

# ANTHROPOMETRY OF FARM WORKERS IN SOUTH-WESTERN NIGERIA

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## ABSTRACT

Thirty-six body dimensions useful for the design of equipment, wearing apparels and work-place were measured from farm workers in the predominantly farming areas of South-Western Nigeria covering Ondo, Oyo, Osun and Ogun States in this study. Measurements were taken in both standing and sitting positions using appropriate tools from a total of 200 farm workers comprising 100 females and 100 males.

The mean, standard deviation, range, mode and percentiles (5<sup>th</sup>, 50<sup>th</sup> and 95<sup>th</sup>) of each body dimension were calculated separately for each gender and also the genders combined. Simple statistical analysis showed that most of the body dimension lengths are positively correlated with the height (stature). Eye height (standing) Vs height for example has a coefficient of correlation of 0.918. Age and body weight, however have very low degree of correlation with height. The body dimension lengths expressed as ratios of the height compare favourably with the findings of other scientists in this field, thus leading support to the reliability of the data. From this study, it is recommended that

- (1) The values of the 5<sup>th</sup> and 95<sup>th</sup> percentiles be used for the range of sizes for design purposes, and that the mean and modal values be considered in deciding what quantity of particular size to produce. Using values in the range of the 5<sup>th</sup> and 95<sup>th</sup> percentiles will ensure that 90% of the population surveyed is taken into account while consideration of the mean and modal values ensures that the sizes of the materials produced are the ones mostly needed in terms of quantities.
- (2) Similar study should be carried out in other parts of the country so as to generate a full database in anthropometry of Nigerian farm workers. This is necessary so that farm equipment designers and manufacturers could be better disposed to satisfy the different population groups in the country.

**Key Words:** Anthropometry, Work-place, Percentile, and Southwestern Nigeria

## INTRODUCTION

Anthropometry is the study of human body dimensions and so is very important in matters relating to man-task systems, work-place designs and other facilities. Anthropometric measurement most frequently known is height, a parameter that differs from one population (race) to the other. This is probably so because other parts of the body segment lengths are fractions of the body height (Winter, 1979). Anthropometric data is a necessary tool for technological take-off of any nation as designers would need to fully know the characteristics of the populations for which their designs are meant to serve.

In Nigeria, part of the gains of the Structural Adjustment Programme (SAP) which puts limitations on imported goods is that the engineers, designers, blacksmiths and other artisans now look inwards to locally produce their goods and services. As a result of this, many engineering workshops have sprung up producing tools and equipment for farmers and other users. It is worth mentioning that before the SAP, most of the tools,

machines and other equipment were imported from manufacturers who have very little or no information concerning the anthropometry of their buyers. The simplest farming tool, cutlass used to be imported from Brazil and Ghana. Other examples of this trend are found in some Japanese and Korean cars imported to Nigeria. These cars though very suitable and comfortable for the manufacturers, they are however grossly unsuitable for Nigerians.

There is therefore the need to carry out an in-depth study on the anthropometry of the different population groups in Nigeria. In Europe and the United States of America, a large amount of anthropometric data is available for reference. For example, Apud *et al.* (1989) reported that the anthropometric data bank assembled and maintained by the Aerospace Medical Research Laboratories in Dayton, Ohio is the largest and most comprehensive single repository of raw anthropometric data in the world. Sen (1964), Sen *et al.* (1977) and Gupta *et al.* (1983) once pointed out that there was considerable difference

between the anthropometric data of Indians, Westerners as well as Africans. Gupta *et al.* (1983) in their work on anthropometric survey of Indian farm workers found that farm workers from Punjab are taller and heavier than those from the other parts of the country.

It is in the light of this that this study was directed to the farmers in the south-western part of Nigeria. It is necessary to do this similar exercise for other parts of the country in order to assist the engineers and designers in proper equipment design. Ensing (1979) reported that the inter-individual differences are affected by factors such as age, sex, ethnic group and race, occupation and socio-economic group. Also, with the aid of anthropometric data, it is possible to provide the best working layout and therefore contribute to a considerable decrease of workload and an improved performance of workers (Zander, 1990).

The bulk of the food items in Nigeria is still being largely produced by the peasant farmers whose main source of farm power is their human energy. The manual method is tedious and labour intensive and a lot of energy is expended in the various processes of land clearing, tilling, ridging, planting, weeding and other cultural operations in which the traditional hand tools are used.

In this study, anthropometric data of farmers both male and female in the predominantly farming areas of southwestern Nigeria were collected and analyzed. This data should therefore be useful for designers and engineers both local and foreign that may be interested in producing for Nigerian farmers in the areas of work-place design, hand tools manufacturing, small tractor design, wearing apparels and so on.

#### MATERIALS AND METHODS

Thirty-six body dimensions considered useful for farm machinery, tool and work-place designs and earlier identified and used by Sen *et al.* (1977), Biman and Grady (1983) and Gite and Yadav (1989) were measured for this study. A total of two hundred peasant farmers comprising one hundred each of male and female full-time farmers were used as subjects. The locations were the predominantly farming areas of southwestern Nigeria comprising eight villages - Epemakinde in Ondo State, Ayepe, Oosa, Ologan and Agbena in Osun State, Ajibode near the University of Ibadan Campus in Oyo State and Orile-Ilugun and Odeda in Ogun State.

Measurements were taken at two different postures, standing erected and sitting erected.

In the standing erected posture, the person stands with his feet closed and his body vertically erected, while heels, buttocks and shoulders touch the same vertical plane. In the sitting erected posture, the person sits with his body vertically erected, while heels, buttocks and shoulders touch the same vertical plane (Ensing, 1979).

The materials used for measurement were specially made and comprise the following: adjustable chair, graduated ruler, stadiometer, tape measure, wooden cone, weighing balance and a vernier calipers.

**THE ADJUSTABLE CHAIR:** This was specially fabricated for taking the sitting posture measurements. It consists of three major parts:

- (1) The adjustable seat measuring 450 x 450 x 72mm.
- (2) The legs - the two front legs measure 500 x 60 x 25mm each while the rear ones measure 810 x 60 x 25mm and carry the back-rest, and
- (3) Two arm rests each measuring 385 x 60 x 25mm.

Slots are made on appropriate parts of the legs to cater for its frequent re-adjustment to suit the different individuals to be measured. The three principal parts connected by bolts and nuts (75 x 800mm) can easily be loosened and re-set when desired, thus also enhancing easy conveyance.

**GRADUATED RULER:** This is used in conjunction with the stadiometer to take measurements other than height like sideways and forward reaches. It is a flat wooden member 205cm long and made to be collapsible into two halves for easy conveyance.

**STADIOMETER:** A portable stadiometer was used for taking the vertical measurements.

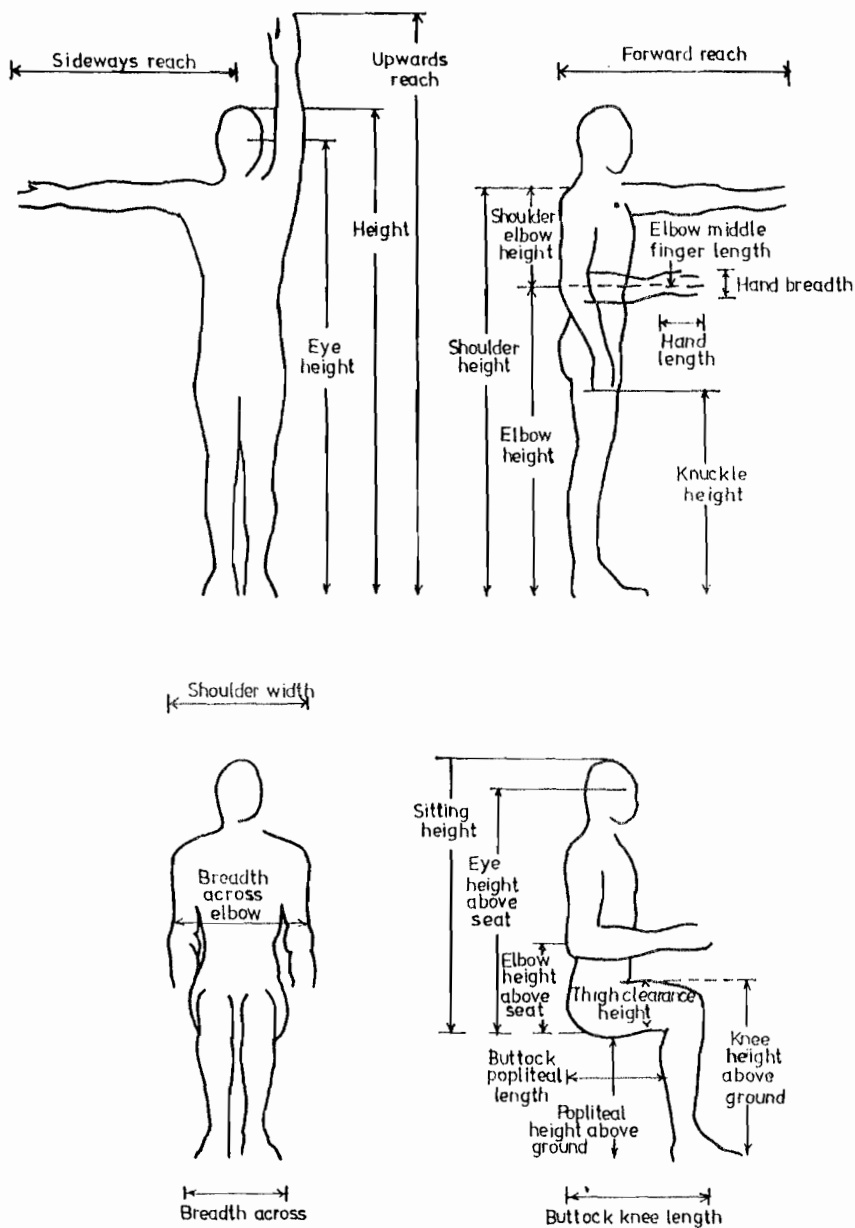
**WOODEN CONE:** This is a specially fabricated instrument designed for measuring the internal grip circumference of the individual farmers. It is 80cm long with a conical section. Its upper and lower ends are respectively 65mm and 42mm diameter.

**TAPE MEASURE:** Two types made of flexible steel and plastic rubber were used for measuring short lengths such as palm length, chest breadth and shoulder width.

**WEIGHING BALANCE:** A household scale with capacity for 210kg was used for taking the weight measurements.

**VERNIER CALIPERS:** This was used in taking the palm thickness of the subjects.

**MEASUREMENTS:** Some of the measurements taken are as guided by Figure 1 according to Singleton (1974). The measurements were subjected to simple statistical analysis by determining the mean, standard deviation, range, the 5<sup>th</sup>, 50<sup>th</sup> and 95<sup>th</sup> percentiles as well as mode.



Source: W.T. Singleton: Introduction to ergonomics (Geneva World Health Organization, 1974)

Fig. 1. Main human dimensions required for design of work spaces

Ensing (1979) noted that for designing and testing work-places, anthropometric data are given in percentiles. A percentile is the value of a measurement that is not exceeded by the given percentage of the population. For practical grounds, it is useful not to consider the entire variability of the measurement within a population, but to accept certain boundaries. For these boundaries, the 5<sup>th</sup> percentiles and 95<sup>th</sup> percentiles have been taken as the lower and upper boundaries. In this way, 90% of a population is taken into account. The 10% skipped population outside the boundaries will generally have such a large spread that taking this group into account will often in technical terms be difficult and in economical terms not very interesting. Special arrangement might be

needed for this group. There could be some designs in which the 5<sup>th</sup> percentile value may be the limiting value while it could also be the 95<sup>th</sup> percentile value in some other conditions. Using the anthropometric measurements, the starting point would always be that the work-place must be adequate for as large as possible part of the population. This means that a mean value is not always sufficient, and that depending on the situation, the upper and/or the lower boundaries of the measurements from a given population are to be used. This is illustrated by the example reported by Apud *et al.* (1989) in which fixing a door in a restricted place was based on the height of the tallest person rather than the height of the average person.

**Table 1: Anthropometric data of female farm workers in South-western Nigeria.**

Serial Number	Dimension	Mean	Standard Deviation	Range	Percentile			Mode
					5	50	95	
1	Weight (kg)	55.1	8.94	37 – 84	41.5	53.5	71.5	50.0
2	Age (yrs.)	29.7	13.97	14 – 72	16.5	23.0	57.5	22.0
3	Sideways Reach	84.4	3.84	75 – 96	78.0	85.0	90.0	86.0
4	Upwards Reach	203.9	9.59	178 – 227	186.5	205.0	219.5	203.0
5	Height (standing)	159.2	7.89	138 – 176	146.5	159.5	173.0	161.0
6	Eye Height (standing)	147.8	6.94	129 – 167	137.0	149.0	160.0	150.0
7	Shoulder Width	38.1	2.27	32 – 44	34.5	38.0	42.0	38.0
8	Forward Reach	83.2	4.20	71 – 95	75.5	83.5	90.0	85.0
9	Shoulder-Elbow Length	33.5	2.55	28 – 49	30.0	33.0	37.5	34.0
10	Shoulder Height	133.5	5.68	118 – 150	123.5	135.0	142.0	135.0
11	Elbow Height (standing)	101.1	4.43	88 – 111	93.0	102.0	107.0	102.0
12	Knuckle Height	69.6	3.72	59 – 80	63.0	70.0	75.0	70.0
13	Breadth Across Body	26.4	2.35	22 – 36	24.0	26.0	30.0	26.0
14	Arm Reach From Wall	80.6	4.32	69 – 92	74.0	81.0	88.0	82.0
15	Hip Breadth	33.3	3.25	28 – 51	29.0	33.0	37.0	33.0
16	Breadth Across Elbow	38.3	3.74	32 – 55	34.0	38.0	44.0	33.0
17	Elbow-Middle-Finger Length	43.1	2.74	36 – 50	38.5	43.0	48.0	44.0
18	Hand Breadth	8.9	0.59	8 – 11	8.0	9.0	10.0	9.0
19	Hand Length	17.9	1.04	15 – 20	16.0	18.0	19.5	18.0
20	Sitting Height	78.5	3.72	69 – 88	72.5	78.0	84.5	77.0
21	Eye Height Above Seat	68.0	3.67	60 – 79	62.0	68.0	73.5	67.0
22	Elbow Height Above Seat	20.1	2.06	14 – 26	17.0	20.0	23.5	20.0
23	Thigh Clearance Height	12.4	1.50	9 – 16.6	10.0	12.0	15.0	12.0
24	Knee Height Above Ground	50.6	2.74	42 – 59	45.0	50.0	54.0	50.0
25	Grip Circumference (mm)	163.3	9.09	145 – 185	150.0	161.0	178.5	170.0
26	Chest Breadth	27.6	1.99	22 – 33	24.5	27.0	31.0	27.0
27	Foot Breadth	7.8	0.73	6 – 9	6.3	8.0	9.0	8.0
28	Foot Length	24.6	1.65	22 – 34	22.5	24.5	27.0	24.0
29	Metacarpal III Length	7.8	0.57	6 – 9	7.0	8.0	8.8	8.0
30	Hand Thickness	2.1	0.41	1 – 2.9	1.2	2.2	2.5	2.3
31	Forearm-Hand Length	73.4	4.10	63.5 – 89	67.0	73.0	80.0	73.0
32	Thumb Tip Reach	11.8	0.76	10 – 13.5	10.5	12.0	13.0	12.0
33	Palm Length	10.4	0.65	9 – 12.5	9.5	10.0	11.5	10.0
34	Hand Circumference	21.6	1.21	19 – 26	20.0	21.5	24.0	21.0
35	Elbow Rest Height	58.8	2.65	53 – 70	55.0	58.0	63.5	58.0
36	Middle Finger Circumference	6.2	0.50	5 – 8	5.5	6.0	7.0	6.0
37	Popliteal Height Above Ground	40.4	1.87	37 – 48	38.0	40.0	44.5	40.0
38	Buttock Popliteal Length	47.3	3.06	38 – 58	43.0	47.0	52.5	47.0

Measurements are in cm except otherwise indicated.

Similarly, correlation analyses were carried out for all the measured parameters separately for male, female and overall farmers.

## RESULTS AND DISCUSSION

The measurements taken are contained in Tables 1, 2 and 3 showing for each dimension, the mean, range, standard deviation, 5<sup>th</sup>, 50<sup>th</sup> and 95<sup>th</sup> percentiles and modal values respectively for both male and female farmers totaling 200. It is necessary to separate measurements according to gender because certain jobs are peculiar to each gender. For example, female farmers are more into sedentary jobs like *gari* frying just in the same way as the males are more into driving, heaping, machine operation and other activities than the females. A work-place that is suitable for a male may be unsuitable for a female farmer.

Measurements suitable for design purposes should be those between the 5<sup>th</sup> and 95<sup>th</sup> percentiles as these will accommodate 90% of

the overall users while excluding 5% of the population of smaller subject and 5% of the larger subjects as the case may be. For designers and manufacturers, the aim is to serve a wide percentage of the population and so the use of the modal values becomes very important, in particular, for wide ranged dimensions. In this study, the modal values and the 50<sup>th</sup> percentiles are almost the same for the wide ranged dimensions.

**APPLICATION OF THE ANTHROPOMETRIC DATA:**  
Areas of use of the measurements could be in the manufacture of hand-tools and wearing apparels, equipment and work-place designs.

### MANUFACTURE OF HAND-TOOLS:

The hand tools most frequently and commonly used by farmers are cutlasses (machetes), hoes, diggers, wheel-barrow, axes, shovels, trowels, knives and so on. These may have short or long handles. The grip circumference will be useful in designing the handles, and for the farmers in this

area (southwestern Nigeria), handle size of 150-180mm circumference will be most suitable as these are values of the 5<sup>th</sup> and 95<sup>th</sup> percentiles. Manufacturers may wish to use the modal value of 160mm and mean value of 164mm as a yardstick for determining what relative quantities of each size in the range to produce. In the production of hand wears such as hand gloves, appropriate parameters such as the palm length, hand circumference, hand breadth, hand length, metacarpal III length (middle finger length) and circumference and the thumb-tip-reach are useful. For the palm length, values of 10.00cm and 12.30cm were obtained for the 5<sup>th</sup> and 95<sup>th</sup> percentiles while hand circumference had 20.00 and 28.00cm as the 5<sup>th</sup> and 95<sup>th</sup> percentiles respectively (Table 3). The mean and modal values should similarly be used to determine the relative quantities of the different size range to produce.

**MANUFACTURE OF FARM WEARING APPARELS:**

The wearing apparels in use by farmers are farm boots, hand gloves, raincoats, overalls, facemasks and so on. These materials protect the farmers and

also provide operational comfort. For example, in the case of farm boot, protection from insect and snake bites and any such harmful thing lurking in muddy waters particularly after a heavy downpour, or in the course of traversing streams or waterways, or working in waterlogged farm as in swamp rice field is guaranteed. With the farm boot on, movement in and around the farm is done without any impediment.

Measurements listed in Table 3 such as the foot length, foot breadth, hand breadth, hand length, chest breadth, hand thickness, palm length, hip breadth, and hand circumference should be used for the manufacture of apparels that are common to both sexes considering the 5<sup>th</sup> and 95<sup>th</sup> percentiles values. The mean and modal values guide the decision on the relative quantity of the various sizes to be produced, more of the modal value sizes than the lower or higher sizes is preferred. For example, if chest breadth has to be used in the manufacture of overalls, several sizes in the range of 25 and 35cm (being the 5<sup>th</sup> and 95<sup>th</sup> percentile values) should be produced, but

Table 2: Anthropometric data of male farm workers in South-western Nigeria.

Serial Number	Dimension	Mean	Standard Deviation	Range	Percentile			Mode
					5	50	95	
1	Weight (kg)	58.9	9.04	41 - 98	48.0	59.0	76.0	59.0
2	Age (yrs.)	49.5	12.69	21 - 80	28.0	50.0	68.0	50.0
3	Sideways Reach	94.2	5.24	82 - 108	85.0	94.0	103.5	93.0
4	Upwards Reach	208.1	9.63	178 - 228	191.5	208.0	220.0	218.0
5	Height (standing)	166.7	7.82	149 - 187	154.5	167.5	179.5	168.0
6	Eye Height (standing)	152.5	7.21	139 - 174	142.0	152.0	165.0	146.0
7	Shoulder Width	45.9	3.20	36 - 55	40.5	46.0	50.0	45.0
8	Forward Reach	91.8	4.04	80 - 99	85.0	92.0	98.0	90.0
9	Shoulder-Elbow Length	35.5	3.02	28 - 46	31.0	35.0	40.0	36.0
10	Shoulder Height	141.4	8.00	125 - 163	128.5	141.0	155.0	136.0
11	Elbow Height (standing)	105.7	4.62	92 - 115	98.0	107.0	114.0	107.0
12	Knuckle Height	66.1	3.98	57 - 73	59.6	66.2	71.8	65.0
13	Breadth Across Body	27.8	3.67	21 - 38	22.0	28.0	35.0	28.0
14	Arm Reach From Wall	91.6	6.5	66 - 107	79.0	92.5	98.0	95.0
15	Hip Breadth	30.8	3.33	23 - 40	25.5	30.0	37.0	28.0
16	Breadth Across Elbow	43.6	3.69	36 - 56	38.0	44.0	50.0	45.0
17	Elbow-Middle-Finger Length	47.9	2.77	41 - 53	53.0	48.0	52.0	50.0
18	Hand Breadth	9.8	1.04	7 - 12	7.2	9.6	12.0	8.2
19	Hand Length	19.4	1.61	11 - 23	15.7	18.6	24.3	17.5
20	Sitting Height	87.8	4.83	74 - 99	80.0	88.0	95.0	87.0
21	Eye Height Above Seat	71.8	8.41	54 - 92	57.5	75.0	82.0	75.0
22	Elbow Height Above Seat	21.7	2.41	16 - 29	17.0	22.0	26.0	22.0
23	Thigh Clearance Height	11.3	1.74	7 - 16	9.0	11.0	15.0	10.0
24	Knee Height Above Ground	56.1	2.17	50 - 62	52.5	56.0	59.5	56.0
25	Grip Circumference (mm)	164.6	10.23	150 - 215	152.5	160.0	180.0	160.0
26	Chest Breadth	30.7	3.25	24 - 40	26.0	31.0	35.0	26.0
27	Foot Breadth	10.0	0.80	8 - 12	8.0	9.5	11.9	9.4
28	Foot Length	27.0	1.47	23 - 30	25.0	27.0	30.0	26.0
29	Metacarpal III Length	8.2	1.20	6 - 10	6.5	8.0	9.8	8.0
30	Hand Thickness	2.2	0.59	1.5 - 2.8	1.6	2.1	2.6	2.2
31	Forearm-Hand Length	48.3	2.86	43 - 55	44	48.0	53.5	48.0
32	Thumb Tip Reach	9.6	1.29	7 - 13	8.0	10.0	12.0	10.0
33	Palm Length	11.7	1.27	10 - 20	10.5	12.0	13.0	12.0
34	Hand Circumference	26.2	1.53	23 - 31	24.0	26.0	29.0	26.0
35	Elbow Rest Height	69.9	2.50	63 - 79	66.0	70.0	74.5	70.0
36	Middle Finger Circumference	7.8	0.69	6 - 9	6.0	8.0	9.0	8.0
37	Popliteal Height Above Ground	48.7	3.04	47 - 67	48.0	48.0	53.5	48.0
38	Buttock Popliteal Length	50.6	3.97	41 - 60	43.5	50.0	57.5	50.0

Measurements are in cm except otherwise indicated.

more should be produced with the size of 26cm (modal value) than any other size.

**EQUIPMENT AND WORK-PLACE DESIGNS:**  
The body measurements taken at both the sitting and standing positions are very crucial

**Table 3: Anthropometric data of farm workers [male & female] in South-western Nigeria.**

Serial Number	Dimension	Mean	Standard Deviation	Range	Percentile			Mode
					5	50	95	
1	Weight (kg)	56.9	9.17	37 - 98	43.5	56.0	75.0	59.0
2	Age (yrs.)	39.6	16.6	14 - 80	18.5	40.0	65.0	22.0
3	Sideways Reach	89.3	6.72	75 - 108	79.5	88.0	100.5	86.0
4	Upwards Reach	206.0	9.82	178 - 228	188.5	205.5	220.0	203.0
5	Height (standing)	163.0	8.69	138 - 187	149.0	162.0	177.0	161.0
6	Eye Height (standing)	150.2	7.45	129 - 174	138.0	150.0	162.5	150.0
7	Shoulder Width	42.0	4.79	32 - 55	35.0	41.5	48.5	38.0
8	Forward Reach	87.5	5.96	71 - 99	78.5	87.0	97.0	85.0
9	Shoulder-Elbow Length	34.5	2.97	28 - 49	31.0	34.0	39.5	34.0
10	Shoulder Height	137.4	7.96	118 - 163	126.0	136.0	153.0	136.0
11	Elbow Height (standing)	103.4	5.07	88 - 115	94.5	104.0	111.0	107.0
12*	Knuckle Height	69.6	3.72	59 - 80	63.0	70.0	75.0	70.0
13	Breadth Across Body	27.1	3.15	21 - 38	23.0	27.0	33.5	26.0
14	Arm Reach From Wall	86.1	7.76	66 - 107	75.0	85.0	98.0	84.0
15	Hip Breadth	32.0	3.52	23 - 51	27.0	32.0	37.0	33.0
16	Breadth Across Elbow	40.9	4.56	32 - 56	35.0	40.0	49.5	38.0
17	Elbow-Middle-Finger Length	45.5	3.65	36 - 53	39.5	45.0	52.0	44.0
18*	Hand Breadth	8.9	0.59	8 - 11	8.0	9.0	10.0	9.0
19*	Hand Length	17.9	1.04	15 - 20	16.0	18.0	19.5	18.0
20	Sitting Height	83.1	6.32	69 - 99	73.5	83.0	94.0	80.0
21	Eye Height Above Seat	69.9	6.74	54 - 92	59.0	70.0	79.0	75.0
22	Elbow Height Above Seat	20.9	2.39	14 - 29	17.0	21.0	25.0	22.0
23	Thigh Clearance Height	11.9	1.72	7 - 16.5	9.5	12.0	15.0	11.0
24	Knee Height Above Ground	53.3	3.71	42 - 62	48.0	53.5	59.0	50.0
25	Grip Circumference (mm)	164.0	9.68	145 - 215	150.0	161.0	180.0	160.0
26	Chest Breadth	29.1	3.11	22 - 40	25.0	28.5	35.0	26.0
27*	Foot Breadth	7.8	0.73	6 - 9	6.3	8.0	9.0	8.0
28	Foot Length	25.8	1.99	22 - 34	23.0	26.0	29.0	26.0
29*	Metacarpal III Length	7.8	0.57	6 - 9	7.0	8.0	8.8	8.0
30*	Hand Thickness	2.1	0.41	1 - 2.9	1.2	2.2	2.5	2.3
31	Forearm-Hand Length	60.8	13.0	43 - 89	44.5	59.3	78.0	48.0
32	Thumb Tip Reach	10.7	1.54	7 - 13.5	8.0	11.0	13.0	12.0
33	Palm Length	11.0	1.20	9 - 20	10.0	11.0	12.3	11.0
34	Hand Circumference	23.9	2.66	19 - 31	20.0	24.0	28.0	21.0
35	Elbow Rest Height	64.4	6.14	53 - 79	55.5	65.0	72.5	70.0
36	Middle Finger Circumference	7.0	0.99	5 - 9	6.0	7.0	9.0	6.0
37	Popliteal Height Above Ground	44.4	4.86	37 - 67	38.0	47.5	48.0	48.0
38	Buttock Popliteal Length	48.9	3.91	38 - 60	53.0	49.0	57.0	50.0

Measurements are in cm except otherwise indicated.

\* Data for only 100 female farm workers

**Table 4: Body Segment Lengths Expressed as Fractions of Body Height**

Serial Number	Dimension	Range	Standard Deviation	Coefficient of Variation	Mean	Mean for Drillis & Contini (1966)
1	Eye Height	0.825 - 1.000	0.019	2.05	0.922	0.936
2	Shoulder Width	0.199 - 0.329	0.024	9.33	0.257	0.259
3	Shoulder Elbow Length	0.167 - 0.290	0.015	7.11	0.212	0.188
4	Shoulder Height	0.764 - 0.925	0.024	2.84	0.843	0.818
5	Elbow Height [standing]	0.559 - 0.701	0.022	3.54	0.634	0.630
6	Knuckle Height	0.207 - 0.490	0.022	2.16	0.437	0.377
7	Breadth Across Body	0.121 - 0.235	0.019	11.88	0.166	0.191
8	Arm Reach from Wall	0.353 - 0.645	0.040	7.65	0.528	0.440
9	Elbow Middle Finger Length	0.221 - 0.331	0.018	6.39	0.279	0.254
10	Hand Length	0.099 - 0.132	0.056	4.47	0.112	0.108
11	Sitting Height	0.155 - 0.506	0.026	5.20	0.510	0.520
12	Eye Height Above Seat	0.345 - 0.526	0.032	7.48	0.429	0.456
13	Elbow Height Above Seat	0.091 - 0.181	0.014	11.01	0.128	0.145
14	Knee Height Above Ground	0.284 - 0.378	0.016	4.81	0.327	0.285
15	Chest Breadth	0.139 - 0.230	0.018	10.21	0.178	0.174
16	Foot Breadth	0.026 - 0.058	0.024	4.00	0.049	0.055
17	Foot Length	0.130 - 0.224	0.010	6.46	0.158	0.152
18	Forearm-Hand Length	0.240 - 0.527	0.087	23.25	0.376	0.332



for equipment and work-place designs. These include weight, height, sideways reach, upwards reach, eye height, sitting height, eye height at sitting, forward reach, shoulder height, knee height above ground and others as contained in Tables 1, 2 and 3. The 5<sup>th</sup> and 95<sup>th</sup> percentile values should be used as the working range depending on which gender is being considered. For example, if a door has to be placed in a restricted space, the minimum height should be determined by the height of the tallest person. The mean value may not be useful in this case. In the design of office or working table and chair, the sitting height, forward reach, sideways reach (sometimes upward reach), knee height, popliteal height above ground, buttock-popliteal length and eye height above seat are the necessary dimensions that should be considered.

#### **INTERACTION OF BODY SEGMENT LENGTHS:**

The correlation analysis done for the data indicates that majority of the body segment lengths are positively correlated with the height. Height Vs eye height (standing) and height Vs knee height above ground, for example, respectively have high degree of correlation coefficients of 0.918 and 0.727. Similarly, shoulder height (standing) Vs height and upward reach Vs height positively correlated with height with correlation coefficients of 0.867 and 0.790 respectively.

Some body segment lengths are however slightly negatively correlated with height. Examples are hip breadth Vs height and hand thickness Vs height with correlation coefficients of -0.103 and -0.123 respectively. This study also shows that age and weight have low degree or no correlation with body segment lengths. Age Vs height, for example, has 0.011 as the correlation coefficient. Similarly is weight Vs height with 0.436 as the correlation coefficient.

Some body segment lengths expressed as fractions of body height are contained in Table 4. A comparison made with the work of Drillis and Contini (1966) shows that the results obtained for this study are reliable. For the eye height (standing) to height ratio, 0.922 was obtained in this study as against 0.936 obtained by Drillis and Contini (1966). Similarly, while this study produced 0.510 for sitting height to height ratio, Drillis and Contini (1966) obtained 0.520. Although there are slight differences, they could be due to the populations (races) used in each case.

Gite and Yadav (1989) in their work on anthropometric survey for agricultural machinery design using 39 Indian farm workers as a case

study, obtained mean values of 49.3kg, 162.0cm, 151.0cm, 102.6cm and 83.8cm respectively for the weight, height (stature), eye height (standing), elbow height and sitting height. In this study on 200 farm workers, 56.9kg, 163.0cm, 150.2cm, 103.4cm and 83.1cm are obtained for the respective body dimensions. Though there is some semblance in these body dimension lengths for the two studies, this study however shows that the Nigerian farm workers are heavier.

#### **CONCLUSIONS AND RECOMMENDATIONS**

The data generated in this study should be useful in the design of work-places, wearing apparels and other farm tools and equipment for farmers (both male and female) in the southwestern part of Nigeria. Undue strains to body parts resulting from inappropriate tool size and work-place designs would be reduced to the barest minimum using the data.

Values of body segment lengths expressed as fractions of height compare favourably with those of other scientists in similar studies thus lending support to the reliability of the data. The slight differences could be due to differences in the populations (races) compared.

It will be necessary to conduct similar study to cover all parts of the country so that a database on anthropometry of Nigerian farmers would be available to interested local and foreign engineers and designers in agriculture. At the moment, it is generally believed that farmers in the northern part of Nigeria are lighter (slimmer) and taller than those from the south who are assumed to be shorter and heavier. A large survey is therefore desirable before drawing a final conclusion in this regard.

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