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REVITALIZATION OF NATIONAL SILK INDUSTRY

SI/PHI/86/884/11-02

REPUBLIC OF THE PHILIPPINES

Technical report: Review of the present condition of the Philippine silk industry and the related research activities*

Prepared for the Government of the Republic of the Philippines
by the United Nations Industrial Development Organization,
acting as executing agency for the United Nations Development Programme

Based on the work of Byong Hee Choe
Silk processing expert

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United Nations Industrial Development Organization
Vienna

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I N D E X

I. MISSION PROGRAMME

DATE	PLACE	REMARKS
November 3, 1987	UNDP, Makati PTRI, Bicutan	Briefing Briefing/Orientation
November 4	UNDP, Makati	
November 5-6	PTRI, Bicutan	Lecture/Discussion
November 7-8	Saturday, Sunday	
November 9	PTRI, Bicutan	Lecture/Discussion
November 10	Fil-Fibers Mfg. Inc. Barang, Marikina	
November 11-13	PTRI, Bicutan	Lecture/Discussion
November 14-15	Saturday, Sunday	
November 16-20	PTRI, Bicutan	Discussion/Lecture
November 21-22	Saturday, Sunday	
November 23-25	PTRI, Bicutan	Lecture
November 26-29	DMMSU Bacnotan, La Union	Lecture
November 30	Holiday	
December 1-4, 1987	UNDP/PTRI Bicutan	Finalization of Report
December 5-6	Saturday, Sunday	
December 7	Departure	

II. FOREWORD

This is a terminal report on silk consultancy in the Philippines. The reporter, Dr. Byong Hee Choe was selected by the UNIDO to work with the Philippine Textile Research Institute for the evaluation and recommendation of silk research and industry. The assignment was currently an implementation of SI/PHI/86/884/11-2/31.7 B. The overall objective of this project is the reform of silk industry in the Philippines which is producing blended silk with polyester fiber textile.

The mission started on November 2, 1987 and will end on December 7, 1987 which is one month and a week service. So, there was no chance to carry out a detailed investigation to prepare the report. He had prepared some materials before he arrived here and herewith submit as a part of recommendation to improve, first, research facilities in the PTRI so that they can hold leadership of the improvement of silk industry in the Philippines.

During his mission, he has carried out silk technology lecture in order to improve their knowledge.

One significant thing to remember is that nobody can produce good quality silk fabric with low grade silk fiber and nobody can make good silk fiber with low grade cocoon. So far, study has been started with sericulture situation here.

There is technical limit of improving silk quality with machine. For the purpose of improving silk quality in the Philippines, it is required to set modern type of machines which the list is included in this report.

III. SERICULTURE IN THE PHILIPPINES

There are many good resources to engage with agriculture in the Philippines, and there is no time limit for producing agricultural crops as much as in Korea andJapan. Such environment had made the farmers to be going that results with rather crude production system throughout the year. For instance, they are not serious with fertilizing or weeding in their farm, specially, they do not care to make compost for the production promotion. They might be satisfied with poor production yield, but this will be covered by the repitition of harvests.

In the temperate countries like Korea and Japan, there is a time limit to engage with agriculture. In other words, everything should be carried out before cold season start. That is why, they have to work and follow schedule and concentrate with the production method to increase the annual production.

Sericulture industry is also required to follow a certain time schedule of work in regard with the propagation of mulberry and silkworm rearing. The silkworm rearing needs periodical mulberry feeding in a day and silkworm need to eat mulberry even midnight. In case of wrong feeding, the cocoon will react and as a result it will lead to a poor harvest. It should be bear in mind that silkworm grow as heavy as 10,000 times during their larvae stage, so far, they have to eat mulberry every four or five hours. Wherever they are raised, the timing of feeding is necessary to engage with sericulture. In other words, the working habit in sericulture is the critical key point to induce success. So, the main problem for the sericulturist is how to induce the farmers to be used with time schedule of work.

From meterorological point of view, the sericultural service should be engaged during the dry season, because silkworms get easy disease during the wet season here. This means that there is also a time limit to engage in sericulture in the Philippines.

In order to engage sericulture during the dry season, it is necessary to provide proper irrigation system for the mulberry farms during the drought season so that the mulberry may grow regardless of the weather. The Philippine has done very good work on rice production

in the past and such activities should be extended to the mulberry farm in the proper way. The temperature in the Philippines is rather higher than the temperature needed in rearing silkworm which may bring about poor cocoon harvest, instead, this will be covered by the repitition of rearing about four times per year. So far, the annual cocoon harvest will be equal or more than the temperate countries.

In case we do our best on the mulberry culture, annual raw silk production would be 1 kg/a or 100 kg/ha in Korea and Japan. So far, this will be a guidance for the economic evaluation on sericulture. If we figure out as $30/kg of raw silk, this will be $300/10a or ₱2,340/10a income which no other agricultural crops may compete against with the sericultural income.

The silkworm rearing house need not use heating or warming system because the temperature is already above the required and the rooms may be wide enough to rear on wood table. In Korea and Japan, they use a smaller room where they set shelves in the room and keep silkworms crowded because they have to save heating cost during the spring season. Such rearing system is not necessary for the Philippine sericulture. In other words, the silkworm rearing house in this country should be much larger than the temperate area use.

The silkworm rearing tables should be insulated to avoid the attack of ants by providing diesel oil underneath of each table stand.

The mulberry varieties that are here have already imported from foreign countries which seem to be not proper for the weather condition here. The imported mulberry shows withering during the dry season here. Such withered mulberry is not favored by silkworm even though it has more nutritive value than the native varieties. The imported mulberry variety has larger leaf size and call more evaporation by sunlight than the smaller leaf which ends with withering.

On the other hand, the native mulberry varieties here that grew for many years thought to be familiar w/ the climate here as far

as mulberry propagation is concerned which won't wither on such temperature. Silkworms do not like to eat such withered mulberry regardless of its nutritive value. This should bear in mind in selecting the mulberry varieties, choose the native varieties in the future.

The sericultural technical matters for farmers should be simple and as easy as radio operation. In order to provide such simple method, there should be careful designing as well as structure of radio which government project, research projects, technical guidance, marketing and extension services may be able to reach the goal.

The present sericulture project being undertaken by the government through the National Science Development Board and the Philippine Textile Research Institute is the continuation of a project started by the new defunct Mountain Province Development Authority (MPDA). Insufficient financial support and lack of facilities hampered the progress of the MPDA sericulture project.

The growing scarcity and prohibitive price of the raw material for Filipino costume, the barong tagalog, prodded no less than the First Lady to spearhead the project.

The project presently concentrates on two major areas:

1. Growing of mulberry plants suitable to Philippine climatic conditions to supply all those who will be involved in sericulture industry.

2. Rearing suitable species of silkworm and efficiently extracting fibers from the produced cocoons.

There are four types of mulberry plants being grown in the project. They belong to the same species (Morus Alba) but manifest different characteristics. They differ in size and thickness of leaves, number of branches, color and resistance to pests and diseases. Another type, Ichinose, brought from Japan, is being acclimatized and has been observed to have lost its characteristics of shedding its leaves during the cold months. This variety is still under observation in nursery beds.

New improved techniques of cultivation are being tried at PTRI 3 hectare mulberry plantation. According to plan, mulberry cuttings will be prepared for distribution to prospective cocoon producers.

Some hybrid varieties brought from foreign countries are presently reared at the Baguio Station of PTRI without carrying on segregation. In effect, the present project calls for the reactivation and expansion of the Sericulture Station in Baguio, harvesting of cocoons and selling of raw silk fiber at the Station, processing into silk fabrics at Fil-Fibers Manufacturing, Inc. and distribution of the finished products at the Nayong Pilipino. The project was also designed in such a way that sericulture industry could be turned over to the barrio people as one lucrative cottage industry in the future.

Problems found during the first project, such as the growing of mulberry trees, silkworm rearing, house management and the culture of silkworms, were extensively discussed and subsequently resulted in the revival of the project under the management of the Philippine Textile Research Institute.

In order to initiate such program, two Korean experts including the writer joined the technical assistance in the Philippines. Meantime, the Philippine government has planned to invest over million dollars for the project.

IV. WORKING ACTIVITIES

PTRI engages with cocoon classification service with the cocoon brought from various farmers and recommends the price of cocoon for farmers and shows guidance of improving cocoon qualities.

In order to clearfy their business, the reporter had spent his time to teach the classification method until his time was available.

This activities was very important because cocoon classification method is the first step to improve silk industry here.

The lectured items are as follows:

I. Cocoon Processing

1. Cocoon in general
   a) shape, b) size, c) wrinkle, d) hardness

2. Characteristics of cocoon filament
   a) shape, b) specific gravity, c) tenacity & elongation

3. Formation of cocoon filament

4. Properties of Cocoon
   a) cocoon shell percentage
   b) length of cocoon filament
   c) weight of cocoon filament
   d) size of cocoon filament
   e) reelability
   f) raw silk percentage of cocoon
   g) defects with in cocoon filament

5. Cocoon Drying
   a) Drying Method
      1.1 drying condition
      1.2 cocoon drying rate
      1.3 once or redrying process
      1.4 other method

b) Cocoon Storage

1.1 Purpose

1.2 Storing room

1.3 Storage method

1.4 Prevention of noxious insect & rat damage

c) Cocoon assorting

1.1 Purpose

1.2 Assorting method

6. Cocoon Cooking

a) Purpose

b) Method of cocoon cooking

c) structure of cocoon cooking machine

d) Cocoon cooking method

e) Cocoon cooking technique

7. Silk Reeling

a) Purpose

b) Development history of reeling method

c) Various reeling method

d) Reeling method

e) Reeling technology

f) silk by-product

8. Silk re-reeling

a) Purpose

b) re-reeling method

c) raw silk finishing

d) silk storage

II. Cocoon Classification

1. Object of cocoon classification

2. Items of cocoon classification

3. Method of coccoon classification

a) quantity of sample cocoon, b) reception of sample cocoon,

c) drying of sample cocoon, d) test of eliminated cocoon percentage, e) grouping of sample cocoon for reeling,

f) cooking of sample cocoon, g) reeling of sample cocoon,

h) neatness test, i) conditioned weight test

4. Calculation of cocoon classification results
   a) eliminated cocoon percentage
   b) length of cocoon filament
   c) reelable percentage
   d) size of cocoon filament
   e) raw silk percentage of cocoon

5. Cocoon Classification
   a) composition of cocoon classification
   b) results of cocoon classification method
   c) cocoon classification method

The reporter had brought his written book of "Sericultural Technology" which is very important for improving their knowledge throughout mulberry culture, silkworm rearing, silk reeling and silk preparation for weaving. There was,however, no available fund to duplicate the necessary copies for the extension of these knowledge. The book was given to PTRI for future duplication.

Other than the lecture activities in the Philippines, he has visited only one silk factory, Fil-Fiber Manufacturing, Inc., located at Barang, Marikina, Metro Manila and observed that the factory has very old facilities. The facilities may be available for the domestic use of silk,but the bottle-neck of the management is the short of domestic raw silk supply. They import Chinese raw silk material.

They agreed about improving the facilities of the factory,but the owner is not interested in improving the facilities at this present time. They said that there are many red tapes of importing the Chinese raw silk.

So far, it will take a long time to improve the slumped situation after all.

The factory was observed as follows:

1. The weaving capacity is 26 looms capacity which is one half of international economic capacity.

2. The kinds of weaving looms should be more various to produce various textiles.

3. There should have soap oil previous soaking process before the silk throwning process to stabilize the twisting result.

4. There should have screen printing equipment to produce various printed silk textiles.

5. The refining or degumming equipment should be replaced with semi-automatic machine.

6. The factory does not carry out its own testing before the sale of their product to improve the merchandize quality.

7. The technicians in the factory could not work better than that with the existing poor facilities.

On the other hand, PTRI stays with more lack of equipment which they should have to carry out the purpose.

V. RECOMMENDATION

1. PTRI is expected to be a government organization to carry out raw silk classification service between silk reelers and weavers in the future. PTRI however, is not able to carry such service with the existing facilities. There are international raw silk testing regulations and classification method for trade of raw silk which is required to install various testing equipment. The necessary testing equipment are as follows:

   (1) Winding tester, 100 bobbins, (2) Balance 100 kg. capacity, (3) Conditioned weight test oven, (4) Denier size reel, electric, 50 skein capacity electric, (5) Denier balance, 21D, 28D, 42D each, (6) Evenness test facilities include standard photograph, (7) seriplane machine, (8) Suter serigraph, (9) Duplan cohesion tester, (10) Degumming tank, (11) Denier skein twister, (12) Seriplane board carrier, (13) Rereeling machine for left over sample.

   When such equipment are ready to operate, somebody should be sent to foreign country to learn how to work out on raw silk test and classification from the obtained test result. Some of these equipment are already installed in the PTRI, but it is not enough to carry out raw silk test at all.

2. The only one business scale silk weaving factory in the Philippines is suffering with the critical shortage of raw silk supply from domestic market, so they are importing some raw silk from China. In this case, there are many red tapes for their importing business which discouraged their operation after all.

   This will recommend such red tapes should be released until some satisfactory amount of cocoons are produced and the domestic raw silk products are ready to supply for the factory as of material.

   In order to improve the produced silk quality, the factory should intend to purchase modern types of facilities as shown in Appendix. For the purchase of new machine, the government should give a good condition of loan for the factory.

VI. APPENDIX - SILK FABRIC PROPOSAL

1. PRODUCTION CAPACITY. (HAN JIN HKKS2 TYPE 50 sets Loom. 55", 2x1)

1. Fabric Name : (REPE DECHIN SILK)
2. Yarn : Warp: silk 21D (2 ply)
   Weft: silk 21D (3 ply)
3. Fabric Width: Woven Width: 50 inch
   Finished Width: 44 inch
4. Density of Woven Fabrics: Werp: 253 ends/inch (non twist)
   Weft: 102 ends/inch: 2,800 tm
   Yarn consumption: 72G
5. Loom : HKKS2 TYPE Loom 55" 2x1 (width HDK Dobby)

a) R. P. M : 165

b) Efficiency : 95%

c) working Hour : 23Hr x 25 days /month

d) Production :

$$\frac{\text{Loom rpm x 60 min x 24 hr x 25 days x Efficiency}}{\text{Pick/inch x 36 inch/yds}}$$

$$= \frac{165 \times 60 \times 23 \times 25 \times 0.95}{102 \times 36} = \frac{5,407,875}{3,672} = 1,473$$

= 1,473 yds/month/set

e) Total Production: 1,473 yds x 50 sets x 12 months

APX : 883,800 yds/

f) Yarn Consumption

72G x 883,800 yds = 63,633, 600G =63,633.$\frac{6}{}$ Kg

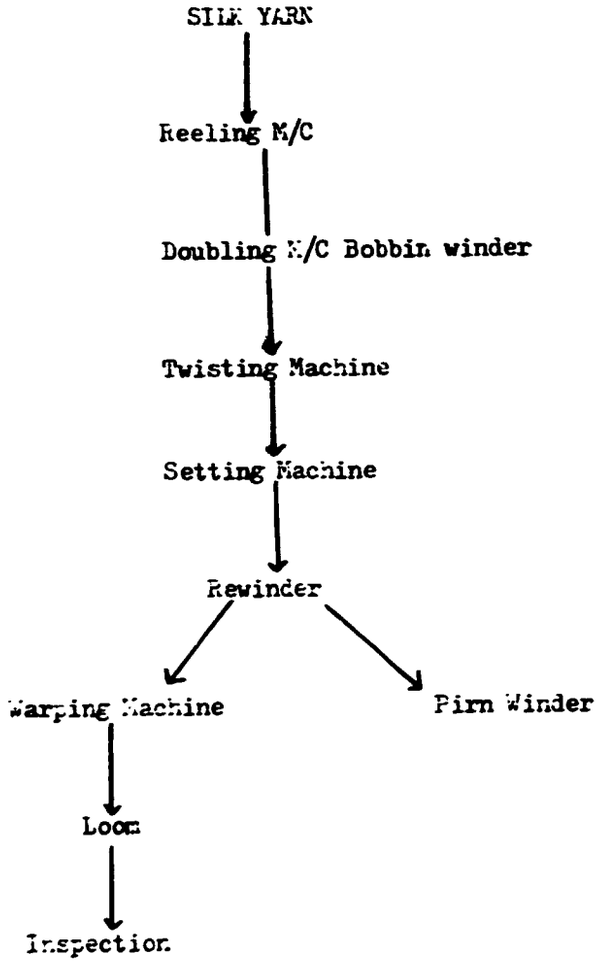
shrinkage & Loss : PREPARATORY & WEAVING

: 3% : 1,900 Kg

TOTAL YARN CONSUMPTION

63,633.$\frac{6}{}$Kg + 1,909 Kg : 65,542.$\frac{6}{}$Kg

2. PROCESS FLOW CHART FOR SILK DOBBY



3. LIST OF MACHINERY AND PRICES

ITEM NO.	DESCRIPTION	QUANTITY	U/PRC (C & F PHIL.)	AMOUNT
1.	HNK$2 type 55" 2 x 1 (Loom)	50 sets	$6,000	$300,000.-
2.	Dobby :			
	HDN Type 16 shafts	50 sets	$1,500	$ 75,000
3.	Winder			
	(1) bobbin Winder (100 spindle)	1 set	$7,000	$ 7,000.-
	(2) Kdoubling M/C (100 spindle)	1 set	$12,000	$ 12,000.-
	(3) Rewinding M/C (100 spindle)	2 sets	$12,000	$24,000.-
4.	sectional warping M/C (85 inch)	2 sets	$22,000	$44,000.-
5.	Twisting M/C (200 spindle)	25 sets	$38,000	$950,000.-
6.	Firn winder M/C (12 spindle)	4 sets	$ 3,000	$ 12,000.-
7.	Steam Setting M/C (150 Kg)	1 set	$11,000	$ 11,000.-
8.	Grey Inspection M/C	2 sets	$ 3,250	$ 6,500.-
9.	Reeling M/C (50 spindle)	1 set	$ 6,250	$ 6,250.-
			Grand Total :	$1,447,750.-

A. Requirement (Land)

(a) Weaving : 820m^2

(b) Preparatory : 550m^2

Commodity : TEXTILE MACHINERY

Maker

Terms of Payment: At sight Confirmed Irrevocable Letter of Credit to be opened in our favour

Shipment Port : Korean Port

Packing : EXPORT STANDARD PACKING

Country of Origin: R. O. K.

Validity : Until September 30, 1986

Reamarks : Maker's Inspection to be final

	Description	Quantity	Unit Price	Amount
*	THROWN SILK YARN MANUFACTURING FACILITIES		CIF MADRAS	
1.	HANK TO BOBBIN WINDER 140 SPINDLES	2 sets	@9,840. -	US$19,680.-
2.	HIGH SPEED DOUBLING MACHINE 60 SPINDLES	1 set	8,830. -	8,830.-
3.	HIGH SPEED TWISTING MACHINE 200 SPINDLES	10 sets	5,030. -	50,300.-
4.	STEAM SETTING MACHINE 100KGS/BATCH	1 set	9,600. -	9,600.-
5.	HIGH SPEED REWINDING MACHINE 60 SPINDLES	1 set	9,760. -	9,760.-
6.	HIGH SPEED REELING MACHINE 50 SPINDLES	1 set	7,500.-	7,500.-
7.	PARTS & ACCESSORIES FOR ABOVE MACHINES			
	1) Aluminum Cylinder 250GR	6,000PCS	@2.00	US$12,000.-
	2) Plastic Bobbin, 250GR	6,000PCS	2.00	12,000.-
	3)Flyer	16,000pcs	0.10	1,600.-
	4) H-Type Bobbin, 750GR	1,600PCS	3.50	5,600.-
	5) Flyer Cap	6,000PCS	0.05	300.-
	6) Hank Reel	300PCS	5.70	1,710
8.	SPARE PARTS FOR 2 YEARS OPERATION	1 Lot	3,800	3,800.-
	TOTAL: CIF MADRAS			U$142,590.-

CALCULATION OF PRODUCTION CAPACITY AS PER M/C

* SILK YARN : 21D/3 PLY

A. Production Capacity :

1. Hank to Bobbin Winder

1) Conditions

a. No. of Spindle : 140Sp

b. Yarn Speed : 200M/Min.

c. Working Rate : 80%

2) Production Capacity

200m/Min. x 24 hr/day x 60 min. x 140SP x 0.8

= 32,256,000m/day x 21D ÷ (9,000M x 1,000GR)

= 75,264KG/day/set

∴ 75.264KG x 2 sets = 150.528 KG/day

2. Hank Speed Doubling Machine

1) Conditions

a. No. of spindle : 60SP

b. Yarn speed : 200M/Min.

c. Working rate : 80%

2) Production Capacity

200M/Min. x 24 hr/day x 60 min. x 60 SP x 0.8

= 13,824000M/day x 21D x 3 Ply ÷ (9,000M x 1,000GR)

= 96.768KG/DAY/SET

3. High Speed Twisting Machine

1) Conditions

a. No. of Spindle : 200

b. Revolution : 8,000 - 9,000 R.P.M.

c. Number of Twist : 2,240 T/M

d. working Rate : 85%

2) Production Capacity

$$\frac{8{,}000RPM \times 60min \times 24\ Hr \times 200SP \times 21D \times 3Ply \times 0.85}{2{,}240\ T/M \times 9{,}000M \times 1{,}000GR}$$

= 6.12KG/DAY/SET

∴ 6.12KG x 10 sets = 61.20KG

4. Heat Setting Machine

1) Conditions

a. Capacity per batch : 100 KG/Batch

b. Number of Batch : 5-9Batch/24hr

2) Production Capacity

100KG/Batch x 6Batch/24Hr = 600Kg/day/set

5. Rewinding Machine

1) Conditions

a. No. of spindle : 60

b. Yarn speed : 200M/Min

c. working Rate : 80%

2) Production Capacity

200M/Min x 24 hr x 60min

= 13,824,000M/day x 21 D x 3 Ply ÷ (9,000 x 1,000GR)

= 96.768KG/day/set.

6. Sectional Warping Machine

1) Conditions

a. Yarn speed : 100M/min.

b. Number of yarn : 572ENDS (Reels) x 14 Repeat = (8,008 ENDS)

c. Working Rate : 25

2) PRODUCTION CAPACITY

$$\frac{100M/Min \times 60\ Min \times 24\ hr \times 572\ ends \times 21D \times 3ply \times 0.25}{9,000M \times 1,000GR}$$

= 144,144 KG/day/set.

7. High speed reeling Machine

1) Conditions

a) Yarn speed : 200M/Min.

b) No. of reel : 50

c) working rate : 80%

2) Production Capacity

200M/Min. x 24 Hr x 60 min x 50SP x 0.8

= 11,520,000M/day x 21D x 3Ply ÷ (9,000M x 1,000GR)

= 80.64KG/day/set

CALCULATION OF PRODUCTION CAPACITY

* Kinds of Fabric to be woven : Amunzen, Dobby & Matt
  Georgette etc.
* Yarn to be used: Warp . . . Polyester 75D
  2,240 T/M (S & Z)
  Weft . . . Polyester 75
  2,240 T/M (S & Z)
* Fabric Width : Weaving width 54 inch
  Finishing width 44 inch
* Density of Woven Fabric : Warp 148 ends/inch
  Weft 80 picks/inch
* Twist Shrinkage & Loss : 16%
* Weaving Shrinkage & Loss : 6 %

1. Production Capacity of Loom
   1. Condition
      a) Number of Loom : 60 sets
      b) Reed Space : 59 inch
      c) Shuttle Box : 2x1
      d) Revolution : 170 rpm
      e) Efficiency : 90%
      f) working hour : 24 hr/day x 300days/year

2. Production Capacity per set

$$\frac{\text{Loom's R. P. M.} \times 24\text{hr} \times 60\text{min} \times \text{efficiency}}{\text{Weft density/inch} \times 36\text{inch}}$$

$$= \frac{170\text{rpm} \times 24\text{ hr} \times 60\text{min} \times 80\%}{80/\text{inch} \times 36\text{inch}}$$

$$= 76.5\ \text{yds/day}$$

3. Total Production Capacity:
   76.50yds x 60sets x 25days/month
   = 114,750 yds/month

4. Yarn Consumption

Warp : $\frac{8{,}000\text{ends} \times 75\text{D} \times 76.5\text{yds/day} \times 0.9144\text{m/yd.}}{(1-0.16) \times (1-0.06) \times 9000\text{m} \times 1{,}000\text{g}}$

$= 5.91\text{kg/day}$

Weft: $\frac{54\text{ inch} \times 75\text{D} \times 80\text{pick/inch} \times 76.5\text{yds/day} \times 0.9144\text{m/yd.}}{(1-0.16) \times 9{,}000\text{m} \times 1{,}000\text{g}}$

$= 3.00\text{kg/day}$

Total yarn Consumption:

(5.91kg + 3.00kg) x 60 sets = 534.60kg/day/60sets

= 160,380kg/year/60sets

2. Required Sets of Preparatory Machines

A. Bobbin Winder

1. Condition

a) Number of spindle : 80

b) Yarn speed : 220m/min

c) Efficiency : 90%

2. Production Capacity per set:

$$\frac{220m/min \times 24hr \times 60min \times 80\ spindles \times 75D \times 0.9}{9,000m \times 1,000gr}$$

= 190 kg/day

3. Required Q'ty:

$$\frac{\text{Total Yarn consumption}}{\text{Production Capacity per set}} = \frac{534.60kg/day}{190kg/day} = 2.8\ sets = 3\ sets$$

B. Twisting Machine

1. Condition:

a) Number of spindles : 200 spindles

b) Revolution : 9,000 rpm

c) Number of Twist : 2,240 T/M

d) Efficiency : 90%

2. Production Capacity per set

$$\frac{9,000rpm \times 60min \times 24hr \times 200spindles \times 75D \times 0.9}{2,240T/M \times 9,000m \times 1,000gr}$$

= 8.67 kg/day

3. Required Q'ty:

$$\frac{534.60\ kg/day}{6.67\ kg/day} = 61,66\ sets = 62\ sets$$

C. Heat Setting Machine

1) Condition

a. Capacity per batch : 100 kg/batch

b. Number of batch : 5-9 batch/24hr

2) Production Capacity per set :

100kg/batch x 6 batch/day = 600kg/day

3) Required q'ty

$\frac{534.60kg/day}{600kg/day} = 0.89 \text{ sets} = 1 \text{ set}$

D. Rewinding Machine

1. Condition

a) Number of spindle : 80 spindles

b) yarn speed : 220m/min.

c) efficiency : 90%

2. Production Capacity per set

$$\frac{220m/min \times 24\ hr \times 60min \times 80spindles \times 75D \times 0.9}{9,000m \times 1,000gr}$$

$$= 190kg/day$$

3. Required q'ty:

$\frac{\text{Total warp consumption}}{\text{Production capacity per set}} = \frac{180kg/day}{190kg/day}$

$= 0.94 \text{ set} = 1 \text{ set}$

E. Section Warping Machine

1. Condition:

a) Yarn speed : 100m/min.

b) Number of Yarn : 572ends x 14repeat (=8,000ends)

c) efficiency : 30%

2. Production Capacity per set:

$$\frac{100m/min. \times 60min \times 24hr \times 572ends \times 75D \times 0.30}{9,000m \times 1,000gr}$$

$= 205.92kg/day$

3. Required q'ty:

$\frac{\text{Total warp consumption}}{\text{Production capacity per set}} = \frac{354.60kg/day}{205.92kg/day}$

$= 1.72 \text{ set} = 2 \text{ sets}$

F. Weft Firn winder

1) condition:

a) number of spindle : 10 spindles

b) yarn speed : 300m/min

c) efficiency : 80%

2) Production capacity per set

$$\frac{300m/min \times 24hr \times 60min \times 10spindles \times 75D \times 0.8}{9,000m \times 1,000gr}$$

= 26.8 kg/day

3) Required q'ty

$$\frac{\text{Total Weft consumption}}{\text{Production Capacity per set}} = \frac{180\text{kg/day}}{28.8\text{kg/day}}$$

= 6.25 sets = 7 sets

G. Grey Cloth Inspection Machine

1. Condition:
   a) Fabric speed : 20yds/min
   b) working rate : 25%
2. Production capacity per set:
   20yds/min x 60min x 24hr x 0.25
   = 6,600yds/day
3. Required q'ty:

$$\frac{\text{Total required Q'ty of Fabric}}{\text{Production capacity per set}} = \frac{4,590\text{yds/day}}{6,600\text{yds/day}}$$

= 0.69 set = 1 set