



MICHIGAN STATE UNIVERSITY  
TEXTILES, CLOTHING AND RELATED ARTS  
COLLEGE OF HOME ECONOMICS

THESIS

138

392

THS

/ A COMPARISON OF THE SPECIFICATIONS AND  
PERFORMANCE QUALITIES OF PHILIPPINE AND AMERICAN  
DUCK, KENAI, PERCALE, AND SAIL CLOTH /

by

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A PROBLEM

Submitted to the College of Home Economics  
Michigan State University  
in partial fulfillment  
of the  
requirements for the degree

of  
MASTER OF ARTS

Department of Clothing, Textiles, and Related Arts  
1959

Thesis

138

390

THS

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## CHAPTER I

### INTRODUCTION

Statement of the Problem. A COMPARISON OF THE SPECIFICATIONS AND PERFORMANCE QUALITIES OF PHILIPPINE AND AMERICAN DUCK, KHAZI, PERCALE AND SAIL CLOTH.

The purpose of the study. The purpose of this study is to compare the specifications and performance qualities of comparable cotton materials which are made in the United States and in the Philippines.

The writer hopes that after the data of this study is complete she will be able to make a report to the National Development Company in the Philippines about the specifications and performance characteristics of these eight cotton materials. If in any way the Philippine materials do not fall within the range of the specifications of the American standards, then this study might in some way help the National Development Company to improve its products.

This study will not only help the writer in her teaching, but also help the National Development Company of the Philippines to produce better and more competitive cotton fabrics for domestic consumption as well as for export.

The scope of the study. In this study, the four cotton fabrics, duck, khaki, percale, and sail cloth from the Philippines are to be compared to the nearest if not the same type of fabric made in the United States. The four fabrics will be compared as to their initial specifications and performance qualities as well as to changes resulting from five launderings.

The discussions will be based on a comparison of pairs of fabrics rather than differences between the various types of fabrics used in this study.

Dimensional change in the fabrics will be determined by hand washing procedure instead of by machine so as to make the procedure more typical of the Philippine way of laundering.

Colorfastness of the fabrics will be based on exposure to light in the Fado-Ometer for periods of 10, 20, 40, and 80 hours.

Inasmuch as the four types of fabrics compared in this study have different end-uses, the uses for each group will be discussed in the section under discussion of results.

Materials included in the study. The materials to be compared are duck, khaki, percale, and sail cloth. It was not possible to secure the identical kinds of materials from the Philippines to compare with the materials produced in the United States. So, in cases where identical materials were not available, the nearest type of fabric in terms of comparable end-use were secured.

| Group of Materials |                         | Width in<br>Inches | Cost per linear<br>yard | Cost per square<br>yard |
|--------------------|-------------------------|--------------------|-------------------------|-------------------------|
| I.                 | Duck, U.S.              | 30                 | \$ .74                  | \$ .89                  |
|                    | Duck, Philippines       | 34                 | .50                     | .53                     |
| II.                | Khaki, U.S.             | 40                 | \$2.35                  | \$2.11                  |
|                    | Khaki, Philippines      | 31                 | 1.25                    | 1.45                    |
| III.               | Percale, U.S.           | 38                 | .49                     | .47                     |
|                    | Percale, Philippines    | 32                 | .40                     | .45                     |
| IV.                | Sail Cloth, U.S.        | 35                 | .59                     | .60                     |
|                    | Sail Cloth, Philippines | 33                 | .58                     | .63                     |

## CHAPTER II

### REVIEW OF LITERATURE

#### Yarn Count

To distinguish differences in weight and fineness, yarns are given size numbers called counts, lea or denier. The term "count" applies to the size of cotton wool and spun yarn whereas "lea" applies to linen, and "denier" applies to filament silk and man-made yarn. (14)

For cotton and spun yarns, the standard used is 840 yards to the pound. The higher the numerical count, the finer the yarn.

The count of cloth and the count of yarn should not be confused. The former denotes the number of pick and ends to a square inch; the latter indicates the weight and fineness of the yarn. The larger the number the finer the yarn. (14)

The yarn count (8) of a fabric indicates the number of ends or warp yarns per inch and the number of picks of filling yarns per inch. This is expressed as warp x filling (example: 64 x 60).

Having an equal yarn count in warp and filling of a fabric does not mean that warp and filling are necessarily of equal strength. In order to facilitate weaving, warp yarns are frequently ply yarns and are stronger than filling yarns. In the process of weaving, the tension on the warp is greater than in the filling. Yarn count alone is a somewhat vague indication of durability. Balanced strength is attained in a



fabric when the tensile strengths of warp and filling are equal. Balanced strength is often desirable in clothing fabrics because the strain is often as great on one set of yarns as on the other, especially in the work and play clothes.

### Twist

The twist (4) of the yarn plays an important role in determining the character of the finished cloth. Differences in fabrics are produced by variation in the amount and direction of twist and the manner in which yarns of differing amount and direction of twist are combined in the construction of the cloth. The best example for this is the crepe fabrics.

Yarn twist (9) causes the fibers to lie in spirals, and, since fibers stresses are in the fiber direction, fiber strength is not fully utilized. The twisting of fibers on themselves lowers fiber strength appreciably, an influence that may assert itself in axial yarn regions. The portion of the fiber strength that cannot be realized in the yarns because of the spiral arrangement of fibers is not completely lost. Radial forces press the fibers together increasing friction and raising the density of the yarn.

Twist (9) has two apparent effects--one tending to reduce the proportion of fiber strength realized, the other tending to increase yarn strength by pressing the fibers together. These opposing effects do not change at similar rates as the twist multiplier is changed. The strengthening influence predominates at low twist, the weakening effect at high twist.

Twist (11) is a measure of the spiral turns given to a yarn

in order to hold the constituent fibers or threads together. Up to a certain point, an increase in the twist tends to make a stronger yarn; but above this point, the additional twist adds a strain to the fibers which results in a weaker yarn. In general, then, there is a certain limit range of twist which is desirable. For certain effects, however, less twist (soft twist) or more twist (hard twist) may be necessary.

Yarns (8) which have been twisted but once are called single. When two or more singles are twisted together, a ply yarn is formed. Such twisting of ply yarns increases the binding strength within each single, and consequently the strength of a ply yarn is greater than the combined strength of its singles.

The direction of twist (8) in yarns is indicated as S and Z. Yarns have Z twist when the angle of the spiral twist of the fibers is that of the center line of the Z. Likewise yarns have S twist when the angle of the spiral of the fibers is that of the center line of the S. A ply yarn is usually twisted in the opposite direction from the singles of which it is composed. The twist is indicated as S/Z or Z/S.

#### Yarn Number

The yarn number (8) is a relative measure of the fineness or coarseness of a yarn. There are several systems of yarn numbering used; for cotton, the cotton hank number is used. In some systems, as the number goes up the yarn is coarser. This applies to the denier, the spynole and the grex number. (In these, the relative measures are weights per unit length).

In the other systems, as the number goes up the yarn is finer. This applies to the metric number, type, runs, cuts, leas, and hanks. (In these, the relative measures are length per unit weight).

### Tensile Strength

The strength (9) of a textile yarn and ultimately the fabric depends to a large extent on the tensile strength of the fibers of which the yarn is composed. This is especially true of the filament materials, such as silk, rayon, and nylon. Yarns manufactured from short-length fibers, like cotton, wool, staple rayons, hemp, jute, ramie, and other similar fibers, in the final analysis depend also on the strength of the fibers for their composite structural characteristics. The contribution of fiber strength to the completed yarn properties varies widely; it depends upon such factors as fiber friction, staple length, the fineness, and yarn twist, in addition to the final fabric specification. The fiber strength still remains the basis for strength requirements of the finished product.

Fine yarns are inherently weaker than coarse yarns. The reason seems to be that fine yarns have a higher surface-to-volume ratio than coarse yarns. Fibers in the yarn surface make few contacts with adjacent fibers and have less radial pressure exerted against them. This effect is sometimes obscured by the fact that only the long, strong cottons can be spun to fine counts.

Cotton yarns are highly complex in structure and behavior. A variety of combination of yarn counts and twist factors are

in common use, the combination being determined by the cotton and the purpose of finished textile.

The strength (13) of any fabric is dependent in part upon the friction developed at all points of contact along the sides of adjacent parallel strands and at the points of intersection with the cross threads. The character of the weave and the closeness, the finish of the fabric, and the kind of fiber employed, the count and character of the yarns in each set of threads are factors which affect the amount of friction and are a part of that somewhat elusive quality called "fabric assistance".

The strength (9) of individual cotton fibers as well as of yarns is influenced to an appreciable extent by relative humidity. Fiber strengths increase with rising relative humidity in the lower range, but do not respond in most cases to increase in relative humidity beyond 60%. It has been estimated that cotton fibers saturated with water are about 20% stronger than air-dry fibers.

The strength (8) of cotton fibers is important because it is associated with desirable service qualities. Breaking strength of a fiber may be expressed either as tenacity or as tensile strength. The relationship of fiber length to strength shows that in general the longer, finer fibers are also stronger.

Tensile strength (8) is the breaking strength per unit of fiber cross-section and is dependent to a large degree upon the amount of cellulose per unit of cross-section area of the fiber. The tensile strength of cotton fibers varied from 66-82

psi for Southeast varieties, to 84-89 psi for some mid-South variety. Density and thickness of fiber walls vary in a measure with variety, region of growth, and maturity. Such qualities help to determine the service which the fiber gives in clothing and household fabrics.

The amount of moisture (8) held by cotton fibers affect physical properties such as breaking strength, hand, and ease of ironing.

#### Shrinkage

Shrinkage (11) is the linear amount of fabric which will contract warpwise or fillingwise when laundered. All fibers have some tendency to shrink, but this tendency is greatly increased if the fabric has been stretched in finishing.

Johnson (11) has shown that shrinkage in cotton goods is nearly totally accounted for by the water, i.e., that the detergents used have little effect on the amount of shrinkage, although they may alter the rate of shrinkage, or the time required for the full amount of shrinkage to occur. It should be considered also that shrinkage is not complete in one laundering; but that the greatest amount of shrinkage would occur within the first five launderings.

In the first washing (11) the force of swelling produces relatively large changes in the shape of the threads; there are local strains in the structure which disappear by further readjustment in the subsequent dryings and washing. These strains can be pictured as places in the yarns where sticking has occurred. When the yarn dries, free space develops, which allows for accomme-

dation between fibers with a less strained and more shrunken structure when the cloth is wet out again. Agitation during the washing treatment helps to overcome these local strains and therefore promotes shrinkage.

Cotton (9) increases in volume upon absorbing moisture from the atmosphere. Therefore, all ordinary cotton is normally slightly swollen. Swelling increases with humidity and may cause tightly constructed cotton goods to become harder or stiffer or to change in dimension. Reverse changes take place when the humidity is decreased.

#### Special Properties and Defects of Cotton

Cotton (9) is highly resistant to degradation by heat and can be ironed at very high temperature. Among its important defects are: (1) its "limpness" when it is wet, (2) its tendency to crease easily and become rumpled, and its tendency to be attacked by fungi, with the loss of strength under moist conditions. At present these defects are generally outweighed by the durability and long, flexing life of cotton and by its high resistance to drastic treatment such as constant laundering.

Cotton (9) is an excellent hygienic material because in purified form it contains no protein, it can be sterilized without danger of disintegration, and it bleaches to a clear white.

Cotton increases in volume upon absorbing moisture from the atmosphere. Therefore, all ordinary cotton is normally slightly swollen. Swelling increases with humidity and may cause tightly constructed cotton goods to become harder or

stiffer and to change in dimensions. Reverse changes take place when the humidity is decreased.

Cotton fibers (14) are comparatively short; therefore one would expect them to produce a yarn that is fairly weak in tensile strength. However, a cotton fiber, because of its natural twist, spins so well that it can be twisted very tightly; hence, since tightly twisted yarns are more durable than those that are slackly twisted, cotton yarns are strong and fabrics made from them are durable.

Stains on cotton can be removed more easily than from other textiles.

Although cotton (4) soils and crushes easily, it can be washed and ironed without injury, as the use of boiling water, weak alkali and soap do not materially affect it. Cotton will withstand much rough handling, high temperature, and boiling water. For this reason cotton is considered by some as the most hygienic fabric, being practical for household articles and garments that are laundered either commercially or at home.

The fact that cotton (7) is stronger when wet than when dry is of obvious advantage in resisting mechanical stresses encountered in laundering.

#### Weave

The plain weave (14) is sometimes called cotton taffeta or tabby weave. Some of the most durable fabrics are made in this construction. The weaving process is comparatively inexpensive because it is simple. Plain weave cloths can be cleaned easily, and when firm and closely woven, they wear well.

Twill weave (14) is the most durable of all weaves. In this weave the filling yarn is interlaced with the warp so as to form a diagonal weave. If the "wales" run from upper right to lower left, the weave is called the right-hand twill; if the "wales" run from upper left to lower right, the weave is called a left-hand twill; if the "wales" run both ways, the weave is a herringbone.

### CHAPTER III

#### TEST METHODS AND PROCEDURES

Specific test procedures are in accordance with A.S.T.M. and CS-5944 standards and were done under controlled conditions of 70°F and 65 R.H.  $\pm 2^\circ\text{F}$ .

##### A. YARN ANALYSIS

1. Yarn Number. Universal Yarn Numbering Balance was the instrument used for determining yarn number. The specimens were placed in the conditioning room four hours before they were weighed. They were measured carefully on a ruler against the proper mark (spun in this case), cut off, twisted into a convenient knot and carefully weighed on the machine. Ten specimens were used and their averages taken.

2. Yarn Twist. A.S.T.M. 1956, page 169. The Suiter Twist Tester was used to determine the twist count. For the single ply yarns, a 30" strip yarn was unravelled to 4" and fastened into the right hand clamp and inserted into the opened left hand clamp of the twist tester (the gauge length for single yarn was 1"). The depressor was lowered onto the yarn with a three gram deflection load and the yarn was pulled to slacken until it was opposite the lower marker. The yarn was then untwisted slowly until it was completely untwisted. Readings were made, recorded, and averaged. For the ply yarns, a ten-inch gauge was used. The twist was completely removed by twisting the yarn in the opposite direction of the original twist. A needle was inserted between the plies at the left jaw and moved to the right jaw. The twist within the ply was

determined by clipping all the plies except one while they were in parallel position. The gauge length was changed from ten to two inches without allowing change in twist. The ply was untwisted until the fibers were parallel..The same method was used for the filling strips.

B. FABRIC ANALYSIS OF ORIGINAL FABRICS AND AFTER ONE LAUNDERING

1. Yarn Count. A.S.T.M. 1956, page 165. By the use of the pick glass the actual number of ends of warp and filling yarns were counted in five different places from each fabric. Count was made at ten different places and the average count for warp and filling calculated. No count was made nearer the selvage than  $1/10$  the width of the fabric.

2. Weight Per Square Yard. A.S.T.M. 1956, page 164. Five specimens having an area of 2 square inches staggered within the area of 20 inches were cut from the fabric and placed in the conditioning room four hours before weight determinations were made. The specimens were weighed on a calibrated scale. The weight per square yard was calculated and comparisons on the original, after one laundering, after five launderings, and a change of weight due to launderings were calculated.

3. Tensile Strength. C85944, 1944, pages 3-5. One set of specimens for warp and one set for filling  $1\frac{1}{2}" \times 12"$  were prepared and ravelled to 1 inch in width. Each set was tested for original wet and dry tensile strength, after having hung in the conditioning room for 24 hours.

With the distance between the two pairs of jaws of the testing machine adjusted to 3 inches the upper half of the

specimen was clamped to the jaws for determination of dry strength for both warp and filling.

The lower half of the set of the test specimens were immersed in distilled water at room temperature for two hours to become thoroughly wet. The specimens were removed one at a time and tested immediately for breaking strength, the testing of each specimen being completed within one minute after its removal from the water.

The five wet and five dry determinations were recorded and averaged.

4. Colorfastness Test Fabrics. (Original Only)

a. Colorfastness to Light. CS 59-44, 1944, pages 21-23. The specimens were prepared (2 1/2" x 7 1/2" the longer dimension running in the warp direction) and placed between opaque covers that shield it from light except for an area of about 1 5/8"x 2" which was exposed to air and light on both sides. The specimens were exposed to the light in the Fado-Ometer for periods of 10, 20, 40, and 80 hours. The specimens were then rated according to the change of colors resulting from exposure.

b. Colorfastness to Laundry. CS 59-44, 1944, pages 15-19. The Launder-Ometer was the instrument of test used, 1-pint preserving jars were held with their bases toward a horizontal shaft 2" from the center of rotation and the shaft rotated at a speed of 40-45 revolutions per minute was used.

Test No. 1. The specimen to be tested was placed in one pint glass jar containing 100 ml. of a 0.5% soap solution heated

to 105°F and ten 5/8" metal balls were added. The jars were then closed and placed in the Launderometer which was half-filled with water at 105°F. The machine was operated for 30 minutes maintaining the temperature of 105°F  $\pm$  2°F. The specimens were rinsed by shaking each vigorously for 1 minute in 100 ml. of water at 105°F. The rinse was repeated with a change of water. The specimens were again rinsed for 2 minutes in 100 ml. of water at 80°F containing 0.05% of acetic acid. The specimens were given a third rinse for 2 minutes with water at 80°F, removed, and dried by pressing the specimens in contact with white cloth with a flat iron having a temperature between 275°F and 300°F with the white cloth uppermost.

Test No. 2. The same procedure was used as in test number one except that the temperature was raised to 120°F  $\pm$  2°F. This was a more severe test. The degree of fading of each group of materials on the two tests were graded and evaluated for color change.

c. Colorfastness to Perspiration. CS 59-44, 1944, pages 23-25. On each of the test specimens a similar sized piece of composite test cloth was sewed and each was wet thoroughly with acid solution. The amount of solution left on the specimen was such a ratio that when the dry roll weighs 2 1/2 g., the total weight was between 6 and 8 oz. depending on the construction of the specimen. The two pieces were then rolled together with the fabric to be tested on the outside. The test cloth was placed against the face of the printed specimens. The same procedure was followed for the alkaline solution test.

Each roll was then placed in a glass tube, one end of which was closed, leaving 1/3 of each roll projecting, the other 2/3 of the roll being protected from evaporation.

The tubes were placed in an oven in which the temperature was maintained at  $100^{\circ} + 2^{\circ}\text{F}$ . The specimens were allowed to remain in the oven until dry. No specimen was rinsed after drying.

The degree of discoloration of the test cloth was rated equal to or greater than that corresponding to Munsell Neutral 7. Discolored test cloth was then scrubbed for three minutes with a 0.5% soap solution at  $120^{\circ}\text{F} + 5^{\circ}\text{F}$ , and then examined again for discoloration.

d. Colorfastness to Crooking. CS 59-44, 1954, pages 12-13.

Dry Cloth Test. One of the test specimens was attached to the top of the board of the Crock meter on which the "finger" rests. A square of the bleached, unstarched cotton cloth was fastened to the "finger"; the "finger" was rested on the test specimen and moved back and forth ten times; that is 20 strokes, timed at an approximate rate of 2 strokes per second. The cotton cloth was removed from the "finger" and the degree of discoloration was rated as less than, equal to, or greater than that corresponding to Munsell Neutral 7. The discolored cotton cloth was then scrubbed for three minutes with a 0.5% soap solution at  $120^{\circ}\text{F}$ , rinsed in warm water ( $100^{\circ}\text{F}$ ), dried, and then examined again for discoloration.

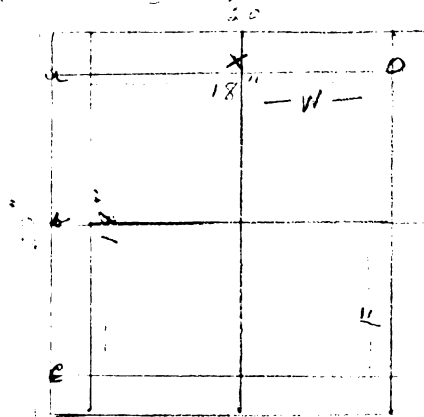
Wet Cloth Test. The preceding test was repeated on the

other specimen with a moistened piece of white cloth used for the colorfastness to wet crocking.

C. PERFORMANCE TESTS ON FABRICS AFTER 1 AND 5 LAUNDERINGS FOR:

1. Dimensional Change. OS 59-44, 1944, pages 30-32.

A 20" x 20" square test specimen was marked off 18" x 18" square accurately by thread lines in both the filling and warp directions. Then another thread line was marked between the center of the 18" x 18" distance on both warwise and filling-wise directions so that there were actually 3 thread line marks on each direction (see diagram).



The marks a, b, c, for the fillingwise direction were carefully made parallel to each other and these were the places measured to determine dimensional change. The warwise direction was marked on lines a, x, O.

The specimens were washed by hand instead of by washing machine to make it more typical of the Philippine way of washing clothes. A sufficient amount of laundry soap and enough warm water to cover the specimens in the dish pan was used. The materials were washed for thirty minutes with a continuous squeezing motion. They were then rinsed thoroughly with cold water. The specimens were placed horizontally on a flat screen

to dry.

When the specimens were damp enough to be ironed, they were laid on a padded ironing table, all noticeable wrinkles carefully smoothed out, and then pressed by raising and lowering the iron so as not to stretch or distort the fabric.

The specimens were then measured with a steel tape measure on the thread line marks. Dimensional change was computed from the average change in inches from the original measurements.

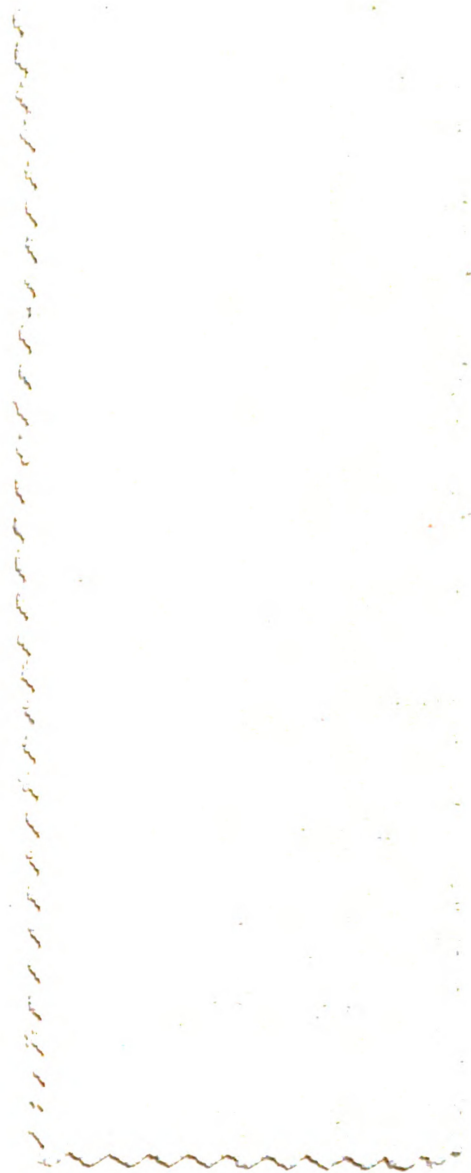
2. Change in Tensile Strength. CS 59-44, 1944, pages 3-5. The same method as indicated under B No. 3 was used for specimens taken from fabrics which had been laundered five times.

3. Change in Yarn Count. A.S.T.M. 1956, page 165. The same procedure as B No. 1 was used for yarn count on specimens after five launderings.

4. Weight Per Square Yard. A.S.T.M. 1956, page 164. The same as method B No. 2 was used for specimens taken from cloth after five launderings.



U.S. DUCK



PHILIPPINE DUCK

## CHAPTER IV

### DISCUSSION AND ANALYSIS OF DATA

#### I. DUCK

Hoye (5) describes duck as a canvas fabric which is one of the heaviest and strongest woven fabrics made. According to the specification description of U.S. duck by Hoye, (6) the specific fabric used in this study is classified as army duck. The U.S. duck is made from two ply yarns in both warp and filling. The Philippine duck under study classifies as a double filled flat duck according to Hoye, with two warp ends woven as one and two-ply yarns in the filling.

Comparisons in terms of performance must take into account the fact that the Philippine double-filled flat duck and the U.S. army duck are actually different types of fabrics and would be expected to perform differently although they have comparable end-uses.

#### A. TEST DATA, AND ANALYSIS OF ORIGINAL FABRICS

##### 1. Yarn Analysis

| Yarn Analysis | <u>U.S. Duck</u> |         | <u>Philippine Duck</u> |           |
|---------------|------------------|---------|------------------------|-----------|
|               | Warp             | Filling | Warp                   | Filling   |
| Yarn number   | 13.59            | 16.19   | 11.86                  | 12.39     |
| Type of yarn  | 2 ply            | 2 ply   | single                 | 2 ply     |
| Twist         | 12/12s           | 9/12s   | 16.8's                 | 11/15.7's |

Analysis of the Philippine duck indicates that coarser heavier yarns were used for both warp and filling than in the U.S. duck. The U.S. duck had a slightly higher tensile strength in both warp and filling primarily because of the greater number of finer yarns and higher twist.

The U.S. duck woven of two ply yarns in both warp and

filling has 12 turns per inch in the single component yarns compared to the ply twist of 9 and 12 respectively in the single yarn. The Philippine duck had a two ply yarn only in the filling. The twist of the two single component yarns and turns per inch in the ply are slightly higher than the filling yarns of the U.S. duck. The warp ends of the Philippine duck woven as one each had approximately 17 turns per inch which is higher than the number of turns of the singles of the ply yarn in the U.S. duck, but lower than the total turns per inch.

## 2. Fabric Analysis

| Fabric Analysis                         | <u>U.S. Duck</u> |         | <u>Philippine Duck</u> |         |
|-----------------------------------------|------------------|---------|------------------------|---------|
|                                         | Warp             | Filling | Warp                   | Filling |
| a. Width in inches                      |                  | 30.5    |                        | 34.52   |
| b. Cost per linear yd.                  |                  | .74¢    |                        | .50¢    |
| c. Weave                                |                  | Plain   |                        | Plain   |
| d. Weight per sq. yd. in oz. (original) |                  | 10.11   |                        | 9.61    |
| e. Yarn count (original)                | 58.8             | 37.6    | 95.2                   | 32.2    |

Although the Philippine duck is 4" wider than the U.S. duck, the latter fabric is more expensive. This may be due, in part, to the quality of cotton used, to its higher construction specifications and higher cost of labor in the United States.

Hoye (6) states that the weight per square yard of a double-filled flat duck is between 8-10 oz. and for the army duck, 9-15 oz. The weight of the Philippine duck in this study is 9.61 oz. and the U.S. duck is 10.11 oz. Both fabrics fall within or exceed the standard specifications in weight for their fabric classification.

Specification standards for the army duck is 50 x 40 yarn

count; for the double-filled duck a yarn count of 80 x 32. The yarn count for the U.S. army duck in this study is 58 x 37. The Philippine flat duck in this study is 95 x 32 yarn count. Both fabrics conform to specification standards in yarn count.

Although both materials are classified as duck, the warp of the Philippine fabric has a higher yarn count (95.2) than the U.S. fabric, (58.8) because the Philippine fabric is a double-filled flat duck in which single yarns are used. The U.S. army duck is a different fabric construction in which two ply yarns are used. The filling of the U.S. army duck is slightly higher in count than the Philippine duck.

### 3. Tensile Strength

| Tensile Strength in<br>Lbs. | U.S. Duck |         | Philippine Duck |         |
|-----------------------------|-----------|---------|-----------------|---------|
|                             | Warp      | Filling | Warp            | Filling |
| Original, dry               | 114.2     | 88.2    | 86.8            | 58.8    |
| Original, wet               | 113.6     | 88.6    | 94.8            | 64.8    |

It is very obvious that in both fabrics the warp is stronger than the filling. This is to facilitate weaving as well as end-use requirements. In the process of weaving, the wear and tension on the warp yarn is greater than on the filling. The tensile strength in both fabrics were higher in wet determination than in dry determination. Mauersberger (9) states that cotton is stronger when wet than when dry.

In the original dry tensile strength, the warp of the U.S. duck is approximately 23% stronger than the Philippine duck, due in part, to the better quality of cotton used, its yarn structure, and higher yarn count. The original dry filling

strength of the U.S. fabric is approximately 35% greater than the Philippine duck due to the difference in yarn size and structure.

#### 4. Colorfastness

| Colorfastness to: | U.S. Duck | Philippine Duck |
|-------------------|-----------|-----------------|
| a. Light          | Class 1   | White           |
| b. Perspiration   |           |                 |
| alkali            | Class 1   | White           |
| Acid              | Class 3   | White           |
| c. Laundry        | Class 2   | White           |
| d. Crocking       |           |                 |
| wet               | Class 1   | White           |
| dry               | Class 4   | White           |

Since the Philippine duck is white, it was not tested for color change. All discussions here, therefore, pertain only to the U.S. duck.

##### A. Colorfastness to Light - Class 1

The material did not show appreciable change after 10 hours exposure to light in the Fade-Ometer, but showed an appreciable change after 20 hours and more change after 80 hours. Such material is considered satisfactory only when colorfastness to light is not important. The U.S. duck in this study does not guarantee the consumer colorfastness to light. Furthermore, for many end-uses this rating is relatively poor.

##### B. Colorfastness to Perspiration

(a) Alkali-Class 1. The discoloration of this material would be insignificant if it is used by itself. If this material is used with white or any other light colored material, this degree of discoloration is excessive because it cannot be removed by soap and water. For working clothing this would

be poor.

(b) Acid-Class 3. This material is expected to give excellent service in resistance to color change due to normal perspiration staining.

C. Colorfastness to Laundry-Class 2.

Since the material did not change in color and did not have an appreciable staining to the attached white cloth, it can be satisfactorily laundered either in home or in commercial laundries provided the temperature of the water used does not exceed 120° F. The material should not be dried under direct sunlight as that would cause greater change in color. The army duck had better fastness to laundering than to light.

D. Colorfastness to Crocking

(a) Wet-Class 1. Inasmuch as the discoloration in crocking when the material was wet did not disappear after scrubbing, the material would not be considered satisfactory for use where this type of discoloration (crocking) could occur. If this material were made into a garment, and worn on a hot day, the moisture due to perspiration would crock and discolor the undergarment. The underarm of the garment would be the area of the garment most affected.

(b) Dry-Class 4. Since there was no appreciable discoloration of the white cloth after the crocking test when the material is dry it may be considered fast to crocking and satisfactory under these conditions of use.

B. TEST DATA AND ANALYSIS AFTER 1 AND 5 LAUNDERINGS

1. Yarn Count

| Yarn Count | U.S. Duck |         | Philippine Duck |         |
|------------|-----------|---------|-----------------|---------|
|            | Warp      | Filling | Warp            | Filling |
| After 1 L  | 59.8      | 41.     | 95.2            | 34.6    |

1. Yarn Count (cont.)

| Yarn Count                   | U.S. Duck      |                 | Philippine Duck |                 |
|------------------------------|----------------|-----------------|-----------------|-----------------|
|                              | Warp           | Filling         | Warp            | Filling         |
| After 5 L                    | 59.2           | 41.6            | 94.8            | 36.0            |
| Change in Count<br>after 1 L | <del>1.0</del> | <del>3.4</del>  | 0               | <del>2.4</del>  |
| Change in Count<br>after 5 L | <del>.4</del>  | <del>4.0</del>  | -.4             | <del>3.8</del>  |
| % change after<br>1 L        | <del>1.8</del> | <del>9.04</del> | 0               | <del>7.4</del>  |
| % change after<br>5 L        | <del>.68</del> | <del>10.6</del> | -.42            | <del>11.8</del> |

The warp of both the Philippine and U.S. fabrics showed insignificant change in yarn count (.4 of a yarn) after the five launderings. The fillings of both materials showed practically the same increase of 4 yarns per inch as a result of warpwise shrinkage. There was no appreciable change in either fabric in warp count.

2. Weight Per Square Yard

| Weight per square<br>yard in ounces | U.S. Duck      |         | Philippine Duck |         |
|-------------------------------------|----------------|---------|-----------------|---------|
|                                     | Warp           | Filling | Warp            | Filling |
| After 1 L                           | 10.06          |         | 10.04           |         |
| After 5 L                           | 10.68          |         | 9.51            |         |
| Change in weight<br>after 1 L       | - .05          |         | <del>.33</del>  |         |
| Change in weight<br>after 5 L       | <del>.57</del> |         | -.10            |         |

The slight increase in weight of the Philippine duck after one laundering is probably due to the particles of soap that were not thoroughly rinsed out. The slight decrease in the four additional launderings can be accounted for by the fiber loss and soluble sizing.

The U.S. duck on the other hand behaved differently. It decreased slightly in weight after one laundering but increased slightly in weight as compared to the original after five laun-

derings. It can be accounted for, in part, by shrinkage.

The slightly higher weight per square yard of the U.S. over the Philippine duck is undoubtedly the differences in yarn and fabric structure of the two fabrics--that is yarn size, twist, and count as well as weave.

### 3. Tensile Strength

| Tensile Strength<br>in Lbs. | U.S. Duck |         | Philippine Duck |         |
|-----------------------------|-----------|---------|-----------------|---------|
|                             | Warp      | Filling | Warp            | Filling |
| After 5 L                   |           |         |                 |         |
| dry                         | 120.6     | 80.4    | 71.2            | 64.2    |
| After 5 L                   |           |         |                 |         |
| wet                         | 168.8     | 94.0    | 76.2            | 66.2    |
| Change in lbs.              |           |         |                 |         |
| after 5 L dry               | +6.4      | -7.8    | -15.6           | +5.4    |
| Change in lbs.              |           |         |                 |         |
| after 5 L wet               | +55.2     | +5.4    | -18.6           | +1.4    |
| % change after              |           |         |                 |         |
| 5 L dry                     | +5.3      | -8.04   | -18.0           | +9.3    |
| % change after              |           |         |                 |         |
| 5 L wet                     | +49.0     | +5.7    | -19.6           | +2.3    |

Dry warp determination of the Philippine duck showed decrease in strength by 18% after five launderings. Wet warp determination showed comparable decrease.

The original wetwarp strength (113.6 lbs.) of the U.S. duck was slightly lower than dry strength (114.2 lbs.). This may be due to the finish of the yarns which did not permit complete absorption of water. The fact that after five launderings the wet-dry strength relationship was significantly different than initially, further supports the fact that water was completely absorbed after five launderings and accounted for this changed relationship. Increase in warp strength after five launderings was due to the significantly high shrinkage in filling.

The increase in filling strength of the U.S. fabric after

five launderings in wet determination is due to the excessively high shrinkage in the warp.

#### 4. Dimensional Change

| Dimensions in inches          | U.S. Duck |         | Philippine Duck |         |
|-------------------------------|-----------|---------|-----------------|---------|
|                               | Warp      | Filling | Warp            | Filling |
| After 1 L                     | 17.70     | 17.80   | 18.32           | 16.75   |
| After 5 L                     | 16.36     | 17.88   | 18.35           | 16.70   |
| Change in inches<br>after 1 L | -1.3      | -.2     | /.32            | -1.25   |
| Change in inches<br>after 5 L | -1.64     | -.12    | /.35            | -1.3    |
| % change after<br>1 L         | -6.9      | -1.1    | /.18            | -6.9    |
| % change after<br>5 L         | -9.1      | -.66    | /.19            | -7.2    |

The warp of the Philippine duck increased in length by 1.8% after one laundering with negligible change thereafter. The slight increase was due to stretching of the yarns after the finish had been removed.

The filling of the Philippine duck shrank a significant 6.9% and 7.2% respectively after the first and fifth launderings. If this fabric is to be used as an apparel material, this degree of shrinkage must be taken into consideration in terms of garment size.

Warpwise, the U.S. duck shrank 6.9% in the first laundering and continued to shrink to a maximum of 9.1% after five launderings. This again is very significant for apparel end-use. The shrinkage in the direction of the filling in the U.S. duck was 1.1% which is within the tolerance of sanforized shrunk guarantee. The width or filling shrinkage in the Philippine duck was over 6% or six times greater than the U.S. duck. On the other hand, the U.S. duck shrank excessively in length and the Philippine duck did not. Inasmuch as both the U.S. and

Philippine duck shrunk excessively in one direction the garment cutter should compensate for this shrinkage expectancy in garment proportions.

Summary and End-Uses

The Philippine and U.S. ducks have comparable end uses-- that is both are used for water buckets, wading pools, tents, awnings, hammocks, overalls, work pants, aprons, coats, slacks, book covers, and washable uniforms.

If these materials were used as tents, hammocks, awnings, and loose leaf covers, the high percentage of shrinkage would not be as significant as if the end-use was a garment in which fit is important. Tents, hammocks, awnings, etc., could be treated with oil or paint to control shrinkage but garments could not be so treated.

If these materials were made into clothing the 7% filling-wise shrinkage of the Philippine duck would be about 2 1/2 inches for every yard and the 9% warwise shrinkage of the U.S. duck would be about 3.2 inches for every yard. One can imagine how a garment would fit with this excessive shrinkage. Therefore, adequate allowance in length and width shrinkage should be made for any garment made from either of these fabrics.

If the Philippine duck were made into pants for example, the greatest amount of shrinkage would be in the width. The U.S. duck, on the other hand, would shrink in length. The U.S. duck would probably be the better of the two materials to choose for work pants because it would be easier to provide greater allowance in length by a turn back cuff at the lower edge and still maintain satisfactory proportion. To increase width proportion to compensate for 7% shrinkage could not be successfully done if shape and fit were important in the style

of the garment.

The tensile strength of both materials related to yarn count, twist, and dimensional change in laundering. The U.S. duck both initially and after five launderings appears to be better than the Philippine duck.

In colorfastness, the U.S. material is not especially good because the color crocked on the white cloth and was not colorfast to perspiration. If this material is not combined with other colored fabric then the bleeding of color in laundering would not be objectionable. Poor colorfastness in crocking, particularly when damp conditions of use exist, as when a person perspires freely, would probably discolor a white undergarment to an objectionable degree.

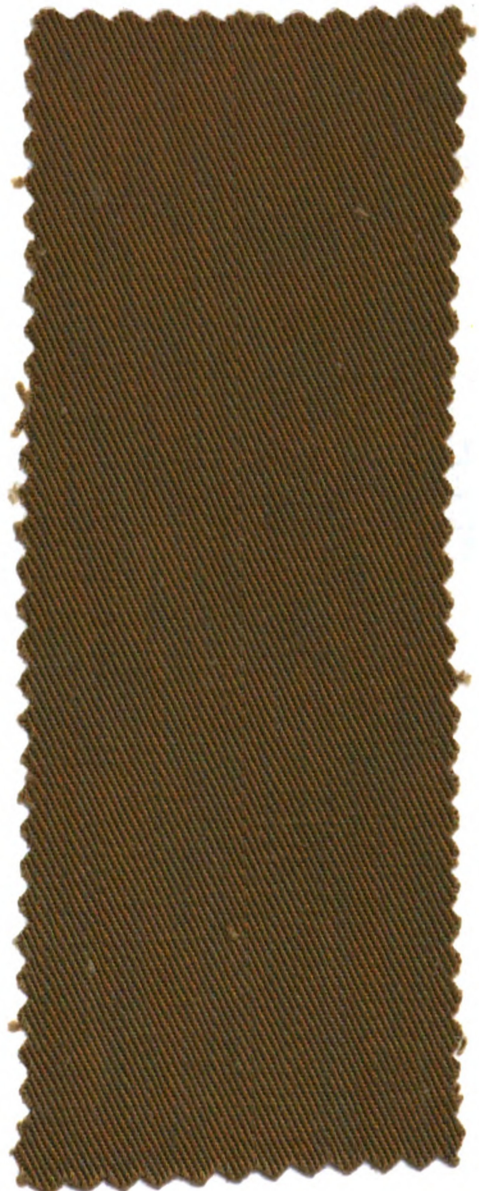
SUMMARY TABLE - DUCK

|                                  | U.S. Duck |         | Philippine Duck |           |
|----------------------------------|-----------|---------|-----------------|-----------|
|                                  | Warp      | Filling | Warp            | Filling   |
| 1. Yarn Analysis                 |           |         |                 |           |
| Yarn Number                      | 13.59     | 16.19   | 11.86           | 12.39     |
| Type of Yarn                     | 2 ply     | 2 ply   | single          | 2 ply     |
| Twist                            | 12/12's   | 9/12's  | 16.8's          | 11/15.7's |
| 2. Fabric Analysis               |           |         |                 |           |
| Width in inches                  |           | 30.5    |                 | 34.52     |
| Cost per linear yard             |           | .74¢    |                 | .50¢      |
| Weave                            |           | Plain   |                 | Plain     |
| Weight per square yard in ounces |           |         |                 |           |
| Original                         |           | 10.11   |                 | 9.61      |
| After 1 L                        |           | 10.06   |                 | 10.04     |
| After 5 L                        |           | 10.68   |                 | 9.51      |
| Change in weight after 1 L       |           | -.05    |                 | +.33      |
| Change in weight after 5 L       |           | +.57    |                 | -.10      |
| Yarn Count                       |           |         |                 |           |
| Original                         | 58.8      | 37.6    | 95.2            | 32.2      |
| After 1 L                        | 59.8      | 41.0    | 95.2            | 34.6      |
| After 5 L                        | 59.2      | 41.6    | 94.8            | 36.0      |
| Change in count after 1 L        | +1.0      | +3.4    | 0               | +2.4      |
| Change in count after 5 L        | + .4      | +4.0    | -.4             | +3.8      |
| % change after 1 L               | +1.8      | +9.04   | 0               | +7.4      |
| % change after 5 L               | + .68     | +10.6   | -.42            | +11.8     |
| 3. Tensile Strength in lbs.      |           |         |                 |           |
| Original dry                     | 114.2     | 88.2    | 86.8            | 58.8      |
| Original wet                     | 113.6     | 88.6    | 84.8            | 64.8      |
| After 5 L dry                    | 120.6     | 80.4    | 71.2            | 64.2      |
| After 5 L wet                    | 168.8     | 94.0    | 76.2            | 66.2      |
| Change in Lbs. after 5 L dry     | + 6.4     | -7.8    | -15.6           | +5.4      |
| after 5 L wet                    | +55.2     | +5.4    | -18.6           | +1.4      |
| % change after 5 L dry           | + 5.3     | -8.04   | -18.0           | +9.3      |
| 5 L wet                          | +49.0     | +5.7    | -19.6           | +2.3      |
| 4. Colorfastness to:             |           |         |                 |           |
| Light                            | Class 1   |         | White           |           |
| Perspiration                     |           |         |                 |           |
| Alkali                           | Class 1   |         | White           |           |
| Acid                             | Class 3   |         | White           |           |
| Laundry                          | Class 2   |         | White           |           |
| Crocking                         |           |         |                 |           |
| Wet                              | Class 1   |         | White           |           |
| Dry                              | Class 4   |         | White           |           |

|                       | U.S. Duck |         | Philippine Duck  |         |
|-----------------------|-----------|---------|------------------|---------|
|                       | Warp      | Filling | Warp             | Filling |
| 5. Dimensional Change |           |         |                  |         |
| in inches             |           |         |                  |         |
| Original              | 18.00     | 18.00   | 18.00            | 18.00   |
| After 1 L             | 16.70     | 17.80   | 18.32            | 16.75   |
| After 5 L             | 16.36     | 17.88   | 18.35            | 16.70   |
| Change in inches      |           |         |                  |         |
| after 1 L             | -1.3      | - .2    | <del>/</del> .32 | -1.25   |
| after 5 L             | -1.64     | - .12   | <del>/</del> .35 | -1.3    |
| % change              |           |         |                  |         |
| after 1 L             | -6.9      | -1.1    | <del>/</del> 1.8 | -6.9    |
| after 5 L             | -9.1      | - .66   | <del>/</del> 1.9 | -7.2    |



U.S. KHAKI



PHILIPPINE KHAKI

## II. KHAKI

Khaki is classified by Hoyer (6) as an army twill and is described as a four-leaf warp twill. It is firmly woven cloth in medium and heavy qualities. Warp yarns which form the twill face bears most of the wear and are stronger than the filling yarns. The Philippine and U.S. khaki are both left-hand twills.

The four-leaf twills are used today mostly for uniforms, overalls, slacks, shoe linings, hunting and working clothing, dress uniforms, summer slacks, trouserings, boy scout clothing, awnings, etc.

### A. TESTS DATA AND ANALYSIS OF ORIGINAL FABRICS

#### 1. Yarn Analysis

|               | U.S. Khaki |         | Philippine Khaki |         |
|---------------|------------|---------|------------------|---------|
| Yarn Analysis | Warp       | Filling | Warp             | Filling |
| Yarn Number   | 14.62      | 15.45   | 12.77            | 8.6     |
| Type of Yarn  | single     | single  | single           | single  |
| Twist         | 19.6's     | 18.5's  | 18.9's           | 15.6's  |

The finer yarns of the U.S. khaki gave the material a finer texture as well as lighter weight when compared to the Philippine khaki in which coarser yarns were used.

As specified by Hoyer (6) the army shirting twill should have an "S" twist for the warp and a "Z" twist for the filling. Both materials have "S" twist and single yarns for both warp and filling.

#### 2. Fabric Analysis

|                          | U.S. Khaki |         | Philippine Khaki |         |
|--------------------------|------------|---------|------------------|---------|
| Fabric Analysis          | Warp       | Filling | Warp             | Filling |
| a. Width in inches       | 40.        |         | 30.8             |         |
| b. Cost per linear yd.   | 2.35       |         | 1.25             |         |
| c. Weave                 | Twill      |         | Twill            |         |
| d. Weight per sq. yd.    |            |         |                  |         |
| in ounces (original)     | 8.72       |         | 9.75             |         |
| e. Yarn count (original) |            |         |                  |         |
|                          | 114.4      | 56.2    | 100.4            | 45.8    |

The cost per linear yard of the U.S. khaki is \$1.10 higher than the Philippine khaki. This cost difference may be due to a better quality of yarn used in the U.S. material and definitely lower labor cost in the Philippines than in the United States.

The Philippine khaki is narrower by 9" than the U.S. khaki because most Filipino men are smaller than the Americans. In most cases the garment cutter would be more particular of the length than the width of the materials.

The standard specification weight per square yard of the army shirting twill according to Hoyer (5) is 6 oz. Both materials are heavier than the specification standard. This could be due to the coarser yarns used.

The original yarn count of the Philippine khaki is approximately 100 x 45 and the U.S. khaki is 114 x 56. As compared to the specifications of Hoyer (5) the two materials are within the standard which ranges from 68 x 42 to 108 x 52.

### 3. Tensile Strength

| Tensile strength<br>in lbs. | U.S. Khaki |         | Philippine Khaki |         |
|-----------------------------|------------|---------|------------------|---------|
|                             | Warp       | Filling | Warp             | Filling |
| Original, dry               | 138.2      | 71.8    | 132.2            | 88.0    |
| Original, wet               | 169.2      | 64.8    | 142.0            | 90.6    |

The original dry and wet tensile strength relationship of the warp of the two materials are comparable. The filling of the Philippine material in original wet tensile strength was 2.6 lbs higher than dry, whereas the U.S. khaki's original wet tensile strength was 7 lbs. lower than its dry tensile strength. The lower wet strength of the U.S. material could be accounted for by the fact that the finish on the fabric

prevented water absorption and the expected wet-dry strength relationship did not exist.

4. Colorfastness.

| Colorfastness to: | U.S. Khaki | Philippine Khaki |
|-------------------|------------|------------------|
| a. Light          | Class 1    | Class 1          |
| b. Perspiration:  |            |                  |
| Alkali            | Class 3    | Class 3          |
| Acid              | Class 3    | Class 3          |
| c. Laundry        | Class 2    | Class 2          |
| d. Crocking       |            |                  |
| Wet               | Class 4    | Class 4          |
| Dry               | Class 4    | Class 4          |

A. Colorfastness to light - All class 1. Both materials did not show appreciable change in color after 10 hours<sup>exposure</sup> in the Fade-Ometer but showed some changes after 20 hours exposure and more changes after 40 and 80 hours. Such materials could not be exposed to light to dry. If either of these materials were used in the Philippines they would not give satisfactory service because the heat of the sun in the Philippines is more intense than in the United States, and most drying is done out of doors.

B. Colorfastness to Perspiration-alkali and acid-  
all class 3. Both fabrics are classified as class 3 in colorfastness to perspiration so that both are expected to give excellent service where resistance of color to normal perspiration is important.

Since both materials could be used in army uniforms, work clothes, overalls, summer slacks, etc., this rating in perspiration test means that the materials would give an excellent service for their end-uses.

C. Colorfastness to Laundry - All class 2. Both materials were able to stand the test in laundry where the temperature of the water was 120<sup>o</sup> F. This showed that both materials were launderable in home and commercial laundries provided the temperature does not exceed 120<sup>o</sup> F and the materials are not exposed to direct sunlight when dried.

D. Colorfastness to Crocking-dry and wet-all class 4. Both materials did not show any appreciable discoloration on the white cloth. Such materials are considered fast to crocking and may be expected to give excellent service where resistance to crocking is important.

B. TEST'S DATA AND ANALYSIS AFTER 1 AND 5 LAUNDERINGS

1. Yarn Count

| Yarn Count      | U.S. Khaki     |                 | Philippine Khaki |                |
|-----------------|----------------|-----------------|------------------|----------------|
|                 | Warp           | Filling         | Warp             | Filling        |
| After 1 L       | 115.5          | 56.4            | 100.8            | 48.6           |
| After 5 L       | 116.6          | 56.8            | 101.3            | 48.6           |
| Change in count |                |                 |                  |                |
| after 1 L       | <del>1.1</del> | <del>.2</del>   | <del>.4</del>    | <del>2.8</del> |
| after 5 L       | <del>2.2</del> | <del>.6</del>   | <del>.9</del>    | <del>2.8</del> |
| % change after  |                |                 |                  |                |
| 1 L             | <del>.97</del> | <del>.35</del>  | <del>.38</del>   | <del>5.7</del> |
| 5 L             | <del>1.8</del> | <del>1.06</del> | <del>.88</del>   | <del>5.7</del> |

The thread count of both materials showed an insignificant increase in five launderings. There was also insignificant shrinkage after the five launderings.

2. Weight per Square Yard

| Weight per square yard<br>in ounces | U.S. Khaki      | Philippine Khaki |
|-------------------------------------|-----------------|------------------|
| After 1 L                           | 8.80            | 9.80             |
| After 5 L                           | 8.45            | 9.70             |
| Change in weight                    |                 |                  |
| after 1 L                           | <del>.08</del>  | <del>.05</del>   |
| after 5 L                           | <del>-.27</del> | <del>-.05</del>  |

The slight increase in weight of the U.S. khaki after one laundering can be accounted for by the particles of soap

that were not removed, whereas the slight decrease in weight of the Philippine khaki after five launderings may be due to the removal of the soluble sizing.

### 3. Tensile Strength

| Tensile strength<br>in lbs. | U.S. Khaki     |                 | Philippine Khaki |                |
|-----------------------------|----------------|-----------------|------------------|----------------|
|                             | Warp           | Filling         | Warp             | Filling        |
| After 5 L, dry              | 140.5          | 69.0            | 142.6            | 94.6           |
| After 5 L, wet              | 163.4          | 83.8            | 153.0            | 98.0           |
| Change in lbs.              |                |                 |                  |                |
| after 5 L, dry              | <del>2.3</del> | -2.8            | <del>16.4</del>  | <del>6.6</del> |
| after 5 L, wet              | -5.8           | <del>22.0</del> | <del>21.0</del>  | <del>7.4</del> |
| % change after              |                |                 |                  |                |
| 5 L, dry                    | <del>1.7</del> | -3.9            | <del>12.0</del>  | <del>7.5</del> |
| 5 L, wet                    | -3.4           | <del>33.0</del> | <del>14.0</del>  | <del>8.3</del> |

After 5 launderings the dry warp of the Philippine khaki increased in strength by 12%. The U.S. khaki increased by 1.7%.

The dry filling of the Philippine material increased by 7.5% as compared to the original after 5 launderings, whereas the filling of the U.S. material decreased by 3.9%. The decrease in strength of the U.S. material might be accounted for by over bleaching during the process of manufacture, or loss of sizing in laundering.

The wet filling of the Philippine material increased in strength by 8.3% after 5 launderings, whereas the U.S. fabric increased by 33%. Although there was no justifiable shrinkage in the filling of the U.S. fabric the 33% increase in the wet tensile strength could be accounted for by the higher yarn count over the Philippine fabric and the removal of finish which allowed more water absorption.

4. Dimensional Change

| Dimensions in inches | U.S. Khaki |                  | Philippine Khaki |                   |
|----------------------|------------|------------------|------------------|-------------------|
|                      | Warp       | Filling          | Warp             | Filling           |
| After 1 L            | 17.92      | 18.10            | 18.8             | 18.2              |
| After 5 L            | 17.66      | 18.16            | 18.03            | 18.37             |
| Change in inches     |            |                  |                  |                   |
| after 1 L            | - .08      | <del>/</del> .10 | <del>/</del> .8  | <del>/</del> .2   |
| after 5 L            | - .34      | <del>/</del> .16 | <del>/</del> .03 | <del>/</del> .37  |
| % change after       |            |                  |                  |                   |
| 1 L                  | - .5       | <del>/</del> .5  | <del>/</del> 4.4 | <del>/</del> 1.1  |
| 5 L                  | -1.8       | <del>/</del> .8  | <del>/</del> .16 | <del>/</del> 2.05 |

In both the filling and warp directions, the Philippine material stretched. The warp of the Philippine material stretched by 4.4% after one laundering which indicated that practically all the soluble finish was removed. It could be possible that the quality of yarn and finish used were poor. The filling stretched a total of 2% in five launderings.

The 1.8% shrinkage of the warp in the U.S. fabric after 5 launderings, and .8% stretching in the filling direction, showed that a better finish and better quality of cotton yarn was used for the U.S. fabric, and more dimensional stability than the Philippine made fabric.

Summary and End-Uses

The end-uses of both materials are the same for both countries--shoe linings, hunting and work clothing, knickers, military uniforms, dress uniforms, summer slacks, trouserings, boy scout clothing, hats, awnings, etc.

In general, both materials seem to be strong enough for their end-uses. This is because they are both twill weave and twill weave permits the wearing of more threads to a square inch because of the fewer interlacings. For this reason Wingate (14) states that twill woven materials are stronger than the plain woven ones.

Provided both materials would not be exposed to direct sunlight, they would probably give a fair service for a certain length of time as far as colorfastness to light and laundry are concerned.

Both materials would render excellent service to perspiration and crocking.

SUMMARY TABLE - KILANI

|                             | U.S. Khaki |         | Philippine Khaki |         |
|-----------------------------|------------|---------|------------------|---------|
|                             | Warp       | Filling | Warp             | Filling |
| 1. Yarn Analysis            |            |         |                  |         |
| Yarn number                 | 14.62      | 15.45   | 12.77            | 8.6     |
| Type of Yarn                | single     | single  | single           | single  |
| Twist                       | 19.6's     | 18.5's  | 18.9's           | 15.5's  |
| 2. Fabric Analysis          |            |         |                  |         |
| Width in inches             | 40.0       |         | 30.8             |         |
| Cost per linear yd.         | \$2.35     |         | \$1.25           |         |
| Weave                       | Twill      |         | Twill            |         |
| Weight per square yard      |            |         |                  |         |
| in ounces                   |            |         |                  |         |
| Original                    | 8.72       |         | 9.75             |         |
| After 1 L                   | 8.80       |         | 9.80             |         |
| After 5 L                   | 8.45       |         | 9.70             |         |
| Change in weight            |            |         |                  |         |
| after 1 L                   | + .08      |         | + .05            |         |
| after 5 L                   | - .27      |         | - .05            |         |
| Yarn Count                  |            |         |                  |         |
| Original                    | 114.4      | 56.2    | 100.4            | 45.8    |
| After 1 L                   | 115.5      | 56.4    | 100.8            | 48.6    |
| After 5 L                   | 116.6      | 56.8    | 101.3            | 48.6    |
| Change in count             |            |         |                  |         |
| after 1 L                   | + 1.1      | + .2    | + .4             | + 2.8   |
| after 5 L                   | + 2.2      | + .6    | + .9             | + 2.8   |
| % change after              |            |         |                  |         |
| 1 L                         | + .97      | + .35   | + .38            | + 5.7   |
| 5 L                         | + 1.8      | + 1.06  | + .88            | + 5.7   |
| 3. Tensile Strength in lbs. |            |         |                  |         |
| Original, dry               | 138.2      | 71.8    | 132.2            | 88.0    |
| Original, wet               | 159.2      | 64.8    | 142.0            | 90.6    |
| After 5 L, dry              | 140.5      | 69.0    | 148.6            | 94.6    |
| After 5 L, wet              | 163.4      | 85.3    | 163.0            | 98.0    |
| Change in lbs. after        |            |         |                  |         |
| 5 L, dry                    | + 2.3      | - 2.8   | + 16.4           | + 6.6   |
| 5 L, wet                    | - 5.8      | + 22.0  | + 21.0           | + 7.4   |
| % change after              |            |         |                  |         |
| 5 L, dry                    | + 1.7      | - 3.9   | + 12.0           | + 7.5   |
| 5 L, wet                    | - 3.4      | + 33.0  | + 14.0           | + 8.3   |
| 4. Colorfastness to:        |            |         |                  |         |
| Light                       | Class 1    |         | Class 1          |         |
| Perspiration:               |            |         |                  |         |
| Alkali                      | Class 3    |         | Class 3          |         |
| Acid                        | Class 3    |         | Class 3          |         |
| Laundry                     | Class 2    |         | Class 2          |         |
| Crocking                    |            |         |                  |         |
| Wet                         | Class 4    |         | Class 4          |         |
| Dry                         | Class 4    |         | Class 4          |         |

|                       | U.S. Khaki |                  | Philippine Khaki |                   |
|-----------------------|------------|------------------|------------------|-------------------|
|                       | Warp       | Filling          | Warp             | Filling           |
| 5. Dimensional Change |            |                  |                  |                   |
| in inches             |            |                  |                  |                   |
| Original              | 18.00      | 18.00            | 18.00            | 18.00             |
| After 1 L             | 17.92      | 18.10            | 18.8             | 18.2              |
| After 5 L             | 17.65      | 18.16            | 18.03            | 18.37             |
| Change in inches      |            |                  |                  |                   |
| after 1 L             | - .08      | <del>/</del> .10 | <del>/</del> .8  | <del>/</del> .2   |
| after 5 L             | - .34      | <del>/</del> .16 | <del>/</del> .03 | <del>/</del> .37  |
| % change after        |            |                  |                  |                   |
| 1 L                   | - .5       | <del>/</del> .5  | <del>/</del> 4.4 | <del>/</del> 1.1  |
| 5 L                   | -1.8       | <del>/</del> .8  | <del>/</del> .16 | <del>/</del> 2.05 |



U.S. PERCALE



PHILIPPINE PERCALE

### III. PERCALE

Hoye (5) classifies printed percale as a carded-yarn, printed, smooth-finished fabric usually converted from standard print cloth by bleaching and printing with designs suitable for dresses, pajamas, children's wear, sportswear, etc. The standard specifications for percale ranges from 48 x 48, to 80 x 80 yarn count.

#### A. TEST DATA AND ANALYSIS ON ORIGINAL FABRICS

##### 1. Yarn Analysis

| Yarn Analysis | U.S. Percale |         | Philippine Percale |         |
|---------------|--------------|---------|--------------------|---------|
|               | Warp         | Filling | Warp               | Filling |
| Yarn number   | 30.1         | 38.05   | 21.09              | 23.20   |
| Type of yarn  | single       | single  | single             | single  |
| Twist         | 18's         | 18.4's  | 19's               | 22's    |

The yarn used in the U.S. percale is size 30's for the warp and 38's for the filling which are finer yarns as compared to the 20's used in the warp and filling of the Philippine percale.

Both materials have "Z" twist in both warp and filling yarns.

##### 2. Fabric Analysis

| Fabric Analysis                             | U.S. Percale |         | Philippine Percale |         |
|---------------------------------------------|--------------|---------|--------------------|---------|
|                                             | Warp         | Filling | Warp               | Filling |
| Width in inches                             | 37.8         |         | 32.55              |         |
| Cost per linear yard                        | .49¢         |         | .40¢               |         |
| Weave                                       | Plain        |         | Plain              |         |
| Weight per square yard in ounces (original) | 3.22         |         | 3.92               |         |
| Yarn count (original)                       | 83.8         | 70.6    | 59.0               | 55.2    |

The difference in width of the U.S. percale (5" wider) is not very significant but such difference may mean that it can be cut to a better advantage.

The U.S. percale is .09¢ higher in price than the Philippine

percale. Such slight difference could be accounted for the wider width of the U.S. fabric, better fiber quality and higher cost of labor in the United States.

The Philippine material weighs 3.92 oz. per square yard which is slightly heavier than 3.22 oz. of the U.S. material.

The Philippine percale has a yarn count of 59 x 52 and the U.S. percale has a yarn count of 83 x 70. Both materials are within the standard specifications of Hoyer (5) and have a balanced count.

### 3. Tensile Strength

| Tensile strength in lbs. | U.S. Percale |         | Philippine Percale |         |
|--------------------------|--------------|---------|--------------------|---------|
|                          | Warp         | Filling | Warp               | Filling |
| Original, dry            | 46.8         | 30.5    | 45.8               | 28.5    |
| Original, wet            | 54.4         | 33.0    | 41.0               | 29.9    |

The warp of the two fabrics were stronger than their filling in the dry tensile strength. This is to be expected to facilitate the strain in weaving.

The warp of the Philippine material became weaker by almost 6 lbs., when wet, although normally, cotton is stronger when wet. In this particular case, the lower wet strength would indicate either poor quality of fiber or over bleaching in the process of manufacture of the Philippine material. The wet filling strength was slightly higher by 1.3 lbs. than dry strength.

The wet warp and filling strength of the U.S. material was 4 lbs., and 3 lbs. respectively higher than dry strength. Inasmuch as the U.S. wet strength is stronger it indicates that a better quality cotton may have been used than that used in the Philippine fabric.

#### 4. Colorfastness

| Colorfastness to: | U.S. Percale | Philippine Percale |
|-------------------|--------------|--------------------|
| a. Light          | Class 2      | Class 3            |
| b. Perspiration   |              |                    |
| Alkali            | Class 0      | Class 1            |
| Acid              | Class 0      | Class 1            |
| c. Laundry        | Class 0      | Class 1            |
| d. Crocking       |              |                    |
| wet               | Class 1      | Class 0            |
| dry               | Class 4      | Class 0            |

##### A. Colorfastness to Light: Philippine Cl. 3; U.S. Cl. 2.

The Philippine material did not show any appreciable change in color after 40 hours exposure to light. The U.S. material showed some change of color after 20 hours of exposure and appreciable change after 40 hours. It would seem that the dye used for the Philippine fabric was of better light fastness quality than that use for the U.S. fabric.

##### B. Colorfastness to Perspiration: Philippines-alkali and acid-Cl. 1; U.S.-alkali and acid-Cl. 0

The Philippine material did not show any appreciable change in color, but discolored the white cloth. The discoloration was removed after scrubbing with soap and water.

The U.S. fabric showed an appreciable change in color and the discoloration on the white cloth was not removed after scrubbing with soap and water.

The staining of the white cloth by the two fabrics would indicate that white undergarments are liable to be stained, especially in the underarm area in the process of rubbing and perspiring.

##### C. Colorfastness to Laundry: Philippines-Cl. 1; U.S.-Cl. 0

The Philippine material did not show any appreciable change in color or appreciable staining of the white cloth. Such materi-

al is considered launderable at lukewarm temperatures and should not be dried outdoors.

The U.S. material, after it was subjected to test No. 1 wherein the temperature of the water was only 105°F, showed both a change in color and stained the white cloth. Such material is considered not launderable. Under special conditions however, it may be laundered, but some change in color is to be expected.

Both materials are rated as poor in launderability.

D. Colorfastness to Crocking: Philippine-wet and dry-Cl. 0; U.S.-wet Cl. 1, dry Cl. 4.

In the dry and wet crocking tests the Philippine material stained the white cloth and the discoloration was not removed after rubbing it with soap and water. The material is not considered fast to crocking and materials coming in contact with them may be expected to discolor.

The U.S. material yielded a discoloration on the white cloth on the wet test which was not removed when washed with soap and water. This means that it would not be satisfactory if it came in contact with white or light colored material. In the dry crocking test it did not show any appreciable change, but that limits it's serviceability under actual conditions of use.

B. TEST DATA AND ANALYSIS AFTER 1 AND 5 LAUNDERINGS

1. Yarn Count

| Yarn Count                   | U.S. Percale |         | Philippine Percale |         |
|------------------------------|--------------|---------|--------------------|---------|
|                              | Warp         | Filling | Warp               | Filling |
| After 1 L                    | 88.2         | 71.6    | 57.2               | 56.8    |
| After 5 L                    | 95.2         | 86.0    | 58.4               | 60.0    |
| Change in count<br>after 1 L | ✓4.4         | ✓1.0    | -1.8               | ✓1.6    |

1. Yarn Count (cont.)

| Yarn count     | U.S. Percal     |                  | Philippine Percal |                |
|----------------|-----------------|------------------|-------------------|----------------|
|                | Warp            | Filling          | Warp              | Filling        |
| after 5 L      | <del>11.4</del> | <del>15.14</del> | - .6              | <del>4.8</del> |
| % change after |                 |                  |                   |                |
| 1 L            | <del>5.2</del>  | <del>.4</del>    | -3.05             | <del>2.8</del> |
| 5 L            | <del>13.7</del> | <del>20.3</del>  | -1.06             | <del>8.6</del> |

The 8.6% increase in the filling (~~4.8~~ yarns) of the Philippine material is related to the 5% shrinkage of the warp after 5 launderings. The 1.06% decrease in the warp (-.6 yarn) is insignificant.

The warp and filling count of the U.S. fabric increased by almost 14% (~~11.4~~ yarns) and 20% (~~15.14~~ yarns) respectively after 5 launderings. This increase in yarn count is the result of the approximately 2.5% and 4.5% shrinkage of the warp and filling respectively after the 5 launderings, and loss of soluble sizing.

2. Weight Per Square Yard

| Weight per square yard in ounces | U.S. Percal | Philippine Percal |
|----------------------------------|-------------|-------------------|
| After 1 L                        | 2.99        | 4.26              |
| After 5 L                        | 2.80        | 3.88              |
| Change in weight                 |             |                   |
| after 1 L                        | -.23        | <del>.34</del>    |
| after 5 L                        | -.42        | -.04              |

The loss of weight after the 5th laundry in both fabrics can be accounted for by loss in finish and soluble sizing.

3. Tensile Strength

| Tensile strength in lbs. | U.S. Percal |         | Philippine Percal |                  |
|--------------------------|-------------|---------|-------------------|------------------|
|                          | Warp        | Filling | Warp              | Filling          |
| After 5 L-dry            | 39.6        | 20.6    | 32.6              | 27.0             |
| After 5 L-wet            | 43.0        | 29.4    | 31.2              | 28.6             |
| Change in lbs. after     |             |         |                   |                  |
| 5 L-dry                  | -10.2       | -10.0   | -14.2             | - 1.6            |
| 5 L-wet                  | -11.4       | - 3.6   | - 9.8             | - <del>1.3</del> |
| % change after           |             |         |                   |                  |
| 5 L-dry                  | -20.4       | -32.0   | -30.3             | - 5.5            |
| 5 L-wet                  | -24.0       | -10.9   | -24.0             | - 4.7            |

After 5 launderings the dry warp strength of the Philippine percale was 30% lower as compared to the 20% loss of <sup>strength in</sup> the U.S. percale. This could be accounted for by the over bleaching during the process of manufacture and the loss of sizing as well as comparative lower warp yarn count in the two fabrics.

Loss in strength of the dry filling of the U.S. percale after 5 launderings was 32% or five times as great as in the Philippine percale. This is very high and it would indicate over bleaching or a false original strength due to sizing.

The wet strength of both the warp and filling yarns in the U.S. fabric was greater than dry strength, both initially and after 5 launderings, which is to be expected of cotton--higher wet strength is to be expected of good quality cotton.

The wet strength of the filling yarns of the Philippine fabric was higher initially and after 5 launderings. The higher (-5.15%) shrinkage in the warp accounts for the less strength change in the filling.

#### 4. Dimensional Change

| Dimensions in inches | U.S. Percale |         | Philippine Percale |         |
|----------------------|--------------|---------|--------------------|---------|
|                      | Warp         | Filling | Warp               | Filling |
| After 1 L            | 18.80        | 17.33   | 17.17              | 18.25   |
| After 5 L            | 17.53        | 17.15   | 17.07              | 18.48   |
| Change in inches     |              |         |                    |         |
| after 1 L            | -1.2         | -.67    | -.83               | /.25    |
| after 5 L            | -.47         | -1.85   | -1.93              | /.48    |
| % change after       |              |         |                    |         |
| 1 L                  | -6.6         | -3.7    | -4.6               | /.13    |
| 5 L                  | -2.3         | -4.7    | -5.15              | /.25    |

Because of the 5% shrinkage in the warp of the Philippine fabric after 5 launderings, the filling yarns became more compact (48.6%) and compensated loss in strength.

The warp of the Philippine fabric shrunk by over 50% whereas the filling of the U.S. fabric shrunk to almost 50%. Neither fabric could be entirely satisfactory in maintaining garment size and fit. Compensation for potential shrinkage should be taken into account before being made into a garment, unless the user pre-shrunk the fabric before cutting.

Summary and End-Uses

Despite the difference in culture of the two countries, the percale material have the same end-uses, that is--it could be made into dresses, pajamas, children's wear, sportswear, etc.

In general, the U.S. percale is superior in quality to the Philippine percale as shown by the higher yarn count, higher yarn number, and higher tensile strength.

Both materials showed similar but relatively poor performance in laundering and colorfastness. The excessive shrinkage of both fabrics will result in unsatisfactory service to the consumer unless they were pre-shrunk before sewing. The pre-shrinking won't even be a guarantee against further shrinkage because cotton often continues to shrink progressively through fifteen <sup>or</sup> more launderings. However, the greatest shrinkage would occur within the first 5 launderings.

The two materials did not give a satisfactory result in colorfastness. Although the Philippine material did not show any appreciable change after 40 hours exposure to light, it still could not be considered satisfactory in service because it faded in the perspiration test. In a warm country like the Philippines where people perspire most of the time, the material should be fast to perspiration as well as to light. The resistance of the Philippine material to light may be of satisfactory quality for this particular case, but in general, it cannot be rated as in resistance to light fading.

The two materials could be worn satisfactorily if they

were made into sleeping garments, but unsatisfactory for children's wear or sportswear.

SUMMARY TABLE - PERCALE

|    |                                             | U.S. Percale |         | Philippine Percale |         |
|----|---------------------------------------------|--------------|---------|--------------------|---------|
|    |                                             | Warp         | Filling | Warp               | Filling |
| 1. | Yarn Analysis                               |              |         |                    |         |
|    | Yarn number                                 | 30.1         | 38.05   | 21.09              | 23.20   |
|    | Type of yarn                                | single       | single  | single             | single  |
|    | Twist                                       | 18's         | 18.4's  | 18's               | 22's    |
| 2. | Fabric Analysis                             |              |         |                    |         |
|    | Width in inches                             | 37.8         |         | 32.65              |         |
|    | Cost per linear yd.                         | .40¢         |         | .40¢               |         |
|    | Weave                                       | Plain        |         | Plain              |         |
|    | Weight per square yard in ounces (original) | 3.22         |         | 3.92               |         |
|    | After 1 L                                   | 2.99         |         | 4.26               |         |
|    | After 5 L                                   | 2.80         |         | 3.88               |         |
|    | Change in weight                            |              |         |                    |         |
|    | After 1 L                                   | - .23        |         | ✓ .34              |         |
|    | After 5 L                                   | - .42        |         | - .04              |         |
|    | Yarn count                                  |              |         |                    |         |
|    | Original                                    | 83.3         | 70.6    | 59.0               | 55.2    |
|    | After 1 L                                   | 88.2         | 71.6    | 57.2               | 56.8    |
|    | After 5 L                                   | 95.2         | 86.0    | 58.4               | 60.0    |
|    | Change in count                             |              |         |                    |         |
|    | After 1 L                                   | ✓ 4.4        | ✓ 1.0   | - 1.8              | ✓ 1.6   |
|    | After 5 L                                   | ✓ 11.4       | ✓ 15.14 | - .6               | ✓ 4.8   |
|    | % change after                              |              |         |                    |         |
|    | 1 L                                         | ✓ 5.2        | ✓ .4    | - 3.05             | ✓ 2.8   |
|    | 5 L                                         | ✓ 13.7       | ✓ 20.3  | - 1.06             | ✓ 8.6   |
| 3. | Tensile Strength in lbs.                    |              |         |                    |         |
|    | Original, dry                               | 49.8         | 30.6    | 46.8               | 28.6    |
|    | Original, wet                               | 54.4         | 33.0    | 41.0               | 29.9    |
|    | After 5 L, dry                              | 39.6         | 20.6    | 32.6               | 27.0    |
|    | After 5 L, wet                              | 43.0         | 29.4    | 31.2               | 28.6    |
|    | Change in lbs.                              |              |         |                    |         |
|    | After 5 L, dry                              | -10.2        | -10.0   | -14.2              | - 1.6   |
|    | After 5 L, wet                              | -11.4        | - 3.6   | - 9.8              | - 1.3   |
|    | % change after                              |              |         |                    |         |
|    | 5 L, dry                                    | -20.4        | -32.0   | -30.3              | - 5.5   |
|    | 5 L, wet                                    | -24.0        | -10.9   | -24.0              | - 4.7   |
| 4. | Colorfastness to:                           |              |         |                    |         |
|    | Light                                       | Class 2      |         | Class 3            |         |
|    | Perspiration                                |              |         |                    |         |
|    | Alkali                                      | Class 0      |         | Class 1            |         |
|    | Acid                                        | Class 0      |         | Class 1            |         |
|    | Laundry                                     | Class 2      |         | Class 1            |         |
|    | Crocking                                    |              |         |                    |         |
|    | wet                                         | Class 1      |         | Class 0            |         |
|    | dry                                         | Class 4      |         | Class 0            |         |
| 5. | Dimensional Change in inches                |              |         |                    |         |
|    | Original                                    | 18.0         | 18.0    | 18.0               | 18.0    |
|    | After 1 L                                   | 16.80        | 17.33   | 17.17              | 18.25   |
|    | After 5 L                                   | 17.53        | 17.15   | 17.07              | 18.48   |

| 5. Dimensional change in inches (cont.) | U.S. Percal |         | Philippine Percal |         |
|-----------------------------------------|-------------|---------|-------------------|---------|
|                                         | Warp        | Filling | Warp              | Filling |
| Change in inches                        |             |         |                   |         |
| After 1 L                               | - 1.2       | - .67   | - .83             | ✓ .25   |
| After 5 L                               | - .47       | - 1.85  | - 1.93            | ✓ .48   |
| % change after                          |             |         |                   |         |
| 1 L                                     | - 6.6       | - 3.7   | - 4.6             | ✓ 1.3   |
| 5 L                                     | - 2.6       | - 4.7   | - 5.15            | ✓ 2.5   |



U.S. SAIL CLOTH



PHILIPPINE SAIL CLOTH

#### IV. SAIL CLOTH

After reading Hoyer's (5) and Carmichael's (3) definition of sail cloth, the writer found that the sail cloths used in this study do not conform to the standard sail cloth described by them. Both authors, Hoyer and Carmichael, classify the material as a duck with combed single-yarn high count cloth. Since the United States and Philippine materials do not conform to these standards, the writer will compare them on their respective physical characteristics only.

##### A. TESTS, DATA AND ANALYSIS ON ORIGINAL FABRICS

###### 1. Yarn Analysis

|                      | <u>U.S. Sail Cloth</u> |                | <u>Philippine Sail Cloth</u> |                |
|----------------------|------------------------|----------------|------------------------------|----------------|
| <u>Yarn Analysis</u> | <u>Warp</u>            | <u>Filling</u> | <u>Warp</u>                  | <u>Filling</u> |
| Yarn number          | 22.0                   | 8.07           | 6.7                          | 8.2            |
| Type of Yarn         | single                 | single         | single                       | single         |
| Twist                | 22.0's                 | 14.5's         | 13.3's                       | 15.0's         |

The fillings of both the U.S. and Philippine materials are the same, size 8. The warp of the U.S. material is almost five times finer than the warp of the Philippine sail cloth, and has a correspondingly higher yarn count.

Both the U.S. and the Philippine materials have "Z" twist in the warp and filling yarns. The U.S. cloth has a higher twist per inch (W-22's; F 14's) than the Philippine fabric, (W-13's; F 15's). The difference in twist and yarn count is sufficient to explain the differences in strength.

###### 2. Fabric Analysis

|                                 | <u>U.S. Sail Cloth</u> |                | <u>Philippine Sail Cloth</u> |                |
|---------------------------------|------------------------|----------------|------------------------------|----------------|
| <u>Fabric Analysis</u>          | <u>Warp</u>            | <u>Filling</u> | <u>Warp</u>                  | <u>Filling</u> |
| Width in inches                 | 35.4                   |                | 33.3                         |                |
| Cost per linear yd.             | .59¢                   |                | .58¢                         |                |
| Weave                           | Plain                  |                | Plain                        |                |
| Weight per square yd. in ounces |                        |                |                              |                |
| (original)                      | 5.12                   |                | 6.43                         |                |
| Yarn count (original)           |                        |                |                              |                |
|                                 | 49.0                   | 42.0           | 25.6                         | 41.6           |

The difference in the price of the two materials is insignificant. The difference in width of the two materials is only 2", but that slight difference may mean it can be cut to better advantage.

The Philippine material is slightly heavier by 1.3 oz. than the U.S. material inasmuch as coarser yarns are used in the Philippine material.

The warp count of the U.S. sail cloth is 45% higher than the Philippine sail cloth. The yarns used in the Philippine material are very much coarser, size 7, as compared to the size 29 of the U.S. material.

### 3. Tensile Strength

| Tensile Strength in lbs. | U.S. Sail Cloth |         | Philippine Sail Cloth |         |
|--------------------------|-----------------|---------|-----------------------|---------|
|                          | Warp            | Filling | Warp                  | Filling |
| Original, dry            | 32.6            | 71.0    | 50.8                  | 73.2    |
| Original, wet            | 41.0            | 83.4    | 57.4                  | 92.4    |

In these particular materials the fillings are very much stronger than the warp which is contrary to the usual practice in weaving. Warp yarns are usually stronger, and the yarn count is usually higher than the filling. However, the filling yarns used in these two materials are much coarser and the thread count is higher than the warps. For some end-uses this might be of advantage. The imbalance in warp and filling strength is very poor in the U.S. fabric.

Despite the fact that the U.S. material had higher yarn count than the warp, the Philippine material was stronger in both wet and dry on the original tests. This could be accounted for by the coarser yarns of the Philippine material.

The fillings of both materials are comparable in strength

in both wet and dry determinations. In both materials the original wet tensile strength is stronger than dry which is to be expected of cotton according to Wingate (14).

4. Colorfastness

| Colorfastness to: | U.S. Sail Cloth | Philippine Sail Cloth |
|-------------------|-----------------|-----------------------|
| 1. Light          | Class 1         | Class 1               |
| 2. Perspiration   |                 |                       |
| Alkali            | Class 1         | Class 1               |
| Acid              | Class 3         | Class 2               |
| 3. Laundry        | Class 2         | Class 1               |
| 4. Crocking       |                 |                       |
| Wet               | Class 0         | Class 2               |
| Dry               | Class 0         | Class 4               |

A. Colorfastness to Light-All Class 1. Both materials did not show any appreciable change in color after 10 hours exposure to light, but appreciable change after 20 hours exposure, and progressive change in color after 40 and 80 hours exposure. These materials are unsatisfactory when fastness to light is important.

B. Colorfastness to Perspiration-Alkali, All Class 1; Acid, U.S. Class 3, Philippine Class 2.

~~Philippine Cl. 2.~~ (a) Alkali. Neither material showed any appreciable change in color but yielded discoloration on the white cloth. The discoloration was not removed after scrubbing with soap and water. When materials come in contact with white or any light colored cloth, it will stain the white cloth and such stain won't be removed with soap and water.

(b) Acid. The Philippine material did not show any appreciable change in color but an appreciable staining of the test cloth, which disappeared after scrubbing with soap and water. When such material happens to stain a white or colored cloth, the stain could be removed by soap and water.

The U.S. material did not show any appreciable change in color or appreciable staining on the white cloth. This material may be expected to give an excellent service where resistance of the color to normal perspiration is important.

C. Colorfastness to Laundry-Philippine, Class 1;  
U.S., Class 2.

After the Philippine material was subjected to test No. 1 there was no appreciable change in color, neither did it stain the white cloth. Such material is considered launderable in lukewarm water with no alkali or chlorine present, but it could not be dried under the heat of the sun.

After the U.S. material was subjected to test No. 2, it did not show any appreciable change in color, nor did it stain the piece of white cloth. Such material is considered launderable in home or commercial laundries under careful methods where the ~~water~~ temperature does not exceed 120°F and when no alkali or chlorine is present. The material should not be dried under sunlight.

The U.S. material has a better rating in colorfastness in laundering because it was not able to stand the severe test No. 2. It can stand harder laundering than the Philippine fabric.

D. Colorfastness to Crocking-Philippine, Wet-Class 2;  
Dry-Class 4; U.S., Wet-Class 0 and Dry Class 0.

Wet. The Philippine material yielded a discoloration on the white cloth but disappeared after it was scrubbed with soap and water. Such material when wet would show some discoloration on white cloth, but the discoloration would be removed with soap and water.

Dry. The Philippine material did not appreciably discolor the white cloth. Such material will be considered fast to crocking when dry, and may be expected to give excellent service where crocking is important.

The U.S. material is Class O in both dry and wet tests. It yielded a discoloration on the white cloth which did not disappear after scrubbing with soap and water. This material would stain any white or light colored fabric that it might happen to rub and the stain won't be removed with soap and water.

B. TEST DATA AND ANALYSIS AFTER 1 AND 5 LAUNDERINGS

1. Yarn Count

| Yarn Count      | U.S. Sail Cloth |                | Philippine Sail Cloth |                |
|-----------------|-----------------|----------------|-----------------------|----------------|
|                 | Warp            | Filling        | Warp                  | Filling        |
| After 1 L       | 49.0            | 42.0           | 28.0                  | 44.2           |
| After 5 L       | 48.4            | 45.0           | 27.4                  | 44.6           |
| Change in count |                 |                |                       |                |
| After 1 L       | 0               | 0              | <del>1.4</del>        | <del>2.6</del> |
| After 5 L       | - .6            | <del>3.0</del> | <del>.8</del>         | <del>3.0</del> |
| % change after  |                 |                |                       |                |
| 1 L             | 0               | 0              | <del>5.3</del>        | <del>6.2</del> |
| 5 L             | -1.4            | <del>6.6</del> | <del>3.0</del>        | <del>6.5</del> |

The yarn count of the Philippine material increased slightly after five launderings both warpwise and fillingwise, as might be expected with the shrinkage of over 3% in the warp, and 1% in the filling.

The increase in filling yarn count of the U.S. material after 5 launderings relates to the 5% shrinkage in the warp.

2. Weight Per Square Yard

| Weight per square yd. in ounces | U.S. Sail Cloth | Philippine Sail Cloth |
|---------------------------------|-----------------|-----------------------|
| After 1 L                       | 5.15            | 6.33                  |
| After 5 L                       | 4.78            | 6.68                  |
| Change in weight after 1 L      | <del>.04</del>  | -.10                  |
| Change in weight after 5 L      | -.34            | <del>.25</del>        |

The very slight increase in weight of the Philippine material after 5 launderings could be accounted for by shrinkage, whereas the very slight decrease in weight of the U.S. material could be due to the loss of soluble sizing or fiber loss.

### 3. Tensile Strength

| Tensile strength in lbs. | U.S. Sail Cloth |         | Philippine Sail Cloth |         |
|--------------------------|-----------------|---------|-----------------------|---------|
|                          | Warp            | Filling | Warp                  | Filling |
| After 5 L, dry           | 27.0            | 71.0    | 45.2                  | 63.6    |
| After 5 L, wet           | 35.0            | 78.8    | 53.4                  | 88.6    |
| Change in lbs. after     |                 |         |                       |         |
| 5 L, dry                 | -5.6            | -.4     | -5.6                  | -9.6    |
| 5 L, wet                 | -8.0            | -4.6    | -4.0                  | -3.8    |
| % change after           |                 |         |                       |         |
| 5 L, dry                 | -17.0           | -.5     | -12.1                 | -15.0   |
| 5 L, wet                 | -14.0           | -5.5    | -6.9                  | -4.1    |

Both materials have a lower dry tensile strength after the 5 launderings in both warp and filling, due to loss of sizing. Loss of strength due to laundering was comparable for the two fabrics. The Philippine fabric had better balance in strength than the U.S. fabric.

### 4. Dimensional Change

| Dimensions in inches | U.S. Sail Cloth |         | Philippine Sail Cloth |         |
|----------------------|-----------------|---------|-----------------------|---------|
|                      | Warp            | Filling | Warp                  | Filling |
| After 1 L            | 17.15           | 18.10   | 17.55                 | 17.56   |
| After 5 L            | 16.95           | 18.45   | 17.45                 | 17.82   |
| Change in inches     |                 |         |                       |         |
| After 1 L            | -.85            | /.10    | -.45                  | -.34    |
| After 5 L            | -1.05           | /.45    | -.55                  | -.18    |
| % change after       |                 |         |                       |         |
| 1 L                  | -4.7            | /.55    | -2.5                  | -1.8    |
| 5 L                  | -5.8            | 2.5     | -3.05                 | -1.0    |

The warp of the Philippine fabric has a significant shrinkage of 2.5% after one laundering and 3% after 5 laund<sup>d</sup>ering. The filling has less than 2% shrinkage. If this fabric were made into a garment enough allowance should be allowed on the warp direction for shrinkage.

Fillingwise, the U.S. fabric stretched by 2.5% after 5 launderings. The stretching could be accounted for by the loss of finish after several launderings. The warp had significant shrinkage of 5% which the consumer would have to take into consideration before cutting the material into a garment. Pre-shrinking before sewing would give the consumer better satisfaction, but it is doubtful if pre-shrinking would compensate for the potential shrinkage which would occur in repetitive launderings.

Summary and End-Uses

Although the Philippine material had a much lower thread count in its warp as compared to the U.S. fabric, the Philippine material was about 35% stronger than the U.S. material. This is due to the coarser yarns used in the Philippine fabric. The tensile strength of the fillings of both materials was practically the same because of the similarity in yarn size.

Both materials showed significantly high shrinkage in the warpwise direction, 36+ for Philippine, and 56+ for the U.S. fabric. The consumer would get more satisfaction if enough allowance for shrinkage in the warpwise direction of the fabrics were made in addition to pre-shrinking the fabric before cutting.

Both materials are unsatisfactory in colorfastness. Their performance in colorfastness to light and perspiration tests indicated that these materials would not be practical to use in a garment for daily wear and which would require frequent launderings. These fabrics would probably give good service as kitchen curtains because curtains are washed less often than garments. Care must be used in washing and drying, washing in warm water and not dried directly in the sun.

These materials would not be very practical to use in a warm country like the Philippines.



SUMMARY TABLE - SAIL CLOTH

|    |                                 | U.S. SAIL CLOTH |                 | PHILIPPINE SAIL CLOTH |                 |
|----|---------------------------------|-----------------|-----------------|-----------------------|-----------------|
|    |                                 | Warp            | Filling         | Warp                  | Filling         |
| 1. | Yarn Analysis                   |                 |                 |                       |                 |
|    | Yarn number                     | 29.0            | 8.07            | 6.7                   | 8.2             |
|    | Type of yarn                    | single          | single          | single                | single          |
|    | Twist                           | 22.9's          | 14.5's          | 13.3's                | 15.6's          |
| 2. | Fabric Analysis                 |                 |                 |                       |                 |
|    | Width in inches                 | 35.4            |                 | 33.3                  |                 |
|    | Cost per linear yd.             | .59¢            |                 | .58¢                  |                 |
|    | Weave                           | Plain           |                 | Plain                 |                 |
|    | Weight per square yd. in ounces |                 |                 |                       |                 |
|    | Original                        | 5.12            |                 | 6.43                  |                 |
|    | After 1 L                       | 5.16            |                 | 6.33                  |                 |
|    | After 5 L                       | 4.78            |                 | 6.68                  |                 |
|    | Change in weight                |                 |                 |                       |                 |
|    | After 1 L                       | <del>4.04</del> |                 | <del>-.10</del>       |                 |
|    | After 5 L                       | <del>-.34</del> |                 | <del>+.25</del>       |                 |
|    | Yarn Count                      |                 |                 |                       |                 |
|    | Original                        | 49.0            | 42.0            | 26.6                  | 41.6            |
|    | After 1 L                       | 49.0            | 42.0            | 28.0                  | 44.2            |
|    | After 5 L                       | 48.4            | 45.0            | 27.4                  | 44.6            |
|    | Change in count                 |                 |                 |                       |                 |
|    | After 1 L                       | 0               | 0               | <del>+1.4</del>       | <del>+2.6</del> |
|    | After 5 L                       | -.6             | <del>+3.0</del> | <del>+.8</del>        | <del>+3.0</del> |
|    | % change after                  |                 |                 |                       |                 |
|    | 1 L                             | 0               | 0               | <del>+5.3</del>       | <del>+6.2</del> |
|    | 5 L                             | -1.4            | <del>+6.6</del> | <del>+3.0</del>       | <del>+6.5</del> |
| 3. | Tensile Strength in lbs.        |                 |                 |                       |                 |
|    | Original, dry                   | 32.6            | 71.0            | 50.8                  | 73.2            |
|    | Original, wet                   | 41.0            | 83.4            | 57.4                  | 92.4            |
|    | After 5 L, dry                  | 27.0            | 71.0            | 45.2                  | 63.6            |
|    | After 5 L, wet                  | 35.0            | 78.8            | 53.4                  | 88.6            |
|    | Change in lbs.                  |                 |                 |                       |                 |
|    | after 5 L                       |                 |                 |                       |                 |
|    | wet                             | -6.0            | -4.6-           | -4.0                  | -3.8            |
|    | after 5 L                       |                 |                 |                       |                 |
|    | dry                             | -5.6            | - .4            | -5.6                  | -9.6            |
|    | % change after                  |                 |                 |                       |                 |
|    | 5 L, dry                        | -17.0           | - .5            | -12.1                 | -13.0           |
|    | 5 L, wet                        | -14.0           | -5.5            | -6.9                  | -4.1            |
| 4. | Colorfastness to:               |                 |                 |                       |                 |
|    | Light                           | Class 1         |                 | Class 1               |                 |
|    | Perspiration:                   |                 |                 |                       |                 |
|    | Alkali                          | Class 1         |                 | Class 1               |                 |
|    | Acid                            | Class 3         |                 | Class 2               |                 |
|    | Laundry                         | Class 2         |                 | Class 1               |                 |
|    | Crocking                        |                 |                 |                       |                 |
|    | wet                             | Class 0         |                 | Class 2               |                 |
|    | dry                             | Class 0         |                 | Class 4               |                 |

|    |                              | U.S. SAIL CLOTH |                  | PHILIPPINE SAIL CLOTH |         |
|----|------------------------------|-----------------|------------------|-----------------------|---------|
|    |                              | Warp            | Filling          | Warp                  | Filling |
| 5. | Dimensional Change in Inches |                 |                  |                       |         |
|    | Original                     | 18.0            | 18.0             | 18.0                  | 18.0    |
|    | After 1 L                    | 17.15           | 18.10            | 17.55                 | 17.66   |
|    | After 5 L                    | 16.95           | 18.45            | 17.45                 | 17.82   |
|    | Change in inches             |                 |                  |                       |         |
|    | After 1 L                    | - .85           | <del>/</del> .10 | - .45                 | - .34   |
|    | After 5 L                    | -1.05           | <del>/</del> .45 | - .55                 | - .18   |
|    | % change after               |                 |                  |                       |         |
|    | 1 L                          | -4.7            | <del>/</del> .55 | -2.5                  | -1.8    |
|    | 5 L                          | -5.8*           | <del>/</del> 2.5 | -3.05                 | -1.0    |

CHAPTER V

SUMMARY AND CONCLUSIONS

The duck, khaki, and percale fabrics produced in the United States and in the Philippines conformed to the standard specifications in yarn count and yarn number. Since the sail cloths do not fall within the standard description, they were compared only in their physical characteristics and performance.

In almost all of the performance tests, the U.S. fabrics rated better than the fabrics produced in the Philippines.

Except for the sail cloth, the tensile strength of the American-made fabrics were very much stronger than the Philippine-made fabrics. This was because of the higher yarn count, twist, and better quality of fiber used in the American-made fabrics. The higher tensile strength of the Philippine sail cloth was due to the coarser, heavier yarn used in its construction.

The high percentage of shrinkage in the U.S. and Philippine duck would be unsatisfactory where dimensional change was important. However, of the two fabrics the U.S. material would probably be the better one to use for garments despite its higher price, because the warpwise shrinkage is easier to compensate than fillingwise shrinkage which was excessive in duck. The Philippine khaki stretched 4.4% in warp and 2.05% in the filling. The U.S. khaki shrank only 1.8% in the warp and stretched slightly in the filling. The U.S. khaki material had a better finish and better quality yarns than the Philippine material. The more than 5% shrinkage of the warp of the Philippine percale and the 4.7%

shrinkage of the U.S. percale, is excessive. Both materials have poor shrinkage performance and poor finish because both became so limp after 5 launderings.

Generally, the four materials, duck, khaki, percale, and sail cloth, had a very poor rating in colorfastness to light, except for the Philippine percale which resisted the 40 hour exposure. The rest were able to resist only 10 hours of exposure in the Fade-Ometer. Those materials would not be practical to use in the Philippines since the heat of the sun there is more intense than here. Since the Philippines has a warm climate, and one could not avoid perspiring, the poor rating of colorfastness to perspiration of these materials showed that they are not practical for use there.

The duck and khaki of the U.S. and Philippines rated as good in the laundry test provided the temperature of the water does not exceed 120°F. This won't give assurance of colorfastness because clothes are usually dried outside in the Philippines, and neither material was colorfast to light. The percale fabrics from both countries rated very poor in colorfastness in laundering. The U.S. sail cloth withstood harder laundering than the sail cloth produced in the Philippines.

Except for the khaki, all the materials showed poor performance in crocking of color. These materials would not be satisfactory for wear in the hot climate of the Philippines.

In general, the U.S. materials had better over-all performance qualities than the Philippine fabrics. This might have been expected because of the modern methods of manufacture and excellent materials available in the United States. However,

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) the less<sup>good</sup> performance qualities of the Philippine fabrics may challenge the National Development Company of the Philippines to improve and upgrade their product if they want to expand their market. While it is true that the Philippine government has quite strict regulations on imported goods and has placed a high tariff on fabrics, the government could not entirely blame her people if they insisted on buying imported goods of superior wear and serviceability.

One of the objectives in this study was to be able to teach textile buymanship more intelligently. The writer feels that she learned much from this study and feels more self-confident, if given the opportunity to teach textiles.

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