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Optimum Oil Palm (*Elaeis guineensis* Jacq.) Planting Density for West Africa

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Context: Oil palm in Nigeria, West-Africa and the world

- Most productive oil crop with yield potentials of 4-8 tons of oil per hectare
- 21 million hectares worlwide (average yield 3.8t/ha) and 4.1 million in West-Africa (average yield 0.7t/ha) (FAOSTAT, 2016)
- Oil palms are planted for 25-30 years and foliage increases up to 12 years after planting.
- Optimum plant density evolves during the life cycle but can not be changed easily after planting.
- Planting density is essential to maximize yield over the planting cycle.
- For phytosanitary reasons it is preferable to replant at the same density.
- Planting material, ecology and management determine the optimum planting density.
- Need to determine optimal lanting density under different scenarios.

This study presents the results from 12 years of trial in Nigeria with the effects of planting density on growth and production so far as well as extrapolation to the full life cycle.

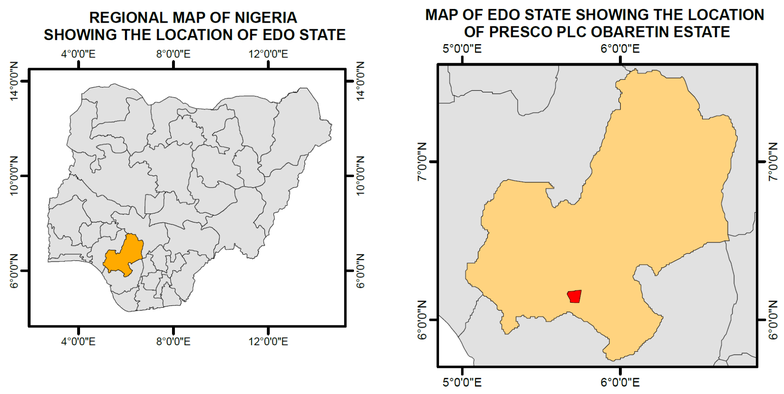

Figure 1: Map of Nigeria and Edo State showing the location of the Presco plc Ologbo estate where the trial was located

Material and methods

- Field trial planted in May 2005 following a simple Fisher block design with 6 treatments, 4 replicates and unit plots of 20 palms surrounded by double borders.
- Trial planted at Obaretin Estate of Presco plc (Fig.1).
- Planting material, soil type and climate are representative of the west-African oil palm regions
- Statistical analysis by ANOVA and comparison by Tukey test for Honest Significant Difference at 5%.

Table 1: Density trial treatments

Treatment	Initial planting density (number of palms per hectare)	Distance between palms (in metres)	Management of planting density
D 1	128	9.5	fixed
D 2	143	9	fixed
D 3	160	8.5	fixed
D 4	180	8	fixed
D 5	180	8	thinned (1)
D 6	205	7.5	fixed

(1) By eliminating every 7th palm at 8 years (one central palm per hexagon)
At eight years (July 2013) the density went from 180 down to 154 p / ha

Results

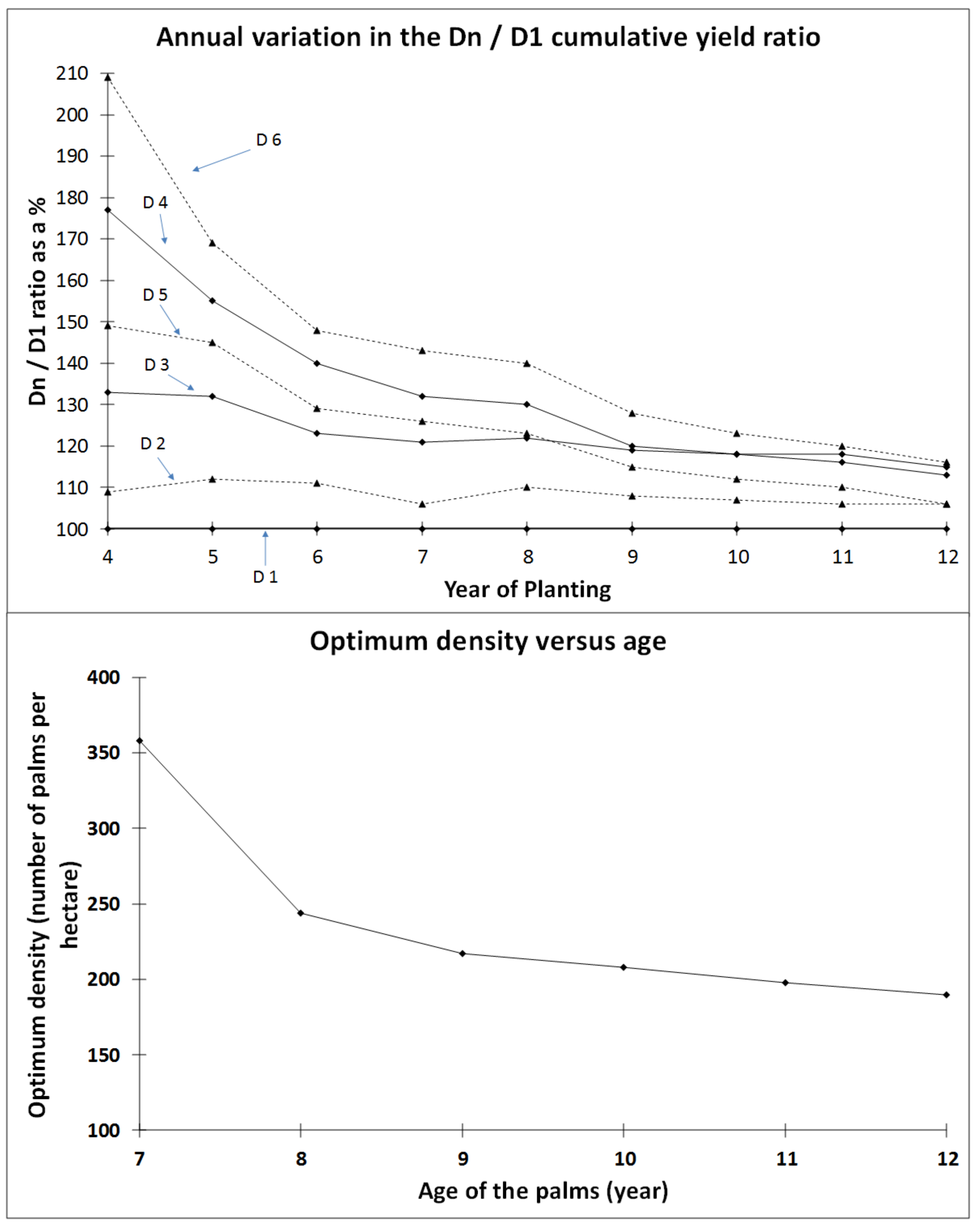

Figure 2: Evolution of annual cumulative yields per density as compared to D1 (A) and evolution of the optimum plantng densitity with age

Table 2: Evolution of annual yield per palm (A) and per hectare (B) with colour code legend (C)

A) Change in annual yield per palm in kg of bunches

	Year after planting								
Treatment	4	5	6	7	8	9	10	11	12
D 1	27.2	34.7	81.0	70.0	110.2^{ab}	125.1^{a}	135.9^{a}	132.6^{a}	148.8^{a}
D 2	27.5	35.8	79.4	61.2	114.4^{a}	117.9^{a}	122.9^{a}	125.3^{ab}	140.9^{a}
D 3	29.9	36.6	75.3	64.6	109.9^{ab}	112.0^{ab}	122.0^{a}	125.3^{ab}	122.0^{ab}
D 4	34.4	33.6	74.2	56.9	98.9^{bc}	83.6^{cd}	106.4^{ab}	102.7^{bc}	103.2^{bc}
D 5	29.9	35.0	66.6	59.8	93.2^{c}	97.5^{bc}	112.4^{ab}	114.8^{abc}	109.2^{bc}
D 6	36.1	29.1	66.6	59.2	91.2^{c}	76.4^{d}	91.2^{b}	88.5^{c}	90.7^{bc}
mean	30.8	34.1	73.9	62.0	103.0	102.1	115.1	114.9	119.2
limit	ns	ns	ns	ns	< 0,05	< 0,01	< 0,01	< 0,01	< 0,01

B) Change in annual yield per unit area in tons of bunches per hectare

	Year after planting								
Treatment	4	5	6	7	8	9	10	11	12
D 1	3.48^{d}	4.44	10.37	8.98	14.11^{b}	16.01	17.40	16.97	19.05
D 2	3.93^{cd}	5.12	11.35	8.75	16.36^{ab}	16.86	17.58	17.91	20.05
D 3	4.78^{bcd}	5.86	12.05	10.34	17.59^{a}	17.92	19.52	20.05	19.53
D 4	6.19^{ab}	6.04	13.35	10.23	17.80^{a}	15.04	19.16	18.49	18.57
D 5	5.38^{bc}	6.30	12.00	10.76	16.78^{a}	15.01	17.32	17.68	16.82
D 6	7.40^{a}	5.96	13.65	12.02	18.69^{a}	15.66	18.69	18.13	18.59
mean	5.19	5.62	12.13	10.18	16.89	16.08	18.28	18.21	18.79
limit	< 0,01	ns	ns	ns	< 0,05	ns	ns	ns	ns

C) Treatment average compared to annual mean (colour code)

Value compared to the year average					
< 80%	80-90%	90-100%	100-110%	110-120%	>120%

Table 3: Evolution of foliage overlap with age for the different planting density treatments

Age of palms (year)			% of foliage overlap					
			7	8	9	10	11	12
D 1	128	9.5	0	1	6	23	21	37
D 2	143	9	3	10	21	39	37	51
D 3	160	8.5	15	28	37	54	55	68
D 4	180	8	36	46	54	68	68	75
D 6	205	7.5	50	61	68	80	81	88
Treatment	Density	Distance						

Conclusions

- Higher planting density gives higher yields in the first years which later drop due to excessive interpalm competition
- Too low a density will not achieve the best yield potential thus underutilizing the land and natural resources
- 12 years after planting the intermediate densities have higher cumulative yields than the highest densities.
- This trend is forcast to continue during the second half of the planting cycle and extrapolations place the optimum density between 143 and 160 palms per hectare for a 25 year cylce.
- Competition for resources between palms is evident through the effect on production.
- More collaborative research in ongoing to further evaluate the different drivers of resource competition so that planting density recommendations can be better adapted to the characteristics of the planting material and environment.

Collaborators

cirad AGRICULTURAL RESEARCH FOR DEVELOPMENT

Presco

200 YEARS GHENT UNIVERSITY

CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE

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References

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