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# CHOICE OF TECHNOLOGIES IN THE LATIN AMERICAN TEXTILE INDUSTRY

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/I. INTRODUCTION

# I. INTRODUCTION

## 1. The concept of technological choice

For centuries the making of cloth has been an artisan activity of major importance. Even after evolving into an industry in modern times, it was slow to introduce the technological improvements that have marked the development of so many other industrial sectors, particularly metal transforming and electronics. By the thirties, although the textile sector had made a large number of technological innovations, these did not prove particularly attractive to textile manufacturers. The textile industry continued to cling to its traditional methods of production, characterized by a high level of employment and the lowest wages paid in the manufacturing sector.

In recent years the shortage of manpower in the industrial countries has become more serious, and has led machinery manufacturers to undertake technological research with the aim of designing machinery that would reduce the share of labour in the production process and hence increasing capital intensity. The outcome is that the existing proportions of capital and labour in the textile industry are becoming reversed, particularly since increasing efforts are being made, despite the high grade of automation already achieved, to devise a continuous and completely automatic process for turning fibre into fabric.

Since it is axiomatic that in Latin America labour is plentiful and capital scarce, highly capital-intensive techniques are obviously not the most appropriate.[1/] The problem is not as simple as that, however, and needs to be considered from various economic and technical angles.

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1/ Throughout this document, the terms "production technique" and "production technology" will be used synonymously. It is, in fact, difficult to draw the line between the two. There is a certain definition for "technique" on which not only dictionaries but also the literature on the subject are in agreement. To put it simply, technique is applied science. The word "technology", on the other hand, has a wider meaning. It is defined as "the systematic knowledge of the industrial arts", as "the means and procedures employed by man to transform the products of nature into objects of use" and as "the theory of the different techniques or the study of the general rules and procedures of technique", hence technology is not in contradistinction to the word technique but, on the contrary, is liable to be confused with it.

At the microeconomic level, undue deference is commonly given to the views of engineers, who by the very nature of their training are utterly averse to using machinery that does not combine all the most advanced techniques available. When an entrepreneur is faced with the problem of choosing a technique, he generally calls in an engineer to advise him, and as a result is fired with enthusiasm for highly automatic techniques, and disregards the economic implications of his choice, which might lead him to think twice. At the macroeconomic level, on the other hand, there is an over-emphasis on the possible consequences of adopting a technique that is less dependent on manpower; planning agencies are, understandably, always concerned about the manpower surplus, and therefore tend to undervalue the technical data that might change the estimates of the economicity of a proposed project, and have a decisive effect on the development process as a whole. Hence there are only two ways of determining the optimum balance of all the factors involved: (a) an evaluation of relative factor prices, taking account both of the prevailing rates and of the possibility of other uses; and (b) a review of operational problems from the technical standpoint, covering such items as the complexity of the equipment in relation to the skills of the manpower available, maintenance costs, the useful life of the machinery in relation to the period within which it is likely to become technologically obsolete, type of ancillary installations, and flexibility of the production process.

When a new industry is to be set up the matter is much simpler. Issues such as those raised above take second place, and other more important factors bearing on the decision to be taken, such as the development capacity of the new industry, come to the fore. This does not happen in the case of traditional industries, such as textile manufacturing; having been first established in Latin America in the middle of the nineteenth century, this industry still operates at the technological level of thirty years ago. The problem here, in addition to being complex, involves subjective considerations.

The bulk of the Latin American textile inventory consists of equipment that is regarded as obsolete and therefore needs to be modernized. From the standpoint of the regional economy as a whole, the aim of this

/reorganization should

reorganization should be twofold: to raise both the growth rate and the employment level to the maximum. Some interesting research has been carried out on these lines,[2] but they are based wholly on macroeconomic data. This means that all the forecasts have been made from figures that are not only difficult to obtain at the macroeconomic level, but have a number of shortcomings. The data compiled so far on investment, productivity, wages and so forth in the Latin American textile industries are admittedly fairly plentiful, and will be extremely useful for any study that may be recommended on technological levels, but are not full enought for definite conclusions to be reached. The problem must necessarily be approached at the microeconomic level.

This is the aim of the present study, which has brought together the technical and economic data at the project level that are needed for weighing up each of the possible technologies that appears to be suitable, in the light of different hypotheses as to factor cost. The first step was to determine the alternative technologies currently in use, together with those offered by the machinery market. This was done by means of a comprehensive survey of textile equipment manufacturers, technical journals and textile mills already established in some of the Latin American countries (see annex for list of manufacturers consulted). It was found that the current production techniques used in the textile industry can be divided into five levels. These may be regarded as corresponding to the years 1930, 1950, 1960, 1965 and lastly, a possibility still at the experimental stage, consisting of semi-continuous yarn production combined with weaving on shuttleless looms.

2/ In 1961 the "Superintendencia do Desenvolvimento do Nordeste" in Brazil launched a programme for replacing the equipment of the textile industry in nine States, and estimated that the result would be to displace about 30 per cent of the labour force employed in the industry. This is such a high proportion in absolute terms that ways and means of re-employing the displaced workers in other sectors were studied. A more recent example is afforded by Mexico, where the authorities have worked out a plan for controlling the unemployment produced by the remodelling of the textile industry. See SUDENE, Primeiro Plano Diretor de Desenvolvimento do Nordeste, Office of the President, 1961, and Nacional Financiera S.A., Banco de México S.A., Programa de Reestructuración de la Industria Textil Algodonera y de Fibras Químicas, México, 1965.

/Of the

Of the five possibilities, three are feasible for use in Latin America. The 1930 alternative was discarded, since equipment of a suitable kind is no longer available on the market, and so was the experimental technique because the manufacturers were unable to supply quotations of equipment of the kind required.[3/]

The formulation of a production process that can constitute a technological alternative does not imply that existing mills should introduce one or more of these possibilities on the exact lines on which they are described in this study. A textile mill can, in fact, combine various technological levels during its fourteen or fifteen different stages of production. It often happens that mills with modern machinery in some of their production stages have completely obsolete equipment in others. In order to establish the technological levels analysed in this study, the machinery had to be grouped in accordance with purely technical criteria. In the light of the technical advances made in each type of machine over the years, it was then determined what stage it had reached at a given time and the group to which it should belong, so as to achieve the greatest possible uniformity in the machinery in any one group. In other words, each grouping formed to constitute a technological alternative has machinery of a uniform "age" in terms of evolution through time.

Consequently one of the limitations of the present study is the fact that it does not take into account all the possible combinations in the eleven production stages covered at the three different technological levels since although the criterion adopted for grouping the machinery in the form of alternative technologies may guarantee a technically uniform production process, there is in fact no a priori guarantee that any particular combination will offer the most economic solution. For instance, production costs could be reduced to the minimum with any one

3/ Latin America has one spinning mill installed with the equipment classified here as experimental, or, more precisely, based on the semi-continuous system of yarn production. It was set up as a pilot project for the method in question, and its managers state that, although it is able to compete, albeit with some difficulty, with other mills, it is not suitable for conditions in Latin America.

/of the

of the 177,000 theoretically possible combinations of the three production alternatives and the eleven processing stages.[4/] Obviously the volume of work involved in searching for the best theoretical solution would be physically impossible with the mechanical aids normally available for purposes of calculation. Moreover, it would not be justifiable to enter into such a high degree of precision until a later stage, on the basis of the results of a first approximation. The present study contains all the basic data necessary for making an analysis in depth in order to determine the most economic combination from the standpoint of production costs, or the combination which, with the least reduction in manpower, would give the greatest returns on capital, or meet other requirements that might arise.

This analysis has been inspired by the fact that some types of textile machines are less developed than others. The complex nature of textile manufacturing has obliged the machinery manufacturers to specialize in small lines. The result of this lack of integration is that machinery design has proceeded haphazard, ignoring the connexion between the various stages of production. This is apparent not only from the technological development of the machinery, in terms of production capacity, automatization and quality of the product, but also from the minimum machine sizes, which are rarely consonant with one another.[5/]

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4/ Any of the three technological levels can be chosen at each stage of production, irrespective of those adopted for the other ten stages. That is, for each stage, each of the three alternatives can be adopted, in conjunction with each of the other three for each of the subsequent stages. With only two stages, $3^2$ different combinations can be made, i.e., there would be nine different working hypotheses. With three stages, the number of combinations would be $3^3$, and with eleven, it would be $3^{11}$, or, to be exact, 177,147 different combinations.

5/ For more details on minimum machine size, see ECLA, Economies of scale in the cotton spinning and weaving industry (E/CN.12/748). The annex to that document gives an account of the production process that makes clear its complex nature.

/2. Theoretical

## 2. Theoretical considerations

The purpose of economic development is to improve living conditions. This is done by raising the level of income, which depends on the increase - and distribution pattern - of the gross domestic product whose rate of growth is, in turn, contingent on the reinvestment rate. This rate, again, depends on what is termed the return on current investment, a term implying that the product of a given amount of capital can be used for other types of investment, either more or less productive than the existing investment, or else for consumption.

Opinions as to the minimum acceptable return on investment are apt to vary, and the private entrepreneur, for instance, does not always agree with the criterion followed in the over-all deconomic development programme. For the entrepreneur, the choice of a technique is basically a question of being familiar with the production techniques available, and of knowing which technique will minimize his production costs, that is, permit the widest profit margin. Although these factors cannot be discounted in a balanced development programme, they are not all-important. From a strictly social standpoint, the highest return on investment could be defined as the maximization of the benefits of the investment. To simplify the problem by reducing it to its basic elements, this means the highest possible product-capital ratio and employment level. These goals are not attainable, over the short term at least, by techniques that are highly capital-intensive. On the other hand, it would have to be determined whether the techniques that aim at the above goals, i.e., the labour-intensive techniques, would be capable of obtaining a sufficient financial surplus for reinvestment to guarantee a growth rate compatible with the country's requirements as visualized in its plans for emerging from its state of stagnation. Generally speaking, this is unlikely.

The higher product-capital ratio permitted by a less advanced technology does not in itself ensure a higher rate of reinvestment.[6/] It

6/ All the comments made here are based on the findings of this study, and apply specifically to the textile industry. This does not necessarily mean that generalizations can be made without reference to the factors proper to other branches of industry.

/may, on

may, on the contrary, result in a lower rate, since the surplus product is transferred to the worker in the form of wages and is then consumed. More advanced techniques tend to increase the financial surplus, which accumulates in the hands of the entrepreneur or the State and is eventually invested, thereby helping to accelerate the economy's growth rate.[7/] By expanding consumption through higher employment and more scattered distribution of value added, highly labour-intensive techniques will be effective over the short term, i.e. the period of maturity of the projects, but the economic growth rate will be slow.

Techniques aimed at maximizing the margin available for reinvestment ensure that growth will be more rapid, but its benefits will only be reaped over the long term. For an under-developed country, short of capital and plagued by chronic unemployment, whether registered or hidden, the first alternative would be the right choice. However, the question is whether the country, in making that choice, might not be sacrificing its growth rate and choosing to remain in a state that, while not total stagnation, certainly prevents it from taking its place among the developed nations. Although the problems that beset the various Latin American countries are all very similar, there does not seem to be any common remedy. Each country must take its own decisions and adopt the measures best suited to its own case. Apart from the problems that are inherent in the particular stage of under-development at which each country is to be found, there are some that are proper to the industrial sector itself, such as market size, consumer habits, alternative methods of using surplus manpower, etc. It should also be borne in mind that the more extreme type of solution is not always advisable. The best course is to evaluate the results of each technology in terms of figures, compare them, and weigh them against the social implications of its adoption. The following section provides some data useful in making the right choice.

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7/ Where the entrepreneurial sector is still in the early stages of its formation, the private entrepreneur does not always reinvest his profits as a matter of course, despite the recognized marginal propensity to save. In such cases a sound policy for attracting new investment would help to correct any shortfall.

/II. THE

## II. THE METHODOLOGY ADOPTED - A MICROECONOMIC APPROACH

### 1. Selection of typical mills

The relative complexity of the manufacturing process and the broad range of products characteristic of the textile industry represent the first obstacle to the formulation of a methodology for studying the choice of appropriate technologies. The large number of variables involved alter, to varying degrees, the functions of production, and in theory this means that each product should be studied separately. Consequently certain simplifications have had to be introduced into the present study, but these in no way affect the validity of the results. Some of these simplifications are referred to in chapter I, and others will be dealt with in later sections.

The aim of this study is to determine which of the technological choices now available to the cotton industry would be the most economic in terms of the factor costs prevailing in Latin America. For this purpose a theoretical mill was postulated, including both a spinning and weaving section, that produces only one type of fabric, unbleached, that can be regarded as typical of the average product in Latin America.

The fabric chosen is that used as the standard product by ECLA in its studies on the textile industry,[8/] and can be regarded as representative of the basic cotton fabric used commonly in the region for household linen and other domestic purposes, and for clothing. The technical specifications for this fabric are given in detail in table A. In brief, it is a fabric 90 cm wide, made of 18 count yarn, 20 threads per square cm (both warp and weft).

The mill size selected is based on the results obtained in an earlier study on economies of scale in the textile industry.[9/] Of the minimum

8/ ECLA, La industria textil en América Latina, Vols. I-X (United Nations publications, Sales Nos. 63.II.G.5; 64.II.G.2; 64.II.G/Mim.2; 64.II.G/Mim.5; 64.II.G/Mim.3; 64.II.G/Mim.4; 65.II.G/Mim.6; 65.II.G/Mim.7; 65.II.G/Mim.8; 65.II.G/Mim.9. Vols. II Brazil and VIII Argentina are the only studies available in English).

9/ See Economies of scale in the cotton spinning and weaving industry, op. cit.

/Table 1

Table 1

MILL-SIZES SELECTED AND CORRESPONDING VOLUMES OF OUTPUT

| | Level A | Level B | Level C |
|---|---|---|---|
| Number of spindles | 13 600 | 15 200 | 14 820 |
| Number of looms | 534 | 530 | 524 |
| Annual output of yarn (tons) | 2 265.6 | 2 643.3 | 2 895.0 |
| Annual output of fabric (thousands of metres) | 16 833 | 19 629 | 21 495 |
| Total investment (thousands of dollars) | 4 453 | 5 658 | 6 508 |
| Labour force (three shifts) | 668 | 446 | 315 |

economic sizes arrived at in that study, and in line with the recommendations set forth there, the size chosen is that offering the best possible balance between the various stages of production, in order to avoid idle capacity in machinery and equipment. Consequently, as the technology adopted varies first with the production capacity of the machinery, and secondly with the minimum size of the machinery, the scale of the production of the three mills postulated cannot be the same.

Table 1 shows the sizes chosen for the three technologies considered. In terms of total physical output it will be seen that most advanced technology (level C) is 1.27 times the size of the least advanced (level A), whereas in terms of investment the ratio is 1:1.46. Between the intermediate technology (level B) and level A, the ratio is 1.16:1.27. Thus the increase in the volume of production is not in proportion to the increase in investment; this is because the main object of technological research in the textile industry has always been automatization aimed at reducing the labour force rather than an increase in the unit output of the machinery

/in effect,

in effect, means reducing the relative cost of the machinery. This general comment applies even though at specific production stages - the cards, for example - the rise in production capacity is more than in proportion to the cost of the machinery.

## 2. Identification of the possible technological choices

As previously stated, research into new designs for the manufacture of textile machinery has centred on the search for a way of reducing to the minimum the labour force employed on running the machines and transporting the material, while the raising of the production capacity of the machinery has taken second place. Admittedly, both the reduction of the labour force and the increase of unit output conduce to the same end, though by different routes, which is the raising of labour productivity.

In principle there are two basic reasons why technological research has followed this trend. The first and most important is the mechanical limitations of the machines themselves, and the nature of the raw material used, in this case cotton. The raising of the speed of certain parts of the machinery has sometimes depended on the improvement of the materials used in their construction; a typical example is the replacement of iron or steel gears and brass bearings with equivalent parts of nylon or other polyamides; since these permit less friction it is possible not only to increase the speed of the machinery, but also to extend the life of the part, reduce noise, and simplify the lubrication routine. In other cases the difficulty of increasing production capacity has been due to the impossibility of exercising a proper control of the raw material. In this connexion a number of efforts have been made to find devices to permit effective control of the cotton fibres, whose original alignment tends to become distorted during the intermediate stages of the production process.

The second reason for the emphasis on manpower reduction is that there is no economic advantage in increasing the production capacity of the machinery, since this would only mean a further increase in the minimum size of the machines, and intensify the problems of economies of scale that

/already exist

already exist in this sector. The manufacturers of the machinery would be limiting their market to a small group of entrepreneurs with large capital resources, which would be unjustifiable, since the textile industry does not require a high level of technical knowledge and is not confined to large economic units.

For these reasons the raising of productivity has been approached by the only method that solves the two problems at once, namely automatization. This method both avoids the technical difficulties of increasing machinery speeds, and at the same time reduces the number of workers, who were beginning to become scarce in the industrialized countries. In spinning, for example, the final goal is the continuous process that enables the fibres to pass through all the stages without any manual intervention. This aim seems to be within sight. The experimental plants so equipped increase day by day, and the emulation stimulated by the entry of the Far Eastern countries into the textile machinery market has further increased competition. In weaving there has been less success in simplifying the processing and introducing automation.10/

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10/ It is difficult to deal with any question relating to technology without using the term "automation", which appears to have been coined in the mid-thirties. In its most modern usage, automation is "the technology of automatic working in which the handling methods, the processes, and the design of the processed material are integrated to utilize as is economically justifiable the mechanization of thought and effort in order to achieve an automatic and in some cases a self-regulating chain of processes." (Definition by L.L. Goodman.) Hence automation, automatization and mechanization are words whose meaning varies only with reference to the degree of the process. Automation implies the replacement of not only physical but also mental effort, by energy transformed by man.

/Thus far

Thus far there are no signs that the operations of weft and warp preparation can be joined to the weaving process as part of a continuous flow operation, although some steps in this direction have been taken, for instance, the elimination of part of the prior preparation of the filling for shuttleless looms, or the automatic preparation of the filling by the loom itself in the conventional weaving process.

A study of the technologies that have existed between 1930 (which may be regarded as the starting point of the development of research in this field) and the present day led to the identification of five different levels that may be considered as representative of modern developments during that period. These five levels are classified in table 2, and are identifiable by the main technical features of the machinery, their speed of operation and their degree of automation. On the basis of these data, once the characteristics of the product to be manufactured are known it is possible to determine the physical output of the machine and the work-load, that is, the number of machines or production units that can be tended by each worker.

It should be pointed out here that the manufacture of the new highly automatic machines has not completely ousted from the market the simplest type of machine, which requires a larger labour force and costs considerably less. For example, machines can be found whose characteristics are those of the most modern machinery available in about 1950. In the light of this fact, the three possible technological choices considered here represent the levels for 1950, 1960 and 1965, referred to for the sake of simplicity as levels A, B and C, respectively. The two levels omitted are that representing 1930, and that representing what is still regarded as an experimental stage. The first is omitted because there is no organized market for such machinery, and the second because, although machines of this type are available, their normal operation cannot be guaranteed by the manufacturers, at least in under-developed areas where there is a shortage of skilled labour. It should be noted that the original intention was to include the experimental level in the present study, in order to examine the possibilities of introducing it in the future, but this proved

/Table 2

impossible because the machinery manufacturers were reluctant to reveal the prices of these machines. Furthermore, certain of the most highly automatic equipment, in more or less established use in the United States, Europe and Japan, such as, for example, automatic doffing for ring frames and fully automatic cone winders, are not quoted by most of the traditional manufacturers of textile machinery.

Table 2 above gives a sufficiently detailed description of the equipment to permit its classification under the head of one of the technological levels considered. Other elements that determine the technological level, such as labour productivity, unit investment, investment per workers, etc., are dealt with below in connexion with the analysis of the results obtained (see tables 6, 7, 8 and 11).

The study of the economic advantages of the various production techniques requires either that the items produced be of identical quality, or else that there must be an assessment, in easily comparable terms, of the quality characteristics of the specific item produced at each level. In the present case the quality was the same (at least in practical terms) for the three processes studied, and hence the production costs are fully comparable and not subject to any correction on account of product quality. It is asserted that the quality was the same in practical terms because strictly speaking there are bound to be small differences between the various processes, and the changes are not always in the same direction, that is, the fact that one technique is more advanced than another is not in itself a guarantee that the product will be better. Some examples may clarify this point; for example, the large package used for intermediate products in spinning with more advanced techniques has reduced the number of unavoidable knots in the spinning process, and thus permits a more regular fabric, containing fewer impurities. On the other hand, the higher speeds of the more modern machines tends to produce a less uniform yarn, despite the control devices included in the machinery, with which some manufacturers have been more successful than others. These quality differences, however, are not of an order that could affect the comparability of the products studied here, which are assumed to be equivalent and interchangeable from the standpoint of quality, in terms of the basic features of weight and dimension, resistance to wear and tear, elasticity, warmth, and ease of finishing treatment.

/3. Structure

### 3. Structure of the model mills selected

Tables B, C and D represent what are known in the textile industry as production charts for the technologies considered here. Production charts establish the operating conditions for each machine in terms of its characteristics, the raw materials to be processed, and the nature of the product to be made, and indicate the output per hour of each production unit, on the basis of the efficiency index established. In the light of the production plans, tables E, F and G were drawn up, giving the data on the consumption and use of the raw materials, the daily output for a 23-hour day, and the machinery needed to carry out the proposed production programme.

The machinery investment needed is shown in table 4 below, which gives the unit and total f.o.b. prices of the machinery and auxiliary equipment. The prices used in this study are those for July 1965, and have been selected from the prices quoted by a very large number of established manufacturers of this type of machinery outside the region, after the most careful study. In addition a survey was made of the prices of manufacturers installed in Latin America.[11] The data gathered were analysed on the basis of technical criteria that permitted their classification under the heads of the technological levels previously established, in order to avoid the possibility that price differences might distort the results. There were, of course, price differences between machines at the same technological level, since the prices are quoted by different manufacturers established in different countries. In these cases an effort was made to determine, as far as possible, the quality level of the machinery, and the experience of the manufacturer, including how far he was in the habit of providing technical assistance, together with any other factors that might justify differences in the cost of the machinery. The last step was to form groups that were homogenous in terms of quality and price, in which the differences in price corresponded to the differences in the technological level.

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11/ With respect to the production of textile machinery in Latin America, see *Los principales sectores de la industria latinoamericana: problemas y perspectivas* (E/CN.12/718), chapter V, *Las industrias mecánicas*.

/In some

In some case, for the sake of simplification, the total cost of the machinery was determined on the basis of the cost of one production unit. Strictly speaking the number of machines needed should have been determined in terms of the number of production units that make up each machine, in order to establish the price of the machine, since the cost of a machine per unit of output varies according to the number of production units it includes. This simplification, however, has not been applied to certain machines such as automatic cone winders and pirn winders that are produced with a fixed number of spindles, and cannot be ordered with any smaller number to suit the customer.

The costs necessary to cover buildings and auxiliary installations were calculated in the light of the specific requirements of each technological level as regards operating conditions. For example, at level C air conditioning was postulated for the whole of the built-over area, because the high speed of the machinery and the delicacy of the controls mean that there must be not only humidity control, but also a constant room temperature. For level B the air conditioning is restricted to the area occupied by the ring frames, the remaining areas having only humidity control, while for level A no air conditioning is assumed, and there is humidity control only for the areas where it is regarded as indispensable. The data relating to investment in building and auxiliary installations are set forth in table I.

Working capital, another important investment item, was estimated on the basis of realistic criteria used in practice, in order to ensure that the enterprise has a permanent circulating fund of working capital. Thus it can be assumed that the enterprise will not be forced to resort to short-term credits, and hence production costs will not be burdened by interests paid under this head.12/ The levels for each item of working

12/ In an inflationary system this hypothesis is not wholly realistic, since the currency depreciation reduces the working capital without the enterprise realizing that a structural deficit is encroaching upon its revolving capital resources. To remedy the situation it becomes increasingly necessary to resort to short-term credits, which lead to the costs of production being burdened with high interest payments.

/capital, and

capital, and the criteria adopted to determine them, are given in table J. The provision of resources to cover the financing of receivables has been omitted, since this item varies widely according to the policy of the individual firm and the bank credit policy prevailing in each country, so that any estimate under this head would be very unreliable. In any case, this is an item that does not represent a very significant proportion of total investment.

Table K gives a summary of the investment needed for each technological level, including costs of freight and insurance, installation and starting up, and interest paid during the period of construction. The installation costs are calculated on the basis of the commissions commonly paid to the manufacturers for this type of work, plus a sufficient margin for small items such as building materials, electrical equipment, auxiliary labour and other items normally needed during the installation of the machinery. Pre-operational costs are calculated as 3 per cent of the total value of fixed investment, on the basis of established projects. The total interest paid during the installation period corresponds to a period of 14 months, and its incidence on the other components of fixed investment represents and interest rate of 12 per cent a year, which was taken as the basis of the cost of capital in hard currency in Latin America. Fixed investment was not regarded as including such items as sites and vehicles, which are regarded as unimportant for the purposes of the present study.

## 4. Determining the costs of production

For the purpose of making a proper analysis of the costs of production, these costs were divided into fixed and variable costs. The annual costs of production are given in table M, and the criteria adopted for estimating each item are clearly described in the footnotes to that table. Attention here is confined to justification of the prices assumed for inputs and factors of production.

/(a) Raw

(a) Raw materials. After a survey of the prices and qualities of cotton produced in Latin America, the type most suitable from the technical and economic standpoint for the manufacture of the product envisaged was selected. This cotton is the Sertão type produced in Brazil, with a staple length of 28 mm, sold at the c.i.f. Liverpool price (international quotation) of 0.60 dollars per kg. It would also include the Mexican Matamoros, which has the same specifications but is slightly more expensive, at 0.65 dollars per kg.13/ For the purpose of calculating the cost of raw material the price postulated is 60 dollar cents per kg of cotton, and on this basis the real cost was determined, in the light of the waste produced during each process, either through the partial recovery of the waste, or through its sale at a price estimated by subtraction on the basis of the cost of the raw cotton.14/ Table 3 gives the prices referred to above, and it should be noted that the percentage of waste is always calculated on the basis of the total cotton processed, that is, the weight of the raw material that is fed into the machine, and not the weight of the cotton produced by the machine.

The view sometimes advanced that the most modern machinery leads to an economy of raw material is not supported in the present study. Although it may be admitted that at some stages of production the machines have been able to reduce, to some extent, the volume of waste produced, this reduction, however important it may be within the programme of waste control in the mill, is not significant for the purposes of the present study. In other words, at the stages of production where waste reduction can be of any mannitude - pickers and cards - it cannot be undertaken without endangering the quality of the product.

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13/ For further details, see Economies of scale in the cotton spinning and weaving industry, op.cit., Chapter III, section 2.

14/ This means that the revenue from the sale of waste cannot later be included in the enterprise's income.

/Table 3

Table 3

REAL COST OF COTTON USED IN MANUFACTURING

| Specifications | Dollars per kilogramme |
|---|---|
| Price of raw cotton | 0.600 |
| Actual waste (11 per cent)[a/] | 0.074 |
| Cost of cotton per kilogramme | 0.674 |
| Less sales value of waste [b/] | 0.010 |
| Real cost of cotton | 0.664 |

a/ As shown in tables E, F and G.

b/ At an estimated price of 15 per cent of the purchase price of raw cotton.

(b) Labour. However great the differences in labour costs between the various Latin American countries, there is nevertheless a surprising degree of uniformity in the cotton industry of the main countries of the region. In this study the labour costs are of capital importance, and hence this uniformity in wage levels (see table 4) permits the conclusions reached here to apply to the whole group.

Table 4

AVERAGE WAGES OF UNSKILLED LABOUR IN THE TEXTILE INDUSTRY PREVAILING IN THE MAIN COTTON-PRODUCING COUNTRIES OF LATIN AMERICA

(Dollars per hour)

| Countries | Direct labour | Indirect labour |
|---|---|---|
| Brazil | 0.36 | - |
| Colombia | 0.34 | 0.27 |
| Mexico | 0.35 | 0.25 |
| Peru | 0.36 | 0.23 |

Source: ECLA, La industria textil en América Latina, Vols.II. Brazil (English only), III. Colombia, V. Peru and XI. Mexico, op.cit.

/Table L

Table L lists the labour force necessary for the operation of three-shift mills, classified by section, and indicating annual costs. In order to maintain comparability with the classification given to the costs of production, the traditional division of labour into direct and indirect has been replaced by a division into fixed and variable.15/ Moreover this approach is more suitable for the purposes of the present study, since it facilitates another kind of classification, which is the level of skill of the labour force. This point is of basic importance, since it is recognized that the advanced technologies, while reducing the total number employed, increase the demand for skilled workers. In the textile industry it has to be admitted that there is no great need for highly skilled workers, and although there is some shortage in this category, it is confined in practice to the maintenance sector. In fact the most modern machines can be run by workers who can easily be trained for this task, and in many cases the machine-tending function has been facilitated by reducing the manual intervention and both the physical and mental effort involved, so that less manual skill and less concentration is needed, since the machine is capable of undertaking more complex operations, and emits signals to warn the operator when there is a break-down, and also indicates where the fault is.

With the aim of determining the changes in the skill level of the workers, an additional classification has been adopted that covers not only skilled and unskilled workers, but also foremen and semi-skilled workers. This last category was established because a machine tender in the textile industry, with rare exceptions, does not attain the level of a skilled worker in the true sense of the term, until he has received training the mill itself for a period that varies between three and six

15/ Fixed labour is that which does not increase or decrease with changes in production within certain limits of installed capacity. In other words, while the variable labour force permits flexibility in adapting to what is strictly required by the volume of production, and thus a corresponding change in costs, the fixed labour force cannot be changed unless there are major changes in the volume of production.

months. On the other hand, the machine tender is at a higher level of skill than the worker who has received no training, and as he is directly responsible for the operating of the machine he receives all or part of his wage in proportion to output, which always means that his wage level is above that of the ordinary worker.

On the basis of the wages prevailing in the countries listed in table 4 above, a wage scale was worked out, as shown in table 5. This ranges from a wage of 0.25 dollars an hour for non-skilled labour, and 0.35 for semi-skilled labour (an increase of 40 per cent) to levels representing increase of 100 and 200 per cent, respectively, for skilled labour and foremen.

Table 5

WAGE SCALE ADOPTED FOR THE PRESENT STUDY

| Manpower classification | Dollars per hour |
|---|---|
| Unskilled | 0.25 |
| Semi-skilled | 0.35 |
| Skilled | 0.50 |
| Supervisors | 0.75 |

(c) Social security contributions. The social security contributions concerned were calculated as 40 per cent of the wages or salaries; although there is a wide variation between countries in this respect, this level of contribution may be regarded as the most common. It should be noted that, in accordance with another feature of the social security legislation in force in Latin America, night workers are paid for eight hours although the shift is only seven hours, and the wage paid is 20 per cent higher that the wage for the same level of work paid to the day worker.

(d) Capital costs. The capital costs, taken in conjunction with the labour costs, play a decisive role in determining the economic advantages of a given production technique.

/In calculating

In calculating capital depreciation a useful life of forty years has been assumed for buildings and fifteen years for machinery, for all the three technological levels studied, on a linear depreciation basis. The choice of a useful life of fifteen years for the machinery has become common practice, not so much because wear rules out any longer period, but because of technological obsolescence. This premise, is of course, strictly theoretical, since there is some evidence - confimed by the present study in the form of the coexistence in the Latin American textile industry of very different technologies - that technological obsolescence, even when it has been shown to exist, does not necessarily imply economic obsolescence. Admittedly this picture could alter, but there is no sign that this is happening in the region, where the relative cost of the factors of production changes slowly in terms of real value.

For the same reason, the same depreciation period has been assumed for all the three technological levels considered, although strictly speaking level A, being less up-to-date and more likely to become technologically obsolete than the other levels, should entail a shorter period of depreciation. The same applies to level B in relation to level C.

To calculate the remuneration of capital, which is also included in the total costs, an interest rate of 12 per cent a year has been assumed, as being the current rates in the Latin American capital market (calculated on the equivalent in hard currency). Nevertheless, in analysing the results this rate is varied in order to study the behaviour of the costs of production at each level as the factor costs vary.

(e) Other cost items. The criteria adopted to determine the other production cost items are described in detail in the footnotes to table M. It should be noted that no items have been included to cover insurance or taxes of any kind, since these are regarded as insignificant for the purposes of the present study; moreover, since they vary widely from country to country, any estimate would necessarily be very inaccurate.

/III. MECHANICAL

## III. TECHNICAL AND ECONOMIC ANALYSIS OF RESULTS

### 1. Main operational coefficients

(a) Number of persons employed and workload

Even if due allowance is made for the difference in the production capacity of the three mills considered in this study, the number of workers will be seen to drop sharply if the least advanced technology is replaced by the most up to date. Between levels A and B it decreases from 668 to 446 and again to 315 at level C. These data are in themselves highly illuminating, but the reduction per unit of output is even more striking with indexes of 100, 57 and 37 for levels A, B and C respectively. It should also be noted that the composition of the labour force differs from one to another as regards degrees of skill. As might be expected, the biggest reduction is in variable labour (indexes: 100, 53 and 30 for the three alternatives), while fixed labour drops to about half between A and C and administrative staff to two-thirds (see table 6).

Table 6

COMPOSITION OF THE LABOUR FORCE AT THE DIFFERENT LEVELS STUDIED

(Number of persons per 1,000 metres/day)[a/]

| Type | Absolute figures | | | Index | | |
|---|---|---|---|---|---|---|
| | Levels | | | Levels | | |
| | A | B | C | A | B | C |
| Total | 11.90 | 6.82 | 4.40 | 100 | 57 | 37 |
| Fixed | 2.42 | 1.62 | 1.28 | 100 | 67 | 53 |
| Variable | 8.80 | 4.69 | 2.67 | 100 | 53 | 30 |
| Administrative | 0.68 | 0.51 | 0.45 | 100 | 75 | 66 |
| Unskilled | 4.36 | 2.78 | 1.41 | 100 | 64 | 32 |
| Semi-skilled | 5.77 | 2.75 | 1.83 | 100 | 48 | 32 |
| Skilled [b/] | 1.51 | 1.08 | 0.88 | 100 | 72 | 58 |
| Technical and administrative | 0.25 | 0.21 | 0.28 | 100 | 84 | 112 |

a/ Based on a 23-hour working day.

b/ Including foremen and office staff.

/As regards

As regards levels of skill, the reduction in the number of workers with specialized training indexes: (100, 72 and 58) is less than in that of unskilled indexes: (100, 64 and 32) or semi-skilled workers indexes: (100, 48 and 32). The technical and administrative cadres, on the other hand, generally increase as the technological level rises because the equipment becomes more complex and therefore entails more efficient supervision, maintenance and production programming. However, compared with the needs of other sectors, the number of skilled workers required by the textile industry is fairly small. While the total labour force drops sharply between levels A and C, there is a slight increase of 12 per cent in the number of technical and administrative staff. Looked at from this standpoint, choice B offers the greatest advantages, since it involves a reduction (index 84) in the number of technicians and administrative staff needed. What may seem paradoxical at first sight actually has a logical explanation: level B undoubtedly has great technical advantages to offer but has not reached the stage of automation at which most mechanical control systems have been replaced by electrical or electronic controls. There is no doubt that repairs to mechanical equipment require less technical knowledge than electrical repairs and far less than electronic repairs. Thus, by cutting down on the number of operatives needed without demanding in exchange a larger number of skilled workers, technology B has a low index for technical and administrative personnel. Although in relative terms, i.e., when compared with the needs of other industries, the number of skilled workers required by the textile industry continues to be moderate as the technological level rises, this question acquires added importance because of the critical shortage of technicians in Latin America. All the foregoing considerations should therefore be taken into account in deciding which technology is to be adopted.

The workloads in terms of the ratio of persons employed to number of machines are given in table 7. The reduction in personnel requirements per unit of production are set forth together with those per unit of output. At level C, the number of hands needed to operate 1,000 ring spindles and the corresponding preparation machines is only 30 per cent of the number needed at level A. The equivalent figure in the weaving section,

/i.e. the

i.e. the number of operatives required to handle 100 looms and the respective preparation machines, is 49 per cent. Finally, it may be noted that the workloads established by ECLA as a standard for the Latin American countries in its studies of the textile industry [16] come very close to the figures for level A in this study. At that level it is assumed that 6.13 workers would be employed per 1,000 spindles and 20.6 workers per 100 looms, while the Latin American standards are 5.00 and 20.00 respectively.

Table 7

WORKLOAD FOR THE DIFFERENT LEVELS STUDIED [a/]

| | Level | | | Index |
|---|---|---|---|---|
| | A | B | C | Level |
| Spinning | | | | |
| Operatives per 1,000 spindles | 6.13 | 2.92 | 1.84 | |
| In opening through roving | 1.69 | 0.94 | 0.63 | |
| In spinning and winding | 4.44 | 1.98 | 1.21 | |
| Weaving | | | | |
| Operatives per 100 looms | 20.6 | 14.6 | 10.1 | |
| Filling and warping | 7.7 | 4.4 | 3.0 | |
| Weaving | 12.9 | 10.2 | 7.1 | |

a/ Excluding administrative and ancillary staff (see table L).

16/ The textile industry in Latin America, Vols. I-XI, op.cit.

/(b) Productivity

(b) Productivity and unit output

The trend of productivity in both spinning and weaving should obviously be inverse to the workload, although not necessarily in proportional terms. In the particular case under consideration, productivity in spinning is virtually doubled between levels A and C, while productivity in weaving becomes two and a half times as much (see table 8). It will be seen that more has been achieved in spinning in relation to the reduction in the number of workers employed. Here again, the Latin American standards are fairly close to level A although the workloads differ. In spinning, the standard is 4,300 grammes per man/hour but 3,940 grammes at level A, while the equivalent figures for weaving are 27 and 22 metres per man/hour. The disparities are due to the fact that productivity is not simply a question of workload but also of the unit output of the machines.[17]

The contention that technological research in the textile industry has always been directed towards reducing the labour force employed by mechanizing the processes rather than by raising the production capacity of the machinery is borne out by the slight extent of the improvement in unit output in both spinning and weaving. The increase in unit output between the two extreme technologies is 17 per cent in spinning and 29 per cent in weaving (see again table 8 and figure I). It should be borne in mind, however, that these figures are not representative of every stage in the production process. In carding and drawing, for instance, the increase obtained in production capacity during the last few years has been as much as 300 per cent. But increments on this scale are few and far between, and are often a controversial issue, especially in carding, where the advantages of making a change have not been admitted by all manufactures.

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17/ More precisely, productivity is the ratio of unit output to workload.

Table 8

PRODUCTIVITY AND UNIT OUTPUT AT THE DIFFERENT LEVELS STUDIED

| | Absolute figures | | | Index | | |
|---|---|---|---|---|---|---|
| | Levels | | | Levels | | |
| | A | B | C | A | B | C |
| Manpower productivity | | | | | | |
| In spinning (grammes per man/hour) | 3 940.00 | 8 641.00 | 15 351.00 | 100 | 219 | 390 |
| In weaving (metres per man/hour) | 22.18 | 36.80 | 58.78 | 100 | 166 | 265 |
| Unit output of machinery | | | | | | |
| Ring spindles (grammes per spindle/hour) | 24.1 | 25.1 | 28.2 | 100 | 104 | 117 |
| Looms (metres per loom/hour) | 4.59 | 5.40 | 5.94 | 100 | 118 | 129 |

a/ Excluding administrative and ancillary staff (see table L).

## 2. Main coefficients of investment: capital intensity

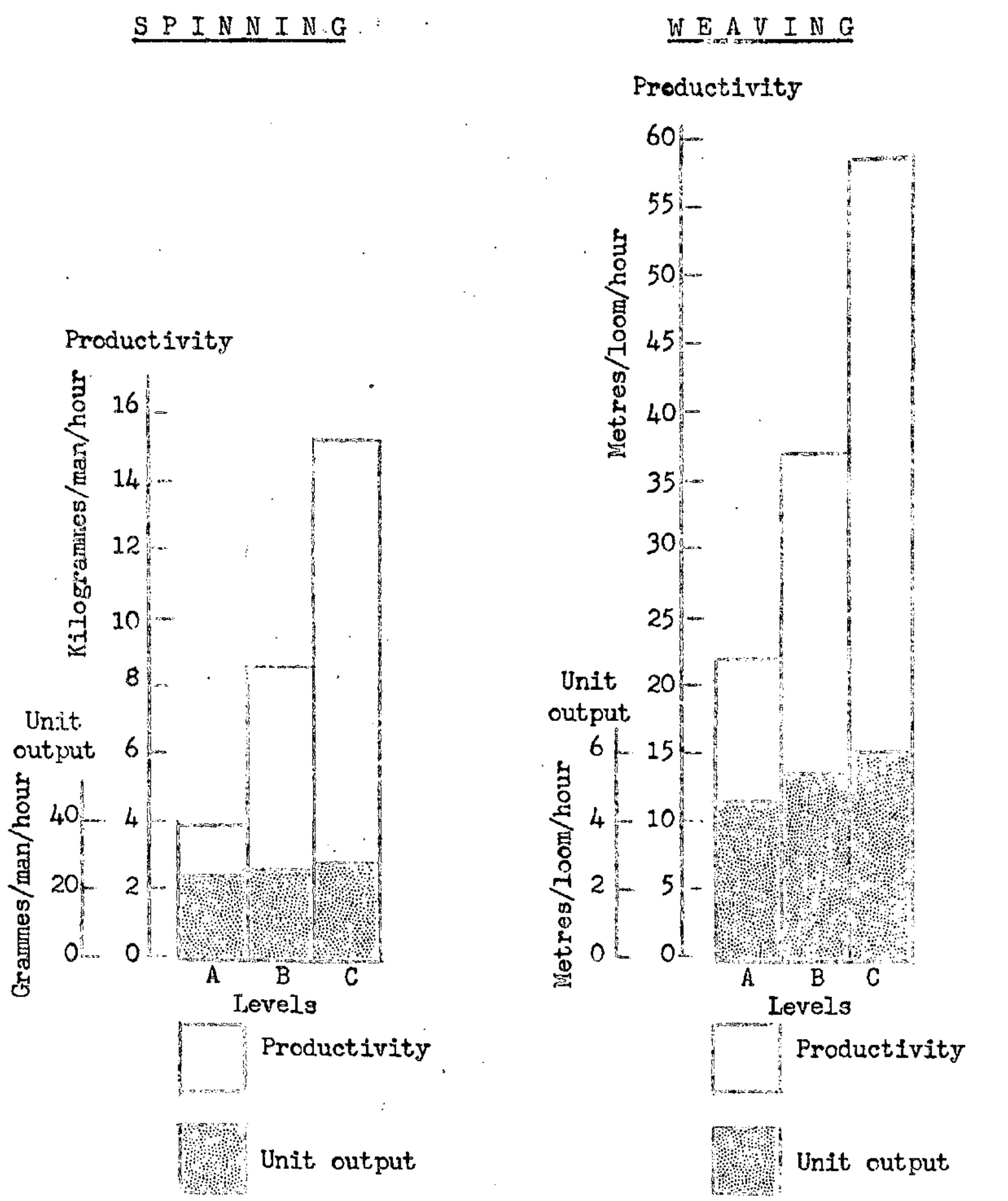
### (a) Investment structure

If investment is divided into fixed assets and working capital, it will be seen that the latter decreases slightly as the technological level rises, because of the increased cost of the equipment at the same cost level for the inputs that make up the working capital. This is a little over 10 per cent of total investment at level A and 8.7 per cent at level C. The distribution of fixed investment between spinning and weaving remains the same at all three levels, i.e. spinning equipment accounts for nearly 42 per cent and weaving equipment for 46 per cent. The remainder is distributed among workshops, laboratory and other facilities.

/Figure I

Figure I

PRODUCTIVITY AND UNIT OUTPUT IN SPINNING AND WEAVING




/The major

The major change between one production technique and another consists in the relative saving obtained in investment in building and ancillary installations if the least advanced technology is substituted for the intermediate. This change is mirroed in the percentage distribution of investment, as set forth in table 9. The space required for installing the machinery is much less at the higher technological levels, although modern lay-out techniques recommend a good deal more room for movement. The saving in space is not indicated in absolute terms in table 8, since it is offset by the increased cost of the ancillary equipment, particularly the air conditioning system, which is essential for the proper operation of the machinery at the most advanced technological level. The reduction can best be gauged from the coefficients of the area required per unit of output. To produce 100 metres of cloth per year, 1.00 $m^2$ of space is needed at level A, 0.86 $m^2$ at level B and 0.77 $m^2$ at level C.

(b) Investment per unit of production and per unit of built-over area

In the textile industry, the unit cost of the machinery is the average cost per final unit of production involved in the process (ring spindle or loom) including the cost of the existing preparation machines and accessories in the section concerned. The cost of the workshops and laboratory and of the other equipment not directly connected with the production process has not been included here. The average cost in spinning is 68 dollars per spindle for level A, 79 dollars for level B and 97 dollars for level C. In weaving the rise in unit cost is more marked, from 1,848 dollars per loom at level A to 2,739 at level B and 3,131 at level C (see table 10).

Other kinds of coefficients generally used for comparing textile machinery have also been worked out, such as the ratio of the cost of the buildings and built-over area to total investment per unit of area. The cost of the buildings per square metre (including light, power, water, steam and air conditioning or humidifying) is about 55 dollars at the first two technological levels and as much as 67 at the most advanced level. The increase in total fixed investment per square metre is less irregular, being 237, 301 and 359 dollars at levels A, B and C respectively.

/Table 9

Table 9

PERCENTAGE DISTRIBUTION OF INVESTMENT

| | Levels | | |
|---|---|---|---|
| | A | B | C |
| Fixed investment | 89.6 | 90.7 | 91.3 |
| Buildings and ancillary installations | 20.7 | 17.0 | 17.0 |
| Equipment a/ | 55.6 | 60.3 | 60.8 |
| Installation costs and interest during construction period | 13.3 | 13.4 | 13.5 |
| Working capital | 10.4 | 9.3 | 8.7 |
| Total | 100.0 | 100.0 | 100.0 |

a/ F.o.b. cost of equipment, and freight, insurance and installation costs.

Table 10

INVESTMENT COSTS PER UNIT OF PRODUCTION AND PER UNIT OF BUILT-OVER AREA

(Dollars)

| | Levels | | |
|---|---|---|---|
| | A | B | C |
| Cost per unit of production | | | |
| Cost of spinning per ring spindle | 68 | 79 | 96 |
| Cost of weaving per loom | 1 848 | 2 739 | 3 131 |
| Cost per unit of area | | | |
| Cost of buildings per square metre a/ | 55 | 56 | 67 |
| Total fixed investment per square metre | 237 | 301 | 359 |

a/ Including the cost of buildings, electric power, an air conditioning or humidifying system, and water and steam installations.

/(c) Capital

(c) Capital intensity at the three different levels

In chapter II an examination is made of the technical aspects characteristic of each of the technological alternatives considered in this study. A review of this kind, although essential, does not offer an evaluation of the economic aspects of the different technological possibilities, among which capital density is a major issue. In this connexion, one of the best known and most controversial factors is the ratio of total investment to manpower in terms of the number of persons employed, or, to be more precise, of the number of man/hours worked. During the last five years the textile industry, and the cotton sector in particular, has come to rank as a highly capital-intensive industry, whereas it used to be regarded as the industry with the highest labour utilization. The reasons underlying the change have been dealt with in the introduction to the present study.

The figures presented here for the capital/labour ratio at the three different levels are full proof that the textile industry has ceased to be a highly labour/intensive activity. The coefficient doubled from 6,600 dollars per person employed in 1950 18/ to 12,700 dollars by 1960 and soared to over 20,000 dollars by 1965 (see table 11). Financial investment accounts for only about 10 per cent of this, the remaining 90 per cent consisting of fixed assets. It is clear that notable progress was made in increasing capital intensity during the fifties, but that even greater headway was made in this respect over the next five years.19/

18/ Utilization of working capital and of the over-all labour force (including the administrative staff) has been estimated on the basis of a three-shift working day (23 hours).

19/ The statistical data show that in 1950 average investment per person employed in the textile industry was 8,700 dollars in the United States, whereas in Colombia, where the installation of the industry was well under way, it was 6,200 dollars (see Jan Tinbergen, "Choice of technology in industrial planning", Industrialization and Productivity, Bulletin No. 1 (United Nations Publication, Sales No: 58.II.B.2), 1958.

Table 11

CAPITAL INTENSITY AT THE DIFFERENT TECHNOLOGICAL LEVELS STUDIED

| | Absolute figures | | | Index | | |
|---|---|---|---|---|---|---|
| | Levels | | | Levels | | |
| | A | B | C | A | B | C |
| Investment per employed person (dollars) a/ | | | | | | |
| Total | 6 666 | 12 687 | 20 659 | 100 | 190 | 310 |
| Fixed investment | 5 977 | 11 517 | 18 864 | - | - | - |
| Working capital | 689 | 1 170 | 1 795 | - | - | - |
| Investment per unit of output (dollars per metre) b/ | 0.264 | 0.288 | 0.303 | 100 | 109 | 115 |
| Gross production value per unit of investment (dollars per year) | 0.784 | 0.661 | 0.612 | 100 | 84 | 78 |
| Gross value added per unit of investment (dollars per year) c/ | 0.374 | 0.285 | 0.254 | 100 | 76 | 68 |

a/ Including administrative and auxiliary staff on the basis of a three-shift working day (see table L).

b/ Investment required to produce one unit of output in a year.

c/ At cost level, i.e. not allowing for profits.

/In so

In so far as the maximization of employment is concerned, there is no doubt that for a given stock of capital, level A is far more advantageous than the other two at which less benefits are reaped as a result of the increase in investment intensity and would thus be unquestionably the best choice. The product capital ratio established confirms that the least advanced technology is the most suitable for the under-developed countries if the guiding principle to be followed in making a choice is singly the maximization of the labour factor. At level A, gross value added annually 20/ per unit of investment is 0.374 dollars, which drops to 0.285 dollars at level B and 0.254 dollars at level C. The reduction between the two extremes is thus 32 per cent (see table 11). These points will be brought up again when the over-all advantages of each technology are discussed in chapter IV.

### 3. Main coefficients relating to production costs

(a) Cost structure

The structure of production costs at each technological level merits special comment, since it has undergone some interesting changes that explain how such widely differing technological levels are able to co-exist on a competitive basis in Latin America. It also explains why the textile entrepreneur makes no effort to renew his equipment (because he keeps his footing on the market), or when he does renovate his mill buys nothing but the most up-to-date machinery.

In the first place, the share of fixed costs increases very little because the rise in capital costs slightly outweighs the reduction in fixed labour costs 21/ (see table 12). The share of capital costs

20/ At the level of production costs, but including annual interest on capital at the rate of 12 per cent.

21/ It is interesting to note that, as a result of the slight rise in fixed costs, the break-even point (the point on the enterprises' production scale at which the volume of receipts equals the fixed costs) drops from 61 per cent of maximum production capacity at level A to 53 per cent at B and 51 per cent at C. Surprisingly enough, the more advanced technologies give an enterprise greater security if it is forced to cut down on production.

/(depreciation, capital

(depreciation, capital remuneration and interest when appropriate) expands by 6.6 per cent if the most advanced technology is adopted instead of the most backward. This is very little in comparison with the reduction in fixed and variable labour costs, which constitute about 26 per cent of the total at level A but slightly less than 13 per cent at level C. The cost of the raw material on the other hand, climbs from 47 to 53 per cent between levels A and C.

Table 12

PERCENTAGE DISTRIBUTION OF PRODUCTION COSTS

| | Levels | | |
|---|---|---|---|
| | A | B | C |
| Fixed costs | 32.4 | 34.9 | 36.9 |
| Manpower a/ | 9.9 | 7.9 | 7.7 |
| Depreciation | 6.5 | 8.1 | 8.8 |
| Interest on capital | 15.3 | 18.1 | 19.6 |
| Other | 0.7 | 0.8 | 0.8 |
| Variable costs | 67.6 | 65.1 | 63.1 |
| Raw material | 47.1 | 51.2 | 52.7 |
| Manpower b/ | 15.9 | 9.0 | 5.4 |
| Total | 100.0 | 100.0 | 100.0 |

a/ Fixed labour and administrative staff, including social security contributions.

b/ Variable labour, including social security contributions.

With this cost structure, it is not surprising that the private entrepreneur should opt for the most advanced technology so long as he has some means of obtaining the necessary capital. Moreover, the item that undergoes the sharpest increase in capital costs as a whole is investment remuneration, or, to put it another way, the remuneration of the entrepreneur's own effort which will thereafter represent part or

/the whole

the whole of his profits. The data compiled here are clearly not enough to form a sound basis on which to take decisions, even at the level of the enterprise; other factors bearing on production costs should be considered as well, in particular the absolute unit cost of production.

(d) Unit cost of production in accordance with a given hypothesis of factor costs

It has been demonstrated that when there are changes in production techniques the ideal mill size for obtaining the greatest yield from the factors of production will differ for each technological level. In the case under consideration, the mill's capacity increase from index 100 at level A to 117 at B and 128 at C. Similarly, the total amount of capital invested expands from 100 to 127 and 146, while the number of persons employed drops from 100 to 67 and 47 respectively (see table 1). These indexes are illuminating. As the three mill sizes are perfectly balanced, and are at what is considered to be the optimum point on the production scale, it is plain that any reduction in unit cost that may be obtained cannot be attributed to a rise in production. The increased capital intensity that is a characteristic feature of the most advanced technologies is clearly discernible in the indexes; these also bring out a number of other points that will be dealt with at greater length when the advantages of each technological level are discussed: (i) the increase of 28 per cent in mill size between level A and level C is not large enough to handicap the introduction of the most advanced technology by problems of market size or of external economies greater than those obtainable at the least advanced level; (ii) the additional capital required - which amounts to 46 per cent - is fairly little since 28 per cent of it would be used for expanding the mill's production capacity; (iii) on the other hand, the labour force employed at level A would be much less than at level C (over 50 per cent less in spite of the 28 per cent increment in output), a factor which should be given its due weight in choosing a technology.

To continue the analysis of the foregoing data, a glance should be taken at the unit values for the main components of production costs which have been worked out on the basis of normal factor costs in Latin America,

/that is,

that is, an interest rate of 12 per.cent for long-term credits[22/] and the wage scale set forth in table 5. As this wage scale is applicable to all three technological levels, their competitive powers can be gauged on an equal footing.[23/] However, as the structure of the labour force varies in accordance with the proportion of skilled to less skilled workers, the total average wage is not the same at the three levels, being 0.587 dollars per hour at A, 0.615 dollars at B and 0.721 at C. The minimum total cost per metre of fabric produced is therefore obtained at the most advanced level, although it is only 10.6 per cent less than the cost at the least advanced. The reduction is sharpest between A and B, being 7.7 per cent of the total of 10.6 per cent. In short, there is scarcely any saving to be achieved in costs by choosing the most advanced instead of the intermediate level, whereas the difference between the least advanced and the intermediate level is relatively large. Furthermore, total labour requirements (variable, fixed and administrative, plus social security charges) drop to 59 per cent at level B and to 44 per cent at level C, while capital costs (depreciation plus interest on investment) increase by about 17 and 27 per cent respectively.

Thus, even judged solely from the angle of what is preferable for the economy of the enterprise, the intermediate technology is the most advantageous for Latin America at the prevailing levels of factor cost, despite the other considerations that may lead entrepreneurs to opt for the most advanced technology. Compared with level A, level B offers the

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22/ Interest payable on short-term credits is not included in production costs on the grounds that a well-organized enterprise will have a permenent fund of working capital. Where there is inflation, however, working capital gradually depreciates in value, and enterprises are compelled to resort to such loans in order to remain in operation (see also footnote 12).

23/ The idea that a mill should pay its workers higher wages simply because it is up to date has no economic justification. Provided that it is economically profitable, a mill can offer better rates of pay in order to obtain a more competent labour force, but however morally desirable it may be for it to pay more than the going rates, the fact that it has better machinery or buildings does not oblige it to do so from the economic standpoint, so long as the surplus profits are reinvested in the mill.

/Table 13

Table 13

UNIT COST OF PRODUCTION AND INDEX OF VALUE ADDED

| Item | Absolute figures (dollars) | | | Index | | |
|---|---|---|---|---|---|---|
| | Levels | | | Levels | | |
| | A | B | C | A | B | C |
| Total unit cost per metre | 0.207 | 0.191 | 0.185 | 100.0 | 92.3 | 89.4 |
| Fixed cost | 0.067 | 0.067 | 0.068 | - | - | - |
| Variable cost | 0.140 | 0.124 | 0.117 | - | - | - |
| Unit cost of items affected by the technological level | | | | | | |
| Total labour a/ | 0.054 | 0.032 | 0.024 | 100.0 | 59.2 | 44.4 |
| Depreciation | 0.014 | 0.015 | 0.016 | 100.0 | 107.1 | 114.3 |
| Interest on capital | 0.032 | 0.035 | 0.036 | 100.0 | 109.4 | 112.5 |
| Gross value added | | | | | | |
| Per unit of product (dollars per metre) | 0.099 | 0.082 | 0.077 | 100.0 | 82.8 | 77.7 |
| Per unit of input (dollars) | 0.910 | 0.757 | 0.709 | 100.0 | 83.2 | 77.9 |
| Per person employed per annum (dollars) | 2 491 | 3 615 | 5 248 | 100.0 | 145.1 | 210.6 |

a/ Including social security charges.

/largest reduction

largest reduction in costs in conjunction with the smallest increment in capital outlay. In other words, it makes for optimum factor utilization since the highest reduction in unit cost can be obtained with the least possible increase in unit investment (see tables 1, 11 and 17). The problem of choice will later be re-examined in macroeconomic terms, and certain factors discussed that are necessary for balanced economic growth.

(c) Production costs in accordance with different hypotheses of factor cost

The results that have just been reviewed are valid for the given level of factor costs, i.e., for an interest rate of 12 per cent on long-term loans and a wage scale commensurate with that set forth in table 5. However similar the problems confronting the Latin American countries may seem to be, it would be going too far to claim that their levels of factor costs, and of capital costs in particular, are absolutely identical. Real labour costs, on the other hand, evolve at quite different rates, depending on the particular stage of development reached by each country. It would be useful therefore to know how far production costs are influenced by variations in factor costs, so as to obtain a clear idea of the real conditions in each country and to determine the way in which each technology would react to the new conditions visualized.

It has been assumed that, as labour costs increase, the rate of interest may be 8 and 4 per cent annually, apart from the actual rate of 12 per cent. A rate of 16 per cent, at the current labour level, has also been postulated (since the possibility of a reduction in the wage level can be ruled out). This combination may come much closer to the actual conditions prevailing in many of the Latin American countries. Labour costs have been assumed to increase by 30, 70 and 120 per cent over their current levels, the calculations being worked out on the basis of the total average wage paid at the mill.24/

24/ The assumption that labout costs will increase as indicated does not mean that all the related categories in table 5 will necessarily climb by 30, 70 or 120 per cent. When a wage adjustment takes place, the better paid categories normally receive a smaller increment in percentage terms. In other words, if the average wage is raised by 30 per cent, there will probably be a higher percentage increase in the lower categories counterbalanced by a smaller adjustment towards the top of the scale. As the labour force varies in structure because of the different levels of skill involved, each technological level will correspond to a fixed basic wage, but the average wage will be higher at the intermediate than at the least advanced level and at the advanced, than at the intermediate level.

/The results

The results are summarized in table 14, which shows that if capital costs rise 16 per cent a year and wages remain constant (which would be more realistic for some countries), there would be no reduction in costs between levels B and C, but a decrease of 7 per cent between A and B (indexes: 100, 93 and 91 for A, B and C respectively). The most advanced technology would be unable to compete in these conditions and the choice would thus lie between B and C. If the guiding principle adopted is the social one of maximizing employment, the choice will obviously fall on the least advanced technology, since an 8 per cent cut in costs would not make up for the substantial reduction in employment that would go with it. One difficulty would still remain, however; technology A is a good deal more oldfashioned than technology B, and, in fact, is twice as far removed in chronological terms as B is from C. In view of the pace at which the textile industry is now developing, which is far greater than it was ten years ago, it may become technologically obsolescent so quickly that choice A will be ruled out as commercially uncompetitive even before wear and tear has made the machinery physically obsolescent. Were this to happen, the industry would be compelled to make a sacrifice without any sort of recompense even of a social nature, since low returns would prevent it from building up a surplus for reinvestment purposes and thus condemn it to stagnate. In such a case, the intermediate technology ought to be chosen even if it involved cutting down on the number of people employed.

Another assumption made is that labout costs would increase by 70 per cent [25/] while capital costs continue to be 12 per cent annually. In this case, the index of production costs would be 100, 87 and 82 for levels A, B and C respectively. The sharpest reduction again takes place between A and B (13 per cent) with only another 5 per cent gained if A and C are directly compared. The intermediate technological level is thus able to maintain its competitive status despite heavy wage increases, and even if such increases are not offset by a corresponding reduction in capital costs.

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25/ This is a sharp rise in real terms and is unlikely to occur unless the structure of the economy alters radically. The possibility has been stated so that to gauge the effect of extreme conditions on the different technological levels.

/Table 14

Table 14

UNIT COST OF PRODUCTION IN ACCORDANCE WITH DIFFERENT HYPOTHESES OF FACTOR COSTS

(Dollars per metre)

| Average wage a/ | | Annual rate of interest on capital | | | |
|---|---|---|---|---|---|
| Increase over present level (percentage) | Dollars per hour | 4 % | 8 % | 12 % | 16 % |
| | | Cost per metre | | | |
| **Level A** | | | | | |
| At present | 0.587 | - | - | 0.207 | 0.218 |
| 30 | 0.763 | - | 0.213 | 0.224 | 0.234 |
| 70 | 0.998 | 0.224 | 0.234 | 0.245 | - |
| 120 | 1.291 | 0.251 | 0.261 | - | - |
| **Level B** | | | | | |
| At present | 0.615 | - | - | 0.191 | 0.202 |
| 30 | 0.799 | - | 0.189 | 0.200 | 0.212 |
| 70 | 1.045 | 0.190 | 0.202 | 0.213 | - |
| 120 | 1.353 | 0.206 | 0.218 | - | - |
| **Level C** | | | | | |
| At present | 0.721 | - | - | 0.185 | 0.198 |
| 30 | 0.937 | - | 0.181 | 0.193 | 0.205 |
| 70 | 1.226 | 0.178 | 0.190 | 0.202 | - |
| 120 | 1.586 | 0.190 | 0.202 | - | - |

a/ Based on the wage scale in table 5. If the increases are uniform, hourly wages in dollars would be as follows (see also footnote 24/):

| Increase | Skilled | Semi-skilled | Unskilled |
|---|---|---|---|
| 30 per cent | 0.65 | 0.45 | 0.32 |
| 70 per cent | 0.85 | 0.59 | 0.42 |
| 100 per cent | 1.10 | 0.77 | 0.55 |

/However, the

However, the general tendency is for the rise in labour costs - which indicates that the industry is developing - to be accompanied by an increase in the amount of capital available and a consequent reduction in the rate of interest representing capital costs. Table 15 presents some hypotheses in this connexion and shows the evolution of production costs if certain combinations of factor costs were to occur. In such cases the intermediate level would be more advantageous than the others during the first two stages, in that it could carry a 30 per cent increase in labour costs, while benefiting from a reduction of capital costs to 12 per cent. But once capital costs drop to 8 per cent, level C would be preferable (see figure II). It is clear from the combinations given in table 15 that level A has little chance of competing at any stage, and that its choice would lead to a sharp drop in productivity.

Table 15

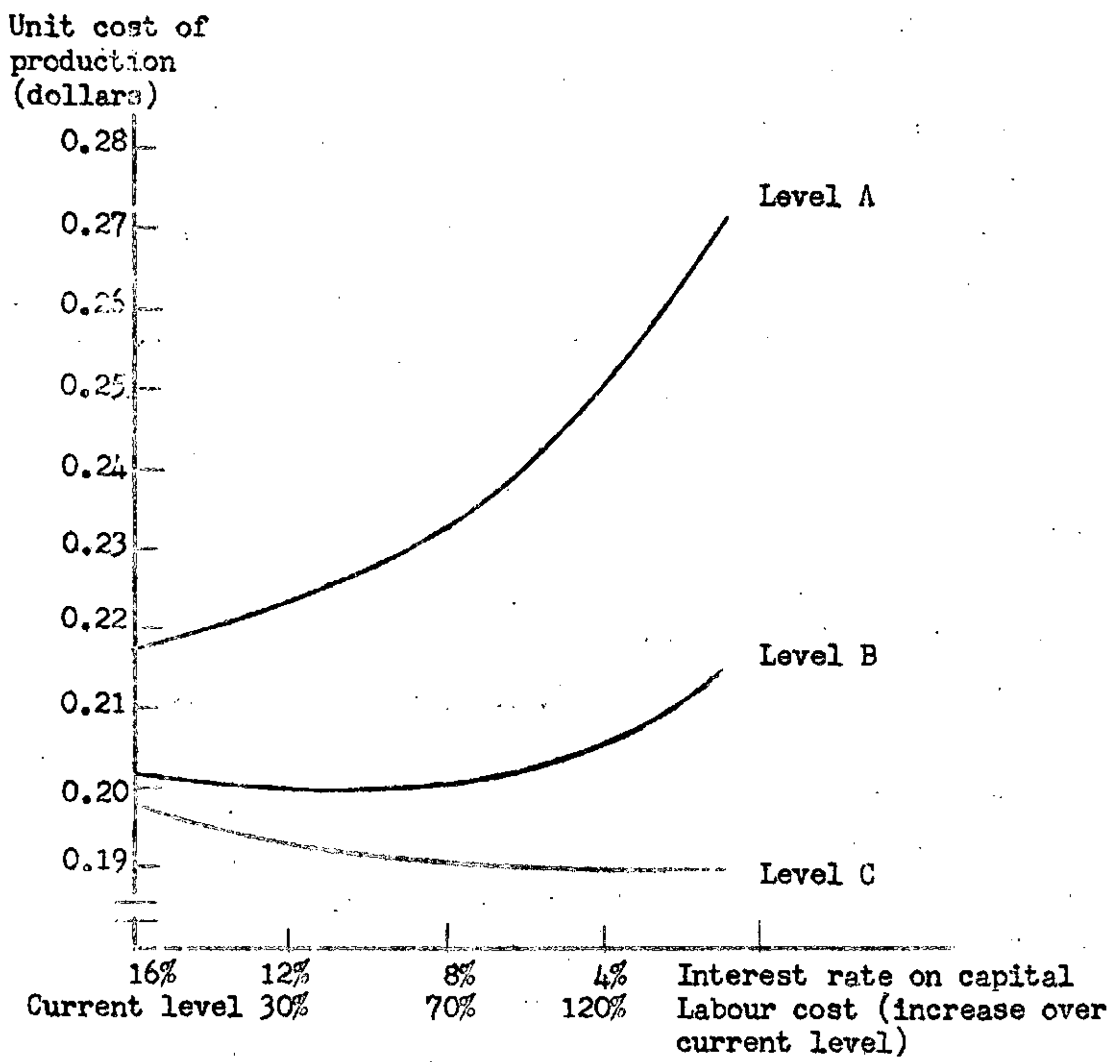
UNIT COST OF PRODUCTION IN ACCORDANCE WITH CERTAIN COMBINATIONS OF FACTOR COSTS

| Hypothesis | | Absolute figures | | | Relative figures | | |
|---|---|---|---|---|---|---|---|
| Labour cost (Percentage increase over present level) | Capital cost (Annual rate of interest) (Percentage) | Levels | | | Levels | | |
| | | A | B | C | A | B | C |
| Actual | 16 | 0.218 | 0.202 | 0.198 | 100 | 93 | 91 |
| 30 | 12 | 0.224 | 0.200 | 0.193 | 100 | 89 | 86 |
| 70 | 8 | 0.234 | 0.202 | 0.190 | 100 | 86 | 81 |
| 120 | 4 | 0.251 | 0.206 | 0.190 | 100 | 82 | 75 |

/Figure II

Figure II

PRODUCTION COSTS ACCORDING TO DIFFERENT HYPOTHESES OF FACTOR COSTS




Source: Table 15

## IV. THE CHOICE OF TECHNOLOGY FROM THE MACROECONOMIC STANDPOINT

### 1. The enterprise's amortization capacity and the surplus available for reinvestment

Thus far the discussion has centred on certain aspects relating mainly to the economy of the enterprise, although they also represent the basis of any consideration of the choice of techniques at the macroeconomic level. In discussing the problems from the microeconomic standpoint it has been unavoidable to refer to problems that really belong in the macroeconomic field, and in the present section also it is not possible to avoid mention of problems that relate rather to the individual enterprise.

A fundamental examination has been made of the changes in production costs that accompany the change in production technique, and the changes in the relative prices of the factors of production. The analysis made contains the elements necessary for the evaluation undertaken in the present section, but it needs to be supplemented with additional data relating to the capacity of each of the technologies to recoup the capital invested.

To determine the amortization capacity of each mill and the corresponding availability of funds for reinvestment, there must be a rapid review of the methodology used in the present study, in view of the special features of the textile industry in Latin America. The production costs set forth in table M include remuneration of capital, which would be the cost of one of the factors of production, regardless of whether this cost is wholly or partly paid by the entrepreneur himself or by third parties. In either case, this remuneration would be available at the end of each period for reinvestment in this or another sector. The costs of production given do not include the enterprise's normal profit, which represents the entrepreneur's remuneration for the service of organizing production. One part of this profit would also be available for reinvestment at the end of each period, the amount depending on the marginal propensity to save shown by the individual entrepreneur.

/For the

For the purpose of calculating the total surplus for reinvestment, a hypothesis regarding the enterprise's income level is needed. The hypothesis is based on an assumed sales price for the fabric produced of 0.25 dollars a metre.[26] The highest surplus available for reinvestment is at level C, 0.078 dollars per metre produced, which represents an increase of 26 per cent over the figure of 0.062 per metre at level A. The intermediate level has a reinvestment surplus that is 19 per cent higher than at level A, 0.074 dollars per metre (see table 16 and figures III and IV).

The increase in unit investment is proportional to the increase in the reinvestment surplus at both levels B and C, but the ratio between the rise in the total investment needed and the rise in the reinvestment surplus is more favourable at the intermediate level. This means that where capital is not a limiting factor level C would provide the best financial results, since it would permit a high level of capital formation. However, as capital availability is low, a maximum level of benefits, in terms, inter alia, of the total investment required, the reinvestment surplus, the creation of employment and return on capital (which is 20 per cent at level B as against 16 per cent at level A, but only 21 per cent at level C, not including the remuneration of capital), is attained, as might be expected, at the intermediate level (see the indexes in table 17 and figure V).

The surplus available permits total recovery of investment with the production of 72 million, 76 million and 83 million metres of fabric, respectively, at levels A, B and C. It should be noted that if the recovery of investment were at the same rate for all three levels, the production figures given above would be strictly proportional to the unit investment

26/ The entrepreneur will try to sell his product at the highest price permitted by the competitive conditions of the market, regardless of his production costs. In normal market conditions it is common practice to establish a minimum sales price on the basis of a 30 per cent surcharge on the cost price (including remuneration of capital). If the sales price is below this level, the article will be regarded as not worth producing, and the mill will try to eliminate this item or reduce the volume produced, and replace it by another more profitable item.

/Table 16

Table 16

DETERMINING THE SURPLUS AVAILABLE FOR REINVESTMENT

(Dollars)

| | Level A | Level B | Level C |
|---|---|---|---|
| I. Total income a/ | 4 208 250 | 4 907 250 | 5 373 750 |
| Total costs b/ | 3 491 835 | 3 742 632 | 3 985 466 |
| Gross annual profit | 716 415 | 1 164 618 | 1 388 284 |
| II. Reinvestment surplus | | | |
| Net profit c/ | 286 566 | 465 847 | 555 313 |
| Depreciation | 227 751 | 302 339 | 349 976 |
| Remuneration of capital | 534 400 | 679 025 | 780 916 |
| Total | 1 048 717 | 4 447 211 | 1 686 205 |
| III. Reinvestment surplus per unit of product | 0.062 | 0.074 | 0.078 |
| IV. Capacity to amortize total investment (years) | 4.24 | 3.91 | 3.85 |

a/ At an estimated sales price of 0.25 dollars a metre.

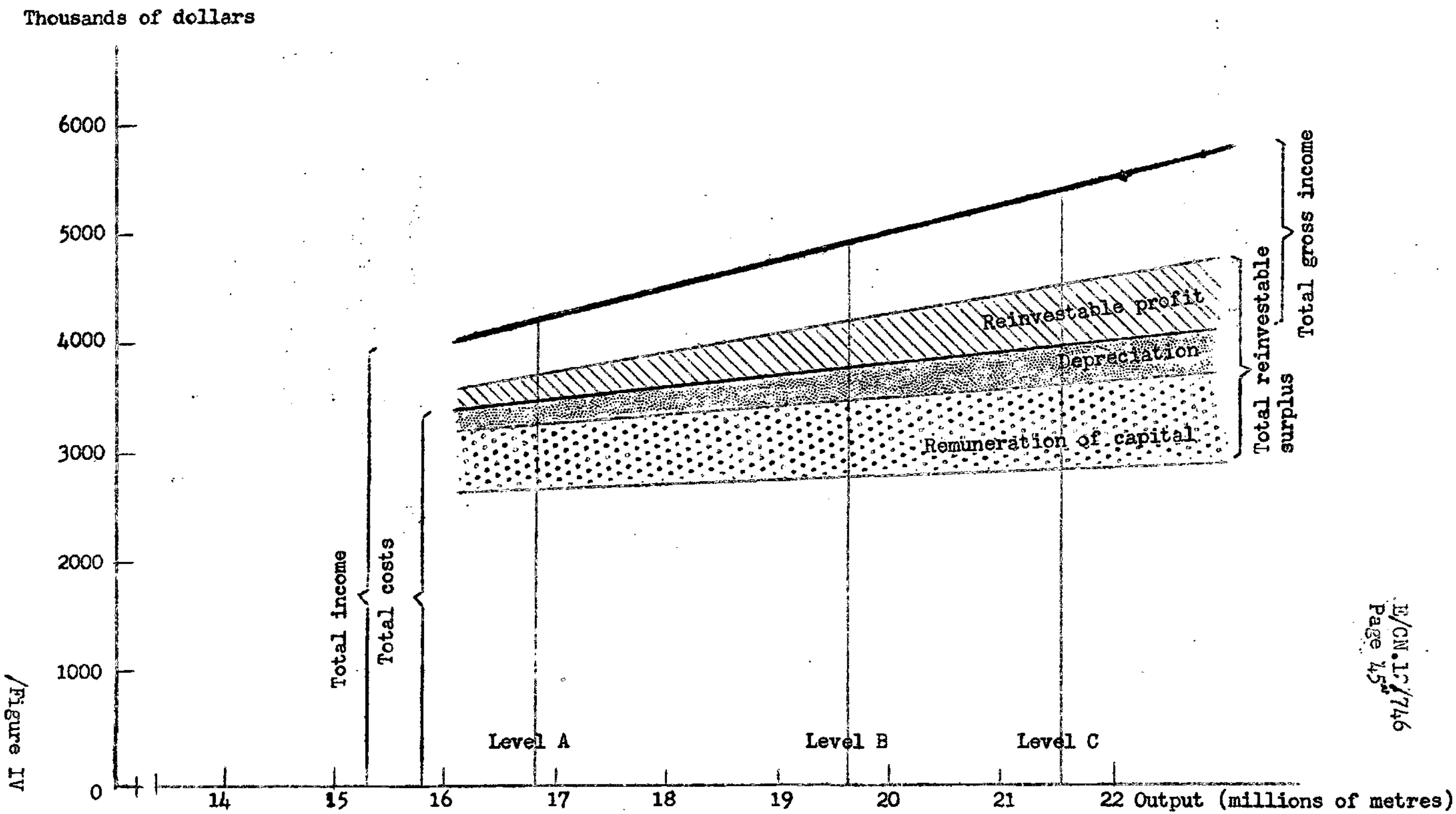
b/ The production costs are as shown in table M, that is, the labour cost hypothesis used is as specified in table 5, and the interest rate is 12 per cent per annum.

c/ 40 per cent of the gross annual profit, which is what remains after deductions for bonuses, taxes, distribution of dividends, contributions to special funds, etc.

/Figure III

# Figure III

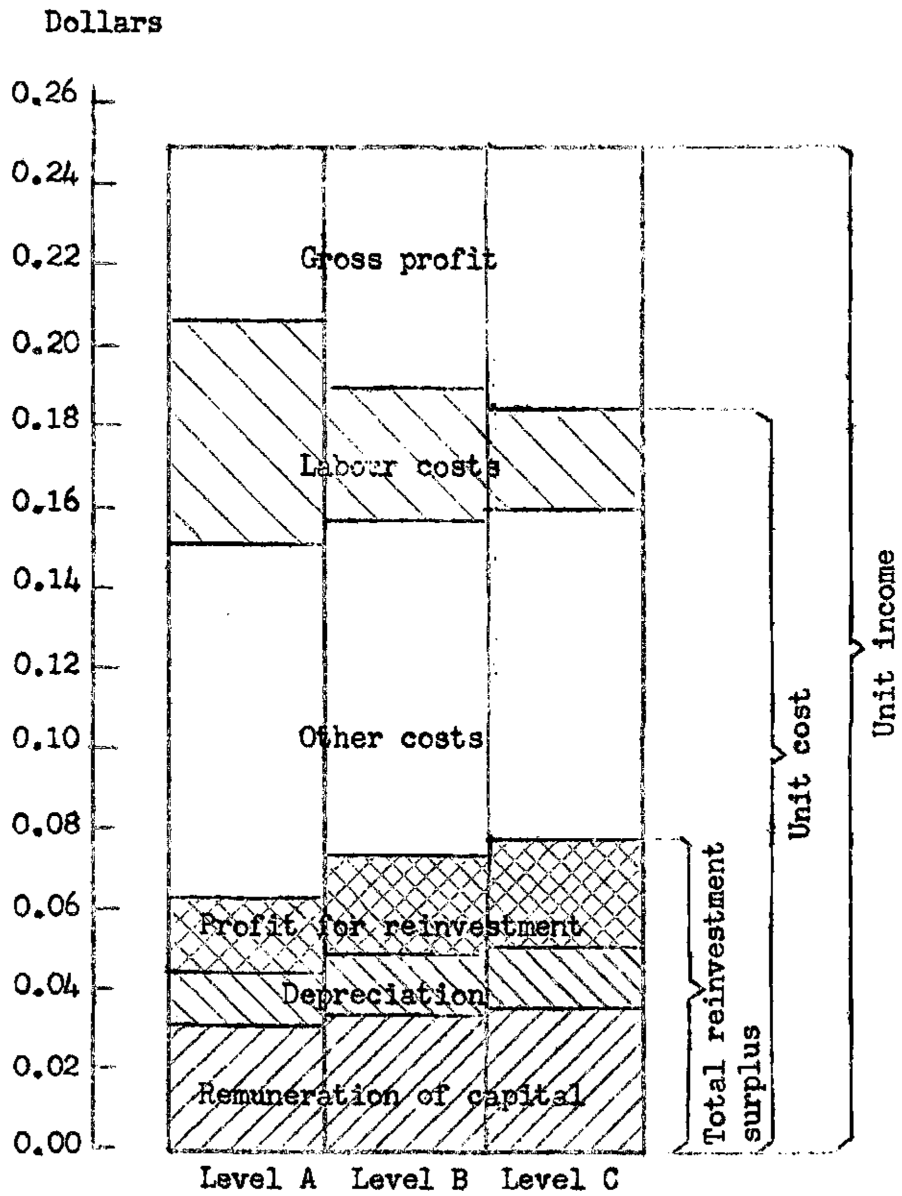
TOTAL INCOME, COST AND SURPLUS AVAILABLE FOR REINVESTMENT




/Figure IV

**Figure IV**

INCOME, COST AND TOTAL REINVESTMENT SURPLUS, PER UNIT OF OUTPUT




Source: See table 13

/Table 17

Table 17

SUMMARY OF THE MAIN EVALUATION COEFFICIENTS AND OTHER INDEXES AFFECTED BY TECHNOLOGICAL LEVEL, AT CURRENT FACTOR COST

| | Indexes | | |
|---|---|---|---|
| | Level A | Level B | Level C |
| Unit cost | 100 | 92 | 89 |
| Unit investment | 100 | 109 | 115 |
| Product-capital ratio at cost level a/ | 100 | 76 | 68 |
| Product-capital ratio (total) b/ | 100 | 92 | 87 |
| Investment per worker | 100 | 190 | 310 |
| Worker per unit of product | 100 | 57 | 37 |
| Value added per worker | 100 | 145 | 211 |
| Reinvestement surplus | 100 | 119 | 126 |
| Total investment required c/ | 100 | 127 | 146 |

a/ Excluding gross profit (see table 11).

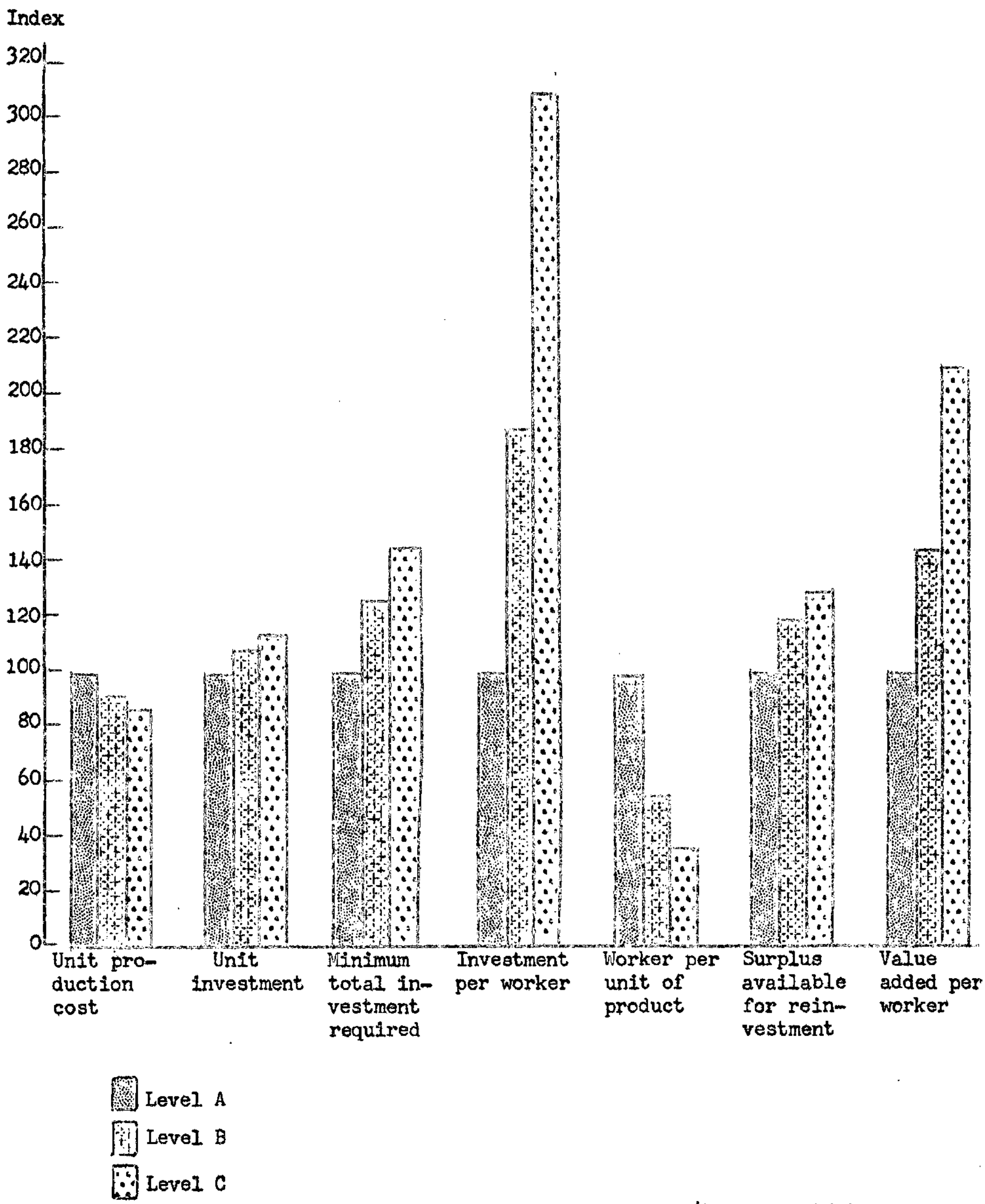
b/ Including an estimated gross profit.

c/ Total investment needed for installation of the minimum economic size.

/Figure V

Figure V

MAIN EVALUATION COEFFICIENTS AND OTHER INDEXES
AFFECTED BY THE TECHNOLOGICAL LEVEL




Source: See table 17

/indexes, which

indexes, which is not the case. On the contrary, while the volume of production needed to amortize the whole of the investment made is represented by indexes of 100, 105 and 115 for levels A, B and C respectively, the corresponding unit investment indexes are 100, 109 and 115. In other words, the effort needed to recover the capital invested is lowest at the intermediate level.

The volume of production needed to amortize the investment rises as the level of automation increases. The same does not apply to the time needed for amortization, since the production capacity is not the same, and as it rises the amortization period is reduced. In fact the total investment is recovered at the end of about four years and three months at level A, three years and eleven months at level B, and three years and ten months at level C.[27/] Here again, it can be seen the further reduction of the period at level C compared with level B is insignificant.

## 2. Summary and discussion of the choices presented

In the light of the results obtained thus far, the problem of selecting production techniques in the cotton industry [28/] appears less complex than it is seen to be if the difficulty of applying a strictly economic solution is borne in mind; that is to say, any solution adopted involves making value judgements and, in the last analysis, is a decision at the level of economic policy.

The two points of view, one emphasizing the importance of maximum product and the other that of reinvestment surplus, are undoubtedly conflicting. The application of either to the exclusion of the other would be dangerous, in view of the two extreme positions they represent, in an industry like the textile industry, which may be regarded as at the beginniing of a technological transition.

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27/ These figures assume that the whole of the surplus is used for amortization purposes, which may not occur in practice; that is, the figures should not be regarded as representing the amortization capacity of an enterprise.

28/ In view of the similarity of the productive processes, and the technological evolution of the machinery, in other branches of the textile industry, the results obtained here can be extended to cover the manufacture of other fibres without any risk of substantial distortion.

/In the

In the present case there is a striking difference in the extent of the changes that occur in the indexes at the levels considered. There is a slight rise in reinvestment surplus at the cost of a very sharp reduction in the number of workers. It can also be seen that the greatest difference are between the lowest and intermediate technological levels, while those between the intermediate and highest level are in many cases insignificant (see table 17).

To obtain one unit of output, level B requires 57 per cent of the labour force needed at level A, and at level C the reduction is to only 37 per cent; in other words, the creation of a vacancy for a worker at level B requires double the amount of capital required at level A, while at level C it requires three times that capital. In view of the effect that a choice of this kind is bound to have in countries where unemployment, either overt or hidden, is chronic, the level that ensures the highest level of employment is unquestionably the most desirable.

However, there are other considerations to be taken into account. The product-capital ratio declines as automation of the productive process increases, that is, as the process becomes more capital-intensive. Hence, from the standpoint of the productivity of capital, the choice once again falls on level A, since this offers the highest product-capital ratio. However, that does not ensure the highest growth rate. On the contrary, as the value added rises because a larger share represents remuneration of labour, the additional portion of product thus created will go to the workers and be used for consumption. Thus the maximization of the product cannot be an objective in itself, without prior study of the composition of the value added and the destination of the product.

The choice of level A technology for the sole purpose of raising employment to the maximum level also involves two risks. Firstly, the reinvestment surplus is very low compared with that for the other two levels, which may lead to too slow a growth rate of the gross product. Where the textile industry has too low a reinvestment surplus, it will be condemned to stagnation. Secondly, the choice of technology A, representing machinery that was modern in 1950, for a sector that is developing very rapidly, as the textile sector is, may mean falling too far behind the industrial countries.

/At the

At the other extreme is technology C, which has the lowest product-capital ratio, but provides the highest surplus for reinvestment. Obviously this level would be preferred by the private entrepreneur looking for the highest profits, and the reinvestment surplus can be allocated either to reinvestment or to consumption. Given that in the entrepreneurial class the marginal propensity to save is higher than the marginal propensity to consume, the most advanced technology ensures the highest growth rate, although the effects are felt only over the long term. From the strictly economic standpoint the preferences of the private entrepreneur are compatible with the possibility of accelerated growth, but the social cost involved in the choice of level C technology may be too high for any likelihood of its being offset over the long term. In most of the Latin American countries the level of unemployment is normally high, and the textile industry may be responsible for this, since it is the industrial sector that could offer the largest volume of employment. In sum, the possibility of maintaining an adequate balance between the supply of capital and of labour, without running the risks referred to above, is provided by level B.

It was asserted above that any choice necessarily involves value judgements. The aim of this study is to gather specific data that can permit the problem to be discussed from the standpoint of the economy as a whole, the individual sector concerned, or the enterprise itself. The decision will necessarily be political, as is only to be expected. What is important is that before taking the decisions involved, the authorities should obtain the technical data that are essential in forming their judgement.

/Annex

## Annex

### Table A

### MAIN CHARACTETISTICS OF THE PRODUCT STUDIED

| | |
|---|---|
| **Yarn** (warp and weft) | |
| Count (English) (carded) | 18 |
| Twist coefficient | 4.00 |
| Turns per inch | 17 |
| Type of cotton | 1 3/16" |
| **Fabric** | |
| Width of grey goods (cm) | 90 |
| Threads per centimetre | 20 |
| Picks per centimetre | 20 |
| Total threads in warp a/ | 1 880 |
| Warp contraction (percentage) | 7.3 |
| Weft contraction (percentage) | 7.3 |
| Weight per linear metre (grammes): | |
| Total | 130 |
| Warp | 66 |
| Weft | 64 |
| Weight per square metre (grammes) | 144 |
| Type of weave | Plain weave |

a/ With triple-yarn selvage.

/Table B

Table B

PRODUCTION PLAN

Level A

| Production stage | Count of yarn produced | Feed hank | Draft | Turns per inch | Speed of operation | Effi- ciency (percent- age) | Production per machine/ hour |
|---|---|---|---|---|---|---|---|
| Scutcher | 0.0012 | - | | - | 9.4 | 90 | 180 kg |
| Card | 0.12 | 0.0012 | 100 | - | 14 rpm | 90 | 8 kg |
| Drawing frame I | 0.12 | 6/0.12 | 6 | - | 240 feet/min. | 85 | 18 kg |
| Drawing frame II | 0.12 | 6/0.12 | 6 | - | 240 feet/min. | 85 | 18 kg |
| Roving frame | 0.75 | 0.12 | 6.25 | 1.00 | 900 rpm | 76 | 820 g |
| Ring spinning frame | 18 | 0.75 | 24 | 17 | 9 100 rpm | 90 | 241 |
| Cone winder | 18 | 18 | - | - | 400 feet/min. | 70 | 505 g |
| Pirn winder | 18 | 18 | - | - | 310 feet/min | 70 | 390 g |
| Warper | - | 4 beams, 470 ends | | | 400 feet/min. | 50 | 168 kg |
| Slasher | - | - | - | - | 48 feet/min a/ | 50 | 81 kg |
| Loom | - | - | - | - | 180 picks/min. | 85 | 4.59m |

a/ Assuming a maximum evaporation capacity of 227 kg per hour and a warp humidity content of 150 per cent.

/Table C

Table C

PRODUCTION PLAN

Level B

| Production stage | Count of yarn produced | Feed hank | Draft | Turns per inch | Speed of operation | Efficiency (percentage) | Production per machine/ hour |
|---|---|---|---|---|---|---|---|
| Scutcher | 0.0012 | - | - | - | 11 rpm | 95 | 210 kg |
| Card | 0.12 | 0.0012 | 100 | - | 21 rpm | 90 | 12 kg |
| Drawing frame I | 0.12 | 6/0.12 | 6 | - | 700 feet/min. | 74 | 46.5kg |
| Drawing frame II | 0.12 | 6/0.12 | 6 | - | 700 feet/min. | 74 | 46.5kg |
| Roving frame | 0.75 | 0.12 | 6.25 | 1.00 | 1 000 rpm | 76 | 910 g |
| Ring spinning frame | 18 | 0.75 | 24 | 17 | 9 500 rpm | 90 | 25.1 g |
| Cone winder | 18 | 18 | - | - | 600 yd/min | 70 | 756 g |
| Pirn winder | 18 | 18 | - | - | 800 yd/min | 80 | 1 140 g |
| Warper | - | 4 beams, 470 ends | | | 600 yd/min | 50 | 253 kg |
| Slasher | - | - | - | - | 56 yd/min a/ | 50 | 94 kg |
| Loom | - | - | - | - | 200 picks /min | 90 | 5.40 m |

a/ Assuming a maximum evaporation capacity of 317 kg per hour and a warp humidity content of 150 per cent.

/Table D

Table D

PRODUCTION PLAN

Level C

| Production stage | Count of yarn produced | Feed hank | Draft | Turns per inch | Speed of operation | Effi-ciency (percen-tage) | Production per machine hour |
|---|---|---|---|---|---|---|---|
| Scutcher | 0.0012 | - | - | - | 12 rpm | 95 | 230 kg |
| Card | 0.12 | 0.0012 | 100 | - | 35 rpm | 90 | 20 " |
| Drawing frame I | 0.12 | 6/0.12 | 6 | - | 1 000 feet/min | 74 | 66.5 |
| Drawing frame II | 0.12 | 6/0.12 | 6 | - | 1 000 feet/min | 74 | 66.5 |
| Roving frame | 0.75 | 0.12 | 625 | 1.00 | 1 200 rpm | 78 | 1 100 g. |
| Ring spinning frame | 18 | 0.75 | 24 | 17 | 10 500 rpm | 92 | 28.2 " |
| Cone winder | 18 | 18 | - | - | 1 250 yd/min | 85 | 1 920 " |
| Pirn winder | 18 | 18 | - | - | 960 yd/min | 85 | 1 460 " |
| Warper | - | 4 beams, 470 ends | | | 600 yd/min | 50 | 253 kg |
| Slasher | - | - | - | - | 61 yd/min a/ | 50 | 103 kg |
| Loom | - | - | - | - | 220 picks /min | 90 | 5.94 m |

a/ Assuming a maximum evaporation capacity of 317 kg per hour and a warp humidity content of 150 per cent.

/Table E

Table E

PRODUCTION PROGRAMME AND MACHINE REQUIREMENTS

Level A

| Machine | Production: Daily unit output (kilogrammes) a/ | Production: Total daily output required (kilogrammes) | Waste per day: Kilogrammes | Waste per day: Percentage | Number of production units: Theoretical | Number of production units: Actual | Number of machines |
|---|---|---|---|---|---|---|---|
| Scutcher | 4 140 | 8 280 | 436 | 5.0 | 2 | 2 | Operating line |
| Card | 184 | 7 783 | 497 | 6.0 | 42.3 | 44 | 44 |
| Drawing frame I | 414 | 7 744 | 39 | 0.5 | 18.7 | 20 | 5 with 4 deliveries |
| Drawing frame II | 414 | 7 705 | 39 | 0.5 | 18.6 | 20 | 5 with 4 deliveries |
| Roving frame | 18.860 | 7 667 | 38 | 0.5 | 406 | 420 | 5 with 84 spindles |
| Ring spinning frame | 0.554 | 7 552 | 115 | 1.5 | 13 630 | 13 600 | 34 with 400 spindles |
| Cone winder | 11.620 | 7 401 | 151 | 2.0 | 637 | 640 | 8 with 80 spindles |
| Pirn winder | 8.970 | 3 594 | 33 | 1.0 | 400 | 416 | 13 with 4x8 spindles |
| Warper | 3 864 | 3 736 | 38 | 1.0 | 1 | 1 | 1 |
| Slasher | 1 863 | 3 700 | 36 | 1.0 | 2 | 2 | 2 |
| Loom | 13.72 (105.57m) | 7 294 (56 110m) | - | - | 531 | 534 | 534 |

| | | | Kilogrammes | Percentage |
|---|---|---|---|---|
| Total input of cotton (kilogrammes) | 8 716 | | | |
| Waste recovered (kilogrammes) | 461 | Total waste | 1 422 | 16.3 |
| Daily consumption of cotton (kilogrammes) | 8 255 | Waste recovered | 461 | 5.3 |
| Annual consumption of cotton (tons) | 2 476 | Net waste | 961 | 11.0 |

a/ With a 23-hour day.

/Table F

Table F

PRODUCTION PROGRAMME AND MACHINE REQUIREMENTS

Level B

| Machine | Production: Daily unit output (kilogrammes) a/ | Production: Total daily output required (kilogrammes) | Waste per day: Kilogrammes | Waste per day: Percentage | Number of production units: Theoretical | Number of production units: Actual | Number of machines |
|---|---|---|---|---|---|---|---|
| Scutcher | 4 830 | 9 660 | 508 | 5.0 | 2 | 2 | Opening line |
| Card | 276 | 9 080 | 580 | 6.0 | 32.9 | 34 | 34 |
| Drawing frame I | 1 070 | 9 035 | 45 | 0.5 | 8.4 | 10 | 5 with 2 deliveries |
| Drawing frame II | 1 070 | 8 990 | 45 | 0.5 | 8.4 | 10 | 5 with 2 deliveries |
| Roving frame | 20.930 | 8 945 | 45 | 0.5 | 427 | 430 | 5 with 86 spindles |
| Ring spinning frame | 0.577 | 8 811 | 134 | 1.5 | 15 270 | 15 200 | 38 with 400 spindles |
| Cone winder | 17.388 | 8 635 | 176 | 2.0 | 497 | 500 | 5 with 100 spindles |
| Pirn winder | 26.220 | 4 189 | 42 | 1.0 | 160 | 180 | 5 with 36 spindles |
| Warper | 5 820 | 4 360 | 44 | 1.0 | 0.7 | 1 | 1 |
| Slasher | 2 162 | 4 317 | 43 | 1.0 | 2 | 2 | 2 |
| Loom | 16.150<br>(124.20m) | 8 506<br>(65 430m) | - | - | 527 | 530 | 530 |

| | | | | |
|---|---|---|---|---|
| Total input of cotton (kilogrammes) | 10 168 | | Kilogrammes | Percentage |
| Waste recovered (kilogrammes) | 540 | Total waste | 5 537 | 17.7 |
| Daily consumption of cotton (kilogrammes) | 9 628 | Waste recovered | 2 721 | 8.7 |
| Annual consumption of cotton (tons) | 2.888 | Net waste | 2 816 | 9.0 |

a/ With a 23-hour day.

/Table G

Table G

PRODUCTION PROGRAMME AND MACHINE

Level C

| Machine | Production: Daily unit output (kilogrammes) a/ | Production: Total daily output required (kilogrammes) | Waste per day: Kilogrammes | Waste per day: Percentage | Number of production units: Theoretical | Number of production units: Actual | Number of machines |
|---|---|---|---|---|---|---|---|
| Scutcher | 5 290 | 10 580 | 557 | 5.0 | 2 | 2 | Opening line |
| Card | 460 | 9 945 | 635 | 6.0 | 21.6 | 22 | 22 |
| Drawing frame I | 1 530 | 9 895 | 50 | 0.5 | 6.4 | 8 | 4 with 2 heads |
| Drawing frame II | 1 530 | 9 846 | 49 | 0.5 | 6.4 | 8 | 4 with 2 heads |
| Roving frame | 25.300 | 9 797 | 49 | 0.5 | 387 | 390 | 4 with 78 spindles |
| Ring spinning frame | 0.648 | 9 650 | 147 | 1.5 | 14 890 | 14 820 | 39 with 380 spindles |
| Cone winder | 44.160 | 9 457 | 193 | 2.0 | 214 | 220 | 22 with 10 spindles |
| Pirn winder | 33.580 | 4 588 | 46 | 1.0 | 137 | 144 | 4 with 36 spindles |
| Warper | 5.820 | 4 775 | 48 | 1.0 | 0.8 | 1 | 1 |
| Slasher | 2 370 | 4 727 | 48 | 1.0 | 2 | 2 | 2 |
| Loom | 17.76 (136.62m) | 9 315 (71 650m) | - | - | 524 | 524 | 524 |

| | | Kilogrammes | Percentage |
|---|---|---|---|
| Total input of cotton | | | |
| Waste recovered (kilogrammes) | Total waste | 1 822 | 16.3 |
| Daily consumption of cotton (kilogrammes) | Waste recovered | 590 | 5.3 |
| Annual consumption of cotton (tons) | Net waste | 1 232 | 11.0 |

a/ With a 23-hour day.

/Table H

Table H

MACHINERY INVESTMENT REQUIREMENTS

(F.o.b. price in dollars)

| Equipment specification | Level A | | | Level B | | | Level C | | |
|---|---|---|---|---|---|---|---|---|---|
| | Unit price | Number required | Total f.o.b. cost | Unit price | Number required | Total f.o.b. cost | Unit price | Number required | Total f.o.b. cost |
| I. Main equipment | | | 1 813 500 | | | 2 523 710 | | | 2 931 466 |
| A. Spinning | | | 870 680 | | | 1 132 200 | | | 1 359 210 |
| 1. Complete opening equipment, with 2 scutchers | 60 000 | 1 | 60 000 | 67 000 | 1 | 67 000 | 73 000 | 1 | 73 000 |
| 2. Dust filter system for opening room | - | - | - | - | - | - | 13 400 | 1 | 13 400 |
| 3. Centralized electric control panel for opening room | - | - | - | 3 500 | 1 | 3 500 | 3 500 | 1 | 3 500 |
| 4. Automatic lap doffing | - | - | - | - | - | - | 5 000 | 1 | 5 000 |
| 5. Cards | 3 900 | 44 | 171 600 | 7 300 | 34 | 248 200 | 11 000 | 22 | 242 000 |
| 6. Pneumatic card waste removal | - | - | - | - | - | - | 650 | 22 | 14 300 |
| 7. Drawing frames | 700 | 40 | 28 000 | 2 240 | 20 | 44 800 | 3 000 | 16 | 48 000 |
| 8. Warping machines | 154 | 420 | 64 680 | 230 | 430 | 98 900 | 285 | 390 | 111 150 |
| 9. Traveller cleaners for roving frames | - | - | - | - | - | - | 10 000 | 1 | 10 000 |
| 10. Ring spinning frames | 33 | 13 600 | 448 800 | 36 | 15 200 | 547 200 | 43 | 14 820 | 637 260 |
| 11. Traveller cleaners for spinning frames | - | - | - | 32 600 | 1 | 32 600 | 32 600 | 1 | 32 600 |
| 12. Cone winders | 90 | 640 | 57 600 | 180 | 500 | 90 000 | 770 | 220 | 169 000 |
| B. Weaving | | | 942 820 | | | 1 391 510 | | | 1 572 256 |
| 1. Pirn winders | 150 | 416 | 62 400 | 374 | 160 | 59 840 | 524 | 144 | 75 426 |
| 2. Warping machines | 9 200 | 1 | 9 200 | 12 370 | 1 | 12 370 | 12 370 | 1 | 12 370 |
| 3. Slashers | 21 760 | 2 | 43 520 | 36 900 | 2 | 73 800 | 50 550 | 2 | 101 100 |
| 4. Looms | 1 550 | 534 | 827 700 | 2 350 | 530 | 1 245 500 | 2 640 | 524 | 1 383 360 |
| II. Auxiliary equipment | | | 11 950 | | | 36 610 | | | 45 570 |
| A. Spinning | | | 8 850 | | | 16 230 | | | 16 460 |
| 1. Scales of different kinds | - | - | 2 000 | - | - | 2 000 | - | - | 2 000 |
| 2. Carts for Handling material | - | - | 500 | - | - | 1 800 | - | - | 2 400 |
| 3. Fork lift | 3 000 | 1 | 3 000 | 3 000 | 1 | 3 000 | 3 000 | 1 | 3 000 |
| 4. Card maintenance equipment | - | - | 550 | - | - | 6 280 | - | - | 4 460 |
| 5. Spinning frame maintenance equipment | - | - | 2 800 | - | - | 2 800 | - | - | 2 800 |
| 6. Air compressor | - | - | - | 350 | 1 | 350 | 450 | 4 | 1 800 |
| B. Weaving | - | - | 3 100 | | | 20 380 | | | 29 110 |
| 1. Knotter | - | - | - | 6 000 | 2 | 12 000 | 6 000 | 2 | 12 000 |
| 2. Size preparation equipment | - | - | 2 800 | - | - | 4 700 | - | - | 7 650 |
| 3. Carts for handling material | - | - | 300 | - | - | 800 | - | - | 1 500 |
| 4. Quill stripper | - | - | - | 2 200 | 1 | 2 200 | 2 200 | 3 | 6 600 |
| 5. Air compressor | - | - | - | 680 | 1 | 680 | 680 | 2 | 1 360 |

Table H (concluded)

| Equipment specification | Level | | | Level B | | | Level C | | |
|---|---|---|---|---|---|---|---|---|---|
| | Unit price | Number required | Total f.o.b. cost | Unit price | Number required | Total f.o.b. cost | Unit price | Number required | Total f.o.b. cost |
| III. Accessories | | | 89 152 | | | 89 282 | | | 85 906 |
| A. Spinning | | | 48 202 | | | 49 622 | | | 46 756 |
| 1. Lap rods (3 per card) | 1 | 132 | 132 | 1 | 102 | 102 | 1 | 66 | 66 |
| 2. Card sliver cans (2 per card) | 15 | 88 | 1 320 | 15 | 68 | 1 020 | 15 | 44 | 660 |
| 3. Drawing frame cans (7 for each delivery plus 2 per intermediate bobbin) | 15 | 1 120 | 16 800 | 15 | 1 000 | 15 000 | 15 | 892 | 13 380 |
| 4. Roving bobbins (2.5 per ring spindle) | (per mil) 700 | 34 | 23 800 | (per mil) 700 | 38 | 26 600 | (per mil) 700 | 37 | 25 900 |
| 5. Ring frame bobbins (3 per ring spindle) | (per mil) 150 | 41 | 6 150 | (per mil) 150 | 46 | 6 900 | (per mil) 150 | 45 | 6 750 |
| B. Weaving | | | 40 950 | | | 39 660 | | | 39 150 |
| 1. Pirns (20 per spindle and 30 per loom) | (per mil) 150 | 25 | 3 750 | (per mil) 150 | 20 | 3 000 | (per mil) 150 | 19 | 2 850 |
| 2. Wooden cones (2 per spindle and 2 000 per warper) | (per mil) 300 | 4 | 1 200 | (per mil) 300 | 3 | 900 | (per mil) 300 | 3 | 900 |
| 3. Cylinders for warpers (10 per slasher and 4 per warper) | 165 | 24 | 3 960 | 165 | 24 | 3 960 | 165 | 24 | 3 960 |
| 4. Harness, reeds, shuttles, etc. (60 dollars per loom) | 60 | 534 | 32 040 | 60 | 530 | 31 800 | 60 | 524 | 31 440 |
| IV. Miscellaneous | | | 256 000 | | | 337 500 | | | 397 000 |
| A. Machine shops and boiler | - | - | 40 000 | - | - | 40 000 | - | - | 40 000 |
| B. Laboratory | - | - | 25 000 | - | - | 25 000 | - | - | 25 000 |
| C. Office furniture and equipment | - | - | 4 000 | - | - | 12 000 | - | - | 30 000 |
| D. Unspecified accessories (5 per cent of I+II) | - | - | 91 270 | - | - | 128 020 | - | - | 148 850 |
| E. Contingencies (per cent of 1+II+III) | - | - | 95 730 | - | - | 132 480 | - | - | 153 150 |
| Total spinning | | | 927 732 | | | 1 198 052 | | | 1 422 426 |
| Total weaving | | | 986 870 | | | 1 451 550 | | | 1 640 516 |
| Total miscellaneous | | | 256 000 | | | 337 500 | | | 397 000 |
| Grand total | | | 2 170 602 | | | 2 987 102 | | | 3 459 942 |

/Table I

Table I

INVESTMENT REQUIREMENTS FOR BUILDINGS AND ANCILLARY FACILITIES

(Dollars)

| Specification | Cost per square metre | Level A | | Level B | | Level C | |
|---|---|---|---|---|---|---|---|
| | | Area required | Total cost | Area required | Total cost | Area required | Total cost |
| I. Buildings (total area) | | 16 830 | 631 080 | 17 050 | 639 320 | 16 530 | 619 880 |
| A. Production area | 36 | 13 680 | 492 480 | 13 860 | 498 960 | 13 430 | 483 480 |
| B. Services area | 44 | 3 150 | 138 600 | 3 190 | 140 360 | 3 100 | 136 400 |
| II. Power and light | 12 | 16 830 | 201 960 | 17 050 | 204 600 | 16 530 | 198 360 |
| III. Air conditioning | 15 | - | - | 3 000 a/ | 45 000 | 16 530 | 247 950 |
| IV. Humidifying | 5 | 9 410 b/ | 47 050 | 6 360 c/ | 31 800 | - | - |
| V. Water and steam (including boilers) | - | - | 42 000 | - | 42 000 | - | 42 000 |
| Total cost | - | - | 922 090 | - | 962 720 | - | 1 108 190 |

a/ Air conditioning in the spinning room.
b/ Humidifying in the spinning and weaving rooms.
c/ Humidifying in the weaving room.

/Table J

Table J

ESTIMATED MINIMUM WORKING CAPITAL NEEDED FOR MILL OPERATION

(Dollars)

| Item | Level A | Level B | Level C |
|---|---|---|---|
| I. Minimum stock of raw cotton | 274 000 | 319 600 | 350 150 |
| II. Material in course of processing | 83 220 | 83 950 | 86 640 |
| III. Stock of finished products | 41 610 | 41 970 | 43 320 |
| IV. Stock of spare parts and ancillary materials | 36 270 | 50 470 | 58 630 |
| V. Minimum cash supply | 25 460 | 25 760 | 26 620 |
| Total working capital | 460 560 | 521 750 | 565 360 |

Bases of estimates: I. Two months' production supply.
II. Ten days' production supply at cost of raw material and labour (including social security charges).
III. Five days' production at cost of raw material and labour (including social security charges).
IV. 2 per cent of the value of the basic equipment.
V. 1 per cent of the annual cost of raw material and labour (including social security charges).

/Table K

Table K

TOTAL INVESTMENT REQUIREMENTS FOR EACH PRODUCTION HYPOTHESIS

(Dollars)

| Item | Level A | Level B | Level C |
|---|---|---|---|
| I. Fixed investment | 3 992 780 | 5 136 792 | 5 942 273 |
| A. Buildings and ancillary fittings a/ | 922 090 | 962 720 | 1 108 190 |
| B. Equipment b/ | 2 170 602 | 2 987 102 | 3 459 942 |
| C. Freight and insurance c/ | 217 060 | 298 710 | 345 994 |
| D. Construction cost d/ | 90 675 | 126 185 | 146 573 |
| E. Pre-operational costs e/ | 102 012 | 131 241 | 151 821 |
| F. Interest payments during construction period f/ | 490 341 | 630 834 | 729 753 |
| II. Working capital | 460 560 | 521 750 | 565 360 |
| A. Permanent stock of working capital g/ | 460 560 | 521 750 | 565 360 |
| III. Total investment | 4 453 340 | 5 658 542 | 6 507 633 |

a/ See table I.
b/ See table H.
c/ 10 per cent of the total value of the equipment.
d/ 5 per cent of the value of the basic equipment (see table H).
e/ 3 per cent of the value of the fixed assets.
f/ 12 per cent yearly on items [illegible], for a period of 14 months.
g/ See table J.

/Table L

**Table L**

**LABOUR REQUIREMENTS AND ANNUAL LABOUR COSTS**

(Dollars)

| Occupation | Classi-fica-tion a/ | Hour-ly wage b/ | Level A: Number of persons employed: 1st shift | 2nd shift | 3rd shift | Total | Total annual cost | Level B: Number of persons employed: 1st shift | 2nd shift | 3rd shift | Total | Total annual cost | Level C: Number of persons employed: 1st shift | 2nd shift | 3rd shift | Total | Total annual cost |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **I. Spinning** | | | | | | 250 | 222 240 | | | | 133 | 121 128 | | | | 82 | 78 840 |
| **A. Opening through roving** | | | | | | 69 | 65 088 | | | | 43 | 42 048 | | | | 28 | 31 248 |
| Opener tender | V | 0.25 | 1 | 1 | 1 | 3 | 1 920 | 1 | 1 | 1 | 3 | 1 920 | - | - | - | - | - |
| Picker tender | V | 0.35 | 1 | 1 | 1 | 3 | 2 688 | 1 | 1 | 1 | 3 | 2 688 | 1 | 1 | 1 | 3 | 2 688 |
| Card tender | V | 0.35 | 2 | 2 | 2 | 6 | 5 376 | 1 | 1 | 1 | 3 | 2 688 | - | - | - | - | - |
| Card helper | V | 0.25 | 3 | 3 | 3 | 9 | 5 760 | 2 | 2 | 2 | 6 | 3 840 | - | - | - | - | - |
| Drawing tender | V | 0.35 | 5 | 5 | 5 | 15 | 13 440 | 2 | 2 | 2 | 6 | 5 376 | 3 | 3 | 3 | 9 | 8 064 |
| Roving tender | V | 0.35 | 3 | 3 | 3 | 9 | 8 064 | 2 | 2 | 2 | 6 | 5 376 | 2 | 2 | 2 | 6 | 5 376 |
| Roving helper | V | 0.25 | 2 | 2 | 2 | 6 | 3 840 | 1 | 1 | 1 | 3 | 1 920 | - | - | - | - | - |
| Oiler | F | 0.25 | 2 | 1 | - | 3 | 1 800 | 1 | 1 | - | 2 | 1 200 | 1 | - | - | 1 | 600 |
| Sweeper | F | 0.25 | 2 | 2 | 1 | 5 | 3 120 | 1 | 1 | 1 | 3 | 1 920 | 1 | 1 | - | 2 | 1 200 |
| Maintenance foreman | F | 0.75 | 2 | 2 | 2 | 6 | 11 520 | 2 | 1 | 1 | 4 | 7 560 | 1 | 1 | 1 | 3 | 5 760 |
| Production foreman | F | 0.75 | 2 | 1 | 1 | 4 | 7 560 | 2 | 1 | 1 | 4 | 7 560 | 2 | 1 | 1 | 4 | 7 560 |
| **B. Spinning and winding** | | | | | | 181 | 157 152 | | | | 90 | 79 080 | | | | 54 | 47 592 |
| Spinners | V | 0.35 | 12 | 12 | 12 | 36 | 32 256 | 8 | 8 | 8 | 24 | 21 504 | 5 | 5 | 5 | 15 | 13 440 |
| Doffer | V | 0.25 | 6 | 6 | 6 | 18 | 11 520 | 4 | 4 | 4 | 12 | 7 680 | 3 | 3 | 3 | 9 | 5 760 |
| Creel loader | V | 0.25 | 2 | 2 | 2 | 6 | 3 840 | 1 | 1 | 1 | 3 | 1 920 | 1 | 1 | 1 | 3 | 1 920 |
| Roll picker | V | 0.25 | 2 | 2 | 2 | 6 | 3 840 | - | - | - | - | - | - | - | - | - | - |
| Steel roll cleaner | F | 0.25 | 2 | 2 | 1 | 5 | 3 120 | 1 | 1 | 1 | 3 | 1 920 | 1 | 1 | 1 | 3 | 1 920 |
| Yarn hauler | V | 0.25 | 1 | 1 | 1 | 3 | 1 920 | 1 | 1 | 1 | 3 | 1 920 | 1 | 1 | 1 | 3 | 1 920 |
| Traveller changer | V | 0.25 | 1 | 1 | - | 2 | 1 200 | 1 | - | - | 1 | 600 | 1 | - | - | 1 | 600 |
| Winder | V | 0.35 | 32 | 32 | 32 | 96 | 86 016 | 12 | 12 | 12 | 36 | 32 256 | 4 | 4 | 4 | 12 | 10 752 |
| Sweeper | F | 0.25 | 1 | 1 | 1 | 3 | 1 920 | 1 | 1 | 1 | 3 | 1 920 | 1 | 1 | 1 | 3 | 1 920 |
| Maintenance foreman | F | 0.75 | 1 | 1 | 1 | 3 | 5 760 | 1 | 1 | - | 2 | 3 600 | 1 | 1 | - | 2 | 3 600 |
| Production foreman | F | 0.75 | 1 | 1 | 1 | 3 | 5 760 | 1 | 1 | 1 | 3 | 5 760 | 1 | 1 | 1 | 3 | 5 760 |
| **II. Weaving** | | | | | | 330 | 298 752 | | | | 232 | 211 824 | | | | 159 | 159 864 |
| **A Preparation** | | | | | | 123 | 107 904 | | | | 70 | 63 600 | | | | 48 | 45 816 |
| Quill tender | V | 0.35 | 13 | 13 | 13 | 39 | 34 944 | 6 | 6 | 6 | 18 | 16 128 | 3 | 3 | 3 | 9 | 8 064 |
| Quill helper | V | 0.25 | 4 | 4 | 4 | 12 | 7 680 | 2 | 2 | 2 | 6 | 3 840 | 1 | 1 | 1 | 3 | 1 920 |
| Warper tender | V | 0.35 | 1 | 1 | 1 | 3 | 2 688 | 1 | 1 | 1 | 3 | 2 688 | 1 | 1 | 1 | 3 | 2 688 |
| Assistant warper tender | V | 0.25 | 1 | 1 | 1 | 3 | 1 920 | 1 | 1 | 1 | 3 | 1 920 | 1 | 1 | 1 | 3 | 1 920 |
| Yarn hauler | V | 0.25 | 1 | 1 | 1 | 3 | 1 920 | 1 | 1 | 1 | 3 | 1 920 | 1 | 1 | 1 | 3 | 1 920 |
| Slasher tender | V | 0.35 | 2 | 2 | 2 | 6 | 5 376 | 2 | 2 | 2 | 6 | 5 376 | 2 | 2 | 2 | 6 | 5 376 |
| Assistant slasher tender | V | 0.25 | 4 | 4 | 4 | 12 | 7 680 | 2 | 2 | 2 | 6 | 3 840 | 1 | 1 | 1 | 3 | 1 920 |
| Size man | V | 0.35 | 1 | 1 | 1 | 3 | 2 688 | 1 | 1 | - | 2 | 1 680 | 1 | - | - | 1 | 840 |
| Tying-in hand | V | 0.35 | - | - | - | - | - | 1 | 1 | 1 | 3 | 2 688 | 1 | 1 | 1 | 3 | 2 688 |
| Drawing-in hand | V | 0.35 | 6 | 6 | 6 | 18 | 16 128 | 2 | 2 | - | 4 | 3 360 | 2 | 2 | - | 4 | 3 360 |
| Oiler | F | 0.25 | 1 | 1 | 1 | 3 | 1 920 | 1 | 1 | - | 2 | 1 200 | 1 | - | - | 1 | 600 |
| Sweeper and quill stripper | F | 0.25 | 4 | 4 | 4 | 12 | 7 680 | 2 | 2 | 2 | 6 | 3 840 | 1 | 1 | - | 2 | 1 200 |
| Maintenance foreman | F | 0.75 | 2 | 2 | 2 | 6 | 11 520 | 2 | 2 | 1 | 5 | 9 360 | 2 | 1 | 1 | 4 | 7 560 |
| Production foreman | F | 0.75 | 1 | 1 | 1 | 3 | 5 760 | 1 | 1 | 1 | 3 | 5 760 | 1 | 1 | 1 | 3 | 5 760 |

/Table L (concluded)

Table L (concluded)

| Occupation | Classification a/ | Hourly wage b/ | Level A: Number of persons employed: 1st shift | 2nd shift | 3rd shift | Total | Total annual cost | Level B: Number of persons employed: 1st shift | 2nd shift | 3rd shift | Total | Total annual cost | Level C: Number of persons employed: 1st shift | 2nd shift | 3rd shift | Total | Total annual cost |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| B. Loom section | | | | | | 207 | 190 848 | | | | 162 | 148 224 | | | | 111 | 114 048 |
| Weaver | V | 0.35 | 26 | 26 | 26 | 78 | 69 888 | 18 | 18 | 18 | 54 | 48 384 | 16 | 16 | 16 | 48 | 43 008 |
| Hauler | V | 0.25 | 4 | 4 | 4 | 12 | 7 680 | 3 | 3 | 3 | 9 | 5 760 | 3 | 3 | 3 | 9 | 5 760 |
| Battery hand | V | 0.25 | 14 | 14 | 14 | 42 | 26 880 | 14 | 14 | 14 | 42 | 26 880 | - | - | - | - | - |
| Warp leader | V | 0.25 | 4 | 4 | 4 | 12 | 7 680 | 3 | 3 | 3 | 9 | 5 760 | 3 | 3 | 3 | 9 | 5 760 |
| Cloth doffer | V | 0.25 | 4 | 4 | 4 | 12 | 7 680 | 3 | 3 | 3 | 9 | 5 760 | 3 | 3 | 3 | 9 | 5 760 |
| Oiler | F | 0.25 | 3 | 3 | 3 | 9 | 5 760 | 2 | 2 | 2 | 6 | 3 840 | 2 | 2 | 2 | 6 | 3 840 |
| Sweeper and loom blower | F | 0.25 | 4 | 4 | 4 | 12 | 7 680 | 3 | 3 | 3 | 9 | 5 760 | 2 | 2 | 2 | 6 | 3 840 |
| Maintenance foreman | F | 0.75 | 8 | 8 | 8 | 24 | 46 080 | 6 | 6 | 6 | 18 | 34 560 | 6 | 6 | 6 | 18 | 34 560 |
| Production foreman | F | 0.75 | 2 | 2 | 2 | 6 | 11 520 | 2 | 2 | 2 | 6 | 11 520 | 2 | 2 | 2 | 6 | 11 520 |
| III. Auxiliary services | | | | | | 50 | 41 280 | | | | 48 | 41 880 | | | | 42 | 41 280 |
| A. Maintenance | | | | | | 24 | 21 840 | | | | 22 | 22 440 | | | | 20 | 24 240 |
| Mechanic | F | 0.50 | 6 | - | - | 6 | 7 200 | 4 | - | - | 4 | 4 800 | 4 | - | - | 4 | 4 800 |
| Electrician | F | 0.50 | 1 | - | - | 1 | 1 200 | 1 | - | - | 1 | 1 200 | 1 | - | - | 1 | 1 200 |
| Welder | F | 0.50 | 2 | - | - | 2 | 2 400 | 2 | - | - | 2 | 2 400 | 1 | - | - | 1 | 2 400 |
| Carpenter | F | 0.50 | 1 | - | - | 1 | 1 200 | 1 | - | - | 1 | 1 200 | 1 | - | - | 1 | 1 200 |
| Workshop hand | F | 0.25 | 12 | - | - | 12 | 7 200 | 9 | - | - | 9 | 5 400 | 6 | - | - | 6 | 3 600 |
| Boilerman | F | 0.35 | 1 | - | - | 1 | 840 | 1 | - | - | 1 | 840 | 1 | - | - | 1 | 840 |
| Air conditioning mechanic | F | 0.50 | - | - | - | - | - | 1 | - | - | 1 | 1 200 | 1 | - | - | 1 | 1 200 |
| Maintenance mechanic | F | 0.75 | 1 | - | - | 1 | 1 800 | 3 | - | - | 3 | 5 400 | 5 | - | - | 5 | 9 000 |
| B. Laboratory | | | | | | 5 | 4 680 | | | | 5 | 4 680 | | | | 5 | 4 680 |
| Sample collector | F | 0.35 | 1 | - | - | 1 | 840 | 1 | - | - | 1 | 840 | 1 | - | - | 1 | 840 |
| Technician | F | 0.35 | 1 | - | - | 1 | 840 | 1 | - | - | 1 | 840 | 1 | - | - | 1 | 840 |
| Assistants | F | 0.25 | 2 | - | - | 2 | 1 200 | 2 | - | - | 2 | 1 200 | 2 | - | - | 2 | 1 200 |
| Analysis assistant | F | 0.75 | 1 | - | - | 1 | 1 800 | 1 | - | - | 1 | 1 800 | 1 | - | - | 1 | 1 800 |
| C. Miscellaneous | | | | | | 21 | 14 760 | | | | 21 | 14 760 | | | | 17 | 12 360 |
| Cotton storage hand | V | 0.35 | 4 | - | - | 4 | 3 360 | 4 | - | - | 4 | 3 360 | 4 | - | - | 4 | 3 360 |
| Harness and shuttle adjuster | V | 0.35 | 3 | - | - | 3 | 2 520 | 3 | - | - | 3 | 2 520 | 3 | - | - | 3 | 2 520 |
| Roller adjuster | V | 0.35 | 2 | - | - | 2 | 1 680 | 2 | - | - | 2 | 1 680 | 2 | - | - | 2 | 1 680 |
| Unspecified | V | 0.25 | 12 | - | - | 12 | 7 200 | 12 | - | - | 12 | 7 200 | 8 | - | - | 8 | 4 800 |
| IV. Administrative staff | | | | | | 38 | 81 840 | | | | 33 | 75 840 | | | | 32 | 93 120 |
| Managerial staff | A | Monthly Salary: US$ 500 | | | | 2 | 12 000 | | | | 1 | 6 000 | | | | 1 | 6 000 |
| Engineers | A | Monthly Salary: US$ 500 | | | | 2 | 12 000 | | | | 3 | 18 000 | | | | 5 | 30 000 |
| Technicians | A | Monthly Salary: US$ 350 | | | | 4 | 16 800 | | | | 4 | 16 800 | | | | 6 | 25 200 |
| Supervisors | A | Monthly Salary: US$ 220 | | | | 6 | 15 840 | | | | 6 | 15 840 | | | | 8 | 21 120 |
| Office staff | A | 0.50 | | | | 18 | 21 600 | | | | 13 | 15 600 | | | | 6 | 7 200 |
| Sweeper and watchman | A | 0.25 | | | | 6 | 3 600 | | | | 6 | 3 600 | | | | 6 | 3 600 |
| Total fixed labour | | | | | | 136 | 165 000 | | | | 106 | 134 400 | | | | 92 | 126 120 |
| Total variable labour | | | | | | 494 | 397 272 | | | | 307 | 240 432 | | | | 191 | 153 864 |
| Total administrative staff | | | | | | 38 | 81 840 | | | | 33 | 75 840 | | | | 32 | 93 120 |
| Grand total | | | | | | 668 | 644 112 | | | | 446 | 450 672 | | | | 315 | 373 104 |

a/ F = fixed; V = variable; A = administrative.
b/ The third shift has been increased by 20 per cent.

Table M

ANNUAL PRODUCTION COSTS ACCORDING TO THE DIFFERENT HYPOTHESES STUDIED

(Dollars)

| Specification | Level A | Level B | Level C | Per metre | | |
|---|---|---|---|---|---|---|
| I. Fixed costs | 1 130 812 | 1 304 969 | 1 470 927 | | | |
| Fixed labour a/ | 165 000 | 134 400 | 126 120 | | | |
| Administrative labour a/ | 81 840 | 75 840 | 93 120 | 0.02053 | 0.01499 | 0.01427 |
| Social security b/ | 98 736 | 84 096 | 87 696 | | | |
| Maintenance c/ | 18 135 | 25 237 | 29 315 | | | |
| Depreiation d/ | 227 751 | 302 339 | 349 976 | 0.01353 | 0.011540 | 0.01628 |
| Interest e/ | 534 400 | 679 025 | 780 916 | 0.03175 | 0.03459 | 0.03633 |
| Overheads f/ | 4 950 | 4 032 | 3 784 | | | |
| II. Variable costs | 2 361 023 | 2 437 663 | 2 514 539 | | | |
| Raw material g/ | 1 644 064 | 1 917 632 | 2 100 896 | | | |
| Ancillary materials h/ | 32 881 | 38 352 | 42 018 | | | |
| Variable labour i/ | 397 272 | 240 432 | 153 864 | 0.03304 | 0.01715 | 0.01002 |
| Social security j/ | 158 909 | 96 173 | 61 546 | | | |
| Maintenance k/ | 36 270 | 50 474 | 58 630 | | | |
| Electric power, water and steam l/ | 56 735 | 58 576 | 60 424 | | | |
| Sales expenditure m/ | 34 892 | 36 024 | 37 161 | | | |
| III. Total costs | 3 491 835 | 3 742 632 | 3 985 466 | | | |

a/ See table L.
b/ 40 per cent of fixed and administrative labour costs.
c/ Fixed maintenance costs, calculated at 1 per cent of the cost of the basic equipment.
d/ Linear depreciation over 40 years for buildings and 15 years for machinery at cost, installed and ready to operate.
e/ 12 per cent of total investment per annum.
f/ 3 per cent of fixed labour costs.
g/ See tables E, F and G.
h/ 2 per cent of raw material costs.
i/ See table L.
j/ 40 per cent of variable labour costs.
k/ Variable maintenance costs, calculated at 2 per cent of the cost of the basic equipment.
l/ About 2.5 per cent of variable production costs.
m/ About 1.5 per cent of variable production costs.

/The data

The data on prices and operating conditions of the machinery referred to in the present study were obtained by consultation with the firms listed below, to which ECLA wishes to express its gratitude.

1. Abbot Machine Co. Inc.
   Greenville, South Carolina
   U.S.A.

2. Barber-Colman Company
   Rockford, Illinois
   U.S.A.

3. Bergedorfer Eisenwerk Aktiengosellschaft Austra-Werke
   Hamburg - Bergedorf
   West Germany

4. British Northrop Sales Limited
   Blackburn, England

5. A. Carniti & Co.
   Oggiono - Commo
   Italy

6. Cocker Machine & Foundry Company
   Gastonia, N.C.
   U.S.A.

7. Deutscher Spinnereimaschinenbau Ingolstadt
   Schiebfach 260
   Ingolstadt - Donau
   West Germany

8. Draper Corporation
   Hopedale, Massachusetts
   U.S.A.

9. Fratelli Marzoli & Co.
   Via Borgogna, 8
   Milano, Italy

10. Gebruder Sucker Gmbtt.
    405 Munchen - Gladbach
    Postfach 205
    West Germany

11. Carlo Gianti S.A.
    Via C. Menotti, 1
    Busto Arsizio-Varese
    Italy

/12. Joseph Hibbert

12. Joseph Hibbert & Co. Ltd.
Century Works, Darwen
Lancashire - England

13. Howa Machinery, Ltd.
Shinkawa-Cho
Near Nagoya, Japan

14. Invest Export (Textima)
Taubenstrasse 7-9
Berlin W8/DDR
German Democratic Republic

15. Leesona Corporation
333 Strawberry Field RD.
Warwick, Rhode Island 02887
U.S.A.

16. Leesona Limited
Heywood, England

17. Lindauer Dornier
Gesellschaft M.b.tt.
Lindau (bodensee)
West Germany

18. Métiers Automatiques Picanol S.A.
1-13 Ave. de Pologne, Ypres
Belgium

19. Pietro Muzzi
Via Luigi Maino, 7
Busto Arsizio
Varese - Italy

20. Omita
Albate, Commo
Italy

21. O.M. Ltd.
Umeda Bldg. 7 Umeda, KITA-KU
Osaka, Japan

22. Platt Bros (Sales) Limited
Oldham, England

23. Rieter Machine Works
Winterthur, Switzerland

24. Ruti Machinery Works Ltd.
Ruti /ZH
Switzerland

25. Saco-Lowell Shops
Box 2327, Greenville, S.C.
U.S.A.

26. Adolph Saurer Ltd.
Arbon
Switzerland

27. W. Schlafhorst & Co.
405 Munchen-Gladbach
West Germany

28. Schweiter Ltd.
8810 Horgen 2, Zurich
Switzerland

29. Société Alsacienne de
Constructions Mécaniques
Boite Postale 319
Molhouse, France

30. Strojexport Kovo Elitex
P.O.B. 7966, Praha
Czechoslovakia

31. Tattersall & Holdworth's
Enschede,
P.O.B. 53
Holland

32. Tecnomeccanica Lombarda S.P.A.
Viale Tunisia, 45
Milano, Italy

33. Toyoda Automatic Loom Works Ltd.
Karia Aichi-Ken
Japan

34. Within Machine Works
Withinsville, Mass.
U.S.A.

35. West Point Foundry & Machine Co.
West Point, Georgia
U.S.A.

36. Zinser Textilmaschinen G.m.b.tt.
7333 Ebersbach (Wuertt) Fils
West Germany