Seeds & Crops

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1. Seeds and seedlings

The production of seeds and seedlings is modelled using available datasets for conventional farming systems. In case a dataset is not available to model a specific seed, a triticale seed dataset is used as proxy. The model is continuously updated to include more datasets.

2. Crops

The Table below shows a list of the crops that can currently be analyzed in the AgBalance® Model.

Group	Class	Subclass
Cereals	Wheat, Maize, Rice	
	Sorghum Barley, Rye	
	Oats, Millet, Triticale	
	Buckwheat, Fonio, Quinoa	
	Canary Seed, Mixed Cereals, Other Cereals	
Vegetables and Melons	Leafy or Stem Vegetables	e.g. Artichokes, Lettuce
	Fruit bearing vegetable	e.g. Cucumber, Eggplants
	Root, Bulb or Tuberous Vegetables	e.g. Carrots, Onion
	Mushrooms and Truffles	
	Melons	e.g. Watermelons, Cantaloupes
	Other Vegetables	
Fruits and nuts	Tropical and Subtropical Fruits	e.g. Avocados, Bananas
	Citrus Fruits	e.g. Grapefruit, Lemons
	Grapes	
	Berries	e.g. Currants, Raspberries
	Pome Fruits and Stone Fruits	e.g. Apples, Apricot
	Nuts	e.g. Almonds, Cashew nuts
	Other Fruits	
Oilseed Crops and Oleaginous Fruits	Soya Beans	
	Groundnuts	
	Other temporary Oilseed Crops	e.g. Castor Bean, Linseed
	Permanent Oilseed Crops	e.g. Coconuts, Oil Palms
Root/Tuber Crops with high starch or inulin content	Potatoes	
	Sweet Potatoes	

Stimulant, Spice and Aromatic Crops	Stimulant Crops	e.g. Coffee, Tea
	Spice and Aromatic Crops	Temporary and Permanent Spice and Aromatic Crops
Leguminous Crops	Beans, Broad Beans	
Sugar Crops	Sugar Beet, Sugar Cane	
Other Crops	Grasses and other Fodder Crops	
	Fiber Crops	
	Medicinal, Pesticidal or similar Crops	
	Rubber	
	Flower Crops	
	Tobacco	
	Other Crops	

Source: The ICC classification adapted to the crops analyzed in the AgBalance® Model from (FAO, 2017)

2.1 Nutrient uptake

Nutrients are chemical organic or inorganic compounds that the crop uses to extract the elements needed for growth. In the AgBalance® Model, the uptake of carbon and macronutrients (N, P, K) are considered for the analyzed agricultural product and reflected in a nutrient balance.

Such balances provide valuable information to farmers, to ensure optimal crop yields with minimum inputs. Nutrient balances in AgBalance® Model are calculated for nitrogen, phosphate and potash and are used for the emission calculation (leaching of excessive nutrients). They consist of the nutrient uptake (based on the N, P and K composition of the agricultural product and by-product), as well as natural nutrient inputs (seeds, irrigation, mineral nitrogen in the soil, precipitation and legumes) and fertilizer nutrient inputs and losses to air and water. Compared to nitrogen, phosphorus and potassium compounds are less mobile and not emitted into the air, therefore, air emissions are excluded.

2.1.1 Carbon uptake

Through carbon fixation, expressed as C content in the crop, the crop can serve as a sink of carbon dioxide (CO_2). This process is considered to have a positive impact on climate change, in case it is stored for a significant period of time (usually more than 100 years). However, this is rarely the case for agricultural products. Therefore, the carbon storage of a crop is accounted for in the inventory, but the sink effect is, by default, excluded from the sustainability analysis. Depending on the goal and scope of the sustainability analysis, it is possible to include the carbon storage in the assessment. In that case, the corresponding CO_2 uptake by the crop is calculated based on the molecular weight of CO_2.

2.1.2 N, P and K macronutrient uptake

The macronutrient uptake of nitrogen (N), phosphorous (P) and potassium (K) is defined in the model as the nutrient content of the agricultural product in the form of K_2O and P_2O_5 instead of in their elemental form. Also, the N, P und K uptake extracted for the crop growth is a valuable parameter required for the analysis of nutrient balance.

2.1.3 Uptake of other elements

For simplification reasons the uptake of other nutrients such as calcium (Ca), magnesium (Mg), sulfur (S), iron (Fe), manganese (Mn), zinc (Zn), copper (Cu) und molybdenum (Mo) or nonmetals like chlorine (Cl) and boron (B) are not considered.

Likewise, the uptake of heavy metals by the crop and the subsequent removal of these elements from the agricultural soil is, in general, not considered. If the effects of this uptake are of special relevance to a sustainability analysis, the content of heavy metals in the harvested yield can be entered for arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), lead (Pb), mercury (Hg), nickel (Ni), thallium (Tl) and zinc (Zn).

2.2 Agricultural product

Every agricultural product output associated with land cultivation can potentially be modelled, in most cases the agricultural product is a crop.

2.2.1 Yield

Yield is a crucial parameter, since it determines the efficiency of the cultivation system and is used to scale the inputs used for the farming practices, as well as the associated environmental impact and economic performance. It describes the amount of the agricultural product (crop) in kg per unit of area (hectare) which is harvested from the field. Yield data for the sustainability analysis in the AgBalance® Model is obtained either from on-farm data or literature data.

2.2.2 Harvest price

Harvest price is a relevant parameter describing the monetary value of the agricultural product representing market or producer price and is considered as a revenue in the economic analysis.

2.2.3 Chemical composition

The agricultural product is characterized in the AgBalance® Model in terms of its chemical composition in order to determine e.g. nutrient uptake by the plant. Dry matter content (DM), Nitrogen (N) and Carbon (C) content must be specified as a fresh weight fraction. Phosphorus (P) and Potassium (K) must be specified as phosphate in oxidized form as (P_2O_5) and potash (K_2O) fraction of a fresh weight. Lower calorific value is specified in MJ per fraction of fresh weight.

On-farm data for specification of agricultural products are generally favored. However, in case on-farm data is not available for the performed sustainability analysis, literature data is recommended to define the chemical composition of the agricultural product e.g. (Fritsch, 2012), (Energy research Centre of the Netherlands, 2018) or (Roy, Finck, Blair, & Tandon, 2006).

2.3 Agricultural by-products and crop residues

In some cases, by-products (e.g. straw from wheat field after harvest) and residues can also result from the applied farming practices.

By-products, in the context of AgBalance®, are all products, which are removed from the field, but are not considered the main reason for growing the crop. The specification of a by-product is similar to the agricultural output: yield, monetary value and chemical specification. The by-product is then considered according to suitable allocation procedure.

Crop residues are, in contrast to the by-product, parts of the plants that are left on the field. An example here, is the straw and stalks left on the field for the incorporation into the soil and improving its quality. The emissions resulting from crop residues in the field are taken into account.

Estimates for the amount of crop residues, which are differentiated into above and below ground residues, are also obtained from literature and available in the model (Dämmgen, 2009) (Fritsch, 2012) (IPCC, 2006)). The amount of Nitrogen (N) within the residues left on the field is automatically calculated and is considered in the model as a source of nitrogen-based emissions.

2.3.1 Emissions of by-products and crop residues

Furthermore, methodological approaches are available for N_2O emissions) from above and below ground residues. The nitrogen in seeds is not considered a source of air emissions in the AgBalance® Model.

In case crop residues are incinerated the emissions of NMVOC, Particulate Matter (2,5 and 10), CO, CO_2, CH_4, Halogenated hydrocarbons, SO_2 and Benzo{a}pyrene are calculated.

The impact of all emissions is reflected according to their contribution to Climate Change, Eutrophication, Toxicity, Acidification, Photochemical Ozone Formation and Particulate Matter.

3. Bibliography

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