

The Practical Manual for the Palm Oil LCA Spreadsheet
(Initial Draft)

December 2013

1. Contents of the spreadsheet

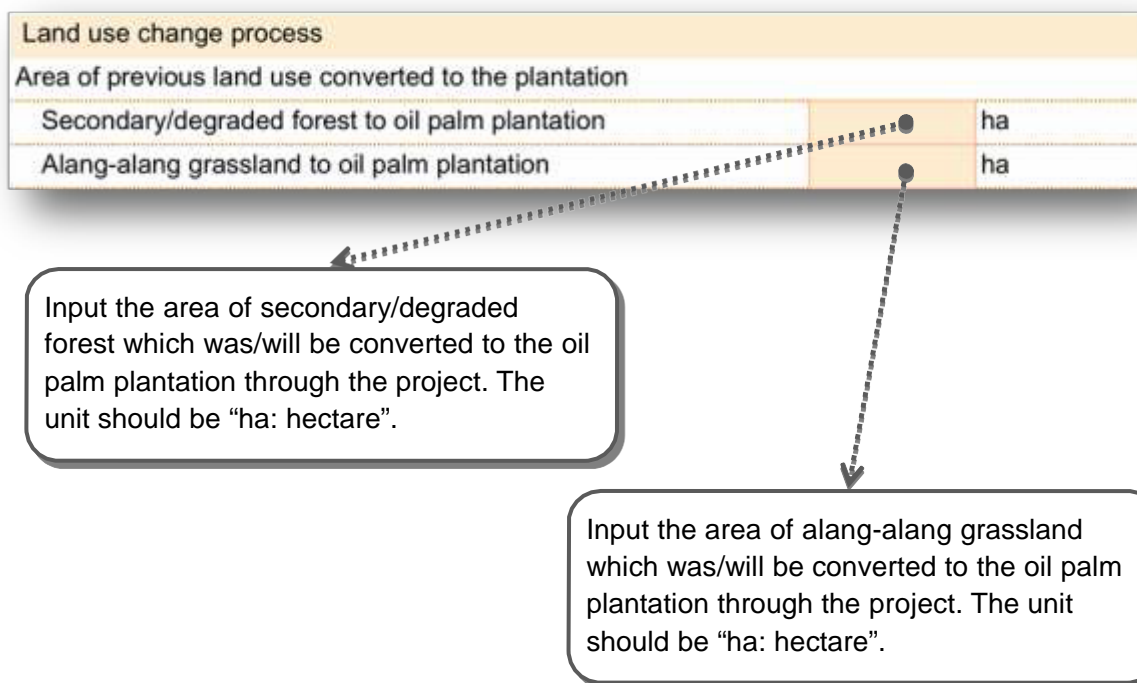
Name of sheet	Outline
Inputs	<ul style="list-style-type: none"> - All the necessary data will be inputted in this sheet. - Data will be separately inputted by processes.
Result (LCI)	<ul style="list-style-type: none"> - One of the results. After completing “Inputs” sheet, the lifecycle inventory will be automatically established.
Result (LCI per 1t-FFB)	<ul style="list-style-type: none"> - One of the results. The lifecycle inventory (per 1 ton of FFB) will be automatically established.
Result (IA)	<ul style="list-style-type: none"> - One of the results. The impact assessment, including global warming, acidification and eutrophication, will be automatically done.
Result (IA per 1t-FFB)	<ul style="list-style-type: none"> - One of the results. The impact assessment (per 1 ton of FFB), including global warming, acidification and eutrophication, will be automatically done.
Graphs	<ul style="list-style-type: none"> - One of the results. Graphs of the inventory and the impact assessment will be automatically created.
Default	<ul style="list-style-type: none"> - Provides necessary fixed data for calculation of emissions etc. No need for project participants to modify this sheet.
cal	<ul style="list-style-type: none"> - Intermediate calculation sheet for the inventory and the impact assessment. No need for project participants to modify this sheet.

Row	Process	Unit
1	Input data for the inventory analysis and the impact assessment	
3	Land use change process	
4	Area of previous land use converted to the plantation	
5	Secondary/degraded forest to oil palm plantation	ha
6	Along-along grassland to oil palm plantation	ha
8	Oil palm cultivation process	
9	FFB production	t/year
10	Solid biomass waste outputs, e.g. litter and deadwood	t/year
11	Fertilizer use	
12	AN: Ammonium nitrate	tonnes/year
13	SOA: Sulphate of ammonia	tonnes/year
14	DAP: Diammonium phosphate	tonnes/year
15	Urea	tonnes/year
16	AC: Ammonium chloride	tonnes/year
17	Kieserite	tonnes/year
18	MOP: Muriate of potash	tonnes/year
19	GRP: Ground rock phosphate	tonnes/year
20	TSP: Triple superphosphate	tonnes/year

2. Procedure of data input - Explanation of the “Inputs” sheet -

2.1 Land use change process

“Land use change process” includes changes of the land use through the project development. The transformation can be from previous land types, such as secondary/degraded forest or alang-alang grassland, to the oil palm plantation. As a result of land use change, carbon in the soil/vegetation is converted to CO₂ and emitted to the air, or CO₂ is sequestered in the soil/vegetation.



2.2 Oil palm cultivation process

The process includes activities related to cultivation of oil palm, such as fertilizer application, pesticide and insecticide use. Diesel oil use for transportation of FFB and other materials are also included in the process.

Oil palm cultivation process	
FFB production	t/year
Solid biomass waste outputs, e.g. litter and deadwood	t/year

Input the annual total production of FFB (Fresh Fruit Bunch) from the oil palm plantation, in tonnes per year.

Input the amount of solid biomass waste from the oil palm plantation in tonnes per year. The waste includes fronds, trunks, covered crops etc.

Fertilizer use	
AN: Ammonium nitrate	tonnes/year
SOA: Sulphate of ammonia	tonnes/year
DAP: Diammonium phosphate	tonnes/year
Urea	tonnes/year
AC: Ammonium chloride	tonnes/year
Kieserite	tonnes/year
MOP: Muriate of potash	tonnes/year
GRP: Ground rock phosphate	tonnes/year
TSP: Triple superphosphate	tonnes/year
GML: Ground magnesium limestone	tonnes/year
EFB: Empty fruit bunch	tonnes/year
POME: Palm oil mill effluent	tonnes/year

Input the annual total amount of fertilizers used for the oil palm cultivation. Please input the amount by types of fertilizers in tonnes per year.

Compost use		tonnes/year
Pesticide use		tonnes/year
Insecticide use		tonnes/year

Input the annual total amount of compost including organic fertilizers, if it is used for the oil palm cultivation.

Input the annual total amount of pesticide used for the oil palm cultivation in tonnes per year.

Input the annual total amount of insecticide used for the oil palm cultivation in tonnes per year.

Input the amount of diesel oil used for transportation of fertilizer from the fertilizer factory to the plantation site. This can be calculated...(*show an example*)

Input the amount of diesel oil used for transportation of pesticide from the pesticide factory to the plantation site. This can be calculated...(*show an example*)

Diesel oil use		
Transportation of the fertilizer (fertilizer factory to the site)		kL/year
Transportation of the pesticide (pesticide factory to the site)		kL/year
Transportation of the insecticide (insecticide factory to the site)		kL/year
Agricultural machineries		kL/year
Transportation of the FFB (plantation site to the mill)		kL/year

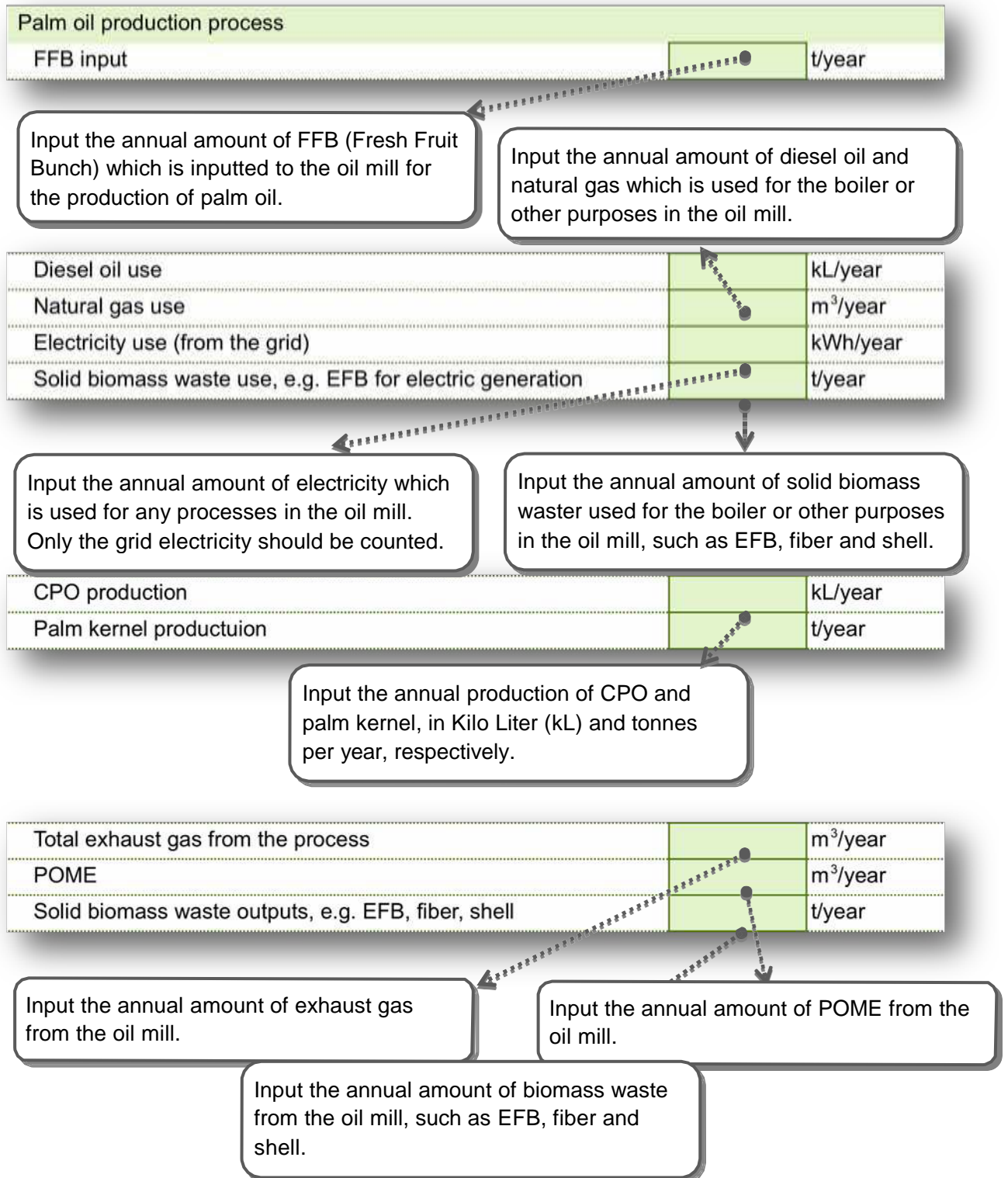
Input the amount of diesel oil used for transportation of insecticide from the insecticide factory to the plantation site. This can be calculated...(*show an example*)

Input the amount of diesel oil used for transportation of FFB from the plantation site to the mill. Annual total consumption should be estimated, and input in Kilo Liter (kL).

Input the annual total amount of diesel oil used for agricultural machineries at the site of oil plantation. Annual total consumption should be estimated, and input in Kilo Liter (kL).

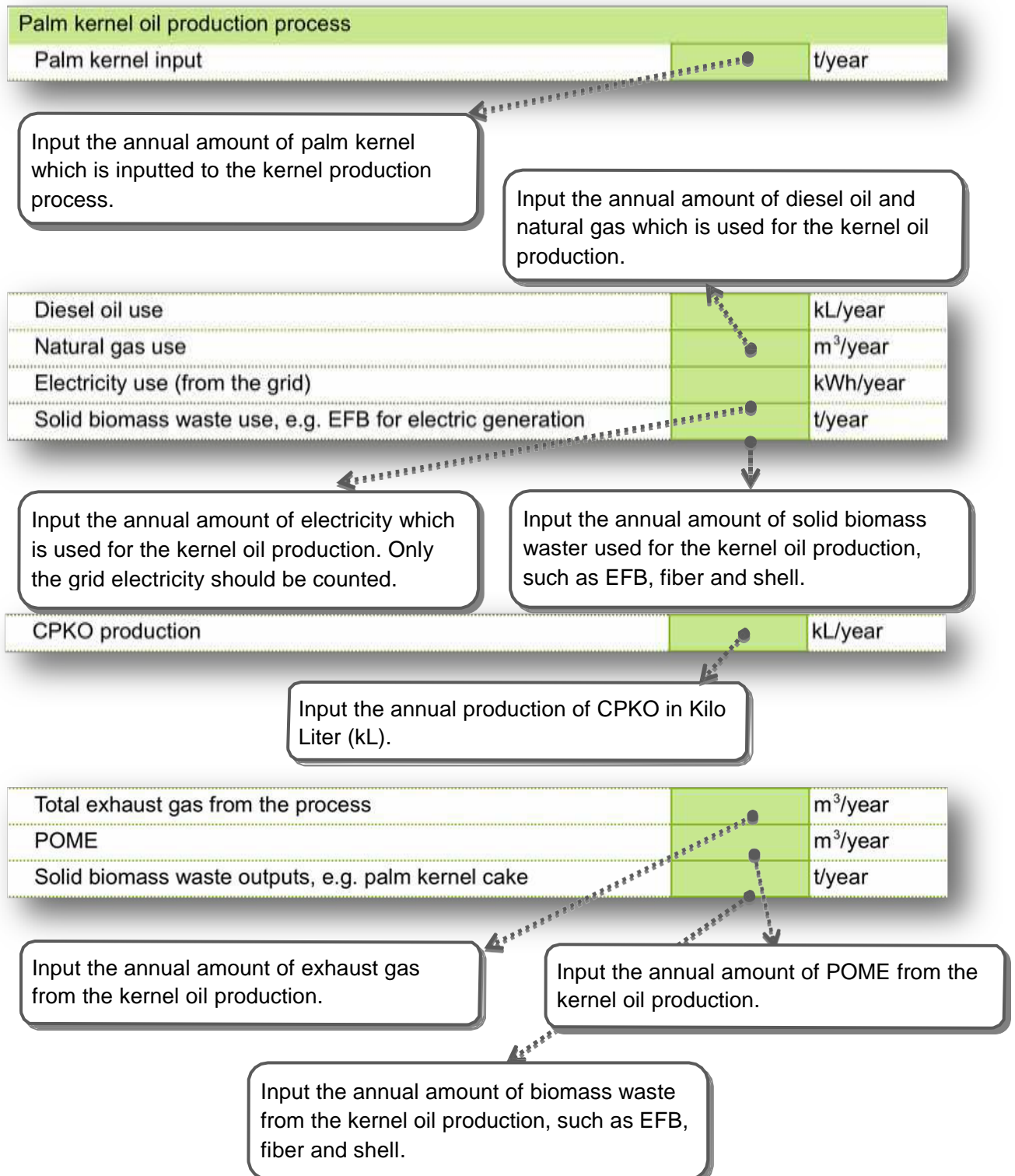
2.3 Palm oil production process

The process includes activities related to palm oil production, such as energy use, discharge of wastes.



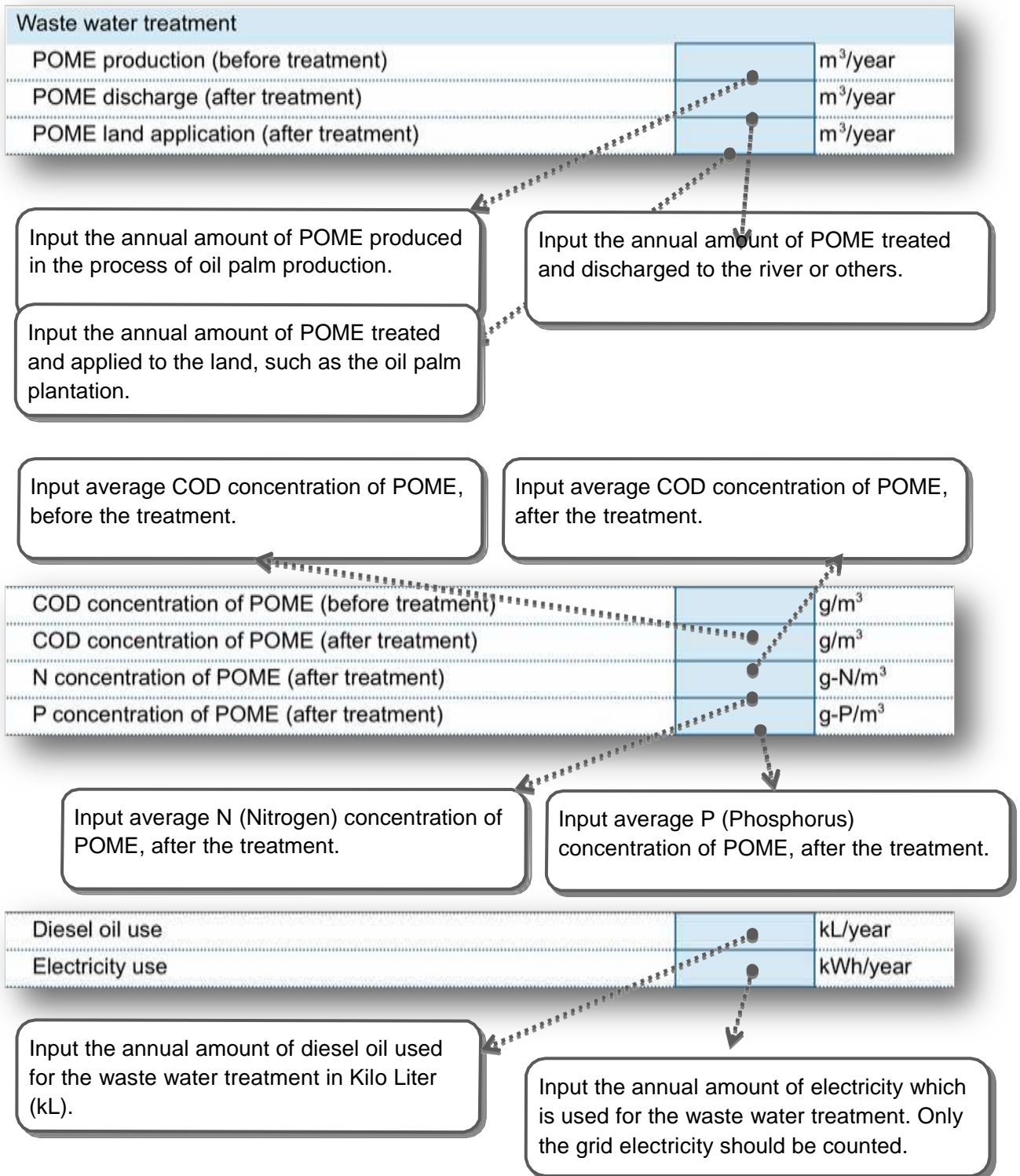
2.4 Palm kernel oil production process

The process includes activities related to palm kernel oil production only. If it is not possible to separate the necessary data from “Palm oil production process”, this process and “Palm oil production process” should be combined with.



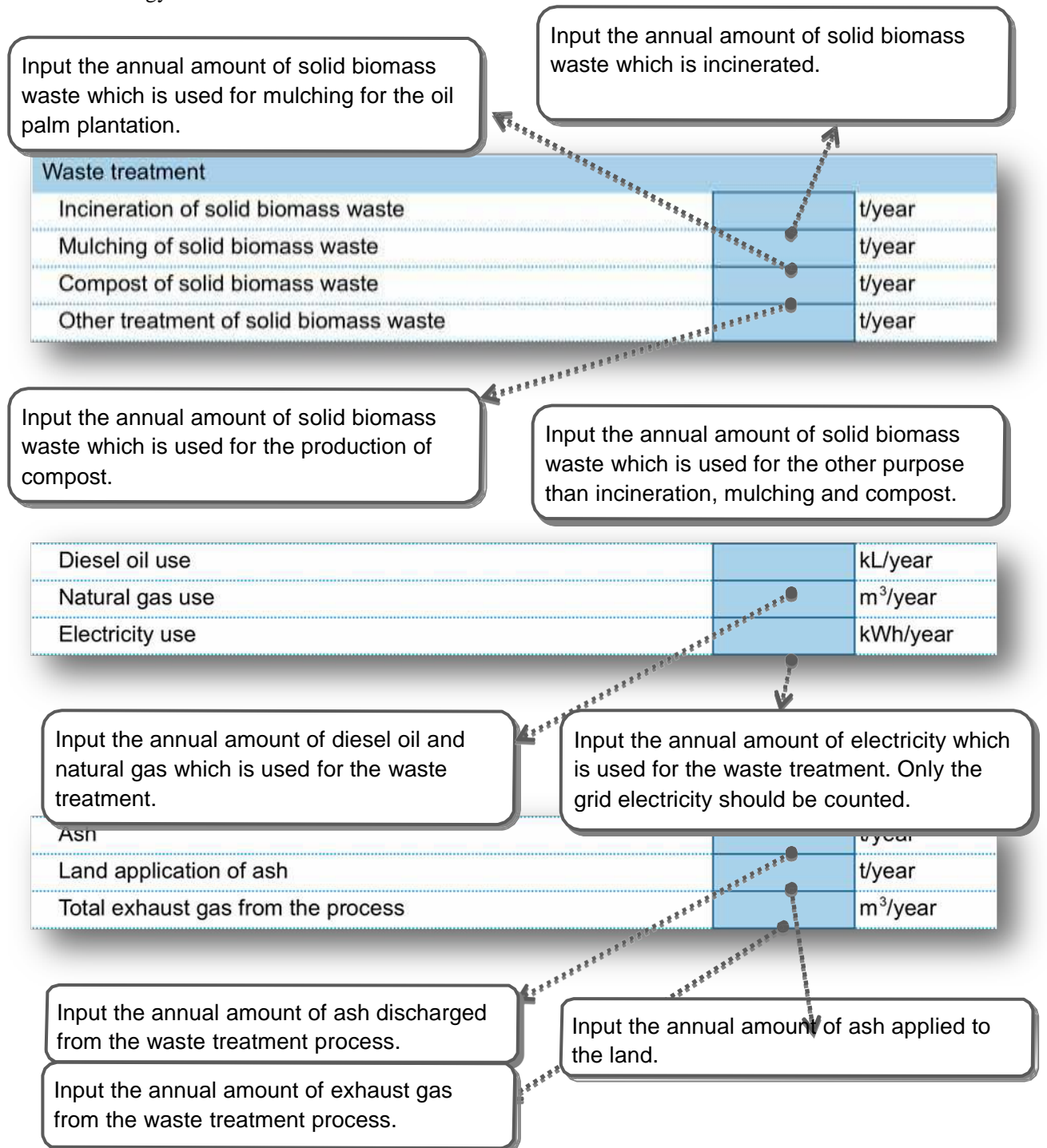
2.5 Waste water treatment

The process includes activities related to waste water treatment, such as POME treatment (such as aerobic/anaerobic treatment) and associated energy uses. *(Methane recovery and energy uses should be included in this process, but not yet included in the spreadsheet)*



2.6 Waste treatment

The process includes activities related to waste treatment, such as incineration, mulching, compost and associated energy uses.



3. Results

3.1 The sheet “Result (LCI)”

Life Cycle Inventory (inputs per year)

	Fertilizer		Chemical		Energy				Material		Waste				
	Synthetic ton	Compost ton	Pesticide ton	Insecticide ton	Grid of M	Natural gas m ³	Solid biomass ton	Electricity MWh	FBE ton	PK ton	POMC m ³	Solid biomass (Incineration) ton	Solid biomass (Milling) ton	Solid biomass (Compost) ton	Solid biomass (CFR) ton
Land use change process	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Oil palm cultivation process	11,012.0	0.0	2.7	0.0	1,157.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Palm oil production process	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Palm kernel oil production process	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Waste water treatment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Waste treatment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	11,012.0	0.0	2.7	0.0	1,157.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Life Cycle Inventory (outputs per year)

	Greenhouse										Acid					Other					Waste product generation ton
	CO ₂ ton	CH ₄ ton	N ₂ O ton	SO ₂ ton	NO _x ton	H ₂ ton	CO ton	CH ₂ O ton	Formaldehyde ton	Acetic acid ton	Formic acid ton	Other acids ton	Other products ton	Other products ton	Other products ton	Other products ton	Other products ton				
Land use change process	Direct	17,101.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
Oil palm cultivation process	Direct	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
Palm oil production process	Direct	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
Palm kernel oil production process	Direct	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
Waste water treatment	Direct	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
Waste treatment	Direct	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
Total	Direct	17,101.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

Life Cycle Inventory (outputs per year (e.g. CO₂ equivalent))

		CO ₂	CH ₄	N ₂ O	SO ₂	NO _x	N	P	COD
		ton-CO ₂ eq	ton-CO ₂ eq	ton-CO ₂ eq	ton-SO ₂ eq	ton-SO ₂ eq	ton	ton	ton
Land use change process	Direct	-17,105.9	0.0	0.0	0.0	0.0	0.0E+00	0.0E+00	0.0E+00
	Indirect	0.0	0.0	0.0	0.0	0.0	0.0E+00	0.0E+00	0.0E+00
	Total	-17,105.9	0.0	0.0	0.0	0.0	0.0E+00	0.0E+00	0.0E+00
Oil palm cultivation process	Direct	3,233.5	10.9	4,583.5	4.8	14.4	0.0E+00	0.0E+00	0.0E+00
	Indirect	10,084.1	205.1	801.2	5.3	6.3	1.4E-03	5.3E-09	1.1E-04
	Total	13,317.5	216.0	5,384.8	10.1	20.7	1.4E-03	5.3E-09	1.1E-04
Palm oil production process	Direct	0.0	10,352.3	1,645.3	187.8	63.3	0.0E+00	0.0E+00	0.0E+00
	Indirect	0.0	0.0	0.0	0.0	0.0	0.0E+00	0.0E+00	0.0E+00
	Total	0.0	10,352.3	1,645.3	187.8	63.3	0.0E+00	0.0E+00	0.0E+00
Palm kernel oil production process	Direct	0.0	0.0	0.0	0.0	0.0	0.0E+00	0.0E+00	0.0E+00
	Indirect	0.0	0.0	0.0	0.0	0.0	0.0E+00	0.0E+00	0.0E+00
	Total	0.0	0.0	0.0	0.0	0.0	0.0E+00	0.0E+00	0.0E+00
Waste water treatment	Direct	0.0	236.3	0.0	0.0	0.0	2.0E+00	0.0E+00	1.0E+00
	Indirect	0.0	0.0	0.0	0.0	0.0	0.0E+00	0.0E+00	0.0E+00
	Total	0.0	236.3	0.0	0.0	0.0	2.0E+00	0.0E+00	1.0E+00
Waste treatment	Direct	0.0	0.0	0.0	0.0	0.0	0.0E+00	0.0E+00	0.0E+00
	Indirect	0.0	0.0	0.0	0.0	0.0	0.0E+00	0.0E+00	0.0E+00
	Total	0.0	0.0	0.0	0.0	0.0	0.0E+00	0.0E+00	0.0E+00
Total	Direct	-13,872.4	10,599.5	6,228.9	192.6	77.7	2.0E+00	0.0E+00	1.0E+00
	Indirect	10,084.1	205.1	801.2	5.3	6.3	1.4E-03	5.3E-09	1.1E-04
	Total	-3,788.4	10,804.6	7,030.1	197.9	84.0	2.0E+00	5.3E-09	1.0E+00

3.2 The sheet “Result (LCI per 1t-FFB)”

Life Cycle Inventory per 1 ton of FFB (inputs per year)

	Fertilizer		Chemical		Energy					Material		Water			
	Synthetic kg/t-FFB	Organic kg/t-FFB	Pesticide kg/t-FFB	Insecticide kg/t-FFB	Grid of LJ-FFB	Natural gas m ³ /t-FFB	Solid biomass kcal/t-FFB	Electricity (grid) kWh/t-FFB	FFB kg/t-FFB	PK kg/t-FFB	POAC m ³ /t-FFB	Solid biomass (Incineration) kg/t-FFB	Solid biomass (Machining) kg/t-FFB	Solid biomass (Compost) kg/t-FFB	Solid biomass (Other) kg/t-FFB
Land use change process	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Oil palm cultivation process	37.8	0.0	0.0	0.0	6.1	0.0	214.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Palm oil production process	0.0	0.0	0.0	0.0	0.0	0.0	314.9	0.0	1,080.0	0.0	0.0	0.0	0.0	0.0	0.0
Palm kernel oil production process	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	52.2	0.0	0.0	0.0	0.0	0.0
Waste water treatment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Waste treatment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	37.8	0.0	0.0	0.0	6.1	0.0	214.9	0.0	1,080.0	52.2	0.0	0.0	0.0	0.0	0.0

Life Cycle Inventory per 1 ton of FFB (outputs per year)

	Greenhouse										Other										Waste product kg/t-FFB
	CO ₂ kg/t-FFB	CH ₄ kg/t-FFB	N ₂ O kg/t-FFB	SO ₂ kg/t-FFB	NO _x kg/t-FFB	H ₂ kg/t-FFB	CO kg/t-FFB	CH ₃ kg/t-FFB	CF ₄ kg/t-FFB	Perfluorocarbons kg/t-FFB	CO ₂ kg/t-FFB	CH ₄ kg/t-FFB	N ₂ O kg/t-FFB	SO ₂ kg/t-FFB	NO _x kg/t-FFB	H ₂ kg/t-FFB	CO kg/t-FFB	CH ₃ kg/t-FFB	CF ₄ kg/t-FFB	Perfluorocarbons kg/t-FFB	
Land use change process	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Oil palm cultivation process	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Palm oil production process	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Palm kernel oil production process	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Waste water treatment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Waste treatment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Life Cycle Inventory per 1 ton of FFB (outputs per year (e.g. CO₂ equivalent))

		CO ₂	CH ₄	N ₂ O	SO ₂	NO _x	N	P	COD
		kgCO ₂ -eq/t-FFB	kgCO ₂ -eq/t-FFB	kgCO ₂ -eq/t-FFB	kgSO ₂ -eq/t-FFB	kgSO ₂ -eq/t-FFB	kg/t-FFB	kg/t-FFB	kg/t-FFB
Land use change process	Direct	-0.9	0.0	0.0	0.0	0.0	0.0E+00	0.0E+00	0.0E+00
	Indirect	0.0	0.0	0.0	0.0	0.0	0.0E+00	0.0E+00	0.0E+00
	Total	-0.9	0.0	0.0	0.0	0.0	0.0E+00	0.0E+00	0.0E+00
Oil palm cultivation process	Direct	11.5	0.0	16.3	0.0	0.1	0.0E+00	0.0E+00	0.0E+00
	Indirect	35.9	0.7	2.9	0.0	0.0	4.8E-06	1.9E-11	3.8E-07
	Total	47.4	0.8	19.2	0.0	0.1	4.8E-06	1.9E-11	3.8E-07
Palm oil production process	Direct	0.0	36.8	5.9	0.7	0.2	0.0E+00	0.0E+00	0.0E+00
	Indirect	0.0	0.0	0.0	0.0	0.0	0.0E+00	0.0E+00	0.0E+00
	Total	0.0	36.8	5.9	0.7	0.2	0.0E+00	0.0E+00	0.0E+00
Palm kernel oil production process	Direct	0.0	0.0	0.0	0.0	0.0	0.0E+00	0.0E+00	0.0E+00
	Indirect	0.0	0.0	0.0	0.0	0.0	0.0E+00	0.0E+00	0.0E+00
	Total	0.0	0.0	0.0	0.0	0.0	0.0E+00	0.0E+00	0.0E+00
Waste water treatment	Direct	0.0	0.8	0.0	0.0	0.0	7.2E-03	0.0E+00	3.6E-03
	Indirect	0.0	0.0	0.0	0.0	0.0	0.0E+00	0.0E+00	0.0E+00
	Total	0.0	0.8	0.0	0.0	0.0	7.2E-03	0.0E+00	3.6E-03
Waste treatment	Direct	0.0	0.0	0.0	0.0	0.0	0.0E+00	0.0E+00	0.0E+00
	Indirect	0.0	0.0	0.0	0.0	0.0	0.0E+00	0.0E+00	0.0E+00
	Total	0.0	0.0	0.0	0.0	0.0	0.0E+00	0.0E+00	0.0E+00
Total	Direct	-0.9	37.7	22.2	0.7	0.3	7.2E-03	0.0E+00	3.6E-03
	Indirect	35.9	0.7	2.9	0.0	0.0	4.8E-06	1.9E-11	3.8E-07
	Total	-13.5	38.5	25.0	0.7	0.3	7.2E-03	1.9E-11	3.6E-03

3.3 The sheet “Result (IA)”

Life Cycle Impact Assessment				
		Global warming ton-CO ₂ eq	Acidification ton-SO ₂ eq	Eutrophication ton
Land use change process	Direct	-17,106	0	0.0E+00
	Indirect	0	0	0.0E+00
	Total	-17,106	0	0.0E+00
Oil palm cultivation process	Direct	7,828	19	0.0E+00
	Indirect	11,090	12	1.5E-03
	Total	18,918	31	1.5E-03
Palm oil production process	Direct	11,998	251	0.0E+00
	Indirect	0	0	0.0E+00
	Total	11,998	251	0.0E+00
Palm kernel oil production process	Direct	0	0	0.0E+00
	Indirect	0	0	0.0E+00
	Total	0	0	0.0E+00
Waste water treatment	Direct	236	0	3.0E+00
	Indirect	0	0	0.0E+00
	Total	236	0	3.0E+00
Waste treatment	Direct	0	0	0.0E+00
	Indirect	0	0	0.0E+00
	Total	0	0	0.0E+00
Total	Direct	2,956	270	3.0E+00
	Indirect	11,090	12	1.5E-03
	Total	14,046	282	3.0E+00

3.4 The sheet “Result (IA per 1t-FFB)”

Life Cycle Impact Assessment (per 1 ton of FFB)				
		Global warming kgCO ₂ eq/t-FFB	Acidification kgSO ₂ eq/t-FFB	Eutrophication kg/t-FFB
Land use change process	Direct	-60.9	0.0	0.0E+00
	Indirect	0.0	0.0	0.0E+00
	Total	-60.9	0.0	0.0E+00
Oil palm cultivation process	Direct	27.9	0.1	0.0E+00
	Indirect	39.5	0.0	5.2E-06
	Total	67.3	0.1	5.2E-06
Palm oil production process	Direct	42.7	0.9	0.0E+00
	Indirect	0.0	0.0	0.0E+00
	Total	42.7	0.9	0.0E+00
Palm kernel oil production process	Direct	0.0	0.0	0.0E+00
	Indirect	0.0	0.0	0.0E+00
	Total	0.0	0.0	0.0E+00
Waste water treatment	Direct	0.8	0.0	1.1E-02
	Indirect	0.0	0.0	0.0E+00
	Total	0.8	0.0	1.1E-02
Waste treatment	Direct	0.0	0.0	0.0E+00
	Indirect	0.0	0.0	0.0E+00
	Total	0.0	0.0	0.0E+00
Total	Direct	10.5	1.0	1.1E-02
	Indirect	39.5	0.0	5.2E-06
	Total	50.0	1.0	1.1E-02

3.5 The sheet “Graphs”

