

10 Appendixes

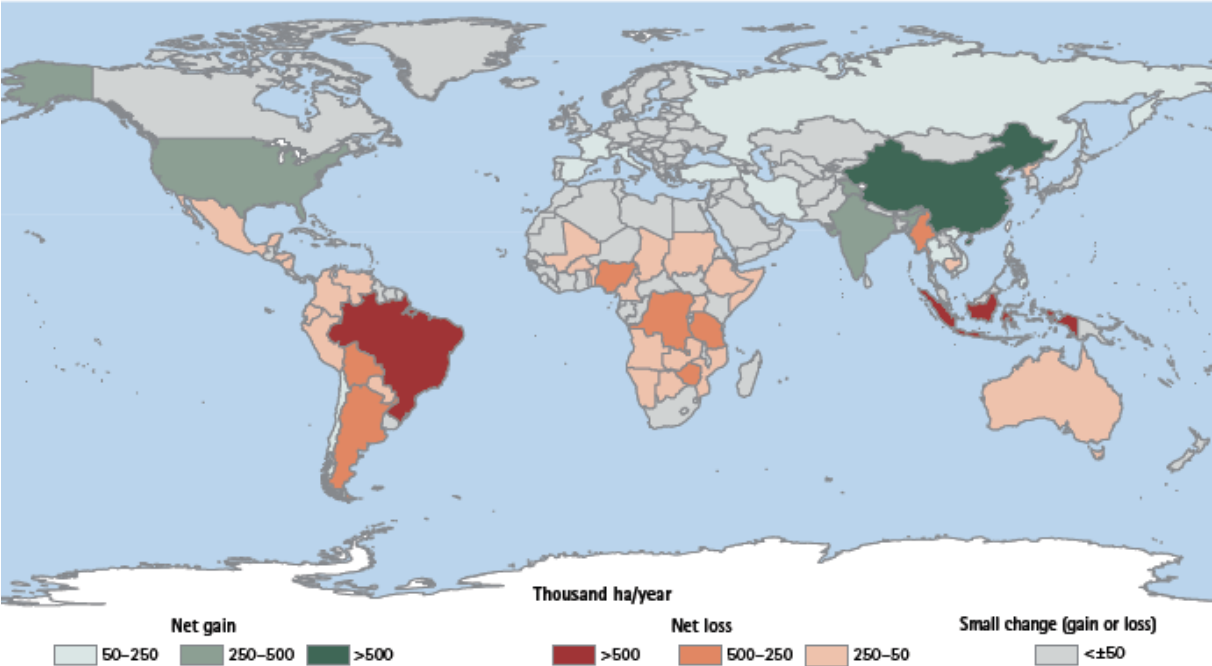
Table 1: Global forest area change, 1990-2015.

Year	Forest (thousand ha)	Annual net change		
		Period	Area (thousand ha)	Rate (%) ^a
1990	4 128 269			
2000	4 055 602	1990-2000	-7 267	-0.18
2005	4 032 743	2000-2005	-4 572	-0.11
2010	4 015 673	2005-2010	-3 414	-0.08
2015	3 999 134	2010-2015	-3 308	-0.08

^a Calculated as the compound annual growth rate.

Source: FAO (2016)

Figure 1: Annual net forest gain/loss by country, 1990–2015.



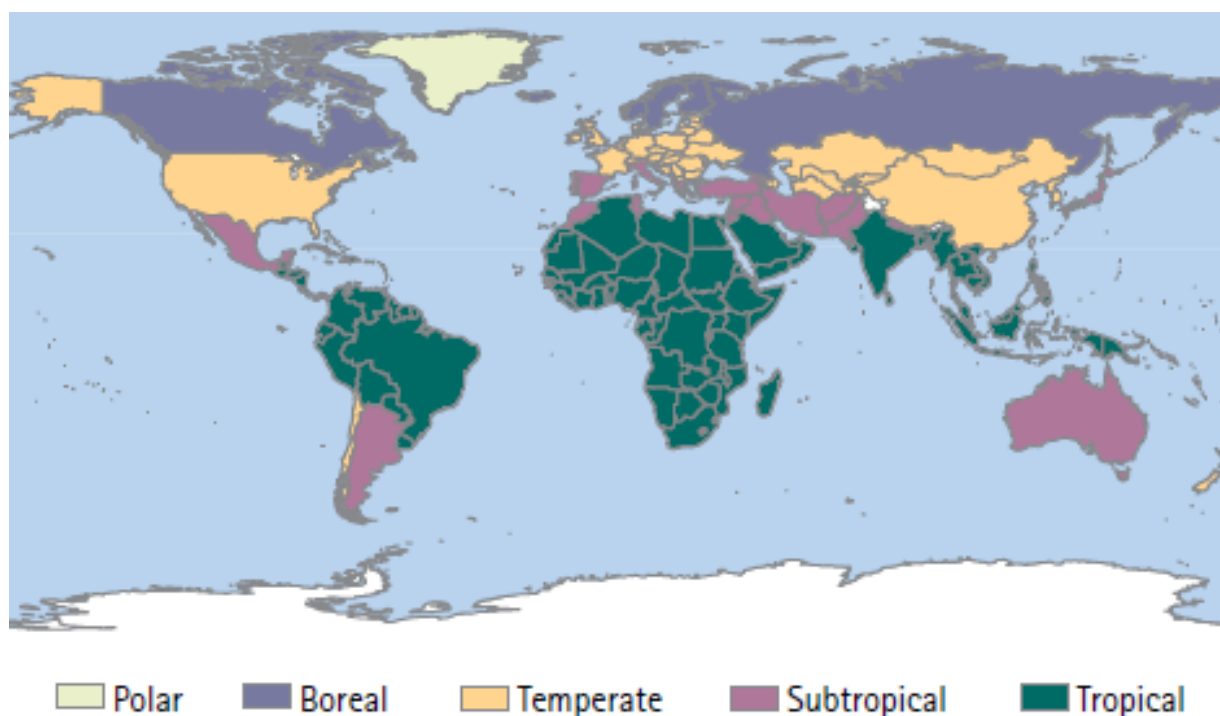
Source: FAO (2016)

Table 2: Top ten countries by reported forest area in 2015.

	Country	Forest area (thousand ha)	% of global forest area
1	Russian Federation	814 931	20
2	Brazil	493 538	12
3	Canada	347 069	9
4	United States of America	310 095	8
5	China	208 321	5
6	Democratic Republic of the Congo	152 578	4
7	Australia	124 751	3
8	Indonesia	91 010	2
9	Peru	73 973	2
10	India	70 682	2
	Total	2 686 948	67

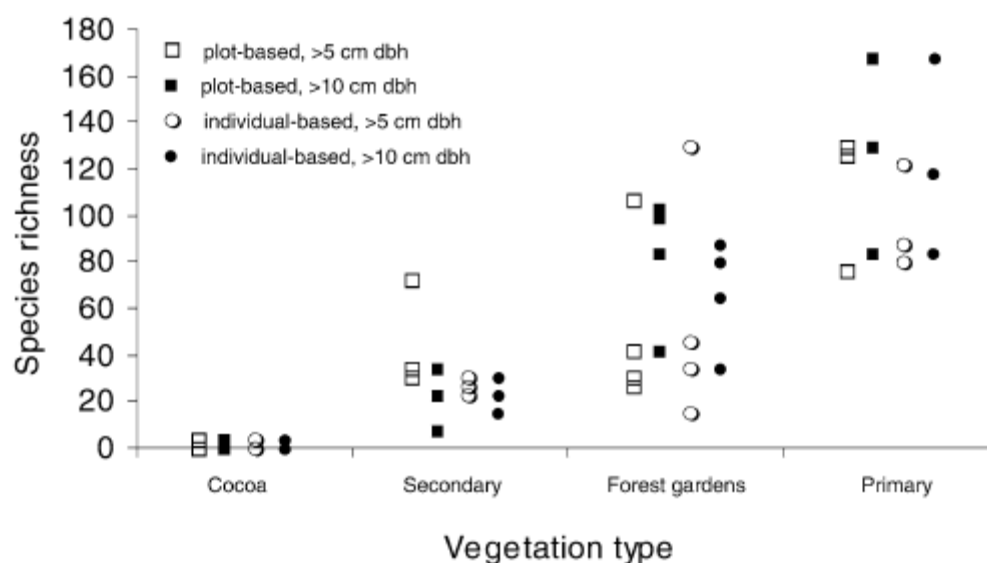
Source: FAO (2016)

Figure 2: Countries by dominant climatic domain



Source: FAO (2016)

Figure 3: Total species numbers estimated with the MMMeans richness estimator for four different habitat types (three to four replicates per system).



Source: Kessler et al. (2005)

Table 3: Impacts on biodiversity through expansion of the selected commodities.

Country and Production Areas	Area Increase by Commodity ($\times 1000$ ha)	B1: Growth Factor Commodity (%)	B2: NCI in production area in 2000* (in % NCI)	B3: NCI Loss by Commodity (% NCI)	B4: Part of Commodity to NCI Loss (in %)	B5: Ecological Claim (in km ²)
Soy Brazil						
Rio Grande do Sul	962	0.24	--	1	1	1,656
Paraná	1,801	0.45	--	1	2	2,065
Mato Grosso	2,940	0.56	+	3	17	31,552
Goiás	1,470	0.55	--	4	10	13,311
Tocantins	233	0.92	+	1	5	2,407
Maranhão	253	0.74	=	1	3	2,480
Piauí	143	0.93	=	1	2	1,400
Total Brazil	9,860	0.46	76%	1	3	65,498
Soy Argentina						
Cordoba	2,500	0.60	--	4	10	7,130
Santa Fé	1,117	0.71	--	2	6	3,468
Entre Rios	988	0.87	--	6	13	4,401
Chaco	904	0.93	=	8	46	6,864
Salta	317	0.85	=	2	10	2,569
Santiago del Estero	660	0.88	=	2	10	2,743
Total Argentina	8,322	0.58	80%	1	5	30,363
Palm oil Indonesia						
North Sumatra	470	0.72	--	4	12	2,529
South Sumatra	180	0.50	=	2	8	1,112
Jambi	316	0.51	--	4	13	1,898
Lampung	60	0.55	--	1	2	270
West Kalimantan	240	0.59	=	1	4	1,615
Total Indonesia	2,300	0.52	72%	1	3	12,082

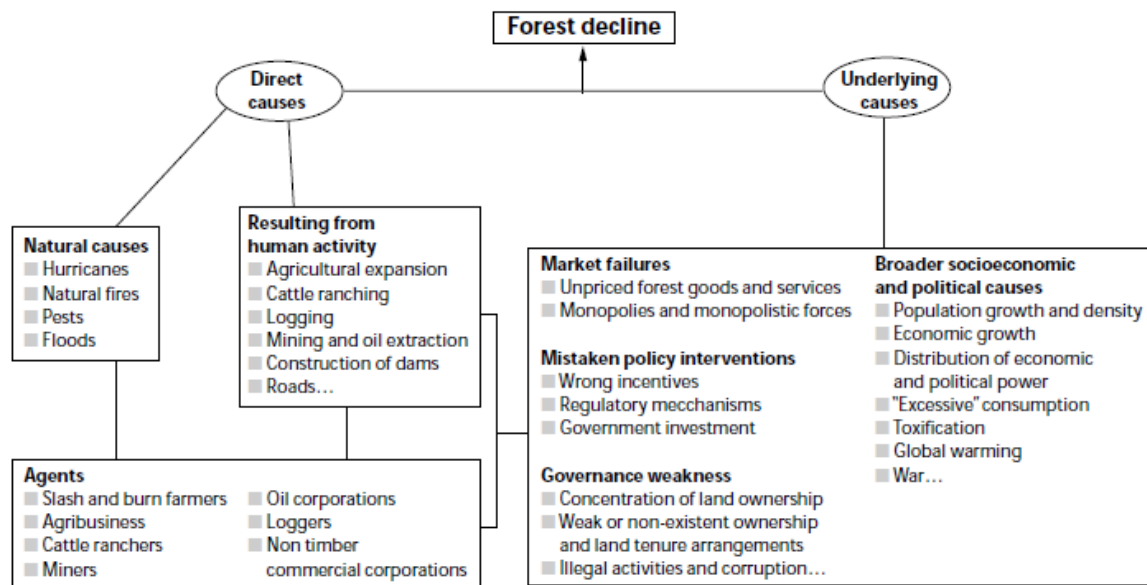
Palm oil Malaysia						
Johor	79	0.03	–	1	2	127
Perak	38	0.13	–	<1	1	76
Pahang	80	0.15	=	<1	2	134
Sabah	647	0.56	=	4	14	2,744
Serawak	390	0.58	+	1	6	1,237
Total Malaysia	1,600	0.41	73%	2	6	4,942
Beef Brazil						
Mato Grosso do Sul	3,700	0.12	--	5	9	17,335
Pará	6,000	0.36	+	2	20	29,129
Rondonia	2,900	0.37	+	6	36	13,580
Total Brazil	43,200	0.18	76%	2	10	198,733
Beef Argentina						
Santa Fé	450	**	--	2	6	3,328
Corrientes	500	–**	–	4	14	3,764
La Pampa	100	–**	=	<1	2	685
Total Argentina	1,700	–**	80%	<1	2	11,719
Coffee Honduras						
El Paraiso	21	0.47	–	2	7	252
Copán	11	0.49	--	3	4	131
Santa Barbara	18	0.47	–	3	7	209
Comayagan	13	0.48	--	2	4	165
Total Honduras	111	0.47	69%	1	3	1,001
Coffee Vietnam						
Dak Lak province	199	0.76	++	8	19	1,396
Total Vietnam	423	0.77	47%	1	2	2,874

* B2: classification of differences: <5%: = ; >5% and <20%: – or 1; >20%: – or ++.

** B1 could not be calculated for beef in Argentina because historical data are not available.

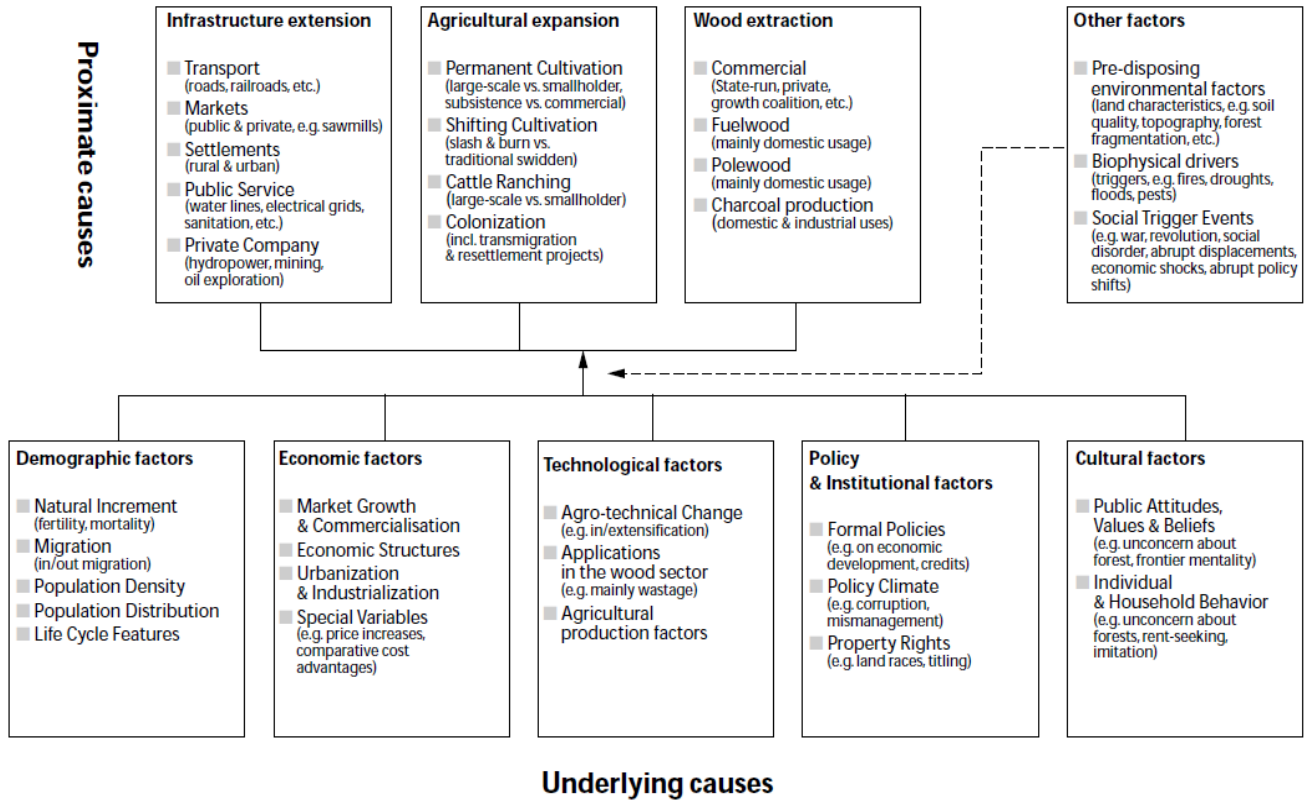
Source: Kessler et al. (2007)

Figure 4: The causes of forest decline – I



Source: Geist and Lambin (2001)

Figure 5: The causes of forest decline - II



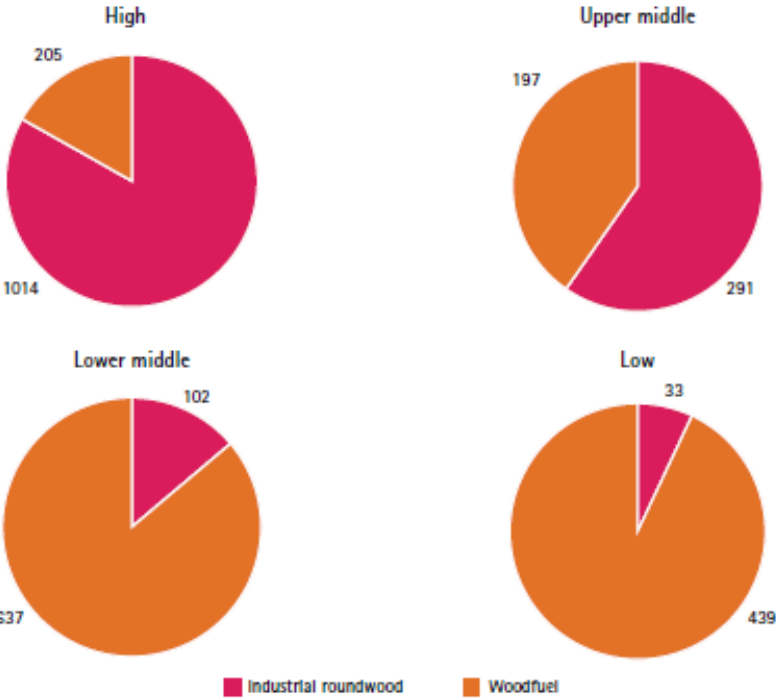
Source: Geist and Lambin (2001)

Table 4: Proportion of villages reporting tree crop estates.

	<u>No Deforestation</u>	<u>Moderate Deforestation</u>	<u>Heavy Deforestation</u>	<u>All Villages</u>
<i>Sumatra</i>	0.04	0.04	0.20	0.04
<i>Nusa Tenggara</i>	0.01	0.00	0.02	0.01
<i>Kalimantan</i>	0.02	0.02	0.08	0.02
<i>Sulawesi</i>	0.03	0.03	0.16	0.04
<i>Maluku</i>	0.02	0.01	0.02	0.02
<i>Irian Jaya</i>	0.01	0.00	0.00	0.01

Source: Chomitz and Griffiths (1996)

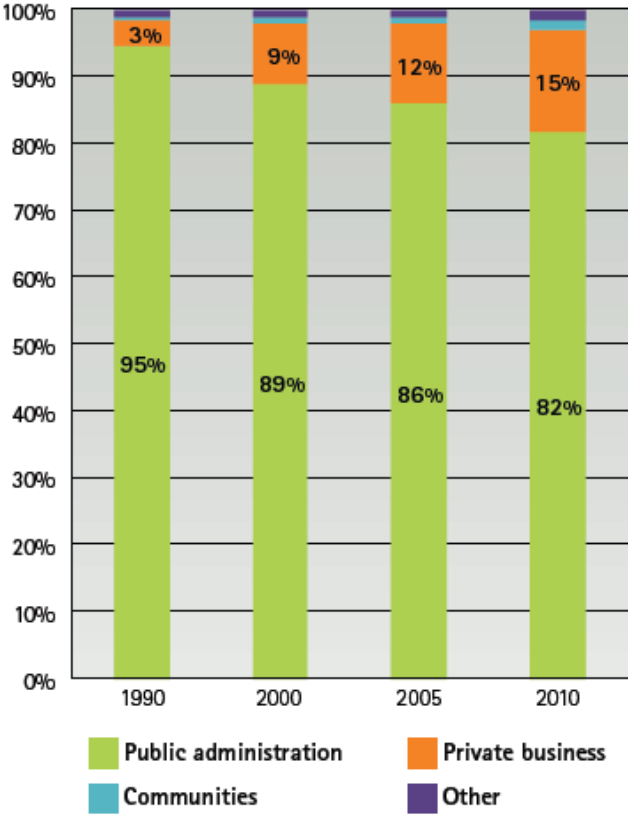
Figure 6: Industrial roundwood and woodfuel removals by income category in 2011



Note: The figures represent annual removals in million m³.

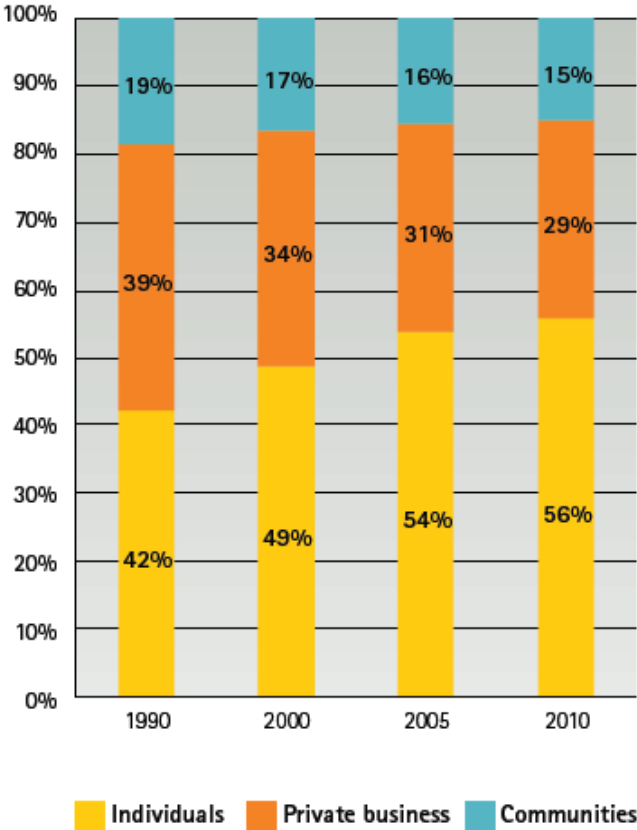
Source: FAO (2016)

Figure 7: Management rights of publicly owned forests, 1990-2010.



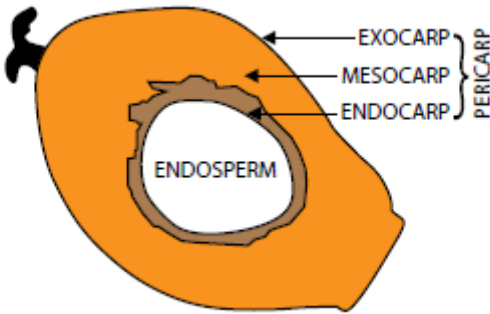
Source: FAO (2016)

Figure 8: Distribution of private ownership of forest, 1990-2010.



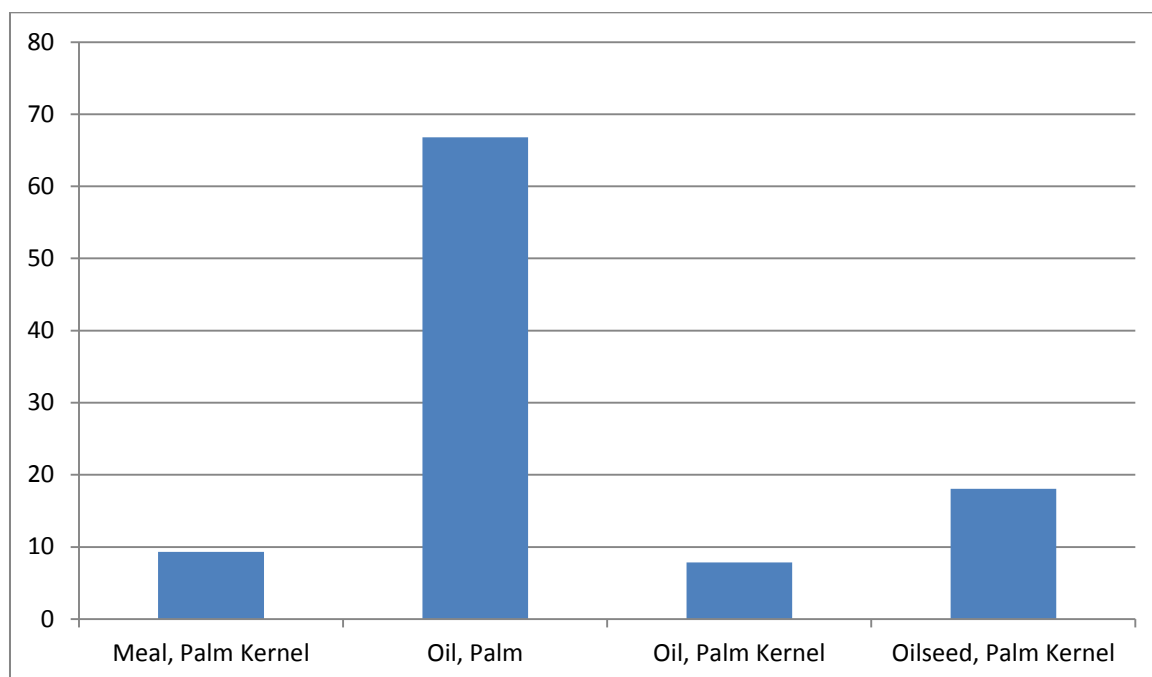
Source: FAO (2016)

Figure 9: Cross section of an oil palm fruit. The fruit comprises outer oily flesh or pericarp (made up of exo-, meso- and endocarp) and an oil-rich seed or kernel (endosperm).



Source: Sheil et al. (2009)

Figure 10: World's production of each commodity coming from the oil palm fruit (in million tons), 2017.



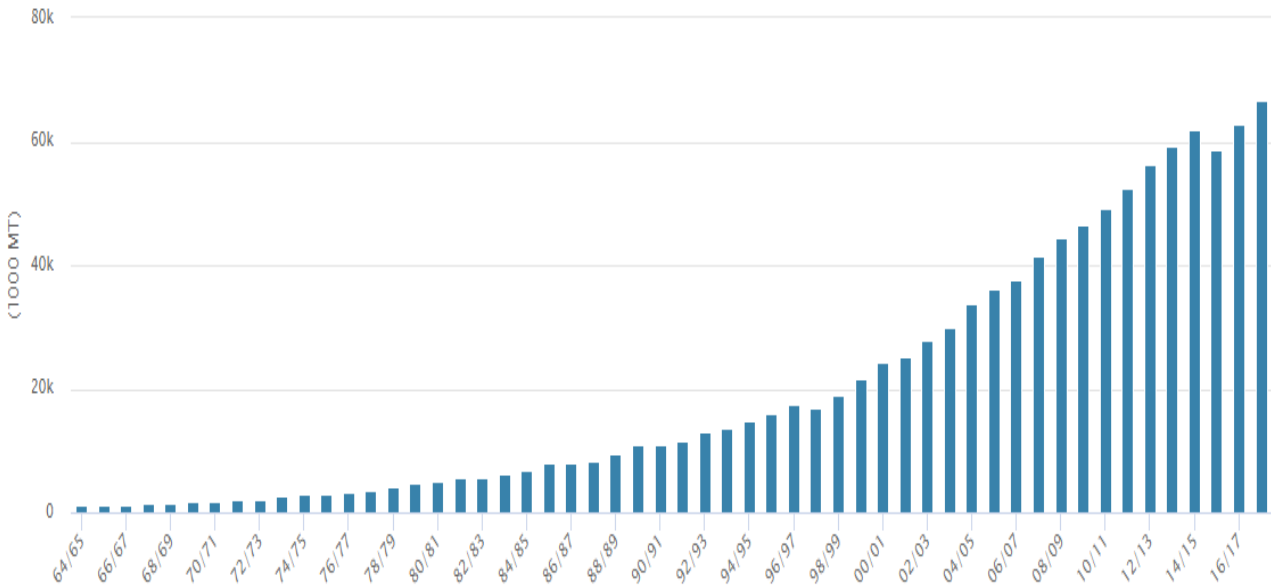
Source: FAS USDA (2017)

Table 5: Actual and projected world vegetable oil figures (10³ MT)

	Actual		Projected		Growth rates
	1978	1988	1990	2000	1988-2000
Lauric acid oils	3585	4569	5342	6441	2.9
Coconut oil	2871	2916	3399	3325	1.1
Palm kernel oil	714	1653	1943	3116	5.4
Cotton seed oil	2829	3264	3349	5163	3.9
Groundnut oil	3265	3961	4013	5130	2.2
Linseed oil	866	846	764	984	1.3
Olive oil	1704	1887	1935	2237	1.4
Palm oil	4049	9369	11009	17656	5.4
Rapeseed oil	3018	7619	7760	11914	3.8
Soybean oil	10720	15115	16469	21374	2.9
Sunflower oil	4281	7395	8028	9684	2.3
Sum	37929	58593	64011	87024	3.0

Source: Hardter et al. (1997)

Figure 11: World production of palm oil for all years, 1965-2017.



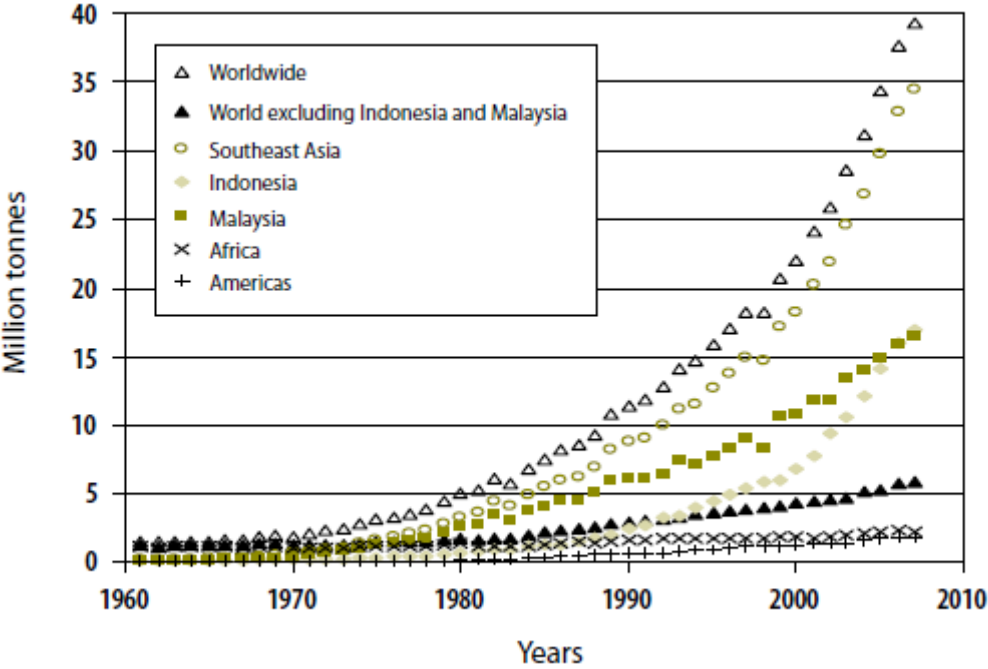
Source: FAS USDA (2017)

Table 6: Top countries of oil palm production

Country	Production (million T)	% of World
Indonesia	36	53.89
Malaysia	21	31.44
Thailand	2.2	3.29
Colombia	1.32	1.98
Nigeria	0.97	1.45
Guatemala	0.74	1.11
Others	4.57	6.84
Total	66.8	100

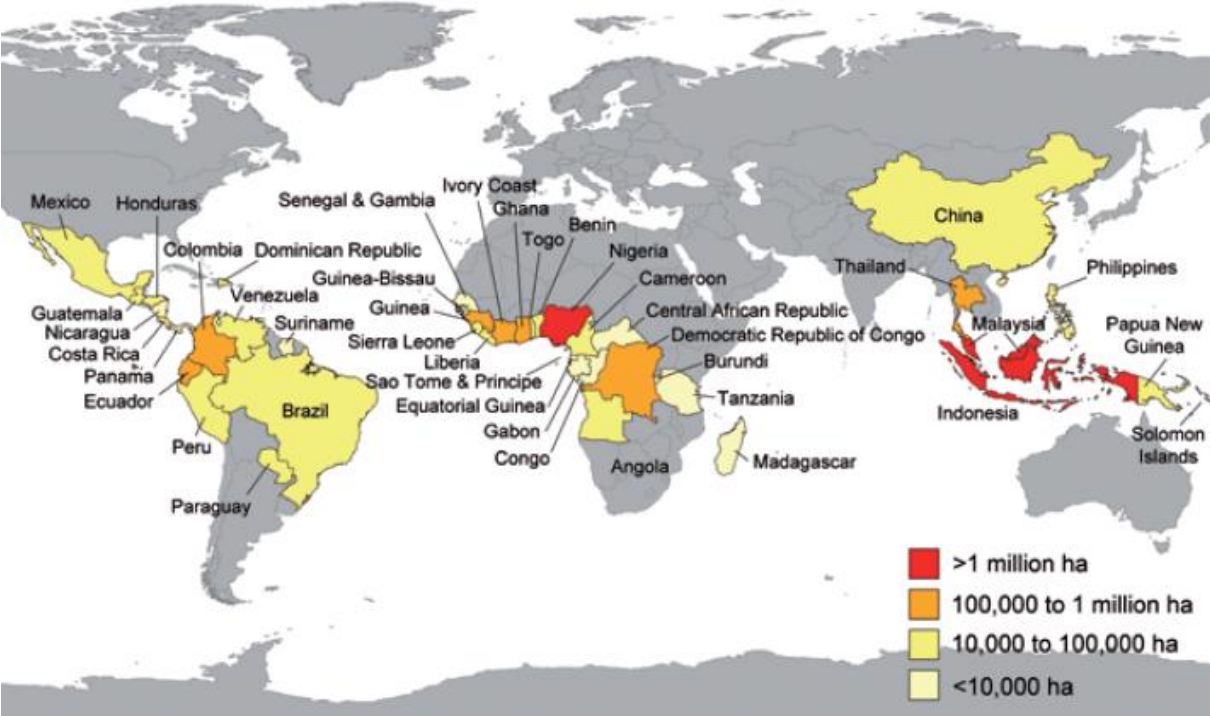
Source: FAS USDA (2017)

Figure 12: Palm oil production in selected areas, 1961-2007.



Source: Sheil et al. (2009)

Figure 13: The extent of oil palm cultivation in 43 oil palm producing countries in 2006.



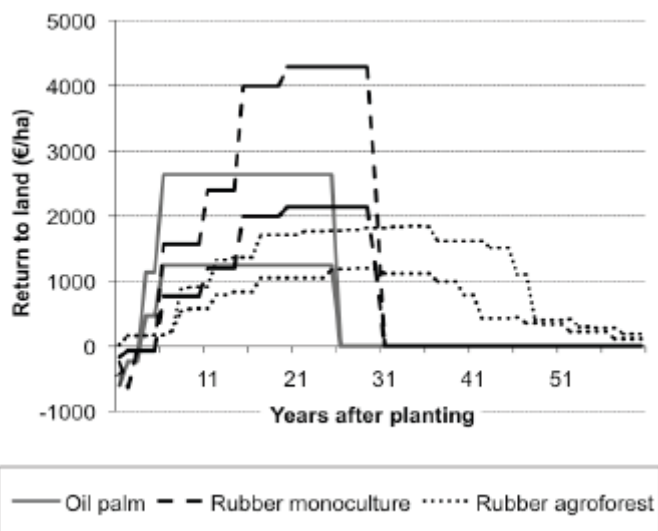
Source: Sheil et al. (2009)

Table 7: Oil production of palm and other major oil crops

Oil type	Oil yield (kg/ha)
Palm	4000-5000
Rapeseed	1000
Groundnut	890
Sunflower	800
Soya bean	375
Coconut	395
Cotton seed	173
Sesame seed	159

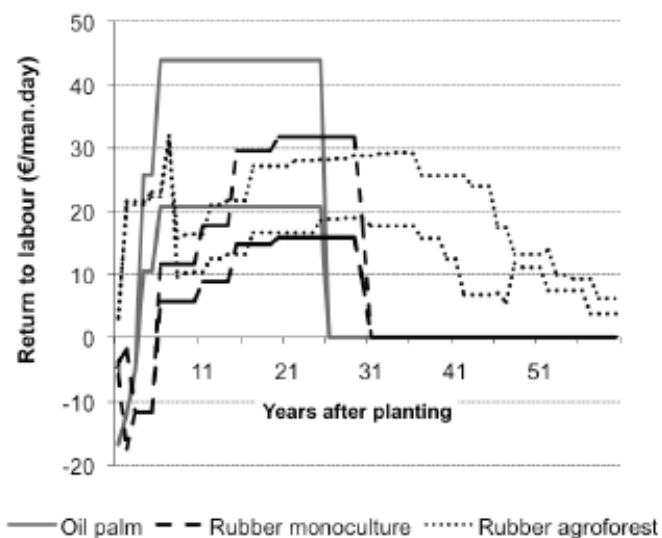
Source: Sheil et al. (2009)

Figure 14: Comparison of returns to land in conditions of high and low prices, according to the age of the plantations.



Source: Feintrenie et al., 2010

Figure 15: Comparison of returns to labour in conditions of high and low prices, according to the age of the plantations.



Source: Feintrenie et al., 2010

Table 8: Companies establishing biodiesel plants in Indonesia as of 2006

Company	Group	Capacity (tons)	Resource based	Location
PT. Anugrah Inti Gemanusa	Eterindo	11,000	Palm	East Java
PT. Artha Trans Jaya		1,200		
PT. Asianagro Agung Jaya	RGM	100,000	Palm	Jakarta
PT. Astra Agro Lestari Tbk	Astra Agro	5,000	Palm	Central Kalimantan
Badan Pengkajian & Penerapan Teknologi (BPPT)	Gov. Institution	1,500	Palm & castor	Tangerang
PT. Bakrie Rekin Bio-Energy	Bakrie & Rekin	60.000-100.000	Palm	Jambi
PT. Biodiesel Indonesia		100,000	Palm	
PT. Energi Alternatif Indonesia		300	Castor	Jakarta
PT. Family Raya Group	Family Raya	7,200	Palm & castor	North Sumatera
PT. Indo Biofuels Energy	Elnusa	150,000	Palm	Merak
PT. Karya Prajona Nelayan	Wilmar	100,000	Palm	North Sumatera
PT. Mulia Indonesia + KTM	Mulia		Palm	North Sumatera

Biotech Sdn Bhd				
PT. Musim Mas	Musim Mas	100,000	Palm	North Sumatera
PT. Perkebunan Nusantara III (Persero)	BUMN	6,000	Palm	North Sumatera
PT. Perkebunan Nusantara IV (Persero)	BUMN	2,400	Palm	Jambi
PT. Perkebunan Nusantara VIII (Persero)	BUMN		Palm	Lampung
PT. Rajawali Nusantara Indonesia	BUMN		Castor	
PT. ReKayasa Industry + PT. Pertamina	Elnusa & BUMN	5,000	Castor	Balongan
PT. Sari Dumai Sejati	Surya Dumai	100,000	Palm	Riau
PT. Wahana Abdi Tirta		30,000	Palm	
PT. Wilmar Bioenergi Indonesia	Wilmar	1,050,000	Palm	Riau

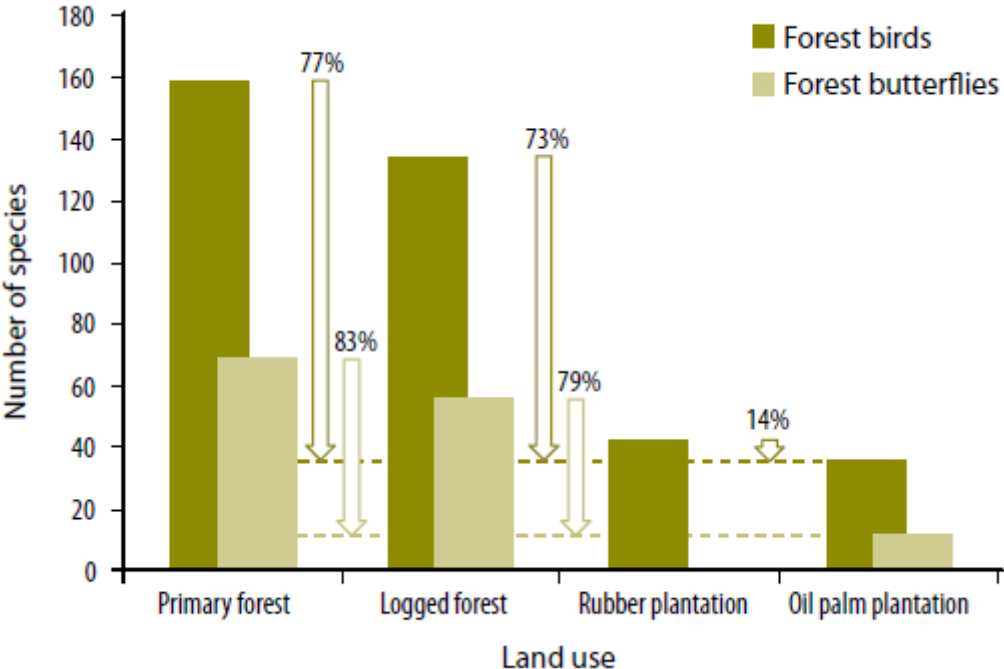
Source: Casson et al. (2007)

Table 9: Agricultural production of five major feedstocks and biofuel energy yields.

Biofuel type	Bio-ethanol						Biodiesel			
	Maize		Sugarcane		Cassava		Soybean		Oil Palm	
Biofuel crop	United States	China	Brazil	India	Nigeria	Brazil	United States	Brazil	Malaysia	Indonesia
Country, top two crop producers in 2005										
Total production 2005, in million metric tonnes	280	133	420	232	42	26	83	50	76	64
Percentage of world production, 2005	40	19	33	18	20	12	39	24	44	37
Average crop yield, 2003-2005, in metric tonnes per hectare	9,4	5	73,5	60,7	10,8	13,6	2,7	2,4	20,6	17,8
Conversion yield in liters per metric ton	399	399	74,5	74,5	137	137	205	205	230	230
Biofuel yield in liters per hectare	3751	1995	5476	4522	1480	1863	552	491	4736	4092
Energy yield in gigajoules per hectare	79,1	41,1	116	95,4	31,2	39,3	18,2	16,1	156	135
2005 petroleum replacement, percent of total petroleum use	2	2,4	40,4	1,8	-	-	0,1	-	-	-

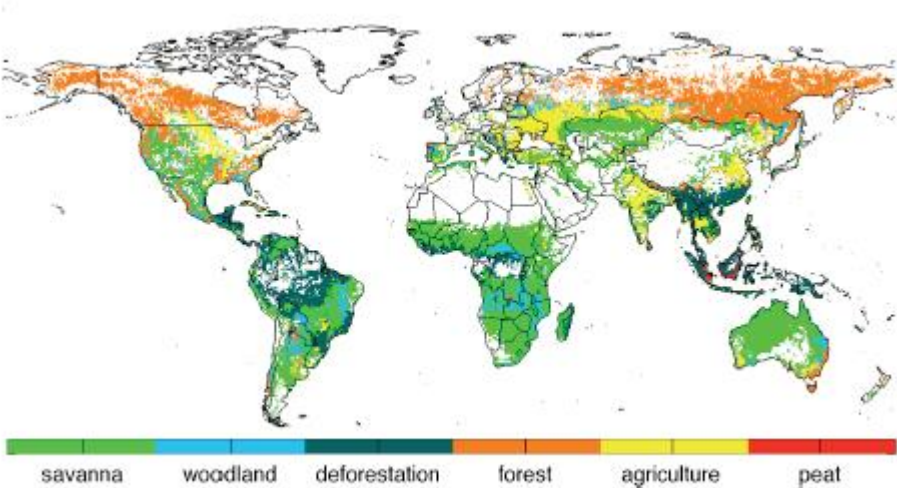
Source: Naylor et al. (2007)

Figure 16: Total numbers of species of forest birds and forest butterflies recorded from different land use types in southern Peninsular Malaysia and Borneo, respectively



Source: Sheil et al. (2009)

Figure 17: Dominant fire type in each 0.5° grid cell based on carbon emissions.



Source: van der Werf et al. (2010)

Table 10: Land holdings owned by the ten largest Indonesian oil palm conglomerates, 1997.

Group	Holding Company	Total land bank Area (ha)	Total area planted (ha)
Salim Group	PT Salim Plantations	1,155,745	95,310
Sinar Mas Group	PT Golden Agri Resources	320,463	113,562
Texmaco Group		168,000	35,500
Raja Garuda Mas	PT Asian Agri	259,075	96,330
Astra Group	PT Astra Agro Lestari Tbk	192,375	125,461
Hashim Group		244,235	105,282
Surya Dumai Group		154,133	23,975
Napan Group	PT PP London Sumatra Indonesia Tbk	245,629	78,944
Duta Palma Group		65,800	25,450
Bakrie Group	PT Bakrie Sumatra Plantations	49,283	23,392
Total		2,854,738	723,206

Source: Casson (2000)

Table 12: Number of observations for our controls.

Variable	Obs	Mean	Std. Dev.	Min	Max
Junior	479	71.46289	4.601773	60.00887	83.83922
Primary	471	64.27345	7.469026	38.04156	83.37273
Senior	491	70.81679	4.660088	56.88334	81.79338
literacy15	7553	90.47311	10.00829	10.93	99.93827
urban	1880	38.20853	30.78193	.76	100
gdp	812	5.00e+07	1.12e+08	260922	9.83e+08
revenue	8064	5.70e+11	1.21e+12	0	3.95e+13
Employment~e	3777	93.43873	3.628554	77.85292	100
road	226	4835.912	3637.465	374	20270

Table 19: Wooldridge test for autocorrelation in regressions from Table 13.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
F-test	78.74	91.05	0.36	0.16	0.15	0.63	3.42	172.60	0.66	7.54	1.03
p-value	0.00	0.00	0.55	0.69	0.70	0.43	0.07	0.00	0.42	0.01	0.32

Table 20: Wooldridge test for autocorrelation in regressions from Table 14.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
F-test	23.11	13.45	0.48	0.04	0.12	4.16	2.42	39.14	0.60	7.97	0.67
p-value	0.00	0.00	0.49	0.83	0.73	0.04	0.13	0.00	0.44	0.01	0.42

Table 21: Wooldridge test for autocorrelation in regressions from Table 15.

	(1)	(2)	(3)	(4)
F-test	200.23	0.49	7.55	1.18
p-value	0.00	0.48	0.01	0.28

Table 22: Wooldridge test for autocorrelation in regressions from Table 16.

	(1)	(2)	(3)	(4)
F-test	53.31	0.31	8.24	1.00
p-value	0.00	0.58	0.00	0.32

Table 23: Wooldridge test for autocorrelation in regressions from Table 17.

	(1)	(2)	(3)	(4)
F-test	205.55	0.61	7.84	0.94
p-value	0.00	0.44	0.01	0.34

Table 24: Wooldridge test for autocorrelation in regressions from Table 18.

	(1)	(2)	(3)	(4)
F-test	42.15	0.67	7.41	0.92
p-value	0.00	0.42	0.01	0.34