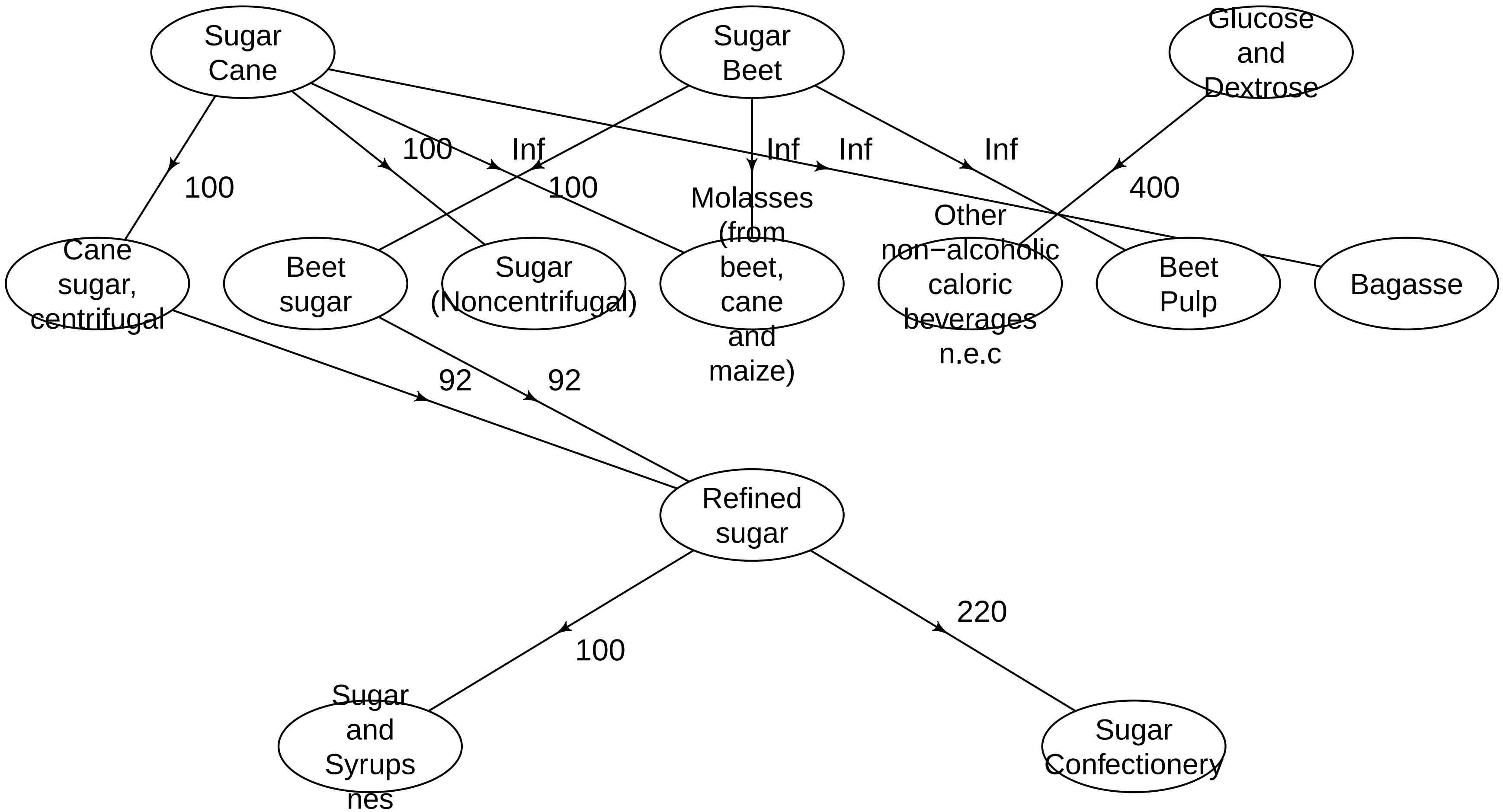
The tourist consumption estimation approach uses tourist data from the WTO as well as last year's consumption patterns to estimate the impact of tourism on local consumption. Note that tourist consumption can be negative; as an extreme example consider a case where many nationals travel abroad but no tourists enter. In this case, that country will certainly have a negative "tourist consumption" because more calories will be assumed abroad than locally.

Residual Other Uses

Work in progress…

Standardization and Balancing

Now, suppose we have the following commodity tree:



We first start with the pre-standardized table:

Name	Production	Imports	Exports	StockChange	Food	Food Processing	Feed	Waste	Seed	Industrial	To
Sugar Beet	26214040	194543	304	-	0	0	0	205504	-	0	
Sugar Cane	26511598	9725	861	-	0	0	0	213257	-	0	
Sugar and Syrups nes	-	387899	2766095	-	22953	0	0	-	-	0	
Beet sugar	4561000	9	194806	-	0	0	0	-	-	0	
Refined sugar	-	1275232	111184	79498	8800000	0	0	-	-	0	
Molasses (from beet, cane and maize)	2075000	464181	236516	-	0	0	0	-	-	0	

Name	Production	Imports	Exports	StockChange	Food	Food Processing	Feed	Waste	Seed	Industrial	To
Undenatured ethyl alcohol (>80%)	-	965161	867423	193313	0	0	0	-	-	0	
Undenatured ethyl alcohol (<=80%)	-	-	-	-	2014156	0	0	-	-	0	
Other non-alcoholic caloric beverages n.e.c	-	1314304	1075983	-	238505	0	0	-	-	0	

The next step in this process is to balance the processed commodities by creating production values. These production values will require an amount of food processing from the parent commodities, and we must start this process at the bottom of the tree, in this case considering “Sugar and Syrups nes” and “Sugar Confectionary” and going up to “Refined Sugar”.

Name	Production	Imports	Exports	StockChange	Food	Food Processing	Feed	Waste	Seed	Industrial	To
Sugar Beet	26214040	194543	304	-	0	0	0	205504	-	0	
Sugar Cane	26511598	9725	861	-	0	0	0	213257	-	0	
Sugar and Syrups nes	**2401148**	387899	2766095	-	22953	0	0	-	-	0	
Beet sugar	4561000	9	194806	-	0	0	0	-	-	0	
Refined sugar	-	1275232	111184	79498	8800000	**2401148**	0	-	-	0	
Molasses (from beet, cane and maize)	2075000	464181	236516	-	0	0	0	-	-	0	
Undenatured ethyl alcohol (>80%)	-	965161	867423	193313	0	0	0	-	-	0	
Undenatured ethyl alcohol (<=80%)	-	-	-	-	2014156	0	0	-	-	0	
Other non-alcoholic caloric beverages n.e.c	-	1314304	1075983	-	238505	0	0	-	-	0	

Next, we move up the tree to the balancing of refined sugar and the food processing required in the beet and cane sugar elements. We don’t have any cane sugar data, so all the production is assumed to come from beet sugar. Note that in this case the extraction rate is not unity, thus we must divide by the extraction rate to compute the amount of food processing (in this case, 0.92):

Name	Production	Imports	Exports	StockChange	Food	Food Processing	Feed	Waste	Seed	Industrial	To
Sugar Beet	26214040	194543	304	-	0	0	0	205504	-	0	
Sugar Cane	26511598	9725	861	-	0	0	0	213257	-	0	
Sugar and Syrups nes	2401148	387899	2766095	-	22953	0	0	-	-	0	
Beet sugar	4561000	9	194806	-	0	**10996302**	0	-	-	0	
Refined sugar	**10116598**	1275232	111184	79498	8800000	2401148	0	-	-	0	
Molasses (from beet, cane and maize)	2075000	464181	236516	-	0	0	0	-	-	0	
Undenatured ethyl alcohol (>80%)	-	965161	867423	193313	0	0	0	-	-	0	
Undenatured ethyl alcohol (<=80%)	-	-	-	-	2014156	0	0	-	-	0	
Other non-alcoholic caloric beverages n.e.c	-	1314304	1075983	-	238505	0	0	-	-	0	

Now, we must balance all the first level processing elements. In this example, there are only two: beet sugar and molasses. The beet sugar case is simple: we have official production data and supply exceeds utilization; thus, we don't need to make any adjustments (other than creating food processing of sugar beet to account for the production of beet sugar). However, the molasses case is much more challenging: we have official production that must be created from one of two parents: sugar cane or sugar beet. Both parents have production, and thus we generate the molasses production according to availability:

Name	Availability	Percent
Sugar Beet	26202775	49.9%
Sugar Cane	26307205	50.1%

Thus, the amount of food allocated to processing for sugar beet and sugar cane is:

Name	Beet Sugar	Beet Sugar Eq.	Molasses	Molasses Eq.	Total
Sugar Beet	4561000	4561000	1035437	10354366	**14915366**
Sugar Cane	0	0	1039563	10395634	**10395634**

Thus, the updated table is:

Name	Production	Imports	Exports	StockChange	Food	Food Processing	Feed	Waste	Seed	Industrial	To
Sugar Beet	26214040	194543	304	-	0	**14915366**	0	205504	-	0	
Sugar Cane	26511598	9725	861	-	0	**10395634**	0	213257	-	0	
Sugar and Syrups nes	2401148	387899	2766095	-	22953	0	0	-	-	0	
Beet sugar	4561000	9	194806	-	0	10996302	0	-	-	0	
Refined sugar	10116598	1275232	111184	79498	8800000	2401148	0	-	-	0	
Molasses (from beet, cane and maize)	2075000	464181	236516	-	0	0	0	-	-	0	
Undenatured ethyl alcohol (>80%)	-	965161	867423	193313	0	0	0	-	-	0	
Undenatured ethyl alcohol (<=80%)	-	-	-	-	2014156	0	0	-	-	0	
Other non-alcoholic caloric beverages n.e.c	-	1314304	1075983	-	238505	0	0	-	-	0	

Now, we must balance the primary products in this table (i.e. sugar cane and sugar beet). To do this, we need to extract the computed **standard deviations (is this the word we're using???)** of each element. The table below shows the expected value and estimated **standard deviation** for each of the elements for wheat:

Variable	Production	Imports	Exports	StockChange	Food	Food Processing	Feed	Waste	Seed	Industrial	Tourist	Residual
Mean	26214040	194543	304	0	0	4561000	0	205504	0	0	0	0
Standard Dev.	0	0	0	0	0	0	0	20550	0	0	0	0

Variable	Production	Imports	Exports	StockChange	Food	Food Processing	Feed	Waste	Seed	Industrial	Tourist	Residual
Mean	26511598	9725	861	0	0	0	0	213257	0	0	0	0
Standard Dev.	0	0	0	0	0	0	0	21326	0	0	0	0

We can also compute calories, fats, and proteins at this point. First, we apply a calorie/fat/protein content factor to each individual element:

Standardization is trivial: all the commodities here are purely additive, so the standardized calories/fats/proteins are simply the sum of the total calories/fats/proteins for each element: