REVIEW ARTICLE

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THE GROWTH OF THE OIL PALM INDUSTRY IN COLOMBIA

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ABSTRACT

Colombia is currently the world's fifth largest producer of palm oil and the largest producer in South and Central America. It has substantial areas of land that can be used for additional oil palm production, and there is considerable scope for increasing yields in existing planted areas. This article reviews the growth in oil palm area and production since the late 1960s in the country's four production zones, examines trends in product extraction rates, compares seasonal variations in yield, and compares various aspects of oil palm performance in Colombia with that in Southeast Asia.

Keywords: oil palm, Colombia, area expansion, yields, product extraction rates.

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INTRODUCTION

Colombia is currently the world's fifth largest producer of palm oil, the second largest producer outside Southeast Asia, and the largest producer in South and Central America (*Table 1*). Even so, the total oil palm area in Colombia in 2009 of 360 537 was still less than 3% of the world's total oil palm planted area (FEDEPALMA, 2010).

In 2005, oil palm occupied only about 0.2% of the total land area in Colombia, and less than 12% of the area under all permanent crops (*Table 2*). In contrast, permanent pasture in that year represented 39% of all land, being second only to forest as a major form of land use in the country. As much as 2419 × 10^3 ha or 2.33% of land in Colombia was earlier considered suitable for oil palm, having no or only moderate restrictions in terms of altitude, soils and climate (Mejia, 2000). Other studies (Romero *et al.*, 1999; Rubiano *et al.*, 2009) support this assessment, showing the considerable potential that exists for future expansion of the crop.

The main factors limiting oil palm production in Colombia are topographic, climatic (seasonal dry periods, excessive rainfall and high day temperatures), edaphic (acidic, poorly structured, badly drained, shallow and infertile soils) and biotic (presence of numerous pests and pathogens). Only lowland areas [commonly defined as land less than 300 m above sea level (PORIM, 1993)] are generally thought to be suitable for oil palm, although the limiting altitude may well change in future as a result of global warming or selection of oil palms with greater tolerance to low temperatures.

In this article, we examine the past development of the Colombian oil palm industry as a background to a further study (Henson *et al.*, 2012) in which we quantify the sequestration of carbon as part of a

TABLE 1. PRODUCTION OF PALM OIL IN DIFFERENT COUNTRIES

Country	Palm oil production (10^3 t)		
	1990	2000	2008
Indonesia	2 413	7 050	19 330
Malaysia	6 095	10 842	17 734
Thailand	199	525	1 170
Nigeria	580	740	860
Colombia	232	524	778
Papua New Guinea	133	336	400
Ecuador	127	218	415
Cote d'Ivoire	224	278	330
Costa Rica	63	137	202
Others	961	1 217	1 877
Total	11 027	21 867	43 096

Source: MPIC (2005), MPOB (2008; 2010), FEDEPALMA (2010).

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TABLE 2. RECENT LAND USE IN COLOMBIA

Land use	1990	2000	2005	1990	2000	2005
		(10^3 ha)			(% of total land)	
Annual crops	3 305	2 399	2 818	3.2	2.3	2.7
Permanent crops	1 662	2 077	1 766	1.6	2.0	1.7
Oil palm	115	125	157	0.1	0.1	0.2
Permanent pasture	40 094	40 094	40 925	38.6	38.6	39.4
Forest	51 520	(50 585)	49 650	49.6	(48.6)	47.8
Other land	7 289	8 715	8 711	7.0	8.4	8.4

Note: annual crops include temporary pasture. Permanent crops include oil palm. There were no data for forest in 2000 and so a mean of the 1990 and 2005 values was assumed. Other land was calculated by difference, assuming total land area to be 103 870 × 10^3 ha.
Source: Pagiola *et al*. (2004), FEDEPALMA (2010).

preliminary assessment of the 'carbon footprint' of the industry and its potential impact on global climate change.

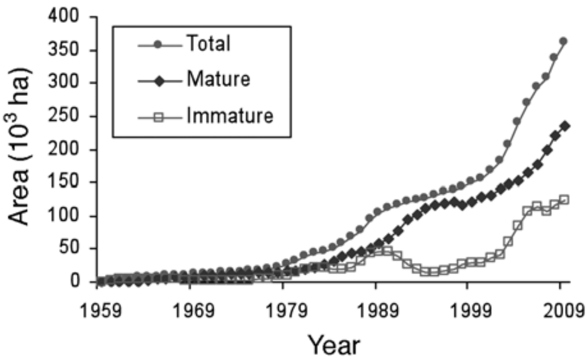
OIL PALM AREA AND DISTRIBUTION IN COLOMBIA

Oil palm cultivation in Colombia is located in four main areas, referred to as the central, northern, eastern and western regions, in 16 states. Each region differs somewhat in climate and other conditions that affect production. Detailed maps showing the distribution of plantations and mills in each region are produced annually by the producers' organisation, FEDEPALMA (Federación Nacional de Cultivadores de Palma de Aceite). In this article, we make extensive use of the data assembled by FEDEPALMA (2010 and earlier years) on oil palm areas and production.

There are records of the areas of mature and immature oil palm plantings in each region from the late 1950s (*Figure 1*) that indicate that the first plantings came into bearing in the early 1960s. However, Hartley (1988) reported that mature (fruiting) plantations existed in Colombia and neighbouring countries towards the end of the 1950s. In any case, the areas were small and only began to increase to any significant extent from the mid 1980s (*Figure 1*).

It can be seen from *Figure 1* that the rate of area expansion has not been constant. It slowed considerably from 1990 to 1999 when very little new planting occurred, leading to a decline in the immature (non-fruiting) area. Later, from 2006 to 2009, there was little increase in the total immature area, probably as a result of the increasing spread of bud rot disease. Despite this, the total planted area (immature plus mature) continued to increase due to the maturation of earlier plantings.

Mean data over the years for the different regions (*Table 3*) show that the eastern region had the largest planted area followed by the northern, central and western regions. The planted area in the western region has actually declined in recent years, as have the immature areas in the north (*Figure 2*). The latter decline will eventually have a negative impact on the total mature (productive) area. The decline in the western region has been mainly attributed to losses due to bud rot disease (FEDEPALMA, 2010).



Source: Bossi and Ochoa (1998), FEDEPALMA (2010, earlier editions and unpublished data).

Figure 1. Changes in oil palm area in Colombia from 1959 to 2009.

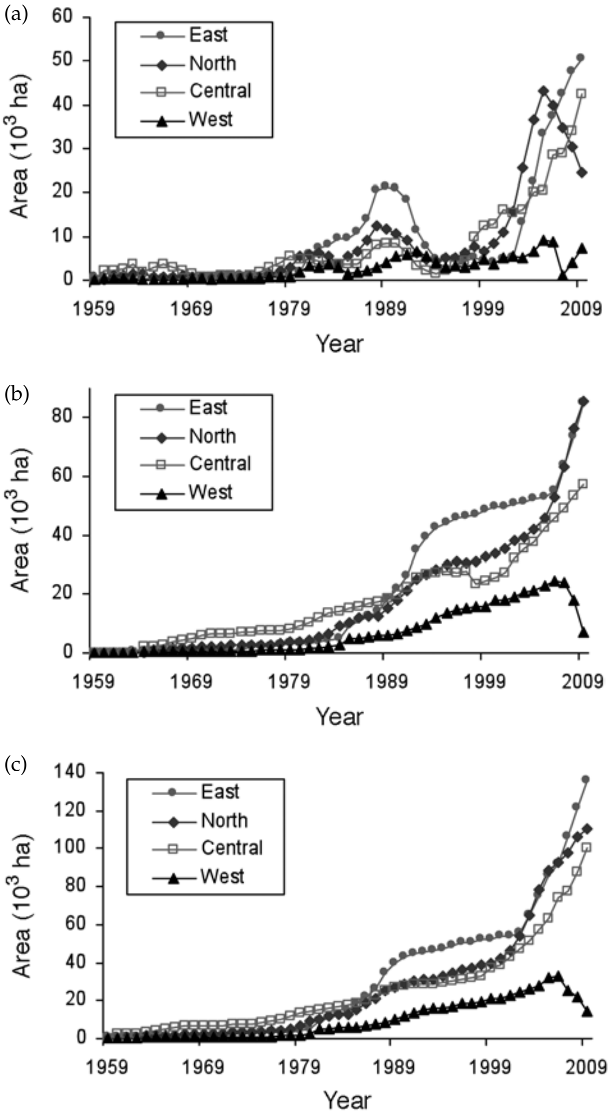
TABLE 3. MEAN AREAS OF OIL PALM IN THE FOUR REGIONS OF COLOMBIA FROM 1959 TO 2009

	Eastern	Northern	Central	Western	Total
			(10^3 ha)		
Immature	9.22	8.39	7.55	2.65	27.81
Mature	21.33	17.92	17.51	7.08	63.83
Total	30.55	26.31	25.06	9.73	91.63

Source: Bossi and Ochoa (1998), FEDEPALMA (2010 and earlier editions).

OIL PALM AGE DISTRIBUTION

From past records of changes in oil palm area, it is possible to determine the age distribution of palms present both nationally and in individual regions,



Source: FEDEPALMA (2010 and earlier editions).

Figure 2. Changes in (a) immature, (b) mature and (c) total oil palm planted area in the four regions of Colombia from 1959 to 2009.

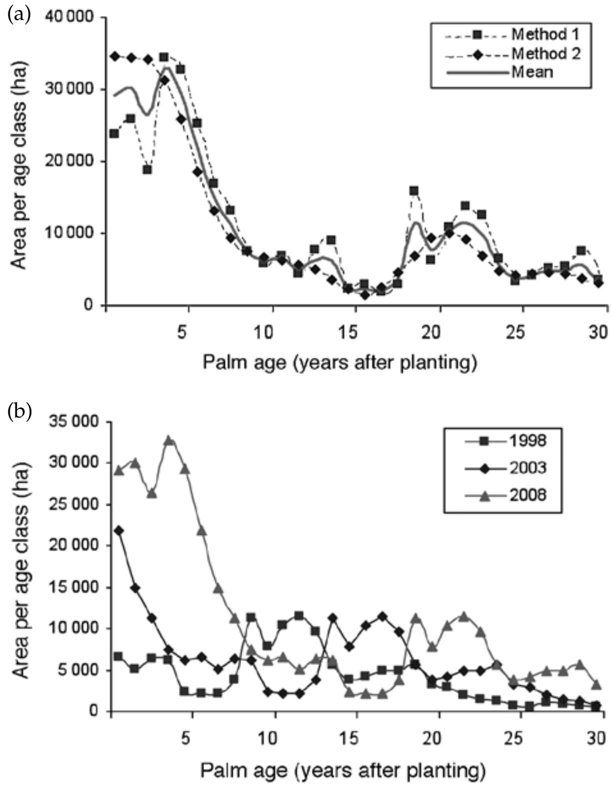


Figure 3. (a) Oil palm area vs. *age distribution in Colombia in 2008 as determined by two methods (Henson, 2003). (b) Oil palm area* vs. *age distribution in Colombia in 1998, 2003 and 2008 (means of the two methods). A 30-year replanting cycle is assumed.*

in different years, provided sufficient previous data are available. Changes in age distribution influence mean yields, and can to some extent be used to predict future yield trends, as well as to explain changes in past yields, and to derive mean standing biomass estimates needed to assess carbon sequestration (Henson *et al*., 2011).

Procedures used previously for Malaysia (Henson, 2003; 2009) were adopted to calculate the age distribution. Two methods had been developed. In Method 1, the age distribution in any year is calculated directly from past planting records by assuming replanting schedules of 20, 25 or 30 years. A replanting cycle of 30 years is assumed as the standard case. In Method 2, the area replanted annually is estimated from the area of immature palms present each year combined with the estimated period of immaturity from planting to first harvest.

Figure 3a shows the age distribution for the whole country in 2008, in which young plantings below eight years dominate the profile. This tendency was less evident in the earlier years as indicated in *Figure 3b*.

Age distributions within the regions in 2008 are shown in *Figure 4*. There are similarities in all the regions apart from the western, for which area estimates are less precise due to the smaller areas involved.

These area data lend support to the reason advanced for the lower yields in recent years, being at least partly due to increases in the proportion of lower yielding younger palms (FEDEPALMA, 2009). However, as there are no precise data relating mean yield to age on either a regional or a national basis, this interpretation remains to be confirmed. There is no indication that the area of old palms (>25 years) has recently increased, although this is likely to be the case within the next five years as palms in the 20- to 23-year age class become 25 years or older.

The mean palm ages calculated for the different regions using 20-, 25- and 30-year replanting cycles for 1998, 2003 and 2008 are given in *Table 4*, and these data support the contention that the mean age has tended to decrease over time.

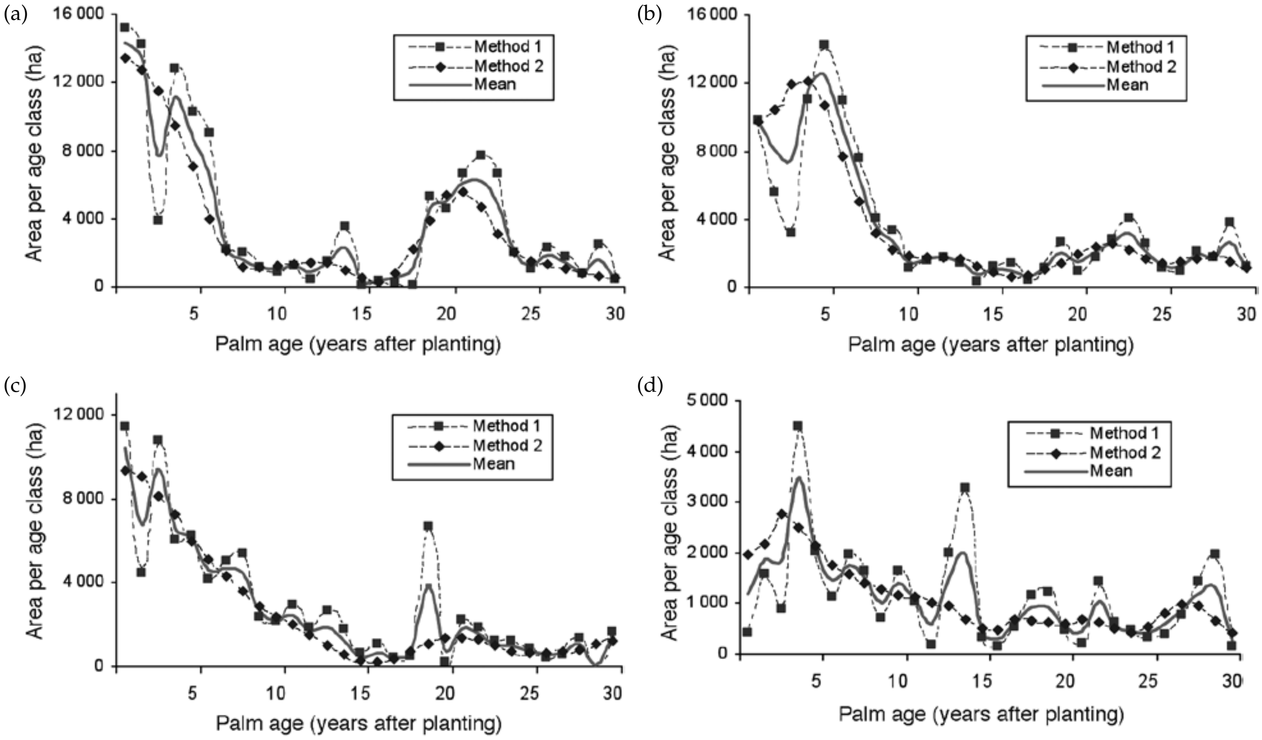


Figure 4. Oil palm area vs. *age distribution in 2008 in (a) eastern region, (b) northern region (c) central region and (d) western region, as determined by the two methods.*

TABLE 4. MEAN OIL PALM AGE IN THE FOUR REGIONS IN 1998, 2003 AND 2008 CALCULATED FOR THREE REPLANTING CYCLE TIMES (RCT)[a]

RCT (years)	Year	Eastern	Northern	Central	Western	Total
		Age (years)				
20	1998	10.81	11.25	9.90	9.80	10.59
	2003	11.26	7.82	7.70	7.97	8.92
	2008	6.05	6.05	6.21	8.18	6.39
25	1998	11.19	12.01	11.51	10.49	11.37
	2003	12.85	10.41	9.21	11.03	10.96
	2008	9.25	7.96	7.94	9.48	8.70
30	1998	11.68	12.25	12.03	10.74	11.75
	2003	13.25	11.05	10.63	11.68	11.55
	2008	10.36	9.74	8.67	12.11	10.11
Mean	1998	11.23	11.84	11.15	10.34	11.24
	2003	12.45	9.76	9.18	10.23	10.48
	2008	8.55	7.92	7.61	9.92	8.40

Note: [a]values are means of data from the two methods for estimating replanted areas.

PRODUCTION OF FRESH FRUIT BUNCHES, PALM OIL, PALM KERNELS AND THEIR COMPONENTS

Data on the production in Colombia of fresh fruit bunches (FFB) and the major products of milling [palm oil (PO), palm kernel (PK), palm kernel oil (PKO) and palm kernel cake (PKC) or meal] are either lacking or imprecise for years prior to 1985. Thus, records of PO production, available from 1967 (Bossi and Ochoa, 1998), were used to calculate FFB and other production data based on extrapolations of extraction ratios observed in later years. (These displayed highly significant linear trends with positive slopes.) The amounts of all the products increased steadily over time (*Figure 5*) due to increases in both mature planted area (*Figure 1*) and, to a lesser extent, in yield per unit area.

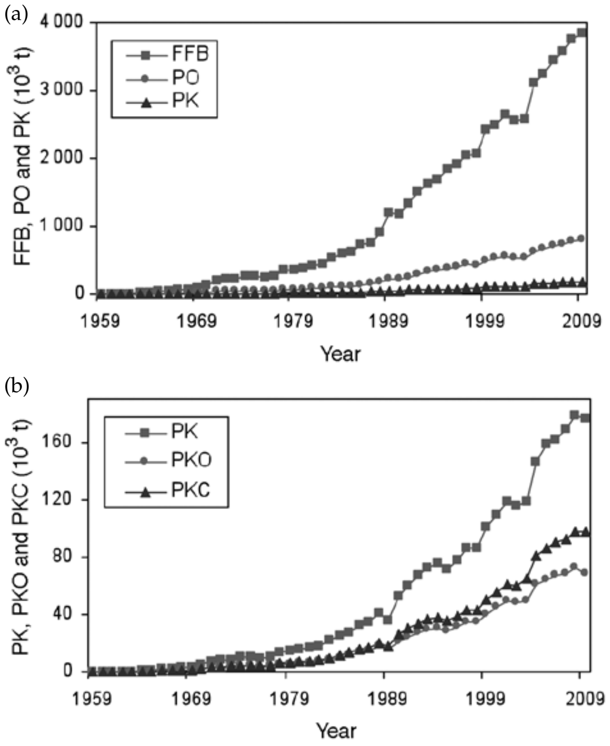
The yields per hectare of FFB, PO and PK shown in *Figure 6* (restricted to 1985 onwards due to the aforementioned uncertainties in production data) have increased steadily over time with highly significant (P<0.001) positive trends. Mean yields for the different regions are given in *Table 5*.

Comparing regions, mean FFB and PO yields per hectare from 1985 to 2009 were highest in the central region, followed by the northern, western and eastern regions, respectively. The trend in relative

TABLE 5. MEAN YIELDS OF FRESH FRUIT BUNCHES (FFB), PALM OIL (PO) AND PALM KERNEL (PK) IN DIFFERENT REGIONS OF COLOMBIA FROM 1985 TO 2009

Product	Eastern	Northern	Central	Western	Total[a]
	(t ha^{-1})				
FFB	14.72	16.88	19.23	15.03	16.51
PO	3.03	3.44	3.83	3.06	3.35
PK	0.66	0.76	0.89	0.63	0.73

Note: [a]weighted for differences in area.
Source: FEDEPALMA (2010 and earlier editions).



Source: FEDEPALMA (2010 and earlier editions).

Figure 5. Changes in (a) fresh fruit bunch (FFB), palm oil (PO) and palm kernel (PK) production in Colombia from 1959 to 2009, and in (b) PK, palm kernel oil (PKO) and palm kernel cake (PKC) production over the same period.

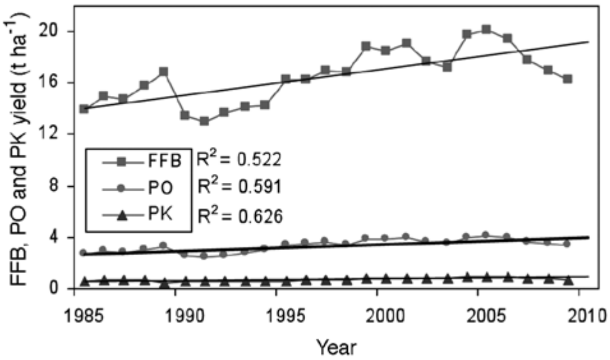


Figure 6. Changes in mean yields per hectare for Colombia of fresh fruit bunches (FFB), palm oil (PO) and palm kernel (PK) from 1985 to 2009 together with fitted linear regressions.

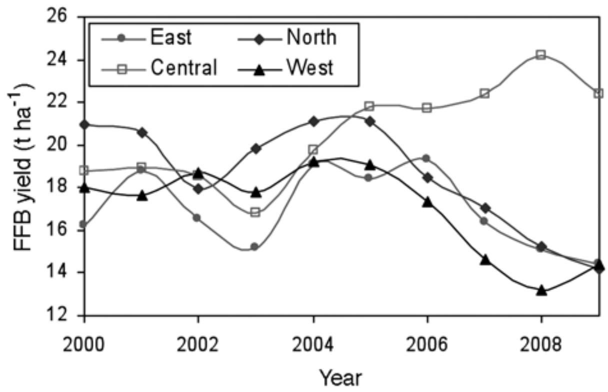
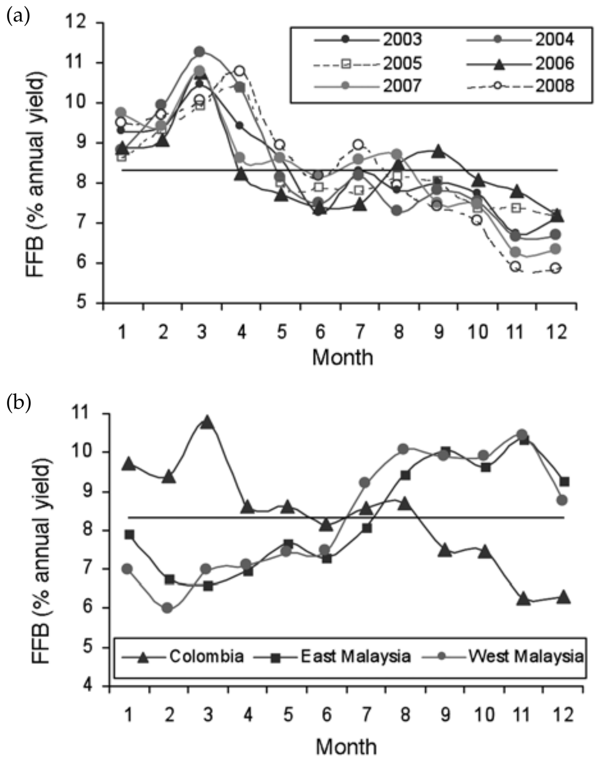


Figure 7. Changes in mean fresh fruit bunches (FFB) yield per hectare in the different regions between 2000 and 2009.



Source: MPOB (2008), FEDEPALMA (2009).

Figure 8. Monthly fresh fruit bunches (FFB) yields as a percentage of annual yield in (a) Colombia from 2003 to 2008 (all regions combined), and in (b) Colombia, West Malaysia and East Malaysia in 2007. Horizontal lines indicate yield in the absence of seasonal variation.

PK yields was similar except that the mean yield in the eastern region was greater than that in the western. Since 2005, there has been a decline in FFB yields in the northern, western and eastern regions (*Figure 7*), most probably due to an increased spread of bud rot disease (FEDEPALMA, 2009). In contrast, the yields in the central region have increased during this time, although this could soon change, again due to an increase in bud rot.

The mean FFB, PO and PK yields in Colombia were lower than those in Malaysia, which from 1985 to 2009 averaged 18.94, 3.69 and 1.05 t ha^{-1}, respectively (MPOB, 2010).

SEASONAL VARIATIONS IN OIL PALM BUNCH PRODUCTION

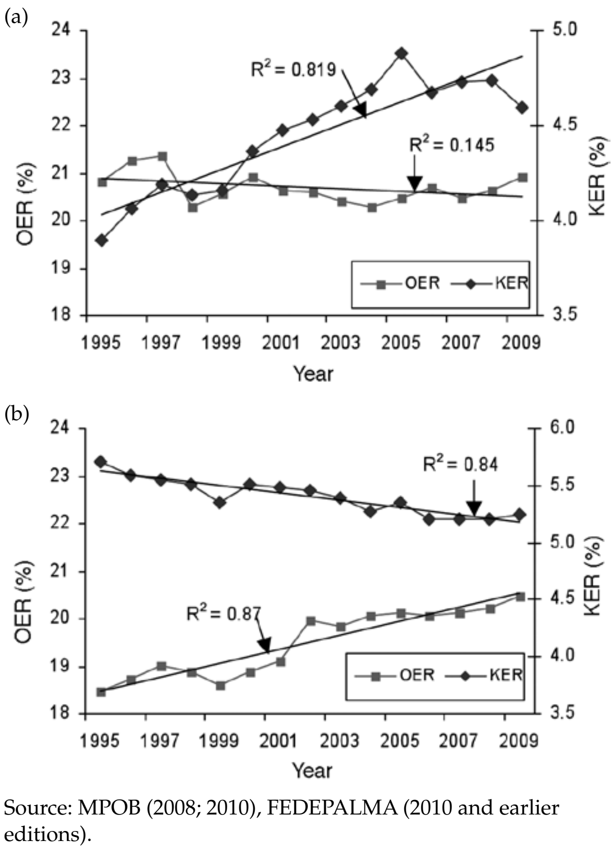
Thus far, only annual yield data have been examined. However, FFB production varies within a year. The extent of this seasonal variation is important as it affects the operations of both the plantation and the mill, and can lead to inefficiencies in both labour and machinery deployment.

Seasonal variation in bunch production is common in all producing countries, but the pattern varies with climate and location. In Colombia, peak FFB production occurs in March or April (*Figure 8a*), whereas in Malaysia and Indonesia the peak is in the latter half of the year (*Figure 8b*), most commonly in September (Henson and Mohd Haniff, 2004).

There are no yield data available with which to compare the mean regional patterns of yield variation in Colombia, but data from individual estates in Colombia and Malaysia (Henson and Mohd Haniff, 2004) suggest that there may be regional differences. In one planting in the northern region, peak FFB yields over 12 years occurred in June and July, while in an eastern estate the peak was in May. Only in the western region did the distribution reflect the national average.

PALM OIL AND PALM KERNEL EXTRACTION RATES

Prior to 1995, Colombian PO and PK yields were estimated assuming nominal extraction rates (ER). Actual ER for individual regions only became available from 1995 onwards. The trends since then in oil extraction rate (OER) and kernel extraction rate (KER) (*Figure 9a*) show that whereas KER has steadily increased, OER has tended to fall. Both trends are in direct contrast to those in Malaysia (*Figure 9b*). The reasons for these different trends are unclear, and are likely to involve several factors,



Source: MPOB (2008; 2010), FEDEPALMA (2010 and earlier editions).

Figure 9. Changes in palm oil extraction rate (OER) and palm kernel extraction rate (KER) for (a) Colombia and (b) Malaysia, from 1995 to 2009.

TABLE 6. MEAN EXTRACTION RATES (%) OF PALM OIL (OER) AND PALM KERNEL (KER) FROM 1995 TO 2009

	Eastern	Northern	Central	Western	All regions[a]
OER	21.24	20.48	20.38	20.78	20.69
KER	4.36	4.53	4.69	3.99	4.45

Note: [a] weighted for differences in area.
Source: FEDEPALMA (2010 and earlier editions).

amongst which differences in harvesting practice and planting materials may play a part.

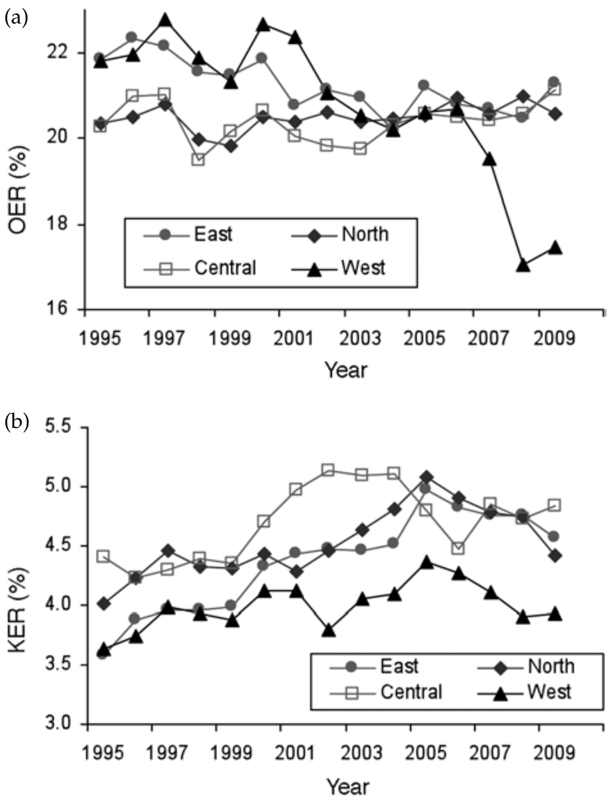
Regional differences in Colombia in mean extraction rates since 1995 are shown in *Table 6*. With the exception of the western region, which showed a substantial fall in OER after 2006, extraction rates have been relatively constant over the years (*Figure 10*). The fall in OER in the western region was not accompanied by any marked change in KER, although there was some decline from a high level in 2005. Regions with the highest OER (eastern and western) had the lowest KER, which is in agreement with the trends over time as shown in *Figure 9a*.

The cause of the low OER in the western region can again be ascribed to an increase in bud rot disease. This is known to lead to a reduction in mesocarp oil content while having little or no affect on kernel content (*Table 7*).

POTENTIAL EXPANSION OF OIL PALM CULTIVATION IN COLOMBIA

As mentioned above, only a very small area of Colombia is currently (2009) occupied by oil palm. Several studies (Romero *et al.*, 1999; Rubiano *et al.*, 2009; Mejia, 2000) have assessed the areas of land that are potentially suitable for oil palm cultivation based on a variety of properties (topographic, edaphic, climatic and socio-economic), and have classified these as having either none, moderate or severe restrictions in terms of their suitability for oil palm. As much as 573 × 10^3 ha of land were identified by Mejia (2000) as having no restrictions, while more than four times this area was classed as having only moderate restrictions (*Table 8*).

Based on these data, a further land area of 213 × 10^3 ha with no restrictions and 2058 × 10^3 ha with only moderate restrictions could be planted with oil palm, representing increases over the area present in 2009 of 59% and 571%, respectively. Most of these areas are in the eastern region with the least in the western. Romero *et al.* (1999) identified even larger areas as being potentially suitable, although these were substantially reduced after socio-economic and other criteria were introduced (Rubiano *et al.*, 2009).



Source: FEDEPALMA (2010 and earlier editions).

Figure 10. Changes in (a) palm oil extraction rate (OER) and (b) palm kernel extraction rate (KER) for the different regions in Colombia from 1995 to 2009.

If yields were to increase as a result of improved management and/or improved planting materials, then total production would increase even more than that resulting solely from increased area. Thus, with a total mature area of, for example, two million hectares and an oil yield of 5 t ha^{-1}, a total output of 10 million tonnes of PO would be possible, which is a substantial increase compared with the 802 000 t produced in 2009. These calculations ignore future changes in factors limiting production such as the further spread of bud rot disease, or inadequate water supply to meet irrigation needs during the dry seasons.

Any expansion in oil palm area will affect other forms of land-use, and will possibly lead to reductions in productivity of other agricultural enterprises. There may also be impacts on biodiversity, carbon stocks, greenhouse gas emissions and other indicators of sustainability that need to be taken into consideration. Such land-use change will be examined in a forthcoming paper (Henson *et al*., 2012).

SUMMARY

The main conclusions arising from the aforementioned data are:

- since the late 1950s, the oil palm planted area has grown steadily, averaging 7069 ha yr^{-1} between 1959 and 2009, with the greatest expansion being in the northern (36.4%),

TABLE 7. EFFECTS OF BUD ROT DISEASE ON FRUIT BUNCH COMPONENTS

Progress of disease	Fruit/bunch	Wet mesocarp/fruit	Oil/wet mesocarp	Oil/bunch	Kernel/bunch
	(% of healthy palm values)				
Initial phase of disease	97.0	96.1	94.9	88.5	111.7
Disease present	95.1	95.8	70.4	63.8	117.5
Some recovery	96.2	94.3	75.2	68.2	126.2
Good recovery	100.3	96.9	84.7	82.4	115.3
High recovery	101.2	97.7	93.1	92.1	110.1

Source: Acevedo *et al*. (2000), Henson (2001).

TABLE 8. AREAS OF LAND IDENTIFIED AS SUITABLE OR MODERATELY SUITABLE FOR OIL PALM IN COLOMBIA

Zone	No restrictions		Moderate restrictions		Potential increase in area over that present in 2009 (10^3 ha)	
	10^3 ha	% total land[a]	10^3 ha	% total land[a]	No restrictions	Moderate restrictions
Eastern	265.3	0.26	1 517.1	1.46	129.5	1 381.2
Northern	228.8	0.22	312.3	0.30	118.5	202.0
Central	14.4	0.01	531.5	0.51	-85.5	431.5
Western	64.5	0.06	57.9	0.06	50.0	43.5
Total	573.0	0.55	2 418.8	2.33	212.5	2 058.3

Note: [a]total land area is assumed to be 103 870 × 10^3 ha.
Source: Mejia (2000), FEDEPALMA (2010).

followed by the eastern (36.2%), central (24.4%) and western (3.1%) regions;
- however, oil palm still occupies only a very small proportion of the existing agricultural area (<0.4%) and less than 14% of the total area that has been identified as being potentially suitable for its cultivation;
- the production of FFB, PO and PK has significantly increased with time due to both area expansion and increase in yield per hectare, although the latter has been limited to some extent by the spread of bud rot disease and other pathogens;
- the extraction rate of PO has tended to decline in recent years while kernel extraction rate has increased;
- there is considerable seasonal variability in monthly FFB production with an amplitude similar to that observed in Southeast Asia but with a different timing of peak production; and
- differences in performance between regions point to the need for a greater understanding and further investigations as to their causes.

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REFERENCES

ACEVEDO, A N J; BURITICA CESPEDES, P; GARCIA NUNEZ, J A and GALVIS DUQUE, N (2000). Economic evaluation of oil losses generated by the bud rot in the Eastern plains of Colombia. *Palmas, 21*: 53-62.

BOSSI, M L and OCHOA, D (1998). *La palma Africana en Colombia, apuntes y memorias (The African Oil Palm in Colombia; Notes and Memories)*. Federación Nacional de Cultivadores de Palma de Aceite, Bogotá, Colombia. Vol. 1. 232 pp.

FEDEPALMA (2010 and earlier editions). *Statistical Yearbook*. Federación Nacional de Cultivadores de Palma de Aceite, Bogotá, Colombia.

HARTLEY, C W S (1988). *The Oil Palm*. 3rd edition. Longman, London. 761 pp.

HENSON, I E (2001). Marco analitico para identificar los factores que determinan las tasas de extraccion de aceite (*Analytical Framework for Identifying Factors Determining Oil Extraction Rates*). *Revista Palmas, 22*: 29-38.

HENSON, I E (2003). The Malaysian national average oil palm: concept and evaluation. *Oil Palm Bulletin No. 46*: 15-27.

HENSON, I E (2009). Modelling carbon sequestration and greenhouse gas emissions associated with oil palm cultivation and land-use change in Malaysia. A re-evaluation and a computer model. *MPOB Technology No. 31*: 116 pp.

HENSON, I E and MOHD HANIFF, H (2004). Seasonal variation in oil palm fruit bunch production: its origins and extent. *The Planter, 80 (937)*: 201-212.

HENSON, I E, RUIZ ROMERO, R and ROMERO, H M (2012). The greenhouse gas balance of the oil palm industry in Colombia. In preparation.

MEJIA, J O (2000). *CENIPALMA internal report*. Centro de Investigación en Palma de Aceite. Bogotá, Colombia.

MPIC (2005). *Statistics on Commodities*. 19th ed. Ministry of Plantation Industries and Commodities, Malaysia. 167 pp.

MPOB (2008 and earlier editions). *Malaysian Oil Palm Statistics*. MPOB, Bangi.

MPOB (2010). http://mpob.gov.my, accessed on 23 June 2010.

PAGIOLA, S; AGOSTINI, P; GOBBI, J; DE HAAN, C; IBRAHIM, M; MURGUEITIO, E; RAMIREZ, E; ROSALES, M and RUIZ, J P (2004). Paying for biodiversity conservation services in agricultural landscapes. *FAO Environmental Department Paper No. 96*. FAO, Rome. 32 pp.

PORIM (1993). Existing and potential oil palm areas in Peninsular Malaysia. *PORIM Occasional Paper No. 29*: 25 pp.

ROMERO, C; MORENO, A and MÚNEVAR, F (1999). *Evaluación edafoclimática de las tierras del trópico bajo colombiano para el cultivo de la palma de aceite. (Edapho-climatic Evaluation of Colombian Tropical Lands under Cultivation for Oil Palm.)* Cenipalma - Corpoica. Santafé de Bogotá. 30 pp.

RUBIANO, D J; CORZO, G; FADUL, M; PALACIOS, A; MARTIN, C; BOOHORQUEZ, E; RAMIREZ, S; GOMEZ, L; SARMIENTO, C and ARCILABURGOS, K (2009). *Zonas ambientalmente aptas para el cultivo de la palma de aceite en Colombia. (Environmentally suitable areas for cultivation of oil palm in Colombia.)* Unpublished manuscript. Ministerio de Ambiente, Vivienda y Desarrollo Rural. Bogotá.