Definition:

$$\frac{Grain/Fruit/Tuber\ yield}{Energy}$$

Description

Benefit: This impact area refers to the weight of harvested parts of plants that possess economic value. It is suitable, where production is to be used food or feed purposes or as a non-energetic production factor in bio-refineries. Crops with high per hectare yield will show high efficiencies in this impact area.

Resource: The use of energy usually refers to inputs of fuel or electricity. Solar irradiation is not considered because it is not a stressed resource, but also because the amount of this natural input would dwarf out all other energy inputs. Furthermore, energy from human or animal labour is usually not considered, although some studies explicitly include it (Arodudu et al., 2017).

Correlation with soil management

[5] Maize had the most efficient biomass production per fossil energy. Low-input cropping and integrated farming were more efficient in biomass production than conventional management
[17] Reduced tillage improves energy use efficiency
[125] Conservation management (including the use of organic compost, cover crops, and reduced level of tillage) increased potato yield per unit of energy input
[248] Small rice-producing farms ranging from 0.61 to 1.0 ha yielded higher energy ratios (4.14) than larger ones

Strength & weaknesses pertaining to measurement of this impact area

Yield: Yield values are generally easy to measure and readily available at farm level or in the form of national inventories. However, their informative value is limited where they do not account for qualitative differences between types of biomass and are not accompanied by information on site conditions such as local climate or soil fertility. Therefore, comparisons between efficiencies of different production processes with regard to yields should only be made where products and site conditions are similar. In some cases, it may be advisable to select alternative indicators where the type of benefit is more clearly defined (e.g., energetic value, financial benefit).

Energy: For this indicator, a number of standard values for agricultural management are readily available. LCA inventories even provide standard values for energy used in precursory processes. If the (fossil) energy input is used as a proxy for greenhouse gas emission, it is necessary to also consider the share of non-energy related GHG emission sources like drained soils or nitrous oxide from fertilizers.

Sample Indicators

Indicator values from		Survey	
Experiment or direct measurement		Statistical- or census data	
Expert assessment		Literature values	
Model		Maps or GIS	
Stakeholder participation		Not provided	

Table 1: No Scale

Indicator	**Unit**	**Indicator values from**
[85] Energy productivity (Fruit yield/Energy input (farmyard manure energy + chemical fertilizers + machinery and diesel fuel energy))	kg * MJ $^{-1}$	

Table 2: Field Scale

Indicator	**Unit**	**Indicator values from**
[5] Energy Intensity (EI) (Grain yield/Fossil energy used in farm operations and production of inputs and machinery)	kg * MJ $^{-1}$	
[17] Energy productivity(Sunflower grain yield/Total energy input (human labor, machinery, chemical fertilizers, diesel fuel, irrigation, seeds))	kg * MJ $^{-1}$	
[125] Potato yield/Total Energy input (direct energy (diesel fuel, lubricants) + indirect energy (manufacturing of machinery, fertilizer, pesticides))	kg * GJ $^{-1}$	

Table 3: Farm Scale

Indicator	Unit	Indicator values from
[276] Energy productivity (Forage yield/Input energy)	kg * MJ $^{-1}$	

Table 4: Regional Scale

Indicator	Unit	Indicator values from
[190] Light use efficiency (Net primary production (crop yield depending on the fraction of plant biomass that is harvested)/Absorbed photosynthetic active radiation)	g * MJ $^{-1}$	 , 
[248] Energy productivity (Crop yield/Input energy)	kg * MJ	 , 

References

ID	Citation	[1]Soil type/ texture
5	Alluvione, F., et al. (2011). "EUE (energy use efficiency) of cropping systems for a sustainable agriculture." Energy **36**(7): 4468-4481.	Coarse-loamy mixed non-acid mesic Typic Hapludalf; Loamy sand
17	Baran, M. F. and O. Gokdogan (2016). "COMPARISON OF ENERGY USE EFFICIENCY OF DIFFERENT TILLAGE METHODS ON THE SECONDARY CROP CORN SILAGE PRODUCTION." Fresenius Environmental Bulletin **25**(9): 3808-3814.	Clayey and loamy soil
85	Gökdoğan, O., et al. (2018). "Studies of Energy Use Efficiency on Fruit Production." Erwerbs-Obstbau: 1-5.	n/a
125	Khakbazan, M., et al. (2017). "Energy Use Efficiency of Conventional versus Conservation Management Practices for Irrigated Potato Production in Southern Alberta." American Journal of Potato Research **94**(2): 105-119.	Mainly orthic brown Chernozemic soils
190	Pan, G., et al. (2009). "Using QuickBird imagery and a production efficiency model to improve crop yield estimation in the semi-arid hilly Loess Plateau, China." Environmental Modelling & Software **24**(4): 510-516.	n/a
248	Talukder, B., et al. (2019). "Energy efficiency of agricultural systems in the southwest coastal zone of Bangladesh." Ecological Indicators **98**: 641-648.	n/a
276	Yousefi, M. and A. Mohammadi (2011). "Economical analysis and energy use efficiency in alfalfa production systems in Iran." Scientific Research and Essays **6**(11): 2332-2336.	n/a

[1]**Soil type/ texture:** If provided, what are type and texture of the soils studied in the paper?