RCN Conference on
Pan American Biofuels
& Bioenergy Sustainability
Golden Tulip Recife Palace,
Recife, Brazil July 22-25, 2014

PAN-AMERICAN BIOFUELS & BIOENERGY SUSTAINABILITY
AN NSF RESEARCH COORDINATION NETWORK

Life cycle assesment study on a soybean complex transformation chain over three years of production of biodiesel as a coproduct

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INTA

VILUCO AGROENERGÍA

Sustainability criteria (Article 17 – EU Directive) (1)

Emition reduction

a) Feedstock production
b) Transformation (Industry).
c) Transport

January 2010	January 2017	January 2018
35%	50 %	60 %

To avoid default values there is a need to calculate real values

Default values have not been modified

Rules for calculating the greenhouse gas impact of biofuels, bioliquids and their fossil fuel comparators

A. *Typical and default values for biofuels if produced with no net carbon emissions from land-use change*

Biofuel production pathway	Typical greenhouse gas emission saving	Default greenhouse ga emission saving
sugar beet ethanol	61 %	52 %
wheat ethanol (process fuel not specified)	32 %	16 %
rape seed biodiesel	45 %	38 %
sunflower biodiesel	58 %	51 %
soybean biodiesel	40 %	31 %
palm oil biodiesel (process not specified)	36 %	19 %

Green House emitions Frias Plant
Santiago del Estero

AG-ENERGY
VILUCO

Objetive of the work

MAIN OBJETIVE

Perform a complete inventory of GHG ivolved in the production and conversion of soybeans in Frias Plant
Follow up this study over three years in order to capture interanual variations

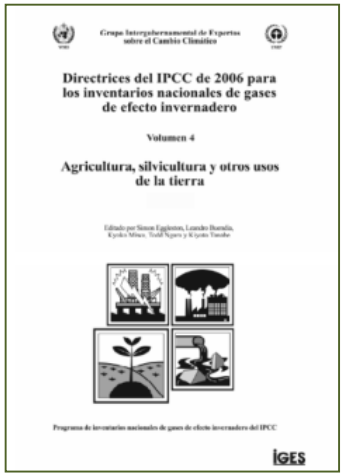
First research core team

Technical seminars

Starting Implementation

Methodological tools used

2006 IPCC directives for national GHG inventories


Grupo Intergubernamental de Expertos sobre el Cambio Climático

Directrices del IPCC de 2006 para los inventarios nacionales de gases de efecto invernadero

Volumen 4

Agricultura, silvicultura y otros usos de la tierra

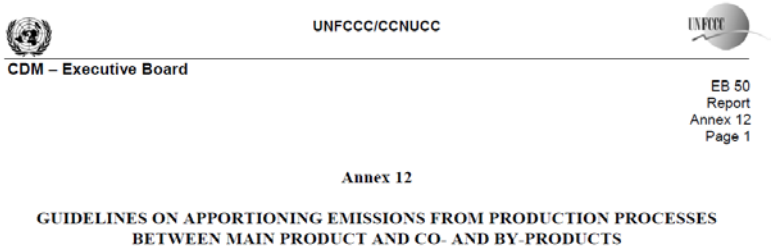
Editado por Simon Eggleston, Leandro Buendia, Kyoko Miwa, Todd Ngara y Kiyoto Tanabe

Programa de inventarios nacionales de gases de efecto invernadero del IPCC

IGES

DIRECTIVE 2009/28/CE
European Union Parliament and council
April 23 2009

EB 50 – Executive MDL board "Guidelines on apportioning emissions from production processes between main product and co-and by-products ".


UNFCCC/CCNUCC

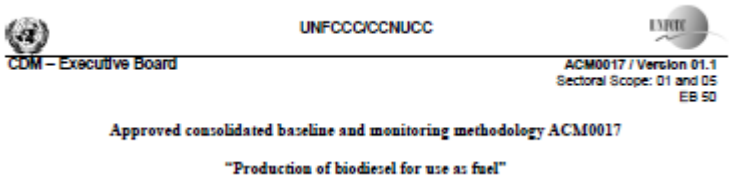
CDM – Executive Board

EB 50
Report
Annex 12
Page 1

Annex 12

GUIDELINES ON APPORTIONING EMISSIONS FROM PRODUCTION PROCESSES BETWEEN MAIN PRODUCT AND CO- AND BY-PRODUCTS

ACM0017 Methodology "Approved consolidated baseline and monitoring methodology Production of biodiesel for use as fuel".


UNFCCC/CCNUCC

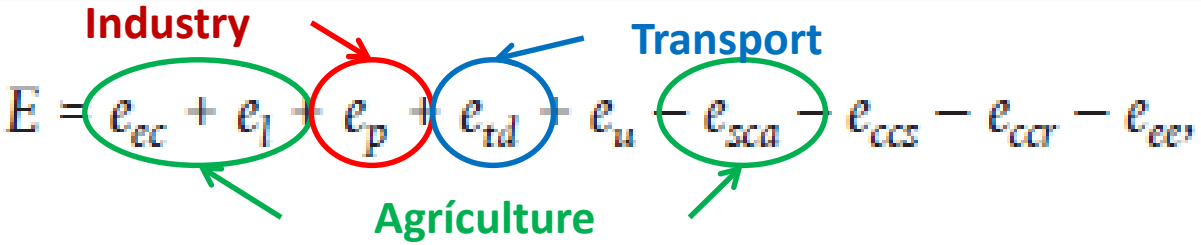
CDM – Executive Board

ACM0017 / Version 01.1
Sectoral Scope: 01 and 05
EB 50

Approved consolidated baseline and monitoring methodology ACM0017

"Production of biodiesel for use as fuel"

Anexo V
Directive EU-RED



E Total emissions from the use of the fuel (soybean based biodiesel)

E_{ec} Emissions from the cultivation raw material (soybean)

e_l Annualised emissions from carbon stock changes caused by land-use change

e_p Emissions from processing

e_{td} Emissions from transport and distribution

e_u Emissions from the fuel in use

e_{sca} Emission savings from soil carbon accumulation via improved agricultural management

e_{ccs} Emission saving from carbon capture and geological storage

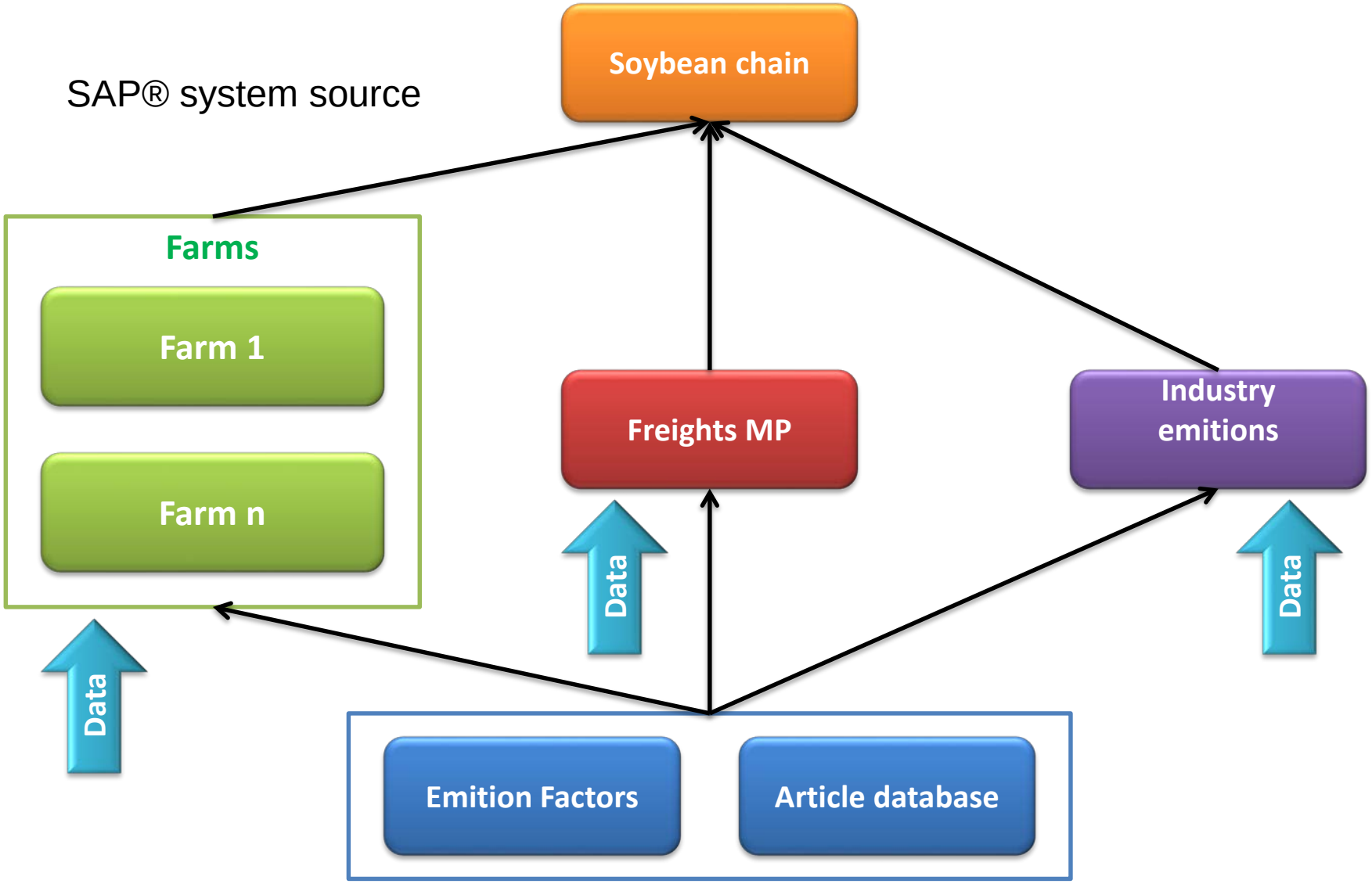
e_{ccr} Emission saving from carbon capture and replacement;

e_{ee} Emission saving from excess electricity from cogeneration

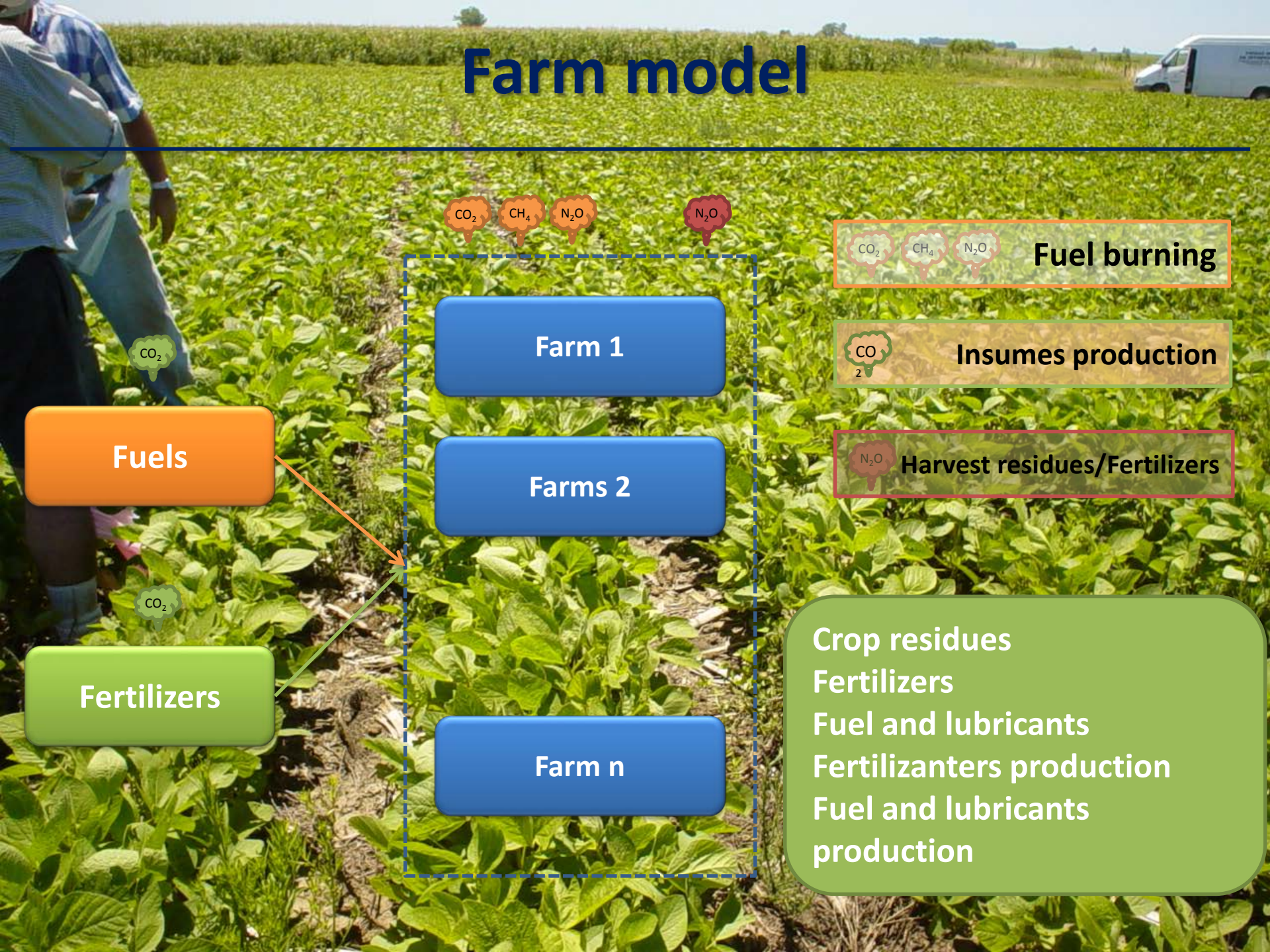
Anexo V concepts included in the study

	Concepto	Incluido
e_{ec} =	Emissions from the cultivation raw material (soybean);,	Yes
e_l =	Annualised emissions from carbon stock changes caused by land-use change,	No Assumption of no change in carbon stoks in soils since January 2008.
e_p =	Emissions from processing	Yes
e_{td} =	Emissions from transport and distribution emissions	Yes
e_u =	Emissions from the fuel in use	No Europen Directive - Anex V - Páragraph 13:Emissions from the fuel in use, eu, shall be taken to be zero for biofuels and bioliquids
e_{sca} =	Emission savings from soil carbon accumulation via improved agricultural management,	No No changes in carbon stoks due to agricultural practces
e_{ccs} =	Emission saving from carbon capture and geological storage,	No There are not any geological storage in place.
e_{ccr} =	Emission saving from carbon capture and replacement	No No biomass is used for fossile fuel replacement.
e_{ee} =	Emission saving from excess electricity from cogeneration .	No No electricity is generated.

Emition calculator



Farm model


CO_2
CH_4
N_2O
N_2O
Fuel burning
CO_2
CH_4
N_2O
Insumes production
CO_2
Harvest residues/Fertilizers
N_2O
CO_2
Fuels
Farm 1
Farms 2
Farm n
CO_2
Fertilizers
Crop residues
Fertilizers
Fuel and lubricants
Fertilizanters production
Fuel and lubricants
production

1. Emissions from the extraction or cultivation of raw materials (e_{ec})

Art. 6:, eec, shall include emissions from the extraction or cultivation process itself; from the collection of raw materials; from waste and leakages; and from the production of chemicals or products used in extraction or cultivation. Capture of CO2 in the cultivation of raw materials shall be excluded. Certified reductions of greenhouse gas emissions from flaring at oil production sites anywhere in the world shall be deducted. Estimates of emissions ……

Agriculture module

- N in agriculture residues, including N fixing crops & return of forage/pastures to the soil
- N suplied to the soil artificially.
- CO_2 coming from Urea use.
- CO_2 coming from fossile fuel employed
- Emissions associated to the life cycle of fertilizers and fossile fuels

- Raw material transport (CO_2 generated by fossile fuel use)

1.1 - N from agriculture residues

DATA SOURCE
Crop type
Production field
Field surface

Method Chapter 11 - Volume 4 IPCC 2006
Guides Level 1 Direct and indirect sources

CALCULATION FLOW

- Step 1: Yield of the crop Kgs/hectare.
- Step 2: Use of equation 11.7 to calculate N of Agricultural residues Cálculo del N de residuos agrícolas, (F_{CR})
- Step 3: Calculate direct emissions by using equation 11.1 of the table 11.1.
- Step 4: Calculate the indirect emissions by lixiviation using equation 11.10 of the table 11.3.

1.2 – Synthetic Fertilizers

DATOS USED
Quantity
Type of fertilizer
Composition

Methodology according to chapter 11 volume 4 of the IPCC 2006 guide - Level 1.Emition sources “Direct” & “Indirect x Deposition in the atmosphere and lixiviation” & CO_2 by the use of urea and derivates

PROCEDURE

- Step 1: Calculate the ammount of synthetic fertilizers applied (FSN) according to type and composition.
- Step 2: Calculate the direct emissions by using equations 11.1 from the table 11.1
- Step 3: Cálculate the indirect emitions by atmosphere deposition by using equation 11.09 and table 11.3.
- Step 4: Calculate the indirect emissions through lixiviation using equation 11.10 & table 11.3.
- Step 5: Calculate the equivalent urea quantity applied (FUREA).
- Step 6: Calculate the CO2 emissions by urea use using equation 11.3

1.3 – Fuel & lubricants

DATA USED
Type of field work
Quantity

Emisions (CO_2-N_2O-CH_4) asociated to the fuel burning for all the field operations preparation, planting, fertilizer and herbicides and harvesting

PROCEDURE

- Step 1: Estimation of fuel and lubricant consumption by converting each field operation for surface to liters of fuel and lubricants. All operations in Viluco are outsorced with specific contractors. Mean numbers are used..
- Step 2: Calculate the direct emissions multiplying the liters by the emission factor

1.4 – Fertilizantes production

DATA USED
Quantity
Type of fertilizer

"A Review of Greenhouse Gas Emission Factors for Fertiliser Production. Sam Wood and Annette Cowie Research and Development Division, State Forests of New South Wales. Cooperative Research Centre for Greenhouse Accounting - For IEA Bioenergy Task 38 - June 2004"

Product	Country	Composition	g CO_{2-e}			Reference
		N:P:K	per kg N	per kg Product	CO_2:N_2O:CH_4	
Urea	Europe Average	46:0:0	*4018.9*	1848.7	97.5:0.1:2.3	Davis and Haglund (1999)
Urea	Europe Average	46:0:0	*1326.1*	610.0	-	Kongshaug (1998)
Urea	Europe: Modern Tech.	46:0:0	*913.0*	420.0	-	Kongshaug (1998)
Urea	Europe	*46:0:0*[a]	1707.3	*785.4*	-	Kuesters and Jenssen (1998)
UAN	Europe	*32:0:0*[a]	3668.0	*1173.8*	36.6:63.4:0.0	Kuesters and Jenssen (1998)
UAN	Europe Average	32:0:0	*5762.9*	1844.1	59.1:39.5:1.4	Davis and Haglund (1998)
UAN	Europe Average	32:0:0	*4093.8*	1310.0	-	Kongshaug (1998)
UAN	Europe Modern Tech.	32:0:0	*2000.0*	640.0	-	Kongshaug (1998)

(a) Composition from Kongshaug (1998).
Note: Figures in *italics* are derived values, based on % N composition.

PROCEDURE

- Step 1: Multiply the quantity of fertilizers by the corresponding emission factor.

1.5 – Production of fuels and lubricants

DATA SOURCE
Quantity

"Approved consolidated baseline and monitoring methodology ACM0017 "Production of biodiesel for use as fuel" - v.01.1 - UNFCCC - CDM Executive Board".

ID Number:	9
Parameter:	EF_{PROD}
Data unit:	tCO_2e/t petrodiesel
Description:	Emission factor for production of crude oil
Source of data:	-
Value to be applied:	The emission factor for the production of crude oil (EF_{PROD}) to be used in equation 1 is **0.073 tCO2e/t petrodiesel**[10]. A global value was calculated with the assumption that that upstream emissions with respect to crude oil production in Annex I countries is zero
Any comment:	-

ID Number:	10
Parameter:	EF_{REF}
Data unit:	tCO_2e/t petrodiesel
Description:	Emission factor related to oil refinery
Source of data:	-
Value to be applied:	The emission factor related to oil refinery (EF_{REF}) shall be one of the following: a) In the absence of a country-specific data, a global average figure of **0.233t-CO2**/t-petrodiesel can be used.[11] b) If refining occurs in the host country, reliable local emission factors from an official information source (e.g. national communications) may be used instead of the default emission factor
Any comment:	-

CALCULATION

- Step 1: Multiply the quantity of fuels and lubricants by the corresponding emission factor. .

1.6 – Farm structural costs / no productive fields

DATA SOURCE
Energy
Operations
Fertilizers

Common Energy emitions for all the farm operations in order to maintain all plots without production including fertilizer and agrochemical use.

DISTRIBUTION

- Total emitions are assigned according to the physical production of each crop, in order to assure a fair distribution between all the farm emitions associated with production.

Summary per field emissions

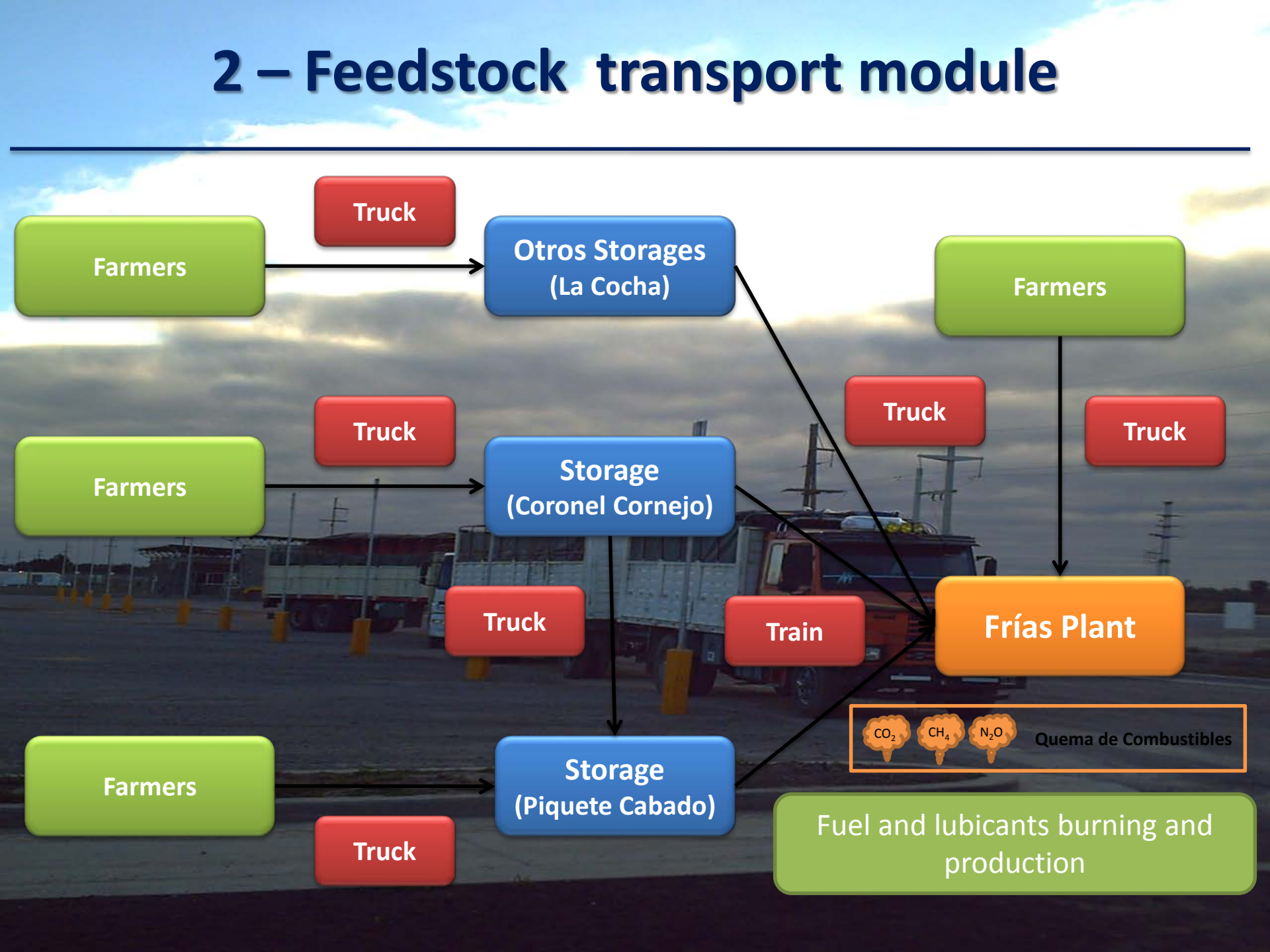
RESUMEN EMISIONES DE GASES DE EFECTO INVERNADERO

Resumen Abastecimiento de Materias Primas de Campos Propios - SOJA 2010-2011

		1280	Arbolito	Cabeza de Caballo	Las Marias	Los Guayacan	Pozo de la Espuela	Rancho Grande	San Jorge	Sara	Total
Producción Soja	Superficie (Hectáreas)	380	1.834	1.203	2.697	1.840	5.168	4.696	682	987	**33.382**
	Produccion (Toneladas)	1.481	6.086	3.063	7.986	3.972	18.255	15.771	2.529	3.408	**104.234**
	Rendimiento (Tn/Ha)	3,90	3,32	2,55	2,96	2,16	3,53	3,36	3,71	3,45	**3,12**
Emisiones Soja (Kgs CO_{2eq})	Residuos de cosecha	107.489	461.665	252.852	627.062	348.376	1.360.374	1.192.197	185.957	255.592	**8.051.244**
	Fertilizantes	-	-	2.810	264.029	-	-	-	-	-	**408.128**
	Combustibles y Lubricantes	47.857	143.736	115.745	213.008	160.793	415.467	356.956	85.606	124.533	**2.838.723**
	Produccion Fertilizantes	-	4.607	1.178	110.670	-	19.720	46.810	-	4.930	**269.398**
	Produccion Combustibles y Lubricantes	4.625	13.900	11.192	20.596	15.536	40.166	34.525	8.282	12.037	**274.486**
	Estructura campo+Lotes sin produccion [1]	36.679	38.338	36.679	40.086	38.772	38.013	38.338	36.679	37.627	**681.594**
	Total x cultivo	**196.650**	**662.247**	**420.456**	**1.275.451**	**563.477**	**1.873.741**	**1.668.826**	**316.524**	**434.719**	**12.523.573**
Emisiones x Tn Soja (Kgs CO_{2eq}/TN)	Residuos de cosecha	73	76	83	79	88	75	76	74	75	**77**
	Fertilizantes	-	-	1	33	-	-	-	-	-	**4**
	Combustibles y Lubricantes	32	24	38	27	40	23	23	34	37	**27**
	Produccion Fertilizantes	-	1	0	14	-	1	3	-	1	**3**
	Produccion Combustibles y Lubricantes	3	2	4	3	4	2	2	3	4	**3**
	Estructura campo+Lotes sin produccion	25	6	12	5	10	2	2	15	11	**7**
	Total x Tonelada	**133**	**109**	**137**	**160**	**142**	**103**	**106**	**125**	**128**	**120**

[1] Asignado por Tonelada producida

2 – Feedstock transport module



2.1 – Transport by Truck

PROFIT® system source

DATA SOURCE
TRIPS
Kilómeters per trip

"Approved consolidated baseline and monitoring methodology ACM0017 "Production of biodiesel for use as fuel" - v.01.1 - UNFCCC - CDM Executive Board".

Emisiones por km recorrido		Unidades	Ecuacion	Valor
	Consumo específico de Gas-Oil	Lt/ 100 Km	Tabla 1.39 - IPCC 1996 - Heavy Duty	29,90
	Consumo ajustado por IDA y Vuelta	Lt/ 100 Km	Según ACM0017 / Version 01.1	59,80
FECO2 LTS	Factor de emision de CO2	KgsCO2/Lts	Ver Hoja Factores de emision Incluye LCA	2,92
CO2	Emisiones CO2 por Transporte por Km	KgsCO2/Km	Ajustado por ida y vuelta	1,74
FEN2O LTS	Factor de emision de N2O	mg N2O/Km	IPCC 2006 - Cuadro 3.2.5 - Pre-Euro Diesel - Autobus - Rural	30,00
N2O	Emisiones N2O por Gas-Oil Transporte	KgN20/Km	Ajustado por ida y vuelta	0,00
FECH4 Lts	Factor de emision de CH4	mg CH4/ km	IPCC 2006 - Cuadro 3.2.5 - Pre-Euro Diesel - Autobus - Rural >	80,00
CH4	Emisiones CH4 por Gas-Oil Transporte	KgCH4/km	Ajustado por ida y vuelta	0,00
$FE_{CO2eq\ Unidad}$	Factor de emision x KM recorrido	$KgsCO_{2eq}$ /Km	FE total x Km	1,76

2.2 – Transport by Train

PROFIT® system source

DATA SOURCE
Tons
Wagons
Wagons per train

"Approved consolidated baseline and monitoring methodology ACM0017 "Production of biodiesel for use as fuel" - v.01.1 - UNFCCC - CDM Executive Board".

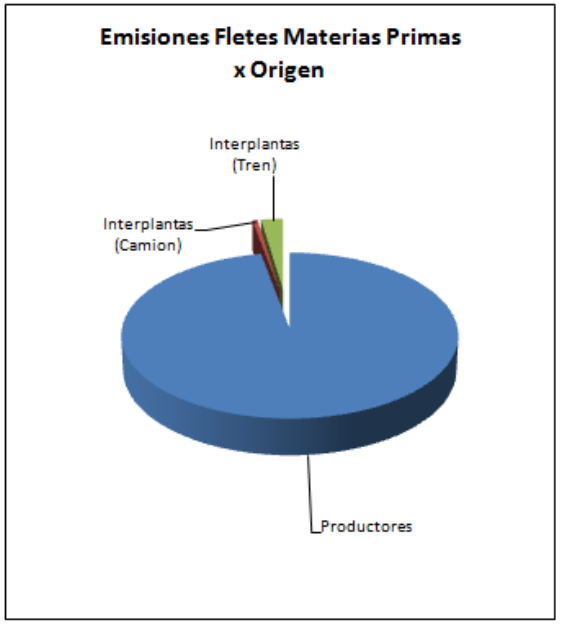
Emisiones por km recorrido		**Unidades**	**Ecuacion**	**Valor**
	Consumo específico de Gas-Oil	Lt/ Km	Locomotora General Motors GT 22 CW [1]	3,40
	Consumo ajustado por IDA y Vuelta	Lt/ Km	Según ACM0017 / Version 01.1	6,80
FECO2 LTS	Factor de emision de CO2	KgsCO2/Lts	Ver Hoja Factores de emision Incluye LCA	2,92
CO2	Emisiones CO2 por Transporte por Km	KgsCO2/Km	Ajustado por ida y vuelta	19,82
FEN2O LTS	Factor de emision de N2O	mg N2O/Km	No hay dato	-
N2O	Emisiones N2O por Gas-Oil Transporte	KgN20/Km	Ajustado por ida y vuelta	-
FECH4 Lts	Factor de emision de CH4	mg CH4/ km	No hay dato	-
CH4	Emisiones CH4 por Gas-Oil Transporte	KgCH4/km	Ajustado por ida y vuelta	-
$FE_{CO2eq\ Unidad}$	Factor de emision x KM recorrido	Kgs CO_{2eq} /Km	FE total x Km	19,82

[1] Fuente: www.forotransportes.com/showthread.php?t=4357

Transport summary MP

RESUMEN EMISIONES DE GASES DE EFECTO INVERNADERO
FLETES MATERIAS PRIMAS - SOJA
2010-2011

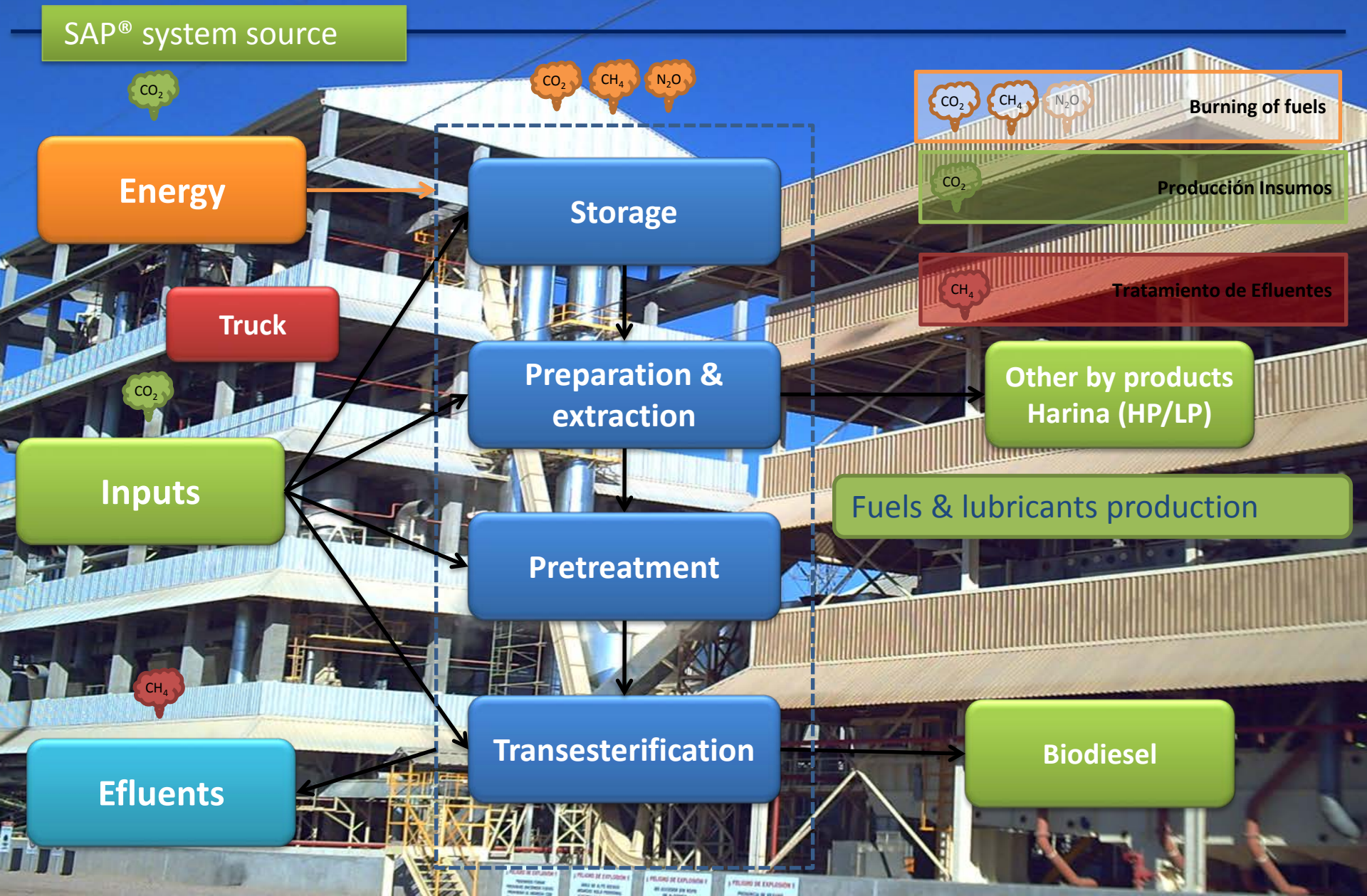
Desde:		Recibido en:	Frias	Alimenta	Cereales del Sur	Otros	Total
Productores	Toneladas	Tn	194.618	14.106	4.846	684	**214.254**
	Distancia Prom.	Km/Viaje	270	30	190	30	**252**
	Emisiones	KgsCO2Eq	3.153.121	23.548	57.713	1.249	**3.235.631**
	Emisiones x Tn	KgsCO2Eq/Tn	**16,2**	**1,7**	**11,9**	**1,8**	**15,1**
Interplantas (Camion)	Toneladas	Tn	-	-	-	2.492	**2.492**
	Distancia Prom.	Km/Viaje	-	-	-	129	**129**
	Emisiones	KgsCO2Eq	-	-	-	19.067	**19.067**
	Emisiones x Tn	KgsCO2Eq/Tn	-	-	-	**7,7**	**7,7**
Interplantas (Tren)	Toneladas	Tn	4.070	-	-	-	**4.070**
	Distancia Prom.	Km/Viaje	555	-	-	-	**555**
	Emisiones	KgsCO2Eq	78.717	-	-	-	**78.717**
	Emisiones x Tn	KgsCO2Eq/Tn	**19,3**	-	-	-	**19,3**
	Total emisiones	**KgsCO2Eq**	**3.231.838**	**23.548**	**57.713**	**20.317**	**3.333.415**



Resumen Ingresado a Frias [1]	Toneladas recibidas en Frias	Tn	198.688
	Total Emisiones por Fletes	KgsCO2Eq/Tn	3.333.415
	Promedio Emisiones x Tn	KgsCO2Eq/Tn	**16,8**

[1] Para utilizar en el calculo de emisiones del biodiesel se toman el total de las emisiones por flete pero tomando en cuenta las Tn recibidas en frias sin tener en cuenta la diferencia entre lo recibido de productores y lo ingresado efectivam

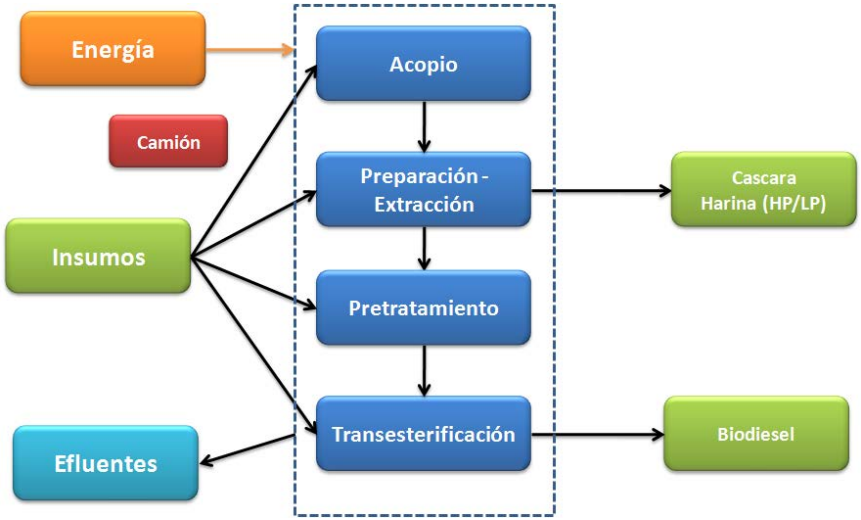
Industrial module (Frías Plant)



3. Transformation emission estimation (e_p)

Art. 11: The accounting of tranformation emitions e_p, shall include the emitions produced during the proper transformation of the feedstock, the residues and the emission produced by the manufacture of the different input materials

- CO_2 from the use of fossile fuels.
- Freigh of input fuels (CO_2 from the use of fossile fuels).
- Emissions related with the life cycle of input materials.
- CH_4 coming from the efluent treatment



3.1 - Energy

EMPLOYED DATA
Consumption
Type of fuel
Sector distribution

Source of emissions associated with fuel consumption

Tipo de Combustible/Energético				Gas-Oil	Nafta	Lubricantes	G.L.P.	Gas Natural	Leña	Energía Electrica	Fuel-Oil
Variable	Descripcion	Unidades	Fuente	Lts	Lts	Lts	Kg	M^3	Kg	KwH	Kg
PCI	Poder Calorífico Inferior	Kcal/unidad	Pagina 197 - Tabla 3.1-16. Factores de Emisión de CO2	8.619	7.607	8.497	10.960	8.300	2.300		9.800
D	Densidad	Kgs/unidad	Pagina 197 - Tabla 3.1-16. Factores de Emisión de CO2	0,8450	0,7350	0,8850	0,5370	0,7190			0,9450
Frac Ox	Fraccion de Carbono Oxidado	%	Modulo Energía - Hoja 1-1 - Método de Referencia	0,990	0,990	0,990	0,990	0,995	0,870		0,990
C_c	Contenido de Carbono	TC/TJ	Pagina 197 - Tabla 3.1-16. Factores de Emisión de CO2	20,28	18,90	20,00	17,20	15,31	29,90		21,25
$FE_{CO2\ KCAL}$	Factor de emision de CO_2	$KgsCO_2$/Kcal	$FE_{co2} = C_c * Frac\ Ox * 44/12$	0,0003082	0,0002872	0,0003040	0,0002614	0,0002339	0,0003993		0,0003230
$FE_{CO2\ Unidad}$	Factor de emision de CO_2	$KgsCO_2$/Unidad	FE x Unidad de consumo	2,66	2,19	2,58	2,87	1,94	0,92	0,351	3,17
FE_{N20}	Factor de emision de N_2O	$KgsN_2O$/TJ	Modulo Energía - Hoja 1-3	2,0	1,00	1,0	0,6	0,525	4,00		0,3
$FE_{N2O\ KCAL}$	Factor de emision de N_2O	$KgsN_2O$/Kcal	Cambio de Unidades	0,000	0,000	0,000	0,000	0,000	0,000		0,000
$FE_{N2O\ Unidad}$	Factor de emision de N_2O	$KgsCO_2$/Unidad		0,000	0,000	0,000	0,000	0,000	0,000		0,000
FE_{CH4}	Factor de emision de CH_4	$KgsCH_4$/TJ	Modulo Energía - Hoja 1-3	11,00	20,00	0,60	1,10	3,125	30,00		2,08
$FE_{CH4\ KCAL}$	Factor de emision de CH_4	$KgsCH_4$/Kcal	Cambio de Unidades	0,000	0,000	0,000	0,000	0,000	0,000		0,000
$FE_{CH4\ Unidad}$	Factor de emision de CH_4	$KgsCO_2$/Unidad		0,000	0,001	0,000	0,000	0,000	0,000		0,000
$FE_{CO2eq\ Unidad}$	Factor de emision de CO_{2eq}	$KgsCO_{2eq}$ /Unidad	FE total x Unidad	2,69	2,21	2,59	2,87	1,95	0,94	0,351	3,17
$FE_{CO2eq\ Kcal}$	Factor de emision de CO_{2eq}	$KgsCO_{2eq}$ /Kcal	FE total x Kcal	0,0003118	0,0002903	0,0003053	0,0002623	0,0002348	0,0004072		0,0003236
Emisiones LCA											
	Emisiones Extracción	$KgCO_{2eq}$/Kg producto	Metodologia MDL: ACM0017 / Version 01.1	0,073	0,073						
	Emisiones Refinado	$KgCO_{2eq}$/Kg producto	Metodologia MDL: ACM0017 / Version 01.1	0,233	0,233						
	Emisiones totales por Kg	$KgCO_{2eq}$/Kg producto		0,306	0,306						
$FE_{CO2eq\ Unidad}$	Factor de emision de CO_{2eq}	$KgsCO_{2eq}$ /Unidad	FE total x Unidad	0,259	0,225	0,259	0,287	0,195			0,317
$FE_{CO2eq\ Kcal}$	Factor de emision de CO_{2eq}	$KgsCO_{2eq}$ /Kcal	FE total x Kcal	0,0000300	0,0000296	0,0000305	0,0000262	0,0000235			0,0000324
$FETotal_{CO2eq\ Kcal}$	Factor de emision de CO_{2eq}	$FE_{CO2eq\ Kcal}$ + LCA	FE total x Unidad	2,946	2,434	2,853	3,162	2,144	0,937	0,351	3,488

3.2 – Input material transport
3.3 – Input material production

EMPLOYED DATA
Cuantity
Truck weight
Distance

Similar model to the one used for raw materials per truck

EMPLOYED DATA
Quantity of methanol

"Approved consolidated baseline and monitoring methodology ACM0017 "Production of biodiesel for use as fuel" - v.01.1 - UNFCCC - CDM Executive Board".

ID Number:	5
Parameter:	EF_{MeOH_PC}
Data unit:	tCO_2/t methanol
Description:	Specific emission per tonne of produced methanol
Source of data:	Apple 1998: <http://edj.net/sinor/SFR4-99art7.html> and 2006 IPCC Guidelines.
Measurement procedures (if any):	1.95 tCO_2/tonne produced methanol
Any comment:	Based on 30 GJ/tonne energy requirement and average of IPCC emissions factors for natural gas and diesel oil

3.4 – Liquid effluents

EMPLOYED DATS
Oil production

Methodoly according to chapter 5 of the IPCC 2006 guide

PROCEDURE

- Step 1: Calculate the ammount of residual water related to the oil production.
- Step 2: Calculate the degradable material (Equation 6.6)
- Step 3: Calculate the total emissions from the final liquid (Equation 6.4).

Apropiation of the emitions Co-Productos

Mass balance: Emitions are appropiate according to real yields and mass balance (% weight) in each step.

Energy content: According to the European Union Directive
Where a fuel production process produces, in combination, the fuel for which emissions are being calculated and one or more other products (co-products), greenhouse gas emissions shall be divided between the fuel or its intermediate product and the co-products in proportion to their energy content (determined by lower heating value in the case of co-products other than electricity). ". Annex V – Point 17.

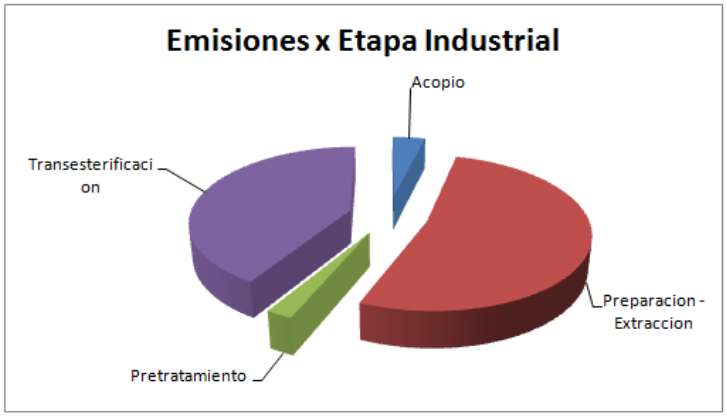
Market price: According to EB 50 – the executive board of the Clean Development Mechanism, for assigning of co-products.This methodology is being used for projects that generate cetrtiified emition green bonus.

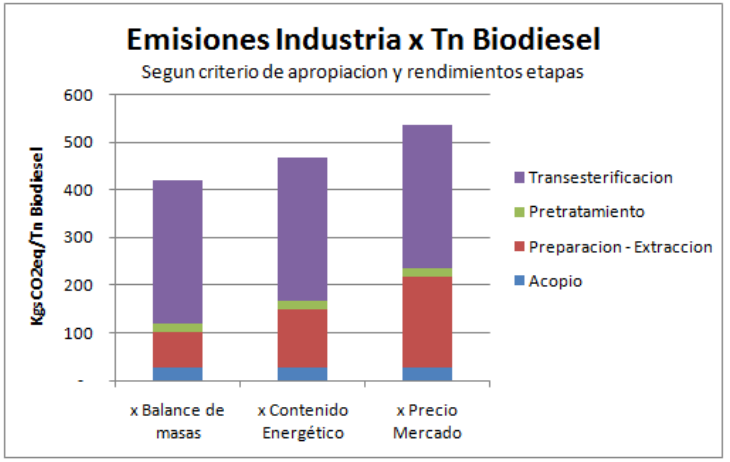
Industry Emissions Summary

RESUMEN EMISIONES DE GASES DE EFECTO INVERNADERO
Planta FRIAS - Santiago del Estero
2.011

Emisiones por Etapa (kgsCO2eq)	Energia	Transporte Insumos	Produccion Insumos	Efluentes	**Total**
Acopio	813.370	2	10	-	**813.382**
Preparacion - Extraccion	10.652.179	18.362	9.374	368.322	**11.048.237**
Pretratamiento	452.970	27.124	259	-	**480.354**
Transesterificacion	1.604.535	427.394	6.659.167	-	**8.691.096**
Total	**13.523.053**	**472.884**	**6.668.810**	**368.322**	**21.033.069**

Etapa	Produccion	Rendimiento	Emisiones por tonelada (KgsCO2eq/Tn) x Balance de masas	x Contenido Energético	x Precio Mercado
Acopio					
Ingreso Total	170.139				
Soja (Seca+Humeda)	167.460	98%	5	5	5
Preparacion - Extraccion					
Ingreso Soja	157.169				
Harina (HP/LP)	113.318	72%	73	62	46
Cascara	8.029	5%	73	55	26
Aceite crudo	30.346	19%	73	118	185
Pretratamiento					
Aceite (crudo/desgomado)	30.387				
Aceite tratado	28.966	95%	17	17	17
Transesterificacion					
Ingreso Aceite	28.728				
Biodiesel	28.873	101%	301	301	301
Resumen Emisiones Industria por Tonelada de Biodiesel					
Acopio			26	26	26
Preparacion - Extraccion			76	123	193
Pretratamiento			17	17	17
Transesterificacion			301	301	301
	Total (KgsCO2eq/Tn)		**420**	**467**	**536**





4. Oversea transport San Lorenzo - Rotterdam

Transporte terrrestre Frias-Puerto (Camión)

Distancia a Puerto	Km	750	Distancia a Puerto San Lorenzo
Aforo x Viaje	Tn/viaje	28,71	Promedio Octubre-Diciembre 2010
Emisiones a Puerto	KgsCO2eq /Tn	46,10	

Transporte martítimo San Lorenzo-Rotterdam (Buque)

Distancia a Puerto	Km	11.357	Distancia lineal corregida por un factor del 42%
Factor de emision x TN Km	$KgsCO_{2eq}$ /Tn Km	0,00418	Buque HANDY MAX (40.000 Tn Año 1980) - Bilan Carbone - V 5.0.
Emisiones a Puerto Destino	KgsCO2eq /Tn	94,94	Se considera el viaje ida y vuelta

Total Transporte a Europa	KgsCO2eq /Tn	141,04	

Summary per Ton

Resumen Emisiones Produccion de Biodiesel

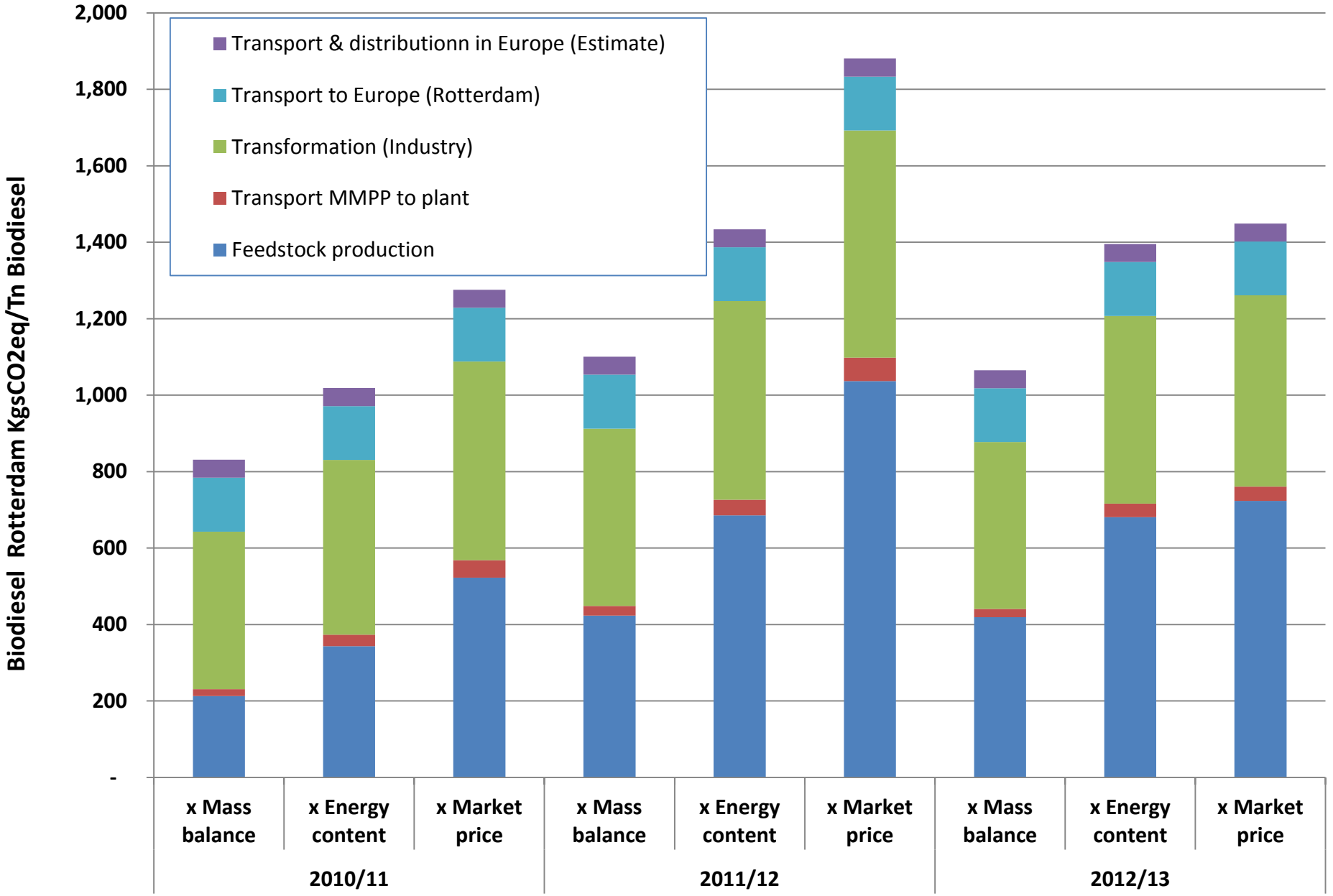
de acuerdo a Directiva Europea de Biocombustibles - EU 2009/28/CE
2010-2011

	Emisiones por tonelada (KgsCO2eq/Tn Biodiesel)	x Balance de masas	x Contenido Energético	x Precio Mercado	
e_{ec}	Extracción o del cultivo de las materias primas	150	243	381	Promedio de los campos propios. Incluye Flete a Planta y Rendimiento Industria de acuerdo a Directiva Europea de Biocombustibles - EU 2009/28/CE. Incluye produccion de insumos.
e_p	Transformación (Industria)	420	467	536	Incluye produccion y transporte de insumos.
e_{td}	Transporte y distribución (Estimado)	141	141	141	Estimado Flete camión hasta San Lorenzo y Barco a Rotterdam.
E_B	**Emisiones procedentes de la produccion y uso de biodiesel (Kgs CO2eq/TN)**	**711**	**851**	**1.059**	

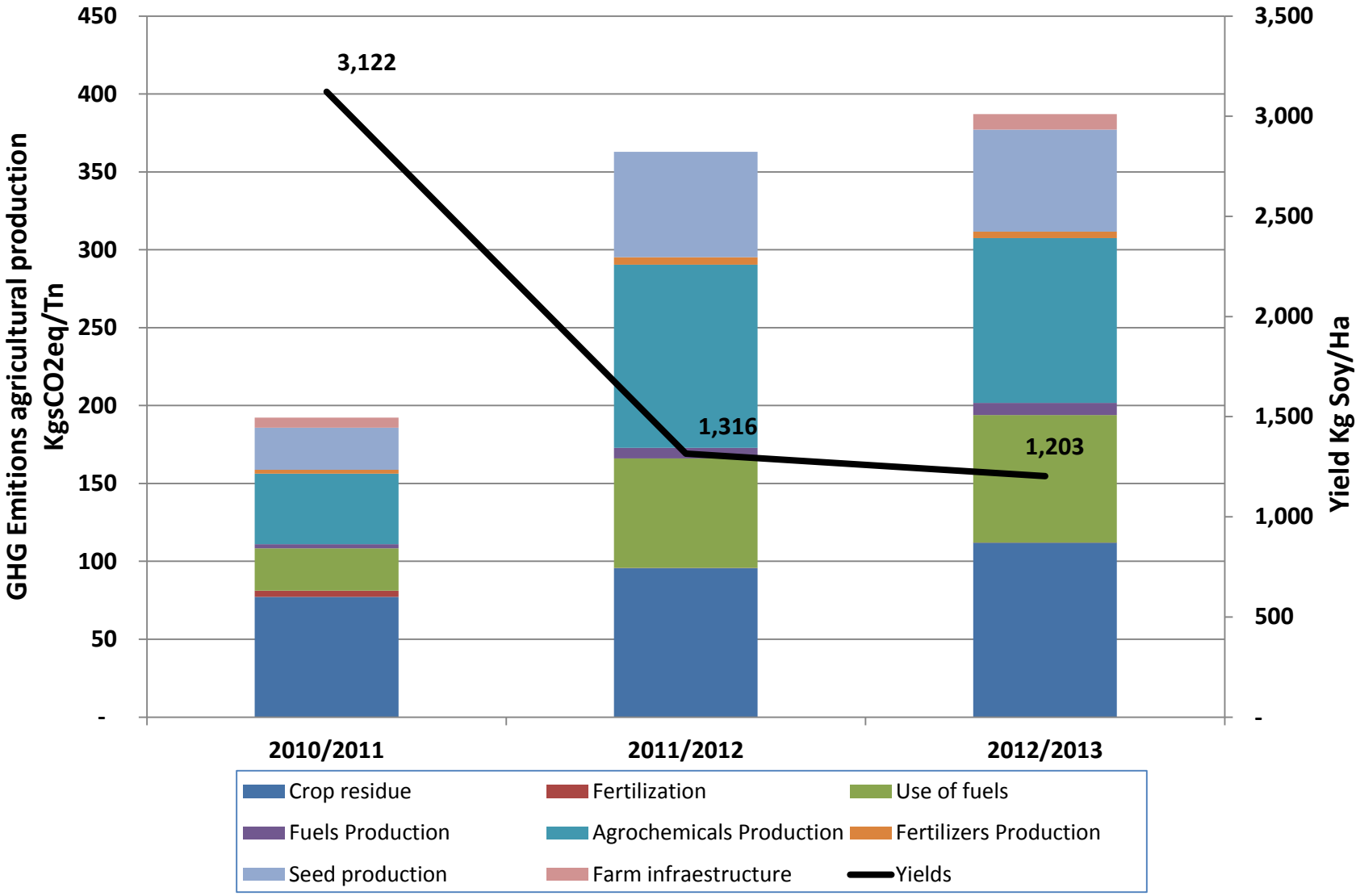
	Emisiones por tonelada (gCO2eq/Mj)	x Balance de masas	x Contenido Energético	x Precio Mercado	Directiva Europea de Biocombustibles - EU 2009/28/CE Valores Tipicos	Valores por Default	
e_{ec}	Etapa Agrícola	4	7	10	19	19	Valores directiva: Anexo V - Articulo D
e_p	Industria	11	13	14	18	26	Valores directiva: Anexo V - Articulo D
e_{td}	Transporte y distribución (Estimado)	4	4	4	13	13	Valores directiva: Anexo V - Articulo D
E_B	**Emisiones procedentes de la produccion y uso de biodiesel (g CO2eq/Mj)**	**19**	**23**	**29**	**50**	**58**	
E_F	Emisiones	83,8	83,8	83,8	83,8	83,8	Directiva Europea - Anexo V - Art. 19
RED	**Reduccion =$(E_F-E_B)/E_F$**	**77%**	**73%**	**66%**	**40%**	**31%**	

Results from all the production and transformig complex 2010/2014 VILUCO S.A.

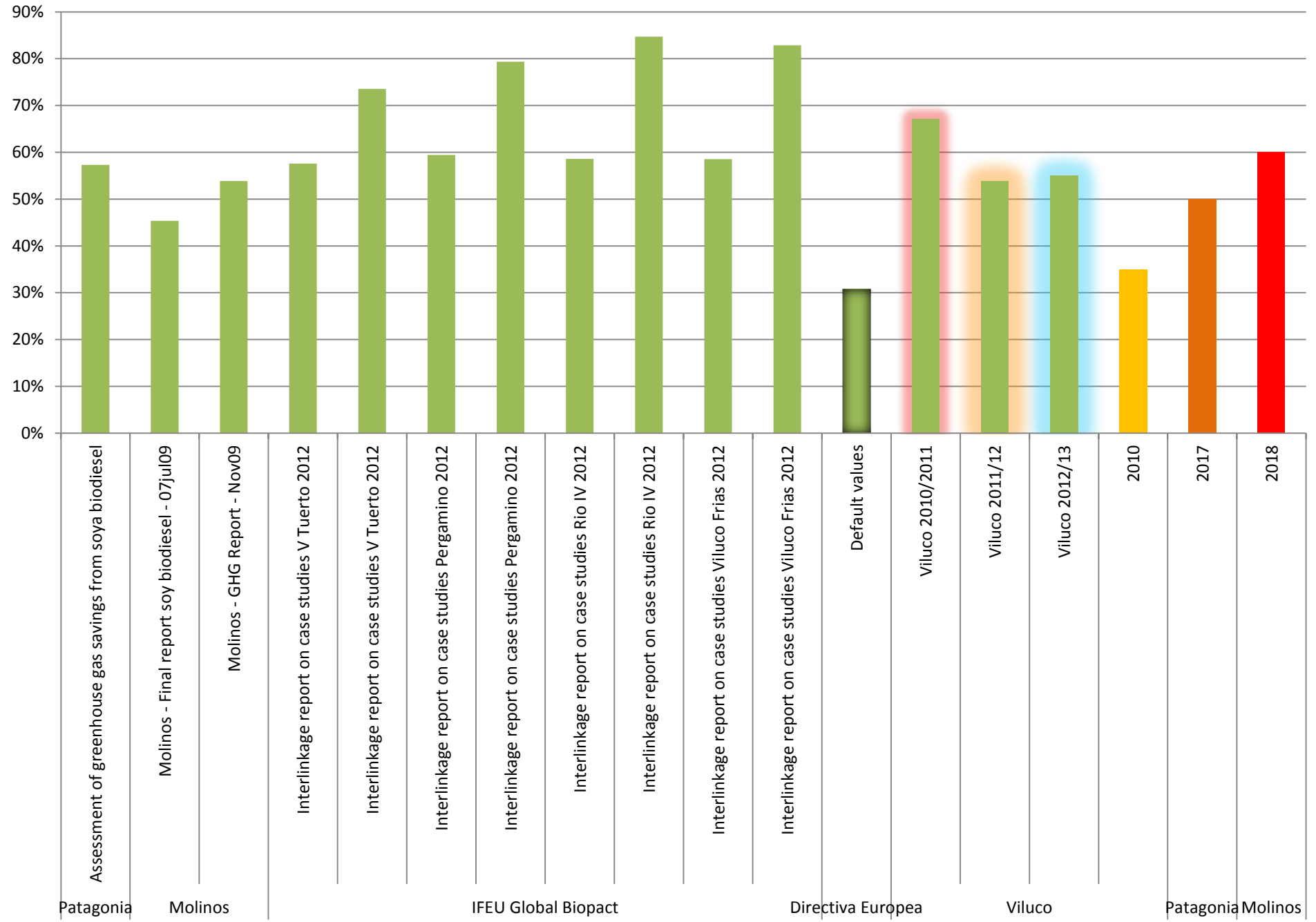
Interanual variation



Yield effect over relative contribution



GHG REDUCTIONS



Ministerio de Agricultura, Ganadería y Pesca
Presidencia de la Nación

INTA

VILUCO
AGROENERGÍA

¡Thanks!

Ings Jorge Hilbert y Sebastián Galbusera

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http://www.inta.gov.ar/info/bioenergia

RCN Conference on
Pan American Biofuels
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Golden Tulip Recife Palace,
Recife, Brazil July 22-25, 2014

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