CHAPTER III

VARIATION AND ASSOCIATION OF TRAITS IN THE MPOB-NIGERIAN OIL PALM GERMPLASM

3.1 INTRODUCTION

Oil palm is the world's most productive oil crop in terms of its oil yield. World's production of oils and fats by 2020, has been projected to hit 174 million tonnes and palm oil production to hit 34 million tonnes (Jalani, 2013). By then, palm oil is expected to be the dominant vegetable oil in the world. Oil palm yield has progressed satisfactorily, however most of the commercial planting materials are based on the four palms planted in Bogor. So, it is widely known that the narrow genetic base of the oil palm has been an obstruction to its selection program. As a result of this situation, oil palm genetic materials have been prospected in its area of relative abundance which is believed to be in Africa; especially the area around the gulf of guinea (Corley & Tinker, 2003) and the first of this expedition was mounted in Nigeria (Rajanaidu & Rao, 1987).

The oil palm breeding materials from Nigeria have been promising and the best material from the MPOB-Nigerian collections have been introgressed into existing breeding programmes with particular emphasis on short stems, more liquid oil composition, high carotene content and high kernel yield (Corley & Tinker, 2003). The characterization of these wild genetic materials forms the first step to their efficient usage.

Furthermore, there is need to deepen the effort of breeding and improvement through genetic variability to make sure that high yielding breeding materials are available for cultivation (Baukoume & Louise, 2007).

Knowledge of genetic variability and relation among oil palm germplasm materials is also crucial for selection of promising breeding materials because it exposes and dictates resource allocation to the promising breeding material. The existence of genetic variability in germplasm also helps facilitate the breeding efficiency and outcome of this will be high selection benefit (Abdullah et al., 2011).

In plant breeding, it is also fascinating to measure relationship between traits. This is frequently done through the calculation of correlation coefficient, which measures the direction and strength of the linear relationship between two quantitative variables. It is written as r and it is always a number between -1 and +1. It is positive when two variables vary in the same direction and negative when in the opposite direction, i.e. if one character increases, the other character will decrease (Moore et al., 2013). According to Falconer (1981) the correlation coefficient is important to determine the measures of selection.

Thus, the objectives of this chapter were to determine the extent of variation and evaluation of correlation coefficient in the yield, agro morpho-physiological traits and oil quality traits in the MPOB-Nigerian *dura* oil palm populations.

3.2 MATERIALS AND METHODS

3.2.1 Plant Breeding Material

The Malaysian Agricultural Research and Development (MARDI) and the Nigerian Institute for Oil Palm Research (NIFOR) in 1973 jointly made collections of oil palm genetic materials in Nigeria to broaden the genetic base of the oil palm. The Nigerian oil palm germplasm was collected at 45 sites (45 populations) (Table 1, Figure 1), with an average of 20 palms per site and 200 seeds per palm. A total of 919 (595 *duras* and 324 *teneras*) open-pollinated bunches were harvested during this collection (Rajanaidu & Rao, 1987). The prospected oil palm breeding materials were planted using eight cubic lattice design on September, 1975 and identified as Trial 0.149 (Rajanaidu & Rao, 1987) at MPOB Station, Kluang, Malaysia. Kluang is characterized by Rengam soil series and a rainfall of about 2500 mm/yr. However, only the *dura* Nigerian oil palm breeding materials were selected for the purpose of this research.

3.2.2 Data Collection

Data collections were carried out for bunch yield, bunch quality components, morphological traits, physiological traits and fatty acid composition.

3.2.2.1 Yield and Yield Components

Harvesting of oil palm usually begins at 36 months after field planting with subsequent operations carried out at regular intervals of seven to ten days, i.e. three rounds in a month. Data on yield and yield components were evaluated from 1982 – 1986. The bunch yield components were fresh fruit bunch (FFB), bunch number (BNO), and average bunch (ABW) **(APPENDIX A)**.

3.2.2.2 Bunch Analysis

Data on bunch analysis were evaluated from 1982 - 1987. Bunch and fruit components were determined using the bunch analysis technique developed by Blaak et al. (1963) (**APPENDIX B1)**. The bunch quality components included fruit to bunch (F/B), oil to bunch (O/B), kernel to bunch (K/B), oil yield (OY), kernel yield (KY), total economic product (TEP), etc. (**APPENDIX B2).**

Figure l: Map of Nigeria showing collection sites and annual rainfall (Ithnin et al. 1996)

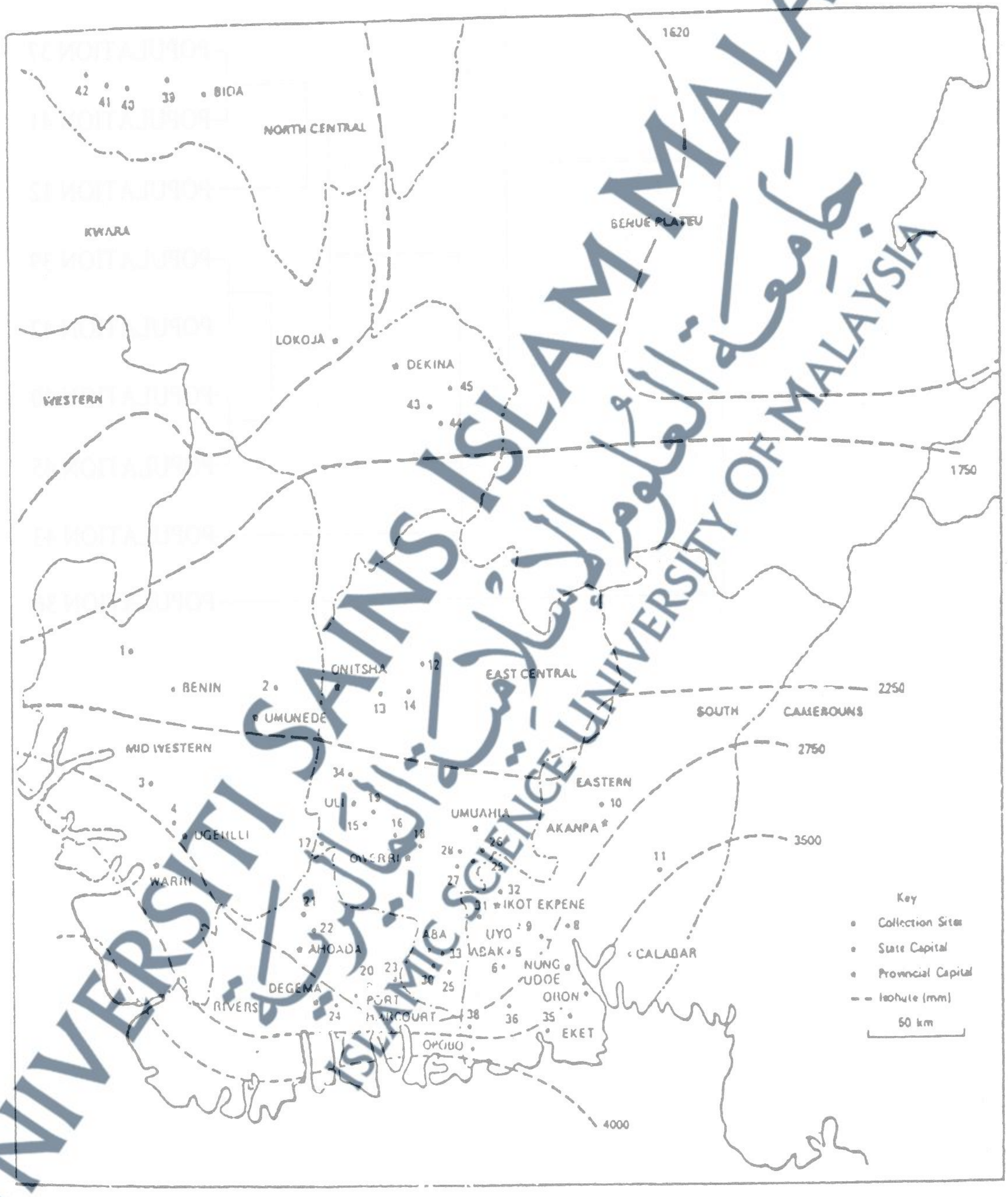

Table 1: Collection sites of the MPOB-Nigerian germplasm materials (Ithnin et al., 1996)

STATE	AREA	SITES	
Middle East	Benin	Iyowa	(01)
	Asaba	Umenda	(02)
	Sapele	Amukpe	(03)
	Ughelli	Ogubi	(04)
South East	Abak	Ikot Okpong	(05)
		Ikot Okoro	(06)
		Ikot Ikan	(07)
		Nung Udoe	(08)
	Ikot Ekpene	Ebok Ndiya	(09)
		Ikot Inemme	(31)
		Ikot Anwana	(32)
	Calabar	Akampa	(10)
		Kwa Falls	(11)
	Eket	Ibono	(35)
		Ikot Okudom	(36)
	Oron	Ebighi Anwa	(37)
	Opobo	Obong	(38)
Middle West	Uda	Umuabi	(12)
	Akwa	Ugwuoba	(13)
		Ufuma	(14)
	Uli Ihiala	Umuaku	(15)
		Ndinyineji	(16)
		Eziama	(19)
		Iseke	(34)
	Owerri	Egbema	(17)
		Aboh-Mbaise	(18)
	Aba	Abala	(25)
		Owo-Ahiafor	(30)
	Umahia	Okwe	(26)
		Ahaba	(27)
		Oloko	(28)
		Mbarrabo	(29)
Rivers	Port Harcort	Umuchrughe	(20)
		Iriebe	(23)
	Degema	Degema	(24)
	Ahoada	Abarigbo	(21)
North West	Bida	Batati	(39)
		Vabiti	(40)
		Labozhi	(41)
		Takuma	(42)
Kwara	Ayangba	Ayangba	(43)
		Ogbalato	(44)
		Ologba	(45)

( ) Indicates the population code of the collected Nigerian oil palm germplasm

3.2.2.3 Vegetative Measurements and Physiological Traits

The vegetative measurements were evaluated eight years after field planting. Frond production was first calculated after the 7th year before other parameters were taken a year after. Data were pooled in 1983. Physiological parameters were estimated based on measurements on pooled data of bunch yields and bunch quality components, following the methods developed by Squire (1986). Data on physiological characters were evaluated in 1986 (**APPENDIX C**).

3.2.2.4 Oil Quality Traits

Oil quality traits were evaluated from 198 - 1997. The fatty acid composition was evaluated using the method proposed by Timms (1978) for routine analysis using Gas chromatography (**APPENDIX D**).

3.2.3 Data Analysis

In order to know the extent of variation in the germplasm materials, secondary data collected was based on population basis and was computed using the Statistical Analysis System (SAS). Simple descriptive statistics for each trait such as mean, standard deviation, standard error, variance, minimum, maximum and coefficient of variation were computed through the MEANS procedure (PROC MEANS) of SAS. Using the “bivariate correlation” option in SPSS (Version 21), Pearson’s correlation coefficients were computed and a two tailed test of significance was applied. The coefficient of correlation was analyzed to evaluate the relationship among the different variables in the MPOB-Nigerian germplasm under study. The correlation of coefficient is written as r and the values for the first variable are x_1 and y_1, the values for the second trait are x_2 and y_2, and so on. The means and standard deviation of the two variables are $\bar{x}$ and $(x_i - \bar{x})$ for the x-values and, $\bar{y}$ and $(y_i - \bar{y})$ for the y value. The correlation *r* between *x* and *y* is given as;

$$r = \frac{\sum (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^{n} (x_i - \bar{x})^2 \sum (y_i - \bar{y})^2}} \qquad (1)$$

3.3 RESULTS

3.3.1 Variations in Traits

There were variations in the all the quantitative traits recorded in the oil palm germplasm prospected in Nigeria. Overall variations of all the traits are presented in Table 2. High variations were recorded on myristic acid (C14:0), oil yield (OY), kernel yield (KY), Bunch number (BNO), mean nut weight (MNW), total economic product (TEP), palm height (HT) and mean fruit weight (MFW) (43.65, 35.03, 33.88, 31.31, 31.14, 30.92, 30.42, 30.32 % respectively). Variations of above 20 % were also recorded on average bunch weight, fresh fruit bunch, petiole cross section, bunch dry mass, vegetative dry mass, leaf area, leaf area index, kernel to bunch, kernel to fruit, total dry mass and oil to bunch. Low levels of variation were recorded in other traits especially for oil to dry mass (ODM) and iodine value (IV) at 5.54 and 4.86 % respectively.

3.3.1.1 Variations in Yield and Yield Components

Grand mean for yield and yield components showed FFB had 149.86 kg/palm/yr, with BNO having 13.24 bunches/palm/yr and average bunch weight of 11.93 kg/palm/yr.

Among the 44 oil palm populations (Table 3), NGA 12 gave the highest *dura* FFB yield of 190.29 kg/palm/yr, with BNO of 17.23 bunches/palm/yr and average bunch weight (ABW) of 11.23 kg/palm/yr, more than 26.98 % above the grand mean. High FFB yields were also observed in populations; NGA 14 (174.18 kg/palm/yr), NGA 37 (167.99 kg/palm/yr), NGA 13 (166.51 kg/palm/yr), NGA 16 (166.92 kg/palm/yr), NGA10 (163.75 kg/palm/yr), NGA 35 (163.01 kg/palm/yr), NGA 11 (162.55 kg/palm/yr), NGA 7 (160.60 kg/palm/yr) and NGA 17 (160.42 kg/palm/yr). On the other hand, lowest FFB yields were observed in NGA 39 (97.69 kg/palm/yr), NGA 40 (100.74 kg/palm/yr), NGA 41 (105.44 kg/palm/yr) and NGA 42 (104.39 kg/palm/yr), more than 29.65 % below the grand mean of FFB of all the populations.

3.3.1.2 Variations in Bunch Quality Components

As indicated in Table 2, the mean value for mean fruit weight (MFW), mesocarp to fruit (MF), kernel to fruit (KF), oil to bunch (OB), oil yield (OY), kernel yield (KY) and total economic product (TEP) were 9.32 %, 44.93 %, 12.7 %, 14.65 %, 8.21 %, 22.17 (kg/palm/yr), 12.22 (kg/palm/yr) and 29.50 (kg/palm/yr) respectively. As presented in Table 4, population NGA 37 had the highest score for mean fruit weight with 11.95 g while population NGA 41 scored lowest with 6.11 g. Populations NGA 16 and 19 had the highest mean score for mesocarp to fruit with 49.82 and 49.33 % respectively while population NGA 41 got the lowest with 37.93 %. In terms of the oil yield and total economic product, highest mean scores were recorded for population NGA 12 with 30.12 (kg/palm/yr) and 38.52 (kg/palm/yr) respectively, while lowest oil yield and total economic product were got by population 42 with 12.58 (kg/palm/yr) and 18.84 (kg/palm/yr) respectively. Lowest total economic product was also recorded for population NGA 39 with 18.84 (kg/palm/yr).

3.3.1.3 Variations in Vegetative Traits

Mean values for vegetative traits for all the populations is presented in Table 5. A range of variations can also be seen in the vegetative traits. Highest frond production was recorded for population NGA 41 (31.27 fronds/yr, equivalent to 2.6 fronds/month). Populations NGA 40 and NGA 39 also showed high frond production with 31.26 and 30.69 fronds/yr respectively while the lowest frond production was exhibited by NGA 44 with 25.20 fronds/yr, equivalent to 2.1 fronds/month. Populations with lowest petiole cross section (PCS) and rachis length (RL) include populations NGA 39 (9.79 cm^3, 3.56 m), NGA 40 (10.87 cm^3, 3.63 m), NGA 41 (9.9 cm^3, 3.50 m) and NGA 42 (10.90 cm^3, 3.60 m).

High trunk height (HT) and trunk diameter (DIAM) were recorded for NGA 35 (1.49 m) and NGA 01 (0.75 m) respectively while short trunk height was showed by NGA 13 (0.91 m) and smaller trunk diameter exhibited by NGA 15, NGA 39 and NGA 42 (0.63 m). Considerable amount of variation was also found in leaflet length (LL) and leaflet width (LW). NGA 14 (87.76 cm) and NGA 3 (4.78 cm) had the highest LL and LW respectively while NGA 41 had the shortest LL and LW (67.51 cm and 3.68 respectively). Leaf Area (LA), a derived component of LL, LW and LN had the highest with NGA 20 with 7.50 cm^3 and lowest with NGA 41 with 4.25 cm^3.

3.3.1.4 Variations in Physiological Traits

Mean scores of physiological traits for the MPOB-Nigerian germplasm are presented in Table 6. The interception of radiation (*f*) depends on the leaf area interception (LAI) and there was no much variation among the populations. Also, there was no marked difference in mean values for bunch index (BI), radiation conversion efficiency (*e)* and net rate assimilation (NAR). Highest score for bunch dry mass was recorded for NGA 12 (15.22 tonnes/ha/yr) while lowest score was recorded for population 39 (7.84 tonnes/ha/yr). Vegetative dry mass (VDM) and total dry mass (TDM) recorded highest with NGA 20 (10.50 tonnes/ha/yr) and NGA 35 (23.32 tonnes/ha/yr) respectively while lowest value for these traits was by NGA 39 (6.86 and 14.69 tonnes/ha/yr).

3.3.1.5 Variations in Oil Quality Traits

The means score for all MPOB-Nigerian populations are presented in Table 7. As presented in Table 2, the iodine value (IV) had the lowest variation (4.86 %) as compared to other traits. There was also no variation for lauric acid (C12:0) and palmitoleic acid (C16:1). However, there was high variation for myristic acid (C14:0). There was also variation in stearic acid (C18:0) and linoleic acid (C18:2). For IV content and C18:1, NGA 02 had the highest value followed by NGA 19 and for C18:0, NGA 19 had the highest value followed by NGA 02. NGA 34 had highest value for C12:0 while NGA 39 had value for C14:0 followed by NGA 34. For C16:0, highest value was recorded for NGA 12 followed by NGA 13.

3.3.2 Correlation of Traits

The correlations among the 43 yield, bunch quality, vegetative, physiological and oil quality traits are presented in Table 8. Fresh fruit bunch (FFB) exhibited strong and positive correlations with average bunch weight (ABW) (r = 0.718), mean fruit weight (MFW) (r = 0.709), mesocarp to fruit (MF) (r = 0.808), oil to bunch (OB) (r = 0.731), oil yield (OY) (r = 0.946), oil to dry mass (ODM) (r = 0.515), total economic product (TEP) (r = 0.964), petiole cross section (PCS) (r = 0.709), rachis length (RL) (*r* = 0.822), leaflet length (LL) (*r* = 0.787), leaf width (LW) (*r* = 0.572), leaflet number (LN) (*r* = 0.735), leaf area (LA) (*r* = 0.732), leaf area index (LAI) (*r* = 0.732), bunch dry mass (BDM) (*r* = 0.992), vegetative dry mass (VDM) (*r* = 0.390), total dry mass (TDM) (*r* = 0.902), bunch index (BI) (*r* = 0.719), radiation conversion efficiency (*e*) (*r* = 0.856) and fractional interception of radiation and (*f*) (*r* = 0.784), but no positive significant correlation with parthenocarpic fruit to bunch (PB), oil to wet mass (OWM), fruit to bunch (FB), trunk diameter (DIAM).

Also, FFB had strong negative correlation with kernel to fruit (KF) (*r* = -0.712), shell to fruit (SF) (*r* = -0.696), kernel to bunch (KB) (*r* = -0.714) and frond production (FP) (*r* = -0.692), but negative non-significant correlation with number of bunches (BNO), palm height (HT), net assimilation rate (NAR) and no significant correlation between FFB and oil quality traits. BNO showed strong positive correlation with bunch index (BI) (*r* = 0.375) and strong negative correlation with ABW (*r* = -0.740), MNW (*r* = -0.398), FB (*r* = -0.414), PCS (*r* = -0.612), RL (*r* = -0.432), LL (*r* = -0.524), LW (*r* = -0.509), LN (*r* = -0.402), HT (*r* = -0.466), LA (*r* = -0.538)and LAI (*r* = -0.538). Average bunch weight (ABW) showed strong correlations with all traits except with PB, OWM, LAR, BI and oil quality traits.

Furthermore, among the vegetative traits there were significant correlations (*r* between 0.394 - 0.947) except for petiole cross section (PCS) with leaf area ratio (LAR) and palm height (HT). Also, among the physiological traits, there were significant correlations (*r* between -0.348 - 0.903) except for net assimilation ration which had no significant correlations with most of the traits. Correlations between vegetative traits and physiological traits were also observed. In addition, IV had negative correlations with BNO (*r* = -0.324), PB (*r* = -0.342), BI (*r* = -0.299), C12:0

(*r* = -0.477), C14:0 (*r* = -0.645) and C16:0 (*r* = -0.799) while it had positive significant correlations with C18:0 (*r* = 0.555) and C18:1 (*r* = 0.727). C12:0 in turn had significant negative correlations with DIAM (*r* = -0.298), C18:0 (*r* = -0.330) and C18:1 (*r* = -0.419). C14:0 was positively correlated with C12:0 (*r* = 0.782) and C16:0 (*r* = 0.537) while it showed negative correlations with C18:0 (*r* = -0.646) and C18:1 (*r* = -0.740). C16:0 had positive significant correlations with BNO (*r* = 0.304), OWM (*r* = 0.358), C14:0 (*r* = 0.537) C18:0 (*r* = 0.771) and C18:1 (*r* = 0.793) and negative significant correlations with IV (*r* = -0.799). Negative correlations also existed between C18:1 and OWM (*r* = -0.401). There was no association between C18:2 with any of the traits.

3.4 DISCUSSION

Existence of variations observed in the traits of the MPOB-Nigerian *dura* oil palm germplasm is requisite and important for effective selection of oil palm accessions with high yield and yield component characters. This observation follows a similar pattern with the findings of Sapey et al. (2012) who discovered variation for both qualitative and quantitative traits assessed on the accessions of oil palm collected in the Northern Regions of Ghana. Okoye et al. (2009) also reported significant genetic variability traits in Deli *dura* x *tenera* oil palm progenies in Nigeria and suggested that selections based on those traits will produce good response if their variability could be exploited in the population. In addition, Kushairi et al. (1999) also recorded wide variations for bunch yields, bunch quality components and morpho-physiological traits among 52 *dura* x *pisifera* (D x P) progenies. Marhalil et al. (2013) also found great variability among the elite germplasm of MPOB-Nigerian *dura* x AVROS *pisifera*.

Analysis of variance performed on the traits among the Nigerian oil palm germplasm materials by Rajanaidu and Rao (1988), reported significance differences between populations and families for most traits except for some of the fatty acid traits. The FFB yield is a function of BNO produced annually and ABW. The high FFB yield in NGA 12 was attributed to the high and balanced BNO (17.23 bunches/palm/yr) and ABW (11.23 kg/bunch). On the other hand, the low FFB yield attributed to NGA 39, NGA 40, NGA 41 and NGA 42 was also due to their lowest ABW and also could be due to their collection from dry areas in Nigeria. Rajanaidu and Rao (1987) also reported population NGA 12 to be the highest FFB yielding population and population 39, 40, 41 and 42 to be of the lowest yields.

The range of mesocarp to fruit (MF) was 26.33 – 64 %; this is because all oil palm germplasm accessions used in this research were of the *dura* type. Sapey et al. (2012) also reported 29.40 – 52.63 % of mesocarp to fruit ratio for *dura* fruit type. The percentage of fruit to bunch (FB) is an important yield factor which increases the proportion of the economic part in the FFB. The fruit quality components, mesocarp to fruit ratio (M/F), shell to fruit ratio (S/F) and kernel to fruit are the relative proportion of mesocarp, shell and kernel to fruit (Hartley, 1988). The oil yield also depends on a number of components; fresh fruit bunch yield, bunch and fruit quality traits. The total economic product, which is the sum of oil yield and kernel yield would be high from bunches of both high mesocarp and kernel (K/B) contents. When high MF, K/B and F/B are combined with high O/B and FFB, yields would be likely increased (Kushairi et al., 1999). Therefore, populations that are high in all these traits would make good selection for high yielding breeding programme.

Short palm height is usually favored in oil palm breeding for ease of harvesting. Asides from this, short height and short diameter of trunk is also preferred as they prolong the economic life of the palm and ease of nutrient being channeled for FFB production (Sapey et al., 2012). Populations with short trunk height can be selected for breeding palms with short height. Also, in oil palm, frond production determines the limit to bunch production as the inflorescence is embedded at the frond axil and each frond subtends only one inflorescence that can potentially be male or female. Palms with low petiole cross section and rachis length are also preferred and can be used in selection programme as they may increase the planting density per hectare. The leaf area index (LAI) is also an important crop, it determines the light interception. It also depends on the mean area of individual fronds, number of fronds per palm and planting density. Therefore, variations in LAI is desirable as long as it is not achieved by planting at high a high density (Henson & Chang, 2000).

Crop yield depends on both total dry matter production and the proportion of dry matter directed into the harvested portion of the crop. The small difference observed between the means of vegetative dry matter (VDM) and bunch dry matter (BDM) would suggested a balanced partitioning of assimilates without competition (Kushairi et al., 1999). The general low levels of variation observed in other traits and also in oil quality suggest little potential for their improvement through selection in the Nigerian germplasm materials collected. Arasu et al. (1987) reported low level of variation in the fatty acid composition of the MPOB-Nigerian oil palm population. However, substantial variation found in some of the oil quality traits can be used for improvement programme.

Furthermore, the correlation studies performed which showed positive and significant relationship between FFB and other yield related traits suggests that selection established on high FFB will automatically enhance and determine the performance of the yield and vegetative traits in palms. This result tallies with the outcome of the research conducted by Marhalil et al. (2013) who found positive and highly significant association between FFB with yield and vegetative traits. There was no significant association between BNO with FFB and BNO for the oil palm populations studied in this research. This can even be observed in population 39, 40, 41 and 42 despite the fact that they had high number of bunches (BNO), they had FFB yield. However, this result contradicts the results from Marhalil et al. (2013) and that of Okoye et al. (2009) who found strong and positive association between FFB and BNO. Also, strong negative association between BNO and ABW was found and was in accordance with results of Marhalil et al. (2013) and Okoye et al. (2009).

According to Oboh and Fakorede (1999), the negative association between BNO and ABW might have turned out because some climatic factors that were unfavourable to the expression of BNO favour ABW. The highly negative significant association between K/F and S/F to M/F is an extra source of variation for O/B. This is because an increase in kernel size leads to increase in shell size; thus, a decrease in the mesocarp content of the fruit. This result tallies with that of Okoye et al. (2009). According to Kushairi et al. (1999), the indirect selection for the more heritable fruit quality trait by increasing M/F or reducing K/F may be more effective in improving oil yield. In correlation analysis, some generalizations can be made and they are that, positive correlation suggests that the variables or traits tend towards one another. Also, negative correlation suggests that if one trait is increased, the other will decrease.

Estimates of the correlation also are valid for the population and environments under which the study is carried out.

3.5 CONCLUSION

It can be concluded from this study that there is wide variability for yield, agronomic and oil quality traits in the MPOB-Nigerian oil palm germplasm especially for FFB and its related components, KB, OY, TEP, leaf parameters, BDM, myristic acid and stearic acid. Also, the wide variation in some of these traits can be used as a yardstick for selection programme and as some of these populations have been utilized one way or the other in present breeding programmes, other populations that have not been utilized can also be incorporated into breeding programme. Furthermore, estimates from correlation studies can be used to determine the best traits such as the selection for traits that exhibit high positive correlations with FFB, for improvement in oil yield, as oil yield is the goal of breeders.

Table 2: Variation in yield, agro-morphophysiological and biochemical traits of the MPOB-Nigerian *dura* oil palm germplasm

	Traits	Mean	Range	CV (%)
Yield components	Fresh fruit bunch (kg/p/yr)	149.86	0.01 - 308.20	27.81
	Bunch number (n/p/yr)	13.24	0.01 - 30.40	31.31
	Average bunch weight (kg/p/yr)	11.93	1.00 - 31.23	29.89
Bunch components	Mean fruit weight (g)	9.32	2.83 - 26.60	30.32
	Mean nut weight (g)	5.11	1.27 - 14.09	31.14
	Parthenocarpic fruit/bunch (%)	2.35	0.00 - 24.70	0
	Mesocarp/fruit (%)	44.93	26.33 - 64.00	13.24
	Kernel/fruit (%)	12.72	4.53 - 23.88	22.84
	Shell/fruit (%)	42.35	22.13 - 57.43	11.86
	Oil/dry mesocarp (%)	74.41	58.20 - 84.83	5.54
	Oil/wet mesocarp (%)	48.61	28.44 - 63.40	11.6
	Fruit/bunch (%)	66.95	39.30 - 83.12	8.43
	Oil/bunch (%)	14.65	6.73 - 25.81	20.51
	Kernel/bunch	8.21	2.90 - 16.35	24.53
	Oil yield (kg/p/yr)	22.17	0.00 - 57.33	35.03
	Kernel yield (kg/p/yr)	12.22	0.00 - 31.85	33.88
	Total economic product (kg/p/yr)	29.5	0.00 – 28.00	30.92
Vegetative traits	Frond production (no)	27.79	16.00 - 43.00	11.75
	Petiole cross section (cm3)	15.73	4.20 - 43.20	27.11
	Rachis length (m)	4.55	1.91 - 7.00	12.8
	Leaflet length (cm)	83.16	24.88 - 126.03	12.36
	Leaflet width (cm)	4.35	2.35 - 7.25	12.72
	Number of leaflet (no)	158.14	89.00 - 210.00	8.71
	Height (m)	1.28	0.05 - 3.19	30.42
	Leaf area (m2)	8.59	1.32 - 14.23	24.05
	Leaf area index	3.9	0.78 - 8.42	24.05
	Diameter of trunk	0.68	0.34 - 1.04	12.08
	Leaf area ratio	20.66	5.21 - 39.95	16.06
Physiological traits	Bunch dry mass (tonnes/ha/yr)	11.86	0.10 - 24.18	26.21
	Vegetative dry mass (tonnes/ha/yr)	8.89	2.48 - 19.89	24.07
	Total dry mass (tonnes/ha/yr)	20.76	2.87 - 38.18	21.21
	Bunch index	0.56	0.01 - 0.75	12.95
	Radiation conversion efficiency (cg/g)	0.83	0.23 - 1.99	16.13
	Fractional interception of radiation	0.79	0.20 - 0.98	11.32
	Net assimilation ratio (tonnes/ha/yr)	10.47	3.69 - 30.82	18.95
Fatty acid composition	Iodine value (cg/g)	54.3	46.66 - 64.89	4.86
	Lauric acid (%)	0.7	0.00 - 5.00	0
	Myristic acid (%)	1.19	0.20 - 3.30	43.65
	Palmitic acid (%)	38.66	30.20 - 45.70	7.75
	Palmitoleic acid (%)	0.06	0.00 - 0.40	0
	Stearic acid (%)	6.23	3.40 - 11.90	21.72
	Oleic acid (%)	41.54	33.10 - 54.60	7.5
	Linoleic acid (%)	10.5	5.30 - 18.10	13.77

CV (coefficient of variation) = σ / μ, σ - standard deviation; μ - mean

Table 3: MPOB-Nigerian *dura* oil palm germplasm means for yield and yield components

POP	FFB	BNO	ABW
NGA 01	145.25	15.34	9.84
NGA 02	136.62	13.79	10.29
NGA 03	151.30	13.95	11.25
NGA 04	141.03	13.68	10.78
NGA 05	155.50	12.27	13.23
NGA 06	150.25	12.11	12.88
NGA 07	160.60	13.70	12.13
NGA 08	151.41	12.65	12.38
NGA 09	151.18	12.74	12.52
NGA 10	163.75	14.29	11.91
NGA 11	162.55	14.02	12.12
NGA 12	190.29	17.23	11.22
NGA 13	166.51	15.54	10.97
NGA 14	174.18	14.31	12.91
NGA 15	168.86	14.92	11.88
NGA 16	166.92	13.49	12.57
NGA 17	160.42	13.46	12.57
NGA 18	154.71	13.10	12.24
NGA 19	153.07	12.57	12.48
NGA 20	152.51	11.84	13.44
NGA 21	147.00	11.12	14.00
NGA 22	143.73	9.91	15.32
NGA 23	148.37	12.01	12.93
NGA 25	151.94	12.71	12.81
NGA 26	159.42	13.46	12.19
NGA 27	157.61	13.60	12.12
NGA 28	158.53	13.52	12.14
NGA 29	153.41	13.33	12.03
NGA 30	155.99	13.19	12.26
NGA 31	145.31	11.78	12.68
NGA 32	156.88	12.56	13.19
NGA 33	155.94	12.68	12.92
NGA 34	153.64	13.72	11.65
NGA 35	163.01	12.99	13.01
NGA 36	149.62	12.66	12.20
NGA 37	167.99	14.03	12.30
NGA 38	144.55	11.67	13.08
NGA 39	97.69	15.24	6.92
NGA 40	100.74	14.54	7.23
NGA 41	105.44	16.28	6.85
NGA 42	104.39	15.28	7.06
NGA 43	159.22	13.95	11.91
NGA 44	149.62	13.06	11.90
NGA 45	152.00	13.03	12.19

Table 4: MPOB-Nigerian *dura* oil palm germplasm means for bunch quality components

POP	MFW	MNW	PB	MF	KF	SF	ODM	OWM	FB	OB	KB	OY	KY	TEP
NGA 01	8.8	4.9	2.6	43.6	12.1	44.3	75.3	50.0	63.7	13.9	7.4	20.2	10.9	26.8
NGA 02	8.9	5.3	2.0	40.7	12.8	46.5	72.3	45.1	65.3	12.1	8.1	16.4	11.0	23.0
NGA 03	9.2	5.4	1.3	42.0	12.2	45.8	73.9	48.0	66.0	13.3	7.9	20.4	12.2	27.7
NGA 04	9.0	5.2	1.6	42.4	12.0	45.6	73.5	48.1	66.7	13.6	7.8	18.9	11.0	25.5
NGA 05	9.7	5.3	2.4	45.0	12.5	42.6	74.9	49.2	67.2	14.9	8.1	23.0	12.5	30.5
NGA 06	9.6	5.3	1.9	44.7	12.7	42.6	75.1	48.9	66.5	14.5	8.2	21.6	12.2	29.0
NGA 07	9.5	5.3	2.5	44.5	12.2	43.3	74.2	48.4	66.2	14.3	7.8	23.1	12.5	30.6
NGA 08	9.8	5.4	1.9	44.8	12.3	42.9	74.3	48.3	66.6	14.4	8.0	21.8	12.0	29.0
NGA 09	9.6	5.4	1.7	44.1	11.7	44.1	75.2	48.9	68.2	14.8	7.8	22.3	11.8	29.4
NGA 10	10.5	5.7	2.1	45.5	11.6	43.0	74.7	47.5	66.6	14.4	7.5	24.0	12.4	31.5
NGA 11	10.1	5.4	2.2	46.7	11.2	42.1	75.2	48.3	67.9	15.4	7.4	25.1	12.0	32.4
NGA 12	9.7	5.0	5.1	48.5	12.2	39.2	75.1	50.6	65.4	16.1	7.4	30.2	13.9	38.5
NGA 13	9.1	5.0	2.0	45.4	12.5	42.1	73.4	47.5	66.9	14.4	8.1	23.9	13.4	32.0
NGA 14	9.5	5.0	2.6	47.3	12.8	39.9	74.9	48.3	67.2	15.4	8.3	26.3	14.4	34.9
NGA 15	8.8	4.5	3.2	48.9	12.2	38.9	74.8	49.3	65.4	15.8	7.6	26.2	12.6	33.7
NGA 16	8.7	4.4	2.8	49.8	11.9	38.3	75.4	48.9	66.2	16.2	7.5	28.0	12.8	35.7
NGA 17	9.7	5.1	2.9	47.2	11.5	41.3	75.4	49.6	67.3	15.8	7.4	25.4	11.8	32.4
NGA 18	9.3	4.8	2.7	48.2	11.8	39.9	75.4	49.6	67.3	16.1	7.7	25.3	12.1	32.6
NGA 19	7.5	3.8	3.5	49.3	11.7	39.0	73.8	48.6	66.0	15.8	7.3	23.9	11.0	30.4
NGA 20	9.4	5.3	2.4	44.2	13.3	42.5	74.7	49.7	66.3	14.6	8.5	22.2	12.9	29.9
NGA 21	9.5	5.3	2.4	44.3	13.2	42.4	74.5	48.7	67.4	14.6	8.6	21.5	12.6	29.1
NGA 22	9.4	5.2	2.9	44.7	12.5	42.8	74.2	47.8	67.8	14.6	8.1	21.1	11.7	28.1
NGA 23	9.6	5.3	2.3	44.9	12.6	42.6	73.7	48.5	66.4	14.5	8.0	21.7	12.0	28.9
NGA 25	9.6	5.1	2.3	47.0	12.0	41.1	74.9	49.3	67.1	15.5	7.7	23.7	11.8	30.8
NGA 26	9.7	5.1	2.7	47.5	12.0	40.5	74.5	48.5	67.3	15.6	7.8	25.0	12.5	32.5
NGA 27	10.1	5.3	2.5	47.4	12.0	40.6	74.7	48.5	68.6	15.8	8.0	25.2	12.6	32.8
NGA 28	10.1	5.2	2.8	48.5	11.3	40.2	75.8	49.8	67.2	16.2	7.3	25.8	11.6	32.8
NGA 29	10.0	5.3	2.5	47.4	12.0	40.6	75.4	49.7	67.6	16.0	7.8	24.6	12.1	31.9
NGA 30	9.9	5.3	2.2	46.7	11.8	41.5	75.2	49.5	67.3	15.6	7.7	24.9	12.1	32.1
NGA 31	10.0	5.3	2.4	46.9	11.9	41.2	75.1	49.7	67.1	15.7	7.6	23.0	11.3	29.8
NGA 32	10.8	5.7	2.0	46.6	11.6	41.8	74.9	48.8	66.9	15.3	7.5	23.7	11.7	30.7
NGA 33	9.9	5.4	2.4	45.7	12.1	42.2	75.6	50.9	67.5	15.7	7.9	24.4	12.2	31.8
NGA 34	8.7	4.6	2.8	46.7	13.2	40.1	74.2	48.5	65.7	14.9	8.2	23.1	12.7	30.7
NGA 35	10.4	5.7	1.9	45.7	11.8	42.5	74.7	49.7	66.3	15.0	7.6	24.7	12.6	32.3
NGA 36	10.5	5.8	1.9	44.7	12.0	43.3	73.5	47.9	68.1	14.6	7.9	21.3	11.5	28.2
NGA 37	12.0	6.1	2.2	48.8	10.5	40.7	76.1	49.6	67.8	16.4	6.9	27.1	11.4	34.0
NGA 38	9.4	5.2	2.0	44.6	12.5	43.0	74.5	47.9	66.1	14.1	8.0	20.5	11.5	27.4
NGA 39	7.7	4.6	2.7	41.1	15.2	43.6	74.2	48.7	66.9	13.4	9.8	13.1	9.6	18.8
NGA 40	6.6	4.1	2.4	38.3	15.8	45.8	73.4	48.9	66.7	12.5	10.2	12.8	10.4	19.1
NGA 41	6.1	3.8	2.8	37.9	15.6	46.5	73.0	48.8	65.8	12.1	9.8	13.1	10.5	19.4
NGA 42	6.3	3.9	2.4	38.1	15.6	46.3	72.5	47.8	66.3	12.1	10.0	12.6	10.4	18.8
NGA 43	8.8	5.0	2.3	43.4	14.3	42.3	73.2	47.7	66.7	13.8	9.2	22.2	14.8	31.0
NGA 44	9.1	5.2	1.9	42.2	15.2	42.6	73.4	47.2	67.0	13.3	9.9	20.1	14.7	28.9
NGA 45	8.6	4.9	2.4	43.1	14.7	42.2	72.7	46.8	67.9	13.7	9.6	21.1	14.7	29.9

Table 5: MPOB-Nigerian *dura* oil palm germplasm means for vegetative traits

POP	FP	PCS	RL	LL	LW	LN	HT	LA	LAI	DIAM	LAR
NGA 01	28.42	15.83	4.76	83.46	4.56	160.38	1.04	6.96	4.12	0.75	22.22
NGA 02	28.20	14.47	4.34	79.43	4.31	154.86	1.05	6.08	3.60	0.71	20.62
NGA 03	26.89	16.42	4.86	84.68	4.78	156.29	1.34	7.24	4.29	0.71	21.48
NGA 04	27.99	15.47	4.74	87.33	4.55	161.42	1.16	7.34	4.35	0.73	23.25
NGA 05	27.75	16.87	4.68	87.36	4.37	160.77	1.32	7.03	4.16	0.69	20.72
NGA 06	27.83	16.84	4.70	87.34	4.46	159.84	1.44	7.13	4.22	0.68	20.96
NGA 07	27.98	16.07	4.45	86.47	4.35	157.74	1.36	6.84	4.05	0.70	20.64
NGA 08	28.26	16.12	4.58	85.16	4.37	159.68	1.34	6.80	4.02	0.70	20.67
NGA 09	28.99	16.19	4.57	85.71	4.45	158.00	1.48	6.91	4.09	0.67	20.94
NGA 10	27.16	16.64	4.72	85.48	4.22	155.75	1.04	6.47	3.83	0.71	19.63
NGA 11	27.10	17.14	4.69	83.49	4.35	158.78	1.18	6.65	3.93	0.68	19.82
NGA 12	25.64	15.69	4.67	85.88	4.24	162.64	1.02	6.78	4.02	0.67	21.86
NGA 13	25.95	15.02	4.73	80.78	4.44	160.49	0.91	6.61	3.91	0.68	22.30
NGA 14	26.83	16.50	4.88	87.76	4.55	162.83	1.05	7.46	4.42	0.70	22.81
NGA 15	27.12	14.93	4.64	81.45	4.37	158.17	1.11	6.44	3.81	0.63	21.88
NGA 16	26.09	15.84	4.73	84.07	4.36	159.07	1.12	6.69	3.96	0.66	21.19
NGA 17	26.88	15.27	4.67	84.27	4.32	159.25	1.14	6.66	3.94	0.66	21.78
NGA 18	28.00	14.97	4.55	80.92	4.33	160.07	1.27	6.43	3.81	0.65	21.38
NGA 19	25.98	14.96	4.67	84.25	4.36	157.34	1.10	6.69	3.96	0.66	22.21
NGA 20	27.49	18.93	4.87	87.20	4.55	164.84	1.48	7.50	4.44	0.70	19.83
NGA 21	27.05	17.29	4.67	87.22	4.47	158.89	1.29	7.08	4.19	0.70	20.58
NGA 22	27.06	17.99	4.71	85.55	4.65	162.38	1.29	7.40	4.38	0.73	20.41
NGA 23	28.37	16.93	4.69	85.81	4.50	159.11	1.40	7.05	4.17	0.70	20.51
NGA 25	28.36	16.58	4.53	82.87	4.44	158.94	1.33	6.71	3.97	0.70	19.97
NGA 26	27.75	15.17	4.51	83.79	4.26	159.12	1.21	6.52	3.86	0.68	21.21
NGA 27	29.00	15.23	4.41	83.86	4.33	154.43	1.47	6.43	3.81	0.68	20.43
NGA 28	27.91	15.88	4.59	85.69	4.27	157.78	1.34	6.63	3.92	0.70	20.39
NGA 29	28.12	14.72	4.44	83.75	4.24	154.41	1.31	6.31	3.73	0.68	20.67
NGA 30	28.23	15.48	4.53	84.57	4.37	158.36	1.42	6.70	3.97	0.66	21.11
NGA 31	28.58	17.02	4.70	84.85	4.49	160.51	1.42	7.00	4.15	0.69	20.42
NGA 32	27.82	16.32	4.64	86.98	4.29	154.03	1.44	6.57	3.89	0.65	20.14
NGA 33	29.04	16.24	4.54	84.76	4.28	160.34	1.38	6.67	3.95	0.68	20.38
NGA 34	27.09	14.39	4.53	81.71	4.15	154.67	0.98	5.98	3.54	0.64	21.25
NGA 35	28.02	18.20	4.77	86.55	4.44	161.54	1.49	7.13	4.22	0.71	19.30
NGA 36	27.64	17.73	4.83	86.37	4.55	162.86	1.43	7.36	4.36	0.72	20.34
NGA 37	28.73	16.96	4.70	88.27	4.39	160.47	1.31	7.14	4.23	0.68	21.14
NGA 38	27.13	17.25	4.78	86.46	4.41	160.22	1.37	7.09	4.20	0.68	20.67
NGA 39	30.69	9.79	3.56	69.31	3.90	145.42	1.45	4.55	2.69	0.63	20.50
NGA 40	31.26	10.87	3.63	69.17	3.93	146.87	1.36	4.59	2.72	0.67	19.01
NGA 41	31.27	9.99	3.50	67.51	3.68	148.05	1.22	4.25	2.52	0.64	19.28
NGA 42	29.45	10.90	3.60	69.45	3.89	150.47	1.30	4.70	2.78	0.63	19.80
NGA 43	24.50	16.39	4.75	79.84	4.53	159.48	1.02	6.60	3.91	0.67	20.46
NGA 44	25.20	15.83	4.70	83.63	4.29	159.81	1.09	6.58	3.90	0.68	20.77
NGA 45	25.86	15.13	4.66	80.59	4.34	159.37	1.03	6.39	3.78	0.68	21.15

Table 6: MPOB-Nigerian *dura* oil palm germplasm means for physiological parameters

POP	BDM	VDM	TDM	BI	E	F	NAR
NGA 01	11.39	9.09	20.48	0.56	0.80	0.82	9.69
NGA 02	10.66	8.35	19.01	0.56	0.79	0.77	10.35
NGA 03	12.15	9.15	21.30	0.57	0.83	0.83	9.82
NGA 04	11.56	8.88	20.43	0.56	0.79	0.84	9.24
NGA 05	12.20	9.47	21.67	0.56	0.85	0.83	10.22
NGA 06	11.74	9.58	21.32	0.55	0.83	0.83	9.88
NGA 07	12.72	9.30	22.01	0.57	0.87	0.81	10.71
NGA 08	11.96	9.35	21.31	0.56	0.84	0.81	10.39
NGA 09	11.86	9.63	21.49	0.55	0.84	0.82	10.28
NGA 10	13.11	8.96	22.08	0.59	0.89	0.79	11.35
NGA 11	12.75	9.17	21.92	0.58	0.88	0.80	10.97
NGA 12	15.22	7.96	23.18	0.65	0.92	0.82	11.27
NGA 13	13.22	7.71	20.93	0.63	0.84	0.80	10.48
NGA 14	13.66	8.79	22.46	0.61	0.86	0.84	10.06
NGA 15	13.25	8.02	21.26	0.62	0.86	0.80	10.90
NGA 16	13.15	8.22	21.37	0.61	0.85	0.80	10.57
NGA 17	12.58	8.24	20.82	0.60	0.83	0.81	10.46
NGA 18	12.94	8.50	21.44	0.60	0.87	0.80	11.03
NGA 19	12.42	7.81	20.23	0.61	0.81	0.80	10.06
NGA 20	12.06	10.50	22.56	0.53	0.86	0.85	9.94
NGA 21	11.62	9.42	21.04	0.55	0.82	0.83	9.77
NGA 22	11.39	9.87	21.26	0.53	0.82	0.84	9.61
NGA 23	11.72	9.85	21.57	0.54	0.84	0.82	10.12
NGA 25	12.07	9.61	21.67	0.56	0.86	0.81	10.71
NGA 26	12.61	8.58	21.19	0.59	0.85	0.80	10.75
NGA 27	12.36	9.20	21.56	0.57	0.87	0.79	11.10
NGA 28	12.48	9.14	21.63	0.58	0.87	0.80	10.82
NGA 29	12.09	8.61	20.70	0.58	0.85	0.79	10.91
NGA 30	12.30	9.00	21.30	0.57	0.85	0.81	10.50
NGA 31	12.10	9.92	22.02	0.55	0.86	0.82	10.42
NGA 32	12.31	9.22	21.52	0.57	0.86	0.80	10.80
NGA 33	12.13	9.60	21.73	0.56	0.87	0.81	10.85
NGA 34	12.05	7.73	19.78	0.60	0.82	0.77	10.86
NGA 35	12.89	10.43	23.32	0.55	0.91	0.83	10.84
NGA 36	11.72	10.11	21.83	0.53	0.84	0.84	9.82
NGA 37	13.18	9.70	22.88	0.57	0.89	0.83	10.62
NGA 38	11.34	9.40	20.74	0.55	0.82	0.82	9.87
NGA 39	7.84	6.86	14.69	0.53	0.72	0.66	10.70
NGA 40	7.95	7.63	15.57	0.50	0.76	0.66	11.27
NGA 41	8.33	6.93	15.26	0.54	0.78	0.63	11.97
NGA 42	8.28	7.00	15.28	0.53	0.73	0.67	10.77
NGA 43	12.54	7.95	20.49	0.61	0.82	0.81	10.24
NGA 44	11.83	8.03	19.85	0.59	0.80	0.80	9.98
NGA 45	12.05	7.88	19.92	0.60	0.81	0.79	10.34

Table 7: MPOB-Nigerian *dura* oil palm germplasm means for oil quality traits

POP	IV	C12:0	C14:0	C16:0	C16:1	C18:0	C18:1	C18:2
NGA 01	54.70	0.01	1.02	39.42	0.10	6.58	41.00	10.97
NGA 02	57.49	0.00	0.40	33.10	0.00	8.60	46.90	9.90
NGA 03	54.87	0.56	1.06	38.46	0.14	6.24	42.02	10.38
NGA 04	53.92	0.65	1.35	39.58	0.08	5.61	41.00	10.56
NGA 05	54.33	0.45	1.12	38.67	0.06	6.50	41.65	10.48
NGA 06	55.01	0.30	0.93	38.54	0.04	6.68	41.28	11.10
NGA 07	54.76	0.20	1.19	39.70	0.08	5.47	41.55	10.80
NGA 08	54.28	0.72	1.07	38.73	0.04	6.24	41.52	10.59
NGA 09	53.49	0.61	1.13	39.94	0.09	6.20	40.46	10.51
NGA 10	53.98	0.92	1.17	37.51	0.10	6.62	43.60	9.04
NGA 11	54.72	0.50	1.09	38.58	0.03	6.23	41.79	10.77
NGA 12	50.82	1.00	1.35	42.35	0.00	5.75	38.55	10.20
NGA 13	54.44	0.48	1.43	40.78	0.15	5.50	38.93	11.53
NGA 14	53.18	0.86	1.18	39.78	0.12	6.32	40.24	10.33
NGA 15	53.49	0.71	1.06	38.58	0.00	6.76	41.46	10.29
NGA 16	53.74	0.79	1.16	38.60	0.06	6.66	41.48	10.18
NGA 17	54.31	0.80	1.27	39.13	0.06	6.26	40.31	11.07
NGA 18	54.30	0.42	1.09	39.45	0.02	5.94	41.06	10.91
NGA 19	57.15	0.00	0.40	32.80	0.00	9.60	45.30	10.50
NGA 20	55.92	0.66	1.11	37.27	0.07	6.19	42.84	10.80
NGA 21	54.61	0.57	1.09	39.10	0.21	6.50	40.92	10.64
NGA 22	54.29	1.15	1.37	38.00	0.02	5.69	42.15	10.35
NGA 23	55.21	0.50	1.04	38.56	0.02	6.48	41.18	11.38
NGA 25	54.30	0.73	1.05	38.24	0.01	6.16	42.65	0.00
NGA 26	54.04	0.57	1.14	39.77	0.13	5.56	41.89	9.95
NGA 27	54.70	0.76	1.10	37.58	0.02	7.02	41.38	10.94
NGA 28	54.02	0.69	1.17	39.16	0.03	5.93	41.18	10.68
NGA 29	53.29	1.21	1.58	40.23	0.07	5.72	38.73	11.33
NGA 30	55.30	1.11	1.21	37.20	0.07	5.98	42.81	10.48
NGA 31	54.94	1.13	1.20	37.66	0.01	6.10	41.96	10.80
NGA 32	54.48	0.40	1.34	38.78	0.06	6.38	41.00	10.94
NGA 33	53.79	0.87	1.20	39.17	0.07	7.03	39.47	11.17
NGA 34	54.59	2.10	1.80	36.80	0.00	6.90	39.10	12.10
NGA 35	55.44	0.38	.10	37.45	0.10	6.98	42.26	10.66
NGA 36	53.30	0.51	1.21	39.47	0.15	5.86	42.69	9.08
NGA 37	53.98	1.44	1.48	37.30	0.03	6.08	42.65	9.87
NGA 38	53.66	2.07	1.63	38.13	0.07	5.40	40.80	10.43
NGA 39	52.71	1.32	1.83	39.75	0.00	5.97	39.00	11.07
NGA 40	54.00	1.34	1.49	38.28	0.06	6.37	40.49	10.81
NGA 41	54.78	0.51	1.19	39.45	0.05	5.48	41.55	10.75
NGA 42	55.08	0.78	1.05	37.67	0.03	5.93	43.30	10.13
NGA 43	53.54	0.95	1.27	38.55	0.05	6.64	40.99	10.35
NGA 44	53.89	0.86	1.32	38.82	0.08	6.53	40.66	10.67
NGA 45	53.55	0.87	1.18	38.54	0.02	6.94	40.83	10.55

Table 8: Correlations among yield, bunch quality, vegetative, physiological and oil quality traits of the MPOB Nigerian oil palm germplasm

	FFB	BNO	ABW	MFW	MNW	PB	MF	KF	SF	ODM	OWM	FB	OB	KB	OY	KY	TEP	FP	PCS	RL	LL	LW	LN	HT	LA	LAI	DIAM	LAR	BDM	VDM	TDM	BI	E	f	NAR	IV	C120	C140	C160	C161	C180	C181	C182
FFB	1																																										
BNO	-.079	1																																									
ABW	.718**	-.740**	1																																								
MFW	.709**	-.372*	.721**	1																																							
MNW	.495**	-.398**	.596**	.925**	1																																						
PB	.213	.355*	-.065	-.203	-.447**	1																																					
MF	.808**	-.186	.660**	.625**	.289	.377*	1																																				
KF	-.712**	.256	-.637**	-.779**	-.585**	.013	-.781**	1																																			
SF	-.696**	.104	-.534**	-.398**	-.045	-.538**	-.923**	.481**	1																																		
ODM	.515**	-.155	.463**	.624**	.397**	.192	.725**	-.688**	-.594**	1																																	
OWM	.216	.052	.126	.216	.022	.403**	.444**	-.328*	-.422**	.762**	1																																
FB	.100	-.414**	.355*	.403**	.384**	-.223	.199	-.159	-.182	.192	-.015	1																															
OB	.731**	-.209	.631**	.637**	.310*	.378*	.963**	-.752**	-.889**	.822**	.612**	.332*	1																														
KB	-.714**	.170	-.582**	-.707**	-.493**	-.105	-.789**	.984**	.501**	-.681**	-.366*	-.002	-.741**	1																													
OY	.946**	-.109	.703**	.704**	.417**	.324*	.934**	-.767**	-.839**	.694**	.418**	.202	.904**	-.767**	1																												
KY	.668**	-.041	.478**	.288	.229	.089	.306*	.000	-.430**	.006	-.121	.152	.240	.024	.528**	1																											
TEP	.964**	-.105	.713**	.685**	.414**	.308*	.896**	-.696**	-.830**	.630**	.360*	.207	.859**	-.692**	.991**	.637**	1																										
FP	-.692**	.137	-.548**	-.269	-.163	-.150	-.430**	.222	.467**	.018	.241	.037	-.277	.233	-.546**	-.763**	-.616**	1																									
PCS	.709**	-.612**	.895**	.774**	.732**	-.213	.514**	-.646**	-.323*	.410**	.104	.191	.475**	-.601**	.625**	.447**	.638**	-.534**	1																								
RL	.822**	-.432**	.834**	.701**	.605**	-.133	.609**	-.666**	-.444**	.374*	.047	.072	.514**	-.641**	.713**	.560**	.736**	-.729**	.911**	1																							
LL	.787**	-.524**	.877**	.822**	.724**	-.125	.644**	-.767**	-.431**	.528**	.183	.189	.602**	-.729**	.727**	.399**	.723**	-.505**	.910**	.903**	1																						
LW	.572**	-.509**	.726**	.565**	.561**	-.292	.368*	-.553**	-.176	.222	-.034	.084	.300*	-.512**	.452**	.368*	.469**	-.536**	.844**	.873**	.777**	1																					
LN	.735**	-.402**	.768**	.594**	.511**	.000	.513**	-.541**	-.387**	.326*	.156	.100	.471**	-.525**	.641**	.535**	.666**	-.613**	.862**	.879**	.810**	.789**	1																				
HT	-.274	-.466**	.135	.244	.319*	-.323*	-.075	-.113	.175	.281	.350*	.368*	.091	-.037	-.143	-.408**	-.194	.568**	.146	-.153	.110	.040	-.101	1																			
LA	.732**	-.538**	.855**	.728**	.667**	-.178	.541**	-.684**	-.339*	.403**	.110	.149	.490**	-.646**	.639**	.426**	.647**	-.559**	.943**	.944**	.947**	.921**	.903**	.069	1																		
LAI	.732**	-.538**	.855**	.728**	.667**	-.178	.541**	-.684**	-.339*	.403**	.110	.149	.490**	-.646**	.639**	.426**	.647**	-.559**	.943**	.944**	.947**	.921**	.903**	.069	1.000**	1																	
DIAM	.202	-.334*	.363*	.403**	.543**	-.355*	-.046	-.316*	.260	-.002	-.144	-.023	-.081	-.289	.062	.071	.068	-.121	.597**	.504**	.515**	.644**	.526**	.043	.616**	.616**	1																
LAR	.420**	.175	.150	.063	-.068	.189	.361*	-.307*	-.317*	.112	.005	-.186	.259	-.344*	.355*	.230	.358*	-.442**	.099	.431**	.339*	.407**	.398**	-.506**	.394**	.394**	.060	1															
BDM	.992**	-.081	.710**	.693**	.472**	.228	.818**	-.720**	-.704**	.511**	.225	.096	.740**	-.724**	.946**	.652**	.962**	-.696**	.701**	.825**	.781**	.582**	.742**	-.279	.735**	.735**	.199	.447**	1														
VDM	.390**	-.667**	.719**	.740**	.768**	-.369*	.317*	-.607**	-.071	.457**	.251	.268	.368*	-.542**	.376*	.059	.351*	-.020	.850**	.623**	.766**	.686**	.632**	.565**	.775**	.775**	.650**	-.162	.380*	1													
TDM	.902**	-.368*	.850**	.847**	.699**	-.006	.741**	-.805**	-.545**	.584**	.280	.194	.708**	-.778**	.862**	.501**	.862**	-.515**	.904**	.889**	.923**	.741**	.833**	.060	.894**	.894**	.446**	.249	.903**	.740**	1												
BI	.719**	.375*	.215	.169	-.071	.467**	.596**	-.288	-.660**	.172	.018	-.088	.476**	-.336*	.678**	.630**	.715**	-.715**	.104	.401**	.240	.103	.301*	-.707**	.188	.188	-.270	.574**	.734**	-.342*	.375*	1											
E	.856**	-.125	.659**	.774**	.577**	.164	.757**	-.748**	-.602**	.643**	.406**	.208	.759**	-.737**	.881**	.441**	.869**	-.320*	.678**	.627**	.698**	.395**	.586**	.073	.599**	.599**	.207	.018	.856**	.575**	.889**	.433**	1										
f	.784**	-.519**	.871**	.753**	.674**	-.152	.593**	-.713**	-.393**	.420**	.112	.144	.533**	-.678**	.693**	.470**	.703**	-.599**	.938**	.961**	.952**	.911**	.899**	.018	.989**	.989**	.579**	.411**	.787**	.745**	.917**	.267	.635**	1									
NAR	-.070	.531**	-.403**	-.148	-.263	.369*	.062	.110	-.155	.123	.250	.019	.126	.076	.065	-.098	.044	.373*	-.496**	-.542**	-.481**	-.738**	-.534**	-.026	-.639**	-.639**	-.540**	-.453**	-.073	-.392**	-.235	.188	.232	-.592**	1								
IV	-.206	-.324*	.053	-.143	-.079	-.342*	-.154	-.067	.257	-.256	-.284	-.209	-.231	-.073	-.240	-.294	-.264	.118	.072	-.007	-.006	.106	-.067	.118	.022	.022	.158	-.162	-.201	.167	-.068	-.299*	-.152	.022	-.172	1							
C120	-.102	-.032	-.037	.025	-.011	.096	.036	.179	-.161	.127	.092	.181	.087	.195	-.014	.039	-.006	.045	-.127	-.131	-.122	-.218	-.156	.019	-.169	-.169	-.298*	-.107	-.111	-.143	-.147	-.023	-.081	-.180	.133	-.447**	1						
C140	-.120	.136	-.149	.071	.084	.029	-.045	.198	-.059	.167	.205	.197	.046	.224	-.049	.036	-.038	.116	-.187	-.173	-.145	-.242	-.187	.063	-.194	-.194	-.243	-.054	-.129	-.162	-.169	-.021	-.091	-.210	.149	-.645**	.782**	1					
C160	.157	.304*	-.065	.122	.117	.159	.029	.042	-.067	.248	.358*	.156	.139	.056	.168	.246	.191	.002	-.035	.003	.028	-.029	.123	.011	.032	.032	-.021	.156	.156	-.039	.095	.174	.157	.025	.115	-.799**	.097	.537**	1				
C161	.124	-.097	.153	.188	.305*	-.425**	-.128	-.061	.218	-.022	-.074	.119	-.115	.005	.016	.214	.048	-.142	.281	.282	.274	.326*	.239	.027	.318*	.318*	.413**	.096	.107	.259	.198	-.073	.059	.283	-.323*	-.063	-.200	.053	.335*	1			
C180	.065	-.126	.094	-.131	-.181	.067	.114	-.047	-.132	-.167	-.214	-.208	.001	-.080	.030	.016	.029	-.193	.028	.110	.039	.059	-.053	-.224	.012	.012	-.024	.073	.057	-.085	.002	.129	-.059	.052	-.081	.555**	-.330*	-.646**	-.771**	-.281	1		
C181	-.100	-.227	.059	-.019	.030	-.213	-.091	-.147	.219	-.269	-.401**	-.124	-.193	-.154	-.153	-.276	-.182	.031	.146	.040	.044	.131	.032	.064	.083	.083	.255	-.206	-.091	.198	.026	-.230	-.032	.068	-.134	.727**	-.419**	-.740**	-.793**	-.117	.508**	1	
C182	-.045	.064	-.091	-.096	-.071	.037	-.087	.114	.053	-.026	.015	-.076	-.082	.103	-.063	.042	-.050	-.022	-.127	-.029	-.029	-.103	-.084	-.048	-.070	-.070	-.198	.164	-.049	-.165	-.112	.070	-.135	-.068	-.041	.039	.052	.179	.073	.072	.027	-.297	1