iJET EXPLORE International Journal of Engineering & Technology
CENTRE OF PROFESSIONAL RESEARCH PUBLICATIONS
ISSN 2049-3444

International Journal of Engineering and Technology Volume 2 No. 6, June, 2012

Anthropometry of South Eastern Nigeria Agricultural Workers

S. N. Onuoha[1] ; F. I.Idike[2]; O. Oduma[3]
[1]Department of Agricultural Engineering Technology, Federal Polytechnic Auchi, P.M.B. 13, Auchi, Edo, Nigeria
Ebonyi State University, P.M.B. 53, Abakaliki, Ebonyi State, Nigeria.
[3]Department of Mechanical Engineering, Ministry of Works and Transport, Abakaliki, Ebonyi, Nigeria.

ABSTRACT

An anthropometric survey of Nigerian farm workers was conducted from the south eastern zone of Nigeria in order to obtain information on the body dimensions, which may be used in ergonomic design of farm equipments. The samples which include males and females involved in different agricultural activities were randomly selected from the five states that made up the South east geopolitical zone, namely: Anambra, Abia, Ebonyi, Enugu and Imo State. Thirty (30) structural body dimensions necessary for the design of farm equipments/machineries were identified and the survey was conducted on 500 farm workers (300males and 200 females) within the age limit of 18 to 50 years. The data obtained from the measurements were statistically analysed and compared with those obtained from south western Nigeria passengers in buses and Agricultural workers in other countries. Results revealed that the mean stature of South eastern male farm workers was 163.4 ± 5.84 and female was 156.8 ± 5.28. The comparison between male and female data indicates that male agricultural workers are bigger than the females in all body dimensions except waist circumference, hand breadth and hip breadth. The mean values of waist circumference, hand breadth and hip breadth for the male were 83.2 ± 4.84, 8.2 ± 0.32 and 32.6 ± 1.84; whereas the values for female were 88.4 ± 5.08, 8.7 ± 0.77 and 37.4 ± 2.43 respectively. The data also showed significant differences among various body dimensions while comparing with other south western states. Some structural body dimensions compared with other ethnic populations of the world indicated slight variations in values. Based on these findings, it is highly recommended that more research be carried out by concern authorities in different states of the country in order to generate necessary data for all categories of people especially farm workers in Nigeria for proper machine design.

Keywords: *Anthropometry, body dimensions, farm equipment, ergonometric design, agricultural workers, south eastern geopolitical zone.*

1. INTRODUCTION

The present need for the use of agricultural machineries/ equipments for agricultural mechanization require a good knowledge and proper design of agricultural equipment with special consideration to efficiency, safety and comfort of people using them. In South eastern Nigerian, mostly local tools and equipment are utilized for performing agricultural operations due to inherited constraint like variation in slopes and altitudes, land tenure systems and cultivation practices. Majority population of the region is tribal and prone to excessive drudgery of farm operations due to the number of biophysical, infrastructural and socio-economic problems resulting into low productivity of most of the agricultural food items as compared to other parts of the country. One of the main reasons of lower agricultural productivity in the region is due to prevalence of traditional method of cultivation and lower mechanization level.

Despite the various approach to modern technology on agricultural machinery/equipment design, a lot of human drudgery in farm operations have not yet been arrested to minimal in Nigeria especially in the south eastern part of the region. In western countries, large amounts of anthropometric data are available for reference. The anthropometric data bank, assembled and maintained by the Aerospace Medical Research Laboratories, Dayton, Ohio, is the largest and most comprehensive data in the world (NASA, 1978). However, it does not contain any data on the Nigeria (West Africa) population. Thus, the anthropometric data of Nigerian agricultural workers are not considered in the design of agricultural equipment and yet most of the equipments been used are imported from Western countries.

Most of these agricultural machines create discomfort and at times break down quickly due to various discrepancies in ergonomic principles with respect to Nigeria Agricultural workers using them. Various factors such as gender, age, race, nutritional status, body dimensions, nature of work among others vary widely across every region, state and country (Yadav et al, 1996, Agrawal et al, 2010). This implies that there must be considerable difference between the anthropometric data of Nigerians and western countries. Some of farm operations in the south eastern region are equally shared by both genders.

Farm operations such as ploughing, harrowing, leveling, pudding are exclusively done by male workers while weeding, uprooting seedlings, transplantation are done by female. However few operations such as fertilizer and chemical application, harvesting, threshing and transportation are done by both genders. For these reasons, anthropometric body limitation of both genders have to be taken into consideration before designing any tool or machinery meant to perform a specific agricultural operation. This will help to increase output and safety, because the man-machine interface decides the ultimate performance of the machinery/equipment.

The study aims at providing an anthropometric data of south eastern agricultural workers of Nigeria as a reference for the ergonomic design and modifications of agricultural equipment and machineries suitable for Nigeria use.

2. MATERIALS AND METHODS

A study of randomly selected five hundred (500) agricultural workers (males and females) of south eastern states (Anambra, Abia, Ebonyi, Enugu and Imo) was undertaken with their ages ranging from 18 to 50 years. 300 Agricultural workers were males whereas others were females.

Thirty (30) anthropometric measurements were carried out which were considered useful for farm equipment design on the workers chosen. In order to measure the various body dimensions of the workers, the following devices were used: an anthropometer, a grip-size measuring device, a grip strength dynamometer and a bathroom weighing scale. The standard anthropometric definition of measurements and techniques were adopted from Pheasant (1986) and Reobuck et al (1975). The observers were given enough practice to measure all the dimensions in a correct posture and in a precise manner. The subjects were asked to stand on the platform of the anthropometer, its arm was adjusted according to the subject's height and measurement was recorded from the vertical scale. In similar form, other measurements were recorded in sitting and standing postures with the help of an anthropometer. The grip diameter was measured with the grip measuring device. The data recorded for the workers were the mean of readings obtained from ten workers.

The results of the measurements were used to evaluate the mean, standard deviation, range, fifth, fiftieth, ninety-fifth percentile and mean differences of male and female Agricultural workers of the body dimensions using Excel Microsoft package.

3. RESULTS AND DISCUSSION

The body dimension measured during the survey were analyzed (Table 1) for mean, standard deviation, range and percentile values of male and female agricultural workers. The data indicate that female agriculturalists are smaller than the male in all body dimensions expect waist circumference, hand breadth and hip breadth (sitting). Analysis of data shows that the mean stature and weight of female agricultural workers (156.8cm and 51.3kg) is significantly lower than their male counterparts (163.4cm and 56.7kg). The differences in mean values and percentage of stature and weight of male and female were observed to be 6.6cm (4.04kg) and 5.4cm (9.52kg). The mean weight and stature of female were found to be 96% and 90.5% in comparison with male workers.

However, the 5^{th}, 50^{th} and 95^{th} percentile values of stature for male agricultural workers were found to be 158.9, 163.6 and 176.6 against their female counterparts with 149.1, 156.5 and 168.0 respectively. This suggest that the design parameter should not exceed the data obtained otherwise the machine will be cumbersome for the users. The body stature is an important dimension to be considered first when designing any machine because of its relevance in determining several other body dimensions.

Further analysis of data shows the mean eye height, shoulder height, elbow height, Matacarped height, sitting height, sitting eye height, sitting shoulder height, elbow rest height, knee height, popliteal height and knuckle height of female workers were found to be 74%-96% of corresponding body dimensions of male workers. The differences in mean values between male and female farm workers for these dimensions range from 2.7cm to 9.3cm. More so, sitting buttock knee length, buttock popliteal length, functional leg length, foot length, shoulder elbow length, forearm length and hand length of female farm workers were found to be 86%-96% of the corresponding dimensions of the male, whereas the differences in their mean values range from 1.2cm to 7.0cm. However, waist circumference, hand breadth and hip breadth (sitting) of female workers were found to be 2%-3% higher than that of male counterparts. The differences in some of the body dimensions such as grip hand strength, grip diameter (internal), hand circumference, arm reach from wall, forward grip reach, thigh clearance and shoulder breadth was 3.2%-28% between male and female workers.

In some agricultural work, most of the tools are manually driven, so proper grip is required for effective force application while working with these tools. The grip dimensions of most tools need to be designed based on anthropometric dimensions obtained. The 5^{th}, 50^{th} and 95^{th} percentile values of grip diameter (internal) were found to be 3.6, 4.2 and 4.9cm for male and 3.1, 3.6 and 4.4 for female farm workers, respectively. The grip dimension of any tool need to be designed in a comfortable way such that person(s) with 5^{th} percentile body dimensions could properly grip the handle. Therefore the minimum

diameter of the grip should be 3.6cm for male and 3.1cm for female farm workers.

The length of grip is a function of breadth of palm of the population and should be considered based on 95th percentile person operating the equipment to enable him/her hold the grip properly. The handle holding height depends upon the elbow height of the population and permitted comfortable range of elbow angle of 100-110^{0} as suggested by Grandjean (1988). The elbow height standing for male and female agricultural workers was found to be 98.4, 102.0 and 108.4 and 87.4, 98.4 and 99.2 for 5th, 50th and 95th percentile, respectively. When elbow grip length is known, the handle height at given elbow angle of 100-110^{0} can be calculated.

The anthropometric values of waist circumference of the farm workers of south eastern Nigeria have been taken into consideration. The waist belt if any is provided should be of length equal to 95th percentile values of waist circumference of 90.4cm for male and 92.5cm for female farm workers as recorded in the (Table1). While 5th percentile waist circumference for male and female workers were found to be 68.6 and 70.4cm respectively. Therefore waist strap must have minimum length of 92.5cm with adjustment of tying the same should be up to 68.6cm so that 95% persons in the population group could be accommodated to use the given strap.

The comparism of major anthropometric dimensions of male subjects of the south eastern states of Nigeria, with those of south western Nigerian passengers in buses(Table 2) reveals that most of the dimensions are smaller for male farm workers of the south eastern region indicating a unique and distinct nature of the anthropometry of the region. Although the anthropometric data of south western region obtained were not from farm workers in the region, it is possible that majority of these passengers are also Agricultural workers because farming occupations dominate the region.

Therefore, machines to be designed for the male Agricultural workers at south western region in Nigeria, need to be modified with suitable adjustments in body dimensions affected.

The mean of some major anthropometric data (body dimensions) of south eastern Nigeria Agricultural farmers were also compared with mean values of other Agricultural workers from other countries as indicated in Table 3. The comparison reveals that the south eastern farm workers in Nigeria are smaller than Indian, German, USA, Japanese, Chinese and British agricultural workers in all structural body dimensions where data were available. The variation may be attributed to the discrepancies in physiological factors and body build up. The lower body dimensions may lead to have uncomfortable postures adopted while working with implements and machinery leading to fatigue on operators and possibly low work output.

Table 4 presents the comparison of sitting height to stature ratio of south eastern states of Nigeria with different countries. Result from this Table shows almost similar ratio of sitting height to stature among different populations which is line with survey carried out on anthropometric data of Indian Agricultural workers (Yadav, et al 2000).

Table 5 shows the comparism of mean ratio between stature and some body dimensions with the ratio obtained by Barkla (1961) for the British populations. This comparison shows little variation. This is in accordance with Murrel (1975) who also stipulated that there is a high probability that whatever the mean stature of a sample, any given body dimension of length will be very nearly a constant proportion of the stature. Therefore, if the stature is known, any dimension that is not available in the sample can be obtained by proportion (Yadav et al, 2000).

Table 1: Anthropometric Data of Male and Female Agricultural Workers of South eastern States of Nigeria.

Body Dimensions	Male(n= 300)					Female (n=200)					Mean diff.
	Mean	Range	Percentile			Mean	Range	Percentile			
			5th	50th	95th			5th	50th	95th	
Body Stature, cm	163.4(5.84)	148.3-182.1	158.9	163.6	176.6	156.8(5.28)	145.3-173.5	149.1	156.5	168.0	6.6
Body Weight, kg	56.7(7.14)	48.3-71.8	41.3	56.3	66.3	51.3(4.91)	35.0-71.3	39.4	51.2	65.8	5.4
Grip strength, kg	34.8(3.43)	29.8-52.1	20.4	35.1	46.6	25.4(2.67)	16.1-38.6	19.2	25.5	33.1	9.4
Grip diameter (internal), cm	4.3(0.40)	2.8-5.2	3.6	4.2	4.9	3.6(0.32)	2.9-4.9	3.1	3.6	4.4	0.7
Waist circumference, cm	70.6(4.48)	68.2-95.9	68.6	83.5	90.4	73.0(6.20)	68.1-98.0	70.4	87.8	92.5	-5.4
Hand circumference, cm	19.7(1.39)	14.8-23.1	15.0	18.8	21.8	17.9(1.26)	14.6-23.5	15.9	17.6	19.1	1.8
Eye height, cm	153.1(5.92)	138.4-172.6	149.1	153.0	167.1	147.2(5.51)	134.6-159.3	138.7	142.1	153.8	5.9
Shoulder heigh t, cm	138.4(4.91)	127.0-149.1	129.3	138.2	195.6	129.1(4.92)	122.0-133.7	125.3	128.2	130.2	9.3
Elbow height, cm	101.2(2.98)	93.8-113.9	98.4	102.0	108.4	98.4(7.06)	88.3-104.7	87.4	98.4	99.2	2.8
Metacarped height, cm	69.3(2.91)	52.1-78.6	54.6	68.9	73.1	64.5(3.12)	59.6-72.5	60.1	63.4	67.0	4.8
Sitting height, cm	83.7(2.64)	63.0-98.4	69.4	83.5	92.9	74.8(2.48)	68.2-82.6	69.0	74.6	77.1	8.9
Sitting eye height, cm	74.6(3.90)	58.3-81.1	61.1	72.8	76.6	66.3(2.08)	61.0-71.5	63.7	65.1	66.0	8.3
Sitting shoulder height, cm	54.2(1.81)	42.8-63.2	48.4	55.3	57.7	48.1(2.64)	43.9-52.7	45.0	47.1	49.3	6.1
Elbow rest height, cm	24.3(3.70)	17.4-31.5	19.6	26.8	29.5	17.9(1.44)	14.1-21.3	15.1	17.8	19.2	6.4
Knee height, cm	52.8(2.41)	46.1-62.3	49.7	51.7	56.6	46.8(2.81)	42.4-53.9	44.2	46.4	48.9	6.0
Popliteal height, cm	43.4(3.35)	38.2-57.6	39.5	43.3	52.1	39.5(2.16)	36.1-42.5	37.1	38.7	40.2	3.9
Knuckle height, cm	68.2(5.12)	53.8-71.0	61.4	68.0	66.4	65.5(3.28)	58.3-69.9	60.3	64.5	67.3	2.7
Buttock knee length, cm	58.0(3.11)	40.6-68.5	49.1	58.3	63.0	51.0(2.49)	45.0-62.8	47.9	52.1	57.6	7.0
Buttock popliteal length, cm	48.2(2.64)	33.7-59.3	42.6	49.1	53.5	43.2(2.71)	37.2-45.9	39.0	41.8	43.9	5.0
Functional leg length, cm	96.7(5.13)	79.4-103.1	81.9	90.1	98.5	90.9(3.90)	85.6-105.3	87.6	91.2	101.6	5.8
Foot length, cm	24.9(2.03)	19.1-32.0	20.1	25.3	29.2	21.4(1.54)	17.9-25.4	18.7	21.3	23.7	3.5
Shoulder elbow length, cm	30.1(2.18)	24.6-49.3	26.8	31.0	44.5	28.8(1.83)	24.2-32.4	25.5	28.5	30.9	1.3
Forearm hand length, cm	48.4(2.58)	37.2-58.6	42.4	48.2	54.6	42.3(1.85)	38.6-47.5	39.9	42.1	45.7	6.1
Hand length, cm	18.6(1.61)	14.8-24.1	15.0	18.8	23.2	17.4(1.38)	14.8-20.2	15.4	17.3	18.6	1.2
Hand breadth, cm	8.2(0.37)	5.7-10.3	6.8	7.9	9.2	8.4(0.77)	7.9-9.4	7.5	8.1	9.0	-0.5
Arm reach from wall, cm	84.1(3.91)	71.8-98.9	75.3	81.2	91.4	77.2(3.76)	65.7-92.1	67.8	78.0	83.5	6.9
Forward grip reach, cm	72.8(3.23)	61.5-96.7	67.1	72.4	91.8	67.7(4.09)	59.5-85.4	61.3	67.6	78.9	5.1
Thigh clearance, cm	13.5(0.92)	10.5-16.3	11.4	13.6	15.7	9.1(0.98)	7.6-14.9	8.1	9.4	12.8	4.4
Hip breadth (sitting) , cm	29.0(1.58)	27.3-36.3	28.5	30.8	35.6	29.6(2.43)	28.2-43.4	32.6	37.5	41.1	-4.8
Shoulder breadth, cm	43.1(2.73)	36.1-58.2	38.6	44.3	55.7	41.7(2.77)	31.8-46.5	38.0	41.5	44.3	1.4

Values in parenthesis are the standard deviation (S.D.)

Table 2: Comparism of Anthropometric Data of Male Agricultural Workers of South eastern Nigeria Nigeria with South Western Passengers in Buses

Body Dimensions	Ismaila et al(2010) South Western Nigeria				Present Study South eastern Nigeria			
	Mean	Percentile			Mean	Percentile		
		5th	50th	95th		5th	50th	95th
Stature(Standing height), cm	174.8(9.7)	158.8	172.5	190.8	163.4(5.8)	158.9	163.6	176.6
Body weight(kg)	-	-	-	-	56.7(7.1)	41.3	56.3	66.3
Popliteal height(PH)	42.8(3.8)	36.6	41.4	49.0	43.4(3.4)	39.5	43.3	52.1
Sitting height(SH)	84.9(4.9)	76.9	83.5	93.0	83.7(2.6)	69.4	83.5	92.9
Knee height	56.9(3.1)	51.2	54.4	61.5	52.8(2.4)	49.7	51.7	56.6
Elbow-Elbow Breadth	48.8(9.3)	33.7	46.0	64.0	-	-	-	-
Eye sitting height	76.2(5.5)	67.2	74.5	85.2	74.6(3.9)	61.1	72.8	76.6
Buttock knee length	63.0(2.8)	58.4	62.1	67.7	58.0(3.1)	49.1	58.3	63.0
Buttock popliteal length	52.6(5.0)	44.4	51.1	60.8	48.2(2.6)	42.6	49.1	53.5
Thigh clearance height(TOH)	14.4(1.5)	11.9	14.1	16.9	13.5(0.9)	11.4	13.6	15.7
Hip Breadth sitting(HBS)	37.7(5.3)	29.0	36.4	46.4	29.0(1.6)	28.5	30.8	35.6
Shoulder Breadth(SB)	47.6(8.6)	33.5	46.1	61.8	43.1(2.7)	38.6	44.3	55.7

Table 3: Comparison of Anthropometric Data of South Eastern Nigeria Agricultural workers with other Ethnic population of the world.

Body Dimensions	Present Study	Yadav et al (1996)	Jurgens et al (1972)	Hertzberg et al (1954)	Yokohori (1972)	Shao &Zhou (1990)	Haaslegrave (1980)
	South eastern Nigerian	1.Indian	2.German	3.US	4.Japanese	5.Chinese	6.British
Body Stature, cm	163.4	161.4	174.5	175.5	165.8	168.82	173.81
Shoulder height, cm	133.8	134.6	146.4	143.5	134.5	NA	NA
Sitting height, cm	83.7	84.8	91.9	91.3	90.4	89.65	91.90
Sitting eye height, cm	70.5	73.9	80.2	79.9	78.5	79.40	80.27
Elbow rest height, cm	21.1	20.3	23.7	23.2	26.0	NA	NA
Popliteal height	41.5	47.1	45.4	43.1	40.2	40.13	NA
Buttock leg length	93.8	97.6	NA	108.5	NA	NA	NA
Footh length	23.2	25.0	26.0	26.7	NA	NA	NA
Shoulder elbow length	29.5	30.2	NA	36.4	NA	NA	NA
Forearm hand length	45.4	45.9	NA	47.8	NA	NA	46.87
Arm reach from wall	80.7	83.1	NA	84.6	NA	NA	NA
Thigh clearance	11.3	13.4	15.1	14.3	NA	NA	NA

Note: NA means not available

Table 4: Comparison of Sitting Height to Stature Ratio with other ethnic Populations of the world.

Ethnic Group	Ratio	Source
South eastern Nigeria	0.5122	Present study
Indian	0.5254	Agrawal et al(2010)
German	0.5266	Jurgens et al (1972)
US	0.5202	Hertzberg et al (1954)
Japanese	0.5452	Yokohori (1972)
Chinese	0.5310	Shao & Zhou(1990)
Bristish	0.5287	Haslegrave(1980)

Table 5: Comparison of mean ratio between Stature and some body dimensions with the ratio given by Barkla (1961)

Body Dimensions	Proportions of Stature	
	Barkla 1961	Present study
Eye height, cm	0.936	0.938
Shoulder height, cm	0.811	0.835
Elbow height, cm	0.608	0.624
Sitting height, cm	0.525	0.495
Sitting eye height, cm	0.477	0.440
Sitting shoulder height, cm	0.340	0.319
Knee height, cm	0.315	0.311
Popliteal height, cm	0.245	2.94
Buttock knee length, cm	0.342	0.286
Buttock popliteal length, cm	0.280	0.340
Forearm hand length, cm	0.272	0.283
Hip breadth (sitting), cm	0.205	0.219
Shoulder breadth, cm	0.260	0.265

4. CONCLUSION AND RECOMMNDATIONS

The survey reveals that the anthropometric data of female and male farm workers in south eastern states of Nigeria could be used as a guide to designing and modifying of agricultural machines suitable to agricultural farm workers. The data also reveal that male farm workers were bigger than their female counterparts in all body dimensions except waist circumference, hand breadth and hip breadth.

Anthropometric data of Nigeria (south eastern) farm workers were found to be smaller in the body measurements when compared with south western passengers in buses and other six countries of the world; whereas the ratio of sitting height to stature is almost similar in all dimensions. Anthropometric data for female, children, adults and disables in general are still missing for Nigeria population groups. It is highly recommended that research be carried out by concerned authorities in different states of the country in order to generate necessary data for all categories of people especially farm workers in Nigeria. The data will be useful for agricultural and machinery design.

Since there was no significant variation in the ratio of sitting height to stature across the various countries of the world, the anthropometric data thus will help engineers and agricultural machineries/ implement manufacturers for designing and construction of machines capable of accommodating various agricultural farm workers in Nigeria and those countries.

REFERENCES

[1] Agrawal, K.N., Singh, R.K.P and Satapathy. K.K. 2010. Anthropometric considerations of farm tools/machinery design for tribal workers of northern Indian. Agric Eng Int: CIGR Journal,12(1):143- 150

[2] Barkla, D. 1961. The Estimation of body measurement of British Population in relation to seat design. Ergonomics 4:123-132.

[3] Grandjean, E.1988. Fitting the task to man. Taylor and Francis, London.

[4] Haslegrave, C.M.1980. Anthropomertic profile of British car driver. Ergonomics, 23(5):437- 467.

[5] Hertzberg, H.T.E., Daniels, G. S. and Churchill, E. 1954. Anthropometry of flying personnel – 1950. Wright Air Development Centre. Wright-patterson Air force Base, Ohio, WADC Tr 52 – 321.

[6] Ismaila,S.O; Akanbi,D.G; Adunkle,N.O; Adetunji, O.R and Kuye,S.I. 2010. An Ergonomics Assessment of Passengers seats in South Western Nigeria.SIGURNOST 52(4) 329-334.

[7] Jurgens, H. W. Helbig, K. and Lengsfeld, W. 1972. Body Measurements of 25 – 50 year old mean upon examination of the anthropometric ergonomic significance of ageing on changes in body shape. Research contract B. M Vg Insan Nr 3571 – V-072, Ministry of Defence Documentation Centre, Military Affairs Department, 53bonn, Freidrich Ebert Alee 32. Germany (in German).

[8] Murrel,K.H.F. 1975. Ergonomics, man and his Working Environment, Chapman and Hall, London.

[9] NASA 1978. Anthropometric Source Book, Vol. II National Aeronautics and Space Administration, Washington.

[10] Pheasant, S. 1986. Body Space: Anthropometry, Ergonomics and Design. Taylor & Francis, London.

[11] Reobuck, J. A., Kroemer, K.H.E. and Thomson, M.S. 1975. Engineering Anthropometry Methods. John Wiley and Sons. New York.

[12] Shao,W., and Y. Zhou. 1990. Design principles of wheeled tractor driver-seat static comfort. Ergonomics, 33(7):959-965.

[13] Yadav, Rajvir, Tewari, V. K. and Prasad, N. 1996. Anthropometric data of Indian farm workers – a module analysis. Applied Ergonomics, 28(1): 69-71.

[14] Yadav Rajvir, Gite, L. P. Kur, N. and Randhawa, J. 2000. An Anthropometry of Indian Female Agricultural workers, Agricultural Mechanization in Asia, Africa and Latin America Vol.31 No.3.

[15] Yokohori, E. 1972. Anthropometry of JASDF Personnel and its application for human engineering. Aeromedical laboratory. Japanese Airself Defence force TAB, Tokyo, Japan