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# INTERNATIONAL FORUM ON APPROPRIATE INDUSTRIAL TECHNOLOGY

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**WORKING GROUP No.3**

**APPROPRIATE TECHNOLOGY  
FOR THE  
PRODUCTION OF TEXTILES**

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**APPROPRIATE TECHNOLOGY FOR TEXTILES**  
**Discussion Paper**

Appropriate Technology for Textiles \*

Issues and Considerations

Note prepared by the secretariat of UNIDO

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This Note has been based on the background documentation on the subject, which is attached.

## INTRODUCTION

1. Clothing is a basic need and the production of textiles is one of the oldest activities of mankind. The industrial revolution began with the mechanisation of textile production, and the industrial development of the advanced countries owed much to the vigorous expansion of their manufacturing textile industries. In the developing countries the textile industry was one of the first to be established when their industrialisation programmes were founded. For these countries the textile sector's importance is also due to high employment potential as well as to the value added to the manufacturing sector. Apart from generally being a labour-intensive industry, it has greater employment linkages of a much larger dimension in agriculture, transport, trade, etc. Thus the orderly structuring of the textile production assumes great significance in the industrialisation programmes of developing countries.

2. Textiles production also offers a wide range of technologies where selection is possible based on socio-economic goals of countries as well as production efficiency. It also permits product and process integration as well as opportunities for bringing industry to the people. In this sense it has all the possibilities of being a highly dynamic sector, rather than the static sector as it has been commonly known.

3. After a half century of stagnation, technological progress in the developed countries during the last two decades has brought a new dimension to textile production. Production capacity of textile machinery has increased dramatically. Advanced automation is now being applied at all stages of fabric and fibre processing. Furthermore an entirely new range of raw materials have been developed which has influenced inter-alia the world textile trade. Although the share of textile production in developed countries in the world production has declined slightly during the last ten years, their exports in machinery and equipment have increased sharply. This trend is likely to enlarge greatly as most of traditional textile producing developing countries are planning to modernise their large-scale production units.

1. THE TEXTILE INDUSTRY IN DEVELOPING COUNTRIES

4. Traditionally, the levels of labour and machine productivity in the developing countries in the textile industry have been significantly lower than those obtained in the other major advanced textile producing countries of the world. The present level of productivity achieved by an average textile industry in the developing countries is substantially below the levels achieved in the developed countries. Developing country-productivity levels can be considered to be between one-half and one-third of those achieved in advanced countries.

5. In the developing countries the average production per spindle/year for 20's count is 82.5 Kg as against 200 kg in the developed countries. A substantial part of the difference is because of lower spindle utilisation. Furthermore, the spindles in the developing countries are worked mostly on the basis of 22.5 hours a day for 300 days a year. In contrast textile mills in developed countries work 24 hours a day for 350 days a year. Of the total installed spindles in the developing countries only about 80% are utilized as against an achievable level of 96%. If the spindle utilization is increased to the maximum permissible levels the production per spindle/year can be increased from 82.5 Kg to 125 Kg. This still leaves a productivity gap of nearly 75 Kg per spindle/year.

6. In weaving also in the developing countries the productivity levels are much lower than those in the developed countries. The productivity per operative shift for a standard sheeting is 2.87 times higher than the comparable figure for weaving on automatic looms. Relative to the productivity per operative/shift on non-automatic power looms, in the developed countries, operative productivity is 6.5 times higher, mainly due to the exclusive use of the automatic loom. This large difference is due to the lower levels of labour productivity and machine productivity. The contribution of labour productivity to overall productivity gap is likely to be more than that of machine productivity.

7. The problems of the textile industry in developing countries belong to two major groups: technological problems relating to modernization, productivity and higher production; socio-economic problems relating to labour, management and working capital.

8. Proper machinery selection is one of the key problems in the development of textile industry. The machinery must suit the two-fold requirements of most developing countries: it should be up to date to allow for competitive production, and, on the other hand, it should not provide unnecessary savings in labour force at the expense of higher capital costs. An effort should be made to choose from the modern technological alternatives a level that strikes a balance between fixed costs based on depreciation and variable costs based essentially on wages.

9. Prices of textile machinery have sharply increased over the last two to three years all over the world. The determination of prices and cost competitiveness of capital goods is normally a difficult exercise since international prices are usually influenced by the size of the manufacturer's domestic market, marginal cost.

10. While the core of a technology might be the machinery, an efficient utilisation of machinery requires also several other peripheral factors of which technical skill, organizational and managerial support, infrastructural facilities for transport, communication and storage, and the availability of appropriate raw materials are the most important. The machinery can be imported relatively easily but the supporting facilities are more difficult to establish and maintain. The lack of such facilities has been an equally important factor in deciding the suitability of imported technologies in developing countries. Because of the bad roads and the distances between the spinning units and the weaving sheds the cost of yarns varies from one location to another as a result of high freight charges. Moreover, the weaving sheds are obliged, in these circumstances, to maintain a large stock of yarn to ensure a regular supply.

11. At the present time the textile industry is working in unfavourable conditions. There is very low productivity, a high density of workers, a low degree of integration, insufficient management skills in production and in marketing, and a shortage of finance. These factors lead to a high cost of production and the inability to compete with imported materials.

12. Synthetics have managed to penetrate cotton markets in three forms: through new products; through new properties in existing products; and through new processes. Other major contributory factors have been extensive promotion campaigns by the synthetic fibre producers, price stability and guaranteed availability.

13. In developing countries, synthetic fibre textiles can cost two or three times more than those made of cotton. Of still greater importance to the relative economies of the developing countries is the fact that a single employee in a synthetic fibre plant can displace up to 33 persons associated with cotton production.

#### 11. REVIEW OF ALTERNATIVE TECHNOLOGIES

14. Production of textiles is undertaken normally in developing countries in the organised (large-scale mills) sector and the dispersed sector (small scale and in rural areas): the organised sector comprising of mills which can be further sub-divided into private sector, public sector and co-operative sector; then the decentralised sector consisting of hand spinning, hand looms, power looms (including art silk looms), knitting, chemical processing, etc. Within each of the sectors, the individual units span a wide spectrum in respect of size, output, turnover, technical competence, and to some extent the level of technology.

15. The textile industry in developing countries has, by and large, yet to adopt the most recent technological developments. The production is generally restricted to "conventional" technology and machinery incorporating the most modern advances has to be imported. In view of the high cost of imported machines and the high levels of import duty, imported technology very often becomes prohibitive for most factories, although individual factories with specialised production patterns may find one or the other imported technology attractive. The upkeep and operation of the modern machinery is also likely to pose problems in many mills, although there are a sufficient number of units with the necessary competence and skills.

16. At the same time, the productivity levels in the organised sector are low, even when allowances are made for the overall level of technology, and low machine utilisation as a result of raw material shortages,



power cuts and labour unrest. The more important factor is the old and obsolete machinery in many mills. Modernisation is an urgent need of the textile industry. However, modernisation context does not imply a switching over to more advanced technologies only. Replacement of machines that are in poor mechanical shape or in need of renovation, i.e., conversion of existing machines for higher productivity is a more realistic and feasible approach.

17. The decentralised sector is even more heterogeneous. The definition of the decentralised sector is largely based on the scale of production and does not always take into consideration the technological factors. Thus, in the knitting sector, there are warp and circular knitting machines which represent a fairly high level of technology. Similarly, between the organised and power loom sectors, there is no basic difference in the level of technology.

18. At the other extreme, the decentralised sector continues to employ techniques which have remained unaltered over decades if not centuries. Hand spinning, hand weaving, block printing are some of the typical examples. Hence, it would be erroneous to broadly equate the decentralised sector as "outmoded" technology.

19. The recent technological developments in spinning, weaving and finishing have been outlined in the background documents submitted to the Forum. This does not mean that developing countries have to adopt the most modern and sophisticated technology. On the contrary, it means that they have a wider range of alternative technologies and machinery than perhaps in industry to suit the factor situations in developing countries, and the markets. A judicious exercise of choice therefore is called for in choosing such technologies.

20. Economies of scale fall into two distinct categories. First, there are those which arise from the possibility of organizing the manufacturing process more efficiently when the volume of output increases, but without the processes themselves undergoing any fundamental change. Machinery and equipment are available in a limited range of sizes, and sometimes the minimum size may have a productive capacity greater than required. It is rarely possible to balance the productive capacity of equipment at each of the many stages of manufacture, and there will always be

idle machine time. As the installed production capacity grows, however, there is a reduction in the proportion of machine time which must be idle, even when the plant as a whole is operating at maximum output. Larger machines, producing a larger output, need not require more operatives to attend them. Economies can be expected in respect of machine maintenance, stocking of spare parts and so on.

### III. DECENTRALISED SPINNING

21. In so far as the textile industry is concerned, the weaving part is already decentralised and technological alternatives are available and in use. There is also gradual upgrading of technologies and appropriate production scales are employed. However, for initiating and integrated decentralised cloth production, the handicap is in the lack of proper technology for decentralised cotton spinning, as compared to the existing technologies for spinning yarn.

22. Many types of looms from traditional to improved varieties to semi-automatic power-looms together with Dobi and Jacquard arrangements to weave more complex pattern cloths are available. Given the parity in the cost of yarn both qualitatively and economically the handloom weavers in rural cottages can withstand the mill production. Some reduction in the cost of various ancillary operations - beam winding, sizing, reeling, dyeing and calendering are no doubt needed but again there is no great technical problem involved: it is more an organizational problem of getting groups of weavers to come together and collectively make use of machinery that is already available, but which has a minimum operating capacity more than sufficient for an individual weaving family.

23. So if a breakthrough can be made and a technologically sound and economically viable decentralised cottage spinning could be evolved then the textile industry could be decentralised in cottages in developing countries. The economic conditions of the cottage weavers where they still exist, as in India, could be improved from starvation level to a viable level.

24. If these weavers can be supplied yarn at the same price as it is available to the weaving section of the mills with greater surety of supply their income will increase and they can be in a position to look after their financial and other needs for future development.

The only solution appears to be to develop a spinning technology in villages preferably within the weavers' families, so that much of the marketing and transport expenses on the yarn could be avoided. These efforts will further create approximately one million jobs in rural areas in India.

25. The Indian experience in introducing and further developing "Amber Charalcha" are referred to in document ID/WG.282/34 prepared by the Appropriate Technology Development Association. It further provides details of the work done including cost calculations which the Working Group may consider and recommend necessary action.

#### IV. TECHNOLOGY OF FINISHING

26. Since finishing is primarily concerned with enhancing the visual and ornamental appeal of textiles, it has to respond, more than any other branch of textiles, to the constantly changing demands of fashion and taste. The introduction of man-made fibres has been accompanied by new dyes, auxiliaries and machinery, specially suited to them. Similarly, the growing popularity of knitted fabrics initiated special finishing techniques such as jet dyeing. Cotton finishing has also undergone significant changes to meet the strong competition from man-made fibres. Wash and wear and durable press finishing of cotton fabrics have been developed in an attempt to match the easy-care performance of man-made fibres. The increasing concern about fire hazards of textiles and pollution has resulted in legislative measures for safety. These steps have in turn catalysed new developments in finishing of which fire retardant finishing, solvent processing, and transfer printing are some major examples.

27. As in case of the technologies of yarn and fabric manufacture, finishing technology has also undergone changes towards higher speeds and elimination of intermittent processing. Continuous bleaching and dyeing have been widely accepted. Machine speeds in many of the finishing operations have also substantially increased with the result that the total time required for fabric finishing is far less than it was a couple of decades ago.

28. A large number of the composite mills have their own processing facilities; in addition some of the spinning mills carry out yarn bleaching and dyeing on a limited scale. In recent years, there has been an appreciable increase in the volume of finishing, particularly in dyeing and printing.

29. Most of the mills process only their own fabrics; processing of fabrics produced in other mills is not common, even though surplus machine capacity is generally available. Large and independent process houses with modern machinery, which buy cloth for finishing or undertake contract finishing are a relatively new phenomenon in the Indian textile industry. The number of such units is, however, steadily increasing.

30. The organised sector has been quicker to introduce the more recent developments in finishing compared to spinning and weaving. Some of the recent developments such as high pressure continuous bleaching, jet dyeing and rotary screen printing are in regular use in a number of mills. The value added in finishing being substantially greater than in spinning or weaving, a versatile range in finishing enhances the profitability of mills. This consideration perhaps explains the relatively quick adoptions of the more recent developments. The textile machinery manufacturing industry in India has also been prompt in arranging for the indigenous manufacture of several modern machines.

31. The problems in comparing different technologies are less severe in the case of printing than in the case of spinning, weaving or knitting. Although the various methods differ with respect to styling possibilities, intricacy of pattern, clarity, etc., there is an adequate common ground for comparison. It is seen that hand screen printing compares favourably with the other technologies in terms of labour cost. The advantages of hand screen printing will be even greater in the short run, as mentioned earlier. This technology is also labour intensive. It should, however, be noted that space requirements for hand screen printing are considerably higher than for other techniques. The cost of land and building will add to the capital requirements; these have not been included in the present analysis because they vary significantly from region to region.

V. AREAS OF R+D

32. The following is a list of R+D work that needs to be undertaken for the benefit of developing countries. This list is only suggestive rather than exhaustive.

- (a) Development of indigeneous spinning machinery;
- (b) Improvement of the aesthetic and performance characteristics of cotton-containing products through appropriate manufacturing process and product modifications (including the use of blends or admixture with man-made fibres) to meet market demands;
- (c) Improvement of the quality of cotton-containing textile products, both woven and knitted, as it affects:
  - "easy-care" performance (structure, finishes, application procedures, optimum blend ratios)
  - shape retention and dimensional stability
  - durability (especially in conjunction with modifying processes)
  - laundryability and ease of drying.
- (d) Minimization of the problems caused by impurities in raw cotton (ginned lint);
- (e) R+D on the improvement of the quality of batik by the mixing of 20-25 per cent of high quality wool to the cotton content;
- (f) Development and evaluation of processes and processing systems making cotton product manufacture more economical.

VI. POLICY IMPLICATIONS

32. Textile industry being the oldest industry has been the subject of concern of policy makers both in developing and developed countries. The developed countries have been concerned with protection of their industries against the competition of textile imports from developing countries. The developing countries on the other hand are concerned with modernisation of their organised sector and developing their competitiveness in the world market. The subject of attention in the Working Group is more concerned with the choice of alternative technologies and actions at the national level to re-orient and restructure the textile sector with a view not only to providing better textile products but also to develop industrial units which fulfil the requirements of socio-economic objectives such as employment,

redistribution of income. The question to be considered therefore is how to fully utilise the technological options available and to search for technological solutions, such as in the case of de-centralised spinning at competitive levels particularly in meeting domestic requirements. This does not imply that developing countries should not adopt the most modern processes particularly in areas such as knitting which is making inroads into weaving as an alternative, and in areas where export potential exists. The entire question of integration of textile production in a harmonious way needs to be looked into more closely particularly in view of the fact that there is a whole range of alternatives in spinning, weaving and finishing as well as alternative production scales. Bearing these considerations in mind the following policy level actions are suggested:

(a) The fiscal and development policies of the government are the most powerful tools in shaping the future pattern of growth. Clear enunciation of a long term and comprehensive policy is necessary. The policy should cover: raw material supply, targets, time schedules, alternative approaches, and the role of different manufacturing sectors and other agencies. Linkage between the textile and other industries should be identified.

(b) A higher utilization of the existing capacity in the organized sector should be strived for. Government, management and labour need to take concerted action to remove the impediments in the higher utilization. Judicious renovation and modernization, correction of imbalances in the present capacity, stricter attention to machinery maintenance are all steps which by themselves would generate a substantial volume of additional production required to meet increased consumption. Therefore, they should receive priority over capacity expansion.

(c) The aspiration of governments in the developing countries is to modernize the textile industry and increase the productivity. But at the same time, they want to protect the indigenous textile machinery industry for obvious reasons as they cannot today compete in quality with some of the foreign manufacturers. Therefore any import of textile machinery must fall in the group of machines which will increase the productivity in the context of appropriate technology, labour and yet be accepted by the import rules and regulations of that country.

(d) The technology of the textile machinery manufacturing industry in the developing countries although apparently not producing high-speed, modern, sophisticated fully automatic machinery currently used by the developed countries, it is nevertheless filling the most important gap and mainly producing such machinery and equipment which is conducive to the requirement of the developing countries. It is therefore suggested that considerable attention be given to this sector by governments to encourage it to introduce technological innovations and at the same time produce machinery appropriate for use in the dispersed sector in most of the developing countries.

(e) Technologies of knitting and garment-making, which combine a fair degree of mechanization with labour intensiveness, can be advantageously used for meeting the internal demand and for exports. Facilities for expansion of these segments should be created.

(f) In most developed countries, wastes of cotton, wool and rayon, blended or otherwise, are used in the production of non-woven fabrics. A full scale market survey would be useful to evaluate the possibilities of the same for the developing countries.

(g) The technology in the decentralized sectors needs to be improved. This area has not received sufficient attention and the efforts so far have been unco-ordinated. The objective should be to enhance labour productivity and product quality with only marginal increases in capital costs. Favourable features of the more advanced technologies can be adapted to suit the requirements of this sector. Financial and credit policies, including incentives and concessions for the decentralized sectors, are needed.

(i) Governments should be made responsible for encouraging the development of a wide range of ancilliary industries, and contributing to the growth of decentralized production by making available its expertise in technology and management to small-scale and cottage industry sectors.

33. The growth of the small scale and cottage industries sectors has been tardy mainly for want of satisfactory marketing arrangements for their products and supply of raw materials. Measures such as purchase preference, reservation for exclusive purchase by Government Departments and Public Sector Undertakings will also be used to support the marketing of these products.

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The following documents are being circulated on the subject:

Appropriate Technology in the Textile Industry of Sri Lanka	ID/WG.282/1
Evaluation of Appropriate Technology for Textile Production	ID/WG.282/12
Appropriate Technology for Textile Industries	ID/WG.282/14
Production of Cotton Cloth	ID/WG.282/23
Appropriate Technology for Cotton Yarn Spinning in Rural Areas	ID/WG.282/34
Dualism and Technological Harmony for Balanced Development	ID/WG.282/59





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