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TRENDS IN THE PRODUCTION AND PROCESSING OF COTTON*

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CONTENTS

THE IMPORTANCE OF COTTON TO GROUP 77 COUNTRIES

Of the 86 countries which are members of the Group of 77, about half are listed as cotton producers in the World Statistics issued by the International Cotton Advisory Committee (ICAC).

The relevant data for these countries is given in the Appendix. In all cases, the values quoted are the means for the three cotton seasons, 1984/5, 1985/6 and 1986/7. The data for this last season is described as "preliminary" by ICAC and may therefore be subject to minor revision.

These producing countries have been subdivided into three groups; those which are net exporters, those which are net importers, and those which have significant local textile production. There is of course some overlap between these categories.

From these tables it is clear that cotton is indeed an important commodity for many of the Group 77 countries in terms both of exports and as a basis for textile production.

Assuming a cotton price of 60 US cents per pound, total export earnings for the 15 exporting countries are about $1700 million annually. Their share of total world trade in raw cotton is about 28%.

Total mill consumption in the Group 77 countries, averaged over the three seasons, is 3,816,000 metric tons corresponding to about 23% of the world total. Much of this processed cotton (in the form of yarn, grey or finished fabric or garments) is subsequently exported and provides a hard currency income.

TRENDS IN COTTON PRODUCTION

a) Broad considerations

In the 40 or so cotton growing countries in the Group of 77, there is a very wide range of soils and climatic conditions, of social and cost structures, of water and labour availability of opportunities to produce alternative crops, of infra-structures etc.

Within such diversity, it is not easy to pick out general trends. One might expect that every country would strive for the highest yields since, at harvest time, a farmer's earnings are largely determined by the weight of cotton he has produced. However, examination of the data shows that yields vary from about twice the world average to almost one tenth of the average. This spread is, in many cases, a reflection of the importance attached to cotton as a major commercial crop and/or of the wide range of input costs which must be covered by the earnings generated from high yields.

Some countries have grown cotton for many decades and have well established grading and marketing systems while others have only recently introduced it. Some countries have little opportunity - due to climatic conditions - of growing crops other than cotton while others have many possibilities and/or include cotton as just one element in a rotation.

Nevertheless, in spite of the wide range of conditions under which cotton is produced in the Group 77 countries, it is possible to identify a few common directions in which many countries are moving. In some cases, real progress is being made; in others, the necessity of action is well recognised but lack of resources makes it difficult or even impossible to make much progress.

b) Varietal improvements

Each country, and frequently each region within a country, needs to find varieties which will flourish under the local conditions. Genetic and breeding research in both developed and developing countries is producing a steady flow of information and new cotton germ plasm. Many of the varietal improvements needed in developing countries can be accomplished by making greater use of the world's germ plasm resources (such as the International Board for Plant Genetic Resources) and information services such as those provided by ICAC.

However, the development of superior varieties does not automatically result in good quality seed being available for planting. There is a growing recognition of the crucial importance of creating a strong organisation which provides farmers annually with seed with a high standard of genetic purity and of quality. Several countries such as Syria, Turkey and Zimbabwe have excellent seed production and distribution programmes which could serve as models for other countries.

c) Engineering applications

In many developing countries, agricultural labour is one of the most abundant resources but in some, it is becoming less available due to the movement of populations away from rural areas. To counter this shortage, some countries are experimenting with machinery for land preparation, seed planting and harvesting. This transition is by no means straightforward and has major implications both for agricultural practices (such as the choice of suitable varieties, size of fields, row spacing, etc) as well as for the ginning operation and fibre quality (see later).

Economic considerations may force some countries into mechanisation but there can still be important benefits for those which have to or prefer to rely on manual methods.

The importance of careful ginning is becoming more widely appreciated. Traditionally ginning was regarded as a Cinderella operation but the losses in weight and quality that can result from poorly maintained or carelessly operated equipment are now generally recognised. This recognition arises, in part, from the trend towards mechanical harvesting mentioned above; cotton gathered in this way is more contaminated with leaf and trash and thus more cleaning is needed during the ginning operation. If this is not done carefully, fibre damage can occur.

d) Crop protection measures

Cotton plants attract a great variety of pests and unless these are controlled, both the quality and the quantity of the fibre crop can be seriously affected. Similarly, control of weeds is essential, not only to maintain yields but also to minimise contamination of the harvested fibre.

With the advent of organochlorine insecticides, frequent spraying of cotton became the norm since this appeared to be a quick and easy way of control. This was undoubtedly true in the short term. However, the loss of "friendly" predators and the build-up of resistance in the troublesome pests forced farmers to use ever higher dose rates and more frequent spraying until in some countries, the cost of insecticides amounted to as much as 30% of total crop production costs.

Clearly this could not continue and the present trend is towards a far more sophisticated approach - integrated pest management (IPM). Several different methods of control are skilfully integrated into a total package which is carefully tailored to the specific location. Consequently, no two IPM systems are alike but typical elements are the establishment of the "economic" threshold of infestation, regular checks of insect populations, biological controls, sterile insect releases, improved cultural practices, strict control over planting and harvesting times as well as post-harvest measures. Chemicals remain as one component but on a very selective basis and with greater emphasis on the use of less potent and more degradable products.

Where IPM methods have been introduced, they have been very successful although good management and an enlightened attitude by the farmers are essential ingredients for success.

e) Fibre quality

The so-called cotton industry consists of two major elements - the producers of the fibre and the processors. While the neatly packaged bale may be the final product for the former group, it is merely the raw material for the latter and the price and acceptability of that bale depends critically on the value that the spinner attaches to it. Indeed, the spinner may refuse to buy that bale at any price if he knows or suspects its contents will not process satisfactorily in his mill.

These comments may seem very obvious but in the past, cotton growers have paid surprisingly little attention to the quality of the fibre they produce. As mentioned earlier, yield has been their major objective.

This attitude is slowly changing for a number of reasons.

Firstly, there is a much better understanding by the spinners of what constitutes a "good" cotton and this is slowly feeding back to the growers. This is discussed in the later sections of this paper.

Secondly, testing methods have advanced to the point where it is now possible to measure many more parameters on the fibre in <u>every</u> bale. This means that a much better technical description of the cotton can now be made and deficiencies which were in the past not recognised now become visible.

Thirdly, there has generally been a surplus of raw cotton in the world in recent years. This has enabled spinners to be very selective and they will choose those growths which give the highest conversion efficiencies and yarn quality in their mills.

Finally, it has become clear that ginning is a key operation which can preserve or seriously damage cotton fibre properties. This realisation is having a profound effect on agricultural practices such as selection of varieties, methods of picking, pre-ginning storage, contamination, etc.

TRENDS IN COTTON PROCESSING

a) Broad considerations

In many respects the situation facing the spinner today parallels that of the cotton farmer. Both are trying to sell into an over-supplied market, both are looking to cut production costs and improve product quality and both frequently have the choice of producing other "crops". In the case of the spinner he can choose to blend cotton with synthetic fibres or wool or even to change over to the manufacture of 100% synthetic yarns.

In the interests of higher efficiency and production, the traditional combination of discrete processing stages between the bale and the final yarn has been replaced by continuous, automatically controlled systems in which little or no human intervention is possible. For the elements of such a system to combine smoothly and generate a uniform product, the quality of the raw fibre input must be both high and consistent.

Slimmer profit margins require that much more attention must be paid to weight losses in processing caused by the need to remove non-fibrous impurities (trash), by inadvertent loss of good fibre and by removal of damaged fibre.

Like the farmer, the spinner must also keep in mind the requirements of his customers - the weavers and knitters. Faced with similar pressures, they too are looking for better quality yarns which will give high processing efficiencies on their faster looms and knitting machines. Certain defects in fibre quality can also cause costly problems for dyers and finishers; these can be very serious because nowadays a customer demands a virtually fault-free final product.

It is important to appreciate that spinners rarely buy all their fibre from one region. A typical spinning mill will obtain bales from three, four or even more countries to guard against crop failure or inadequate supplies from one source. Only by taking such precautions can the spinner be reasonably certain of producing a constant quality of yarn on a regular basis. One of the rare exceptions to this rule is Zimbabwe. The producers there have established such an excellent record in terms of quality and availability that certain spinners now have sufficient confidence to rely solely on supplies of cotton from that country.

b) **General fibre quality requirements**

Whatever system of cotton spinning is used there are certain basic requirements which the raw fibre must meet if it is to be acceptable to the spinner.

It must be clean.

Almost any extraneous material causes problems at some stage in the pipeline from cotton bale to finished fabric. The range of materials which have been found in cotton bales is incredible; while the most common and troublesome contaminants are pieces of plastic twine and honeydew, shoes, stones, clothing, machine parts, pieces of rubber have also been reported. In the "old days" most of these impurities could be removed by hand during the manual feeding of the opening equipment in the mill, but nowadays, such remedial action is impossible in mills which have modern equipment.

Plastic (particularly polypropylene) string causes immense problems because it is disintegrated and dispersed by the machinery in a spinning mill to such an extent that a small length can spoil many hundreds of garments worth tens of thousands of dollars. The spoilage is due to the fact that polypropylene will not accept dyestuffs and therefore small fragments appear as shiny white specks against a dyed background in for example, a velvet dress or pair of slacks. Since the problem is only detectable at this late stage in the processing, it is not difficult to imagine the aggravation and litigation which can be generated. After such a costly experience, a spinner will often refuse to use cotton from the offending producing country.

The other serious contaminant is honeydew. This can cause the cotton to be completely unspinnable, a situation which creates such serious problems for the spinner that again he may refuse to trade with that supplier. Cotton exports from the Sudan have, in recent years, been affected by such considerations.

Since impurities can be introduced into the raw cotton at many points, remedial actions are equally numerous. However, they all involve the use of rigid systems of control and inspection from the field to the final bale, together with education programmes to make everyone aware of the serious effects of the contamination.

Another source of contamination is the cotton plant itself. Whole, broken or immature seeds can pass through the gin, and fragments of leaf and stalk can also be incorporated into the bale. In general this type of visible contamination (trash) is not a major problem. All cleaning machinery in mills is designed to remove large particles of trash and any small fragments remaining can usually be eliminated by subsequent scouring and bleaching of the yarn or fabric. Raw cotton also contains fine dust from a variety of sources. In ring, air jet and friction spinning, its presence causes no problems but in rotor spinning, the dust collects in the rotor grooves and causes yarn irregularities.

However, it is extremely important that the steps taken by the ginner to produce a clean product do not cause excessive damage to the fibres themselves. There are at present strong financial pressures on the ginner to increase production speeds and to produce a visibly clean product. These objectives are often achieved at the expense of the "invisible" fibre damage which only becomes apparent in the spinning mill.

It must be mature.

Maturity is the ratio of fibre wall thickness to overall diameter. A low maturity (thin fibre walls) is always a disadvantage because such fibres tend to tangle to produce unsightly neps, to break easily and to cause dyeing difficulties. In a recent survey in 94 major spinning mills in 19 countries, 90% of the respondents stated that fibre maturity was an important quality factor.

In many countries, a Micronaire measurement is often used as an indication of fibre maturity. This test can give rise to very misleading results. It is outside the scope of this paper to explain the reasoning behind this statement or to suggest alternative approaches. Suffice to say that a Micronaire reading of say 3.6 can mean either a relatively coarse, immature fibre or a fine, mature fibre. A spinner would view these two products very differently!

It must contain few broken fibres.

Before cotton lint is removed from its parent seeds, it contains very few (1-3%) short fibres. But by the time the lint is in bale form, the percentage of short fibres can be as high as 10-20% due to the damage caused in ginning and cleaning. Broken fibres have a very deleterious influence on yarn quality and processing efficiency and can result in a considerable loss of weight and therefore value. A spinner accepts that every bale will contain some broken fibres but he hopes that not only will the percentage be low but that they will be distributed more or less uniformly throughout the delivery.

Indeed, many spinners have stated that they prefer to buy somewhat dirty but undamaged cotton and clean it (gently) themselves.

A recent paper from a leading UK spinning company has highlighted the growing incidence of broken fibres. From test results on over 2500 otherwise similar samples they concluded that

"the extent of the overall increases over the last twenty years in fibres less than 1/2 inch were:

Russian growths	11% to 20% (by number)
Colombian	12% to 20%
Mississippi	14% to 25%
African	11% to 15%

The spinner must be concerned that the trends.....show no sign of levelling off."

It is significant that the lowest rate of increase is for the African growths where the cotton is still hand picked and where pressures for increased production and cleaning at the gins have been less severe than, for example, in the USA.

The growing incidence of fibre breakage, largely during ginning has prompted research workers, notably in Belgium, to examine possible remedial actions. They have postulated that if fibres could be removed very readily from their parent seeds, ginning could be a much more "gentle" operation with a resulting decrease in fibre damage. In order to examine this idea, they developed a device for measuring the strength of fibre to seed attachment and have shown that it varies widely. Typical results are 10 units for barbadense varieties, 40-80 units for hirsutum varieties and several hundred units for wild species.

This work is being followed up and expanded by the International Institute for Cotton (IIC) and several cotton growing countries have expressed keen interest in, and support for, the work.

c) **New spinning systems**

It is important to keep a sense of proportion about the importance of new systems for yarn production.

The first rotor spinning machines were shown at an international exhibition over twenty years ago. They have very clear advantages for the production of coarser count (heavier) yarns and yet rotor spun yarns represent only about 20% by weight of all short staple yarns produced today. The remaining 80% of yarn is still manufactured on ring spinning frames. One major machinery manufacturer estimates that by the year 2000, the corresponding figures will be 40% for rotors and 55% for ring spinning with only 5% of yarn produced on the newer systems.

A spinner, looking for raw material for his rotor machines, can generally find what he wants within the very wide range of varieties, growths, qualities, etc that are available from the eighty or so cotton producing countries. He will of course be looking for particular combinations of fibre properties (see later) which are somewhat different from those desired by ring spinners but such combinations are available in sufficient quantities to meet his needs today.

Thus the argument that a cotton producer, especially in the countries under consideration, should concentrate on producing fibre for new spinning systems is misguided. Most of these producers have so many problems producing an adequate yield of fibre which meets the general quality criteria described earlier, that to propose they should attempt to produce a crop with special characteristics is quite inappropriate.

Of course, it may happen that one particular growth that has been found to be agronomically very suitable in a particular country, does produce fibre whose characteristics are very suitable for rotor spinning. In such a case, advantage should obviously be taken of this fortuitous circumstance. But in general, breeding programmes should concentrate on producing plants suitable for the local conditions and fibre which is suitable for conventional spinning.

i) Rotor spinning

As mentioned above, this system is firmly established in many countries as the preferred method of producing coarse count yarns for knitted outerwear and underwear, towels, denim, curtainings, dress fabrics, etc. The geographical distribution of the rotor installations which were active in 1984 (latest data available) was approximately as follows:

Africa	82,000	rotors
North America	328,000	"
South America	120,000	"
Asia/Oceania	622,000	"
Europe (Comecon)	3,403,000	"
Europe (rest)	423,000	"

At present the penetration of the rotor system is 40% in Europe and almost as much in the USA although in the world as a whole, the penetration is around 20%.

About 40% of rotor spun yarns are 100% cotton and a further 36% are cotton/polyester blends and therefore the system is clearly very suitable for spinning cotton.

The most important fibre qualities required for both good processing performance and good yarn quality are, in order, high fibre strength, fineness and cleanliness.

High fibre strength is very important because the geometrical arrangement of fibres in a rotor yarn is such that the individual fibres cannot contribute fully to the strength of yarn. Consequently, rotor yarns are commonly 10-15% weaker than ring spun yarns and this disadvantage can be offset only by using stronger fibres.

Fineness is important for similar reasons. It is well established that 15-20% more fibres are required in the cross-section of a rotor yarn in order to guarantee adequate strength and spinning stability. Thus, unless the fibres are fine, the count range of yarns which can be spun is limited to the coarser end.

A clean raw material is essential for rotor spinning. In this context, cleanliness means the virtual absence of visible contamination (trash) and also of fine dust. If present, both can collect in the grooves of the rotors and, unless removed at regular intervals, can produce faulty yarn. One leading German manufacturer suggests that trash levels in raw cotton should be below 1g per kg and dust levels below 0.03g per kg for satisfactory rotor spinning.

A high level of maturity is always advantageous as explained previously.

Fibre length and length uniformity are less important for rotor spinning than for ring spinning and as the same German manufacturer says "the long staple varieties sought by ring spinners are not the ideal raw material for rotor spinning if strength and fineness are lacking."

ii) Other spinning systems

At the present time, two other ·ple spinning systems have reached the stage of development at which their potential is being evaluated in commercial trials. The systems are known as "friction" and "air jet."

As far as raw material requirements are concerned, both have much in common with rotor spinning. None of the systems produces yarns as strong as ring spun yarns although the rotor and friction systems produce - with pure cotton - rather better strength realisations than does the air jet approach.

Thus for all three systems - rotor, friction and air jet - the fibre quality requirements are likely to be similar with strength, fineness, maturity and cleanliness all being important.

However, as more experience is gained with these systems, it is likely that other fibre features of importance to processing efficiency and/or yarn quality may be identified. For example, in friction spinning it appears that cottons of different origins behave differently in their ability to accept twist. This behaviour is presumably related to their surface frictional characteristics. This is a property not normally studied and one where control or selection may be quite difficult.

d) H.V.I.

As mentioned previously, it is now possible to measure fibre length, length uniformity, strength, elongation, colour, trash and micronaire extremely rapidly on what are termed "High Volume Instruments". Typically one test unit costs about $150,000 but it is capable of measuring these properties on about 2,000 bales of cotton in one day. This enables a producer or merchant to test very large numbers of bales during a season. In Texas, for example, over 90% of all bales produced are currently tested on H.V. lines; for the US as a whole the figure is 37%. This last figure corresponds to over 5m bales.

Over 200 H.V. lines are already in operation in about 30 countries and there is little doubt that these numbers will increase rapidly.

Measuring fibre properties is merely the first step. The second is to relate the level of these properties to the spinning performance of the fibre and to attach monetary values to different levels of each property. This is clearly a very complex task but it is being vigorously tackled in the USA and in Europe and the system finally adopted there may well have a powerful influence on the assessment of cotton fibre prices in the rest of the world.

The growing use of H.V.I. systems by both cotton producers and by the more progressive spinners will inevitably have an impact on cotton exports from developing countries. They will be at a considerable disadvantage in that their customers (e.g. merchants or spinners) will be able to find out more about the quality of the sample or consignment than the grower/exporter.

The author has already heard of cases where a particular consignment was being offered at a low price by the developing country exporter because it was thought to be of a poor quality. An importer acquired a sample, tested it on his H.V. line and discovered that, in fact, the fibre quality was very good. He bought a substantial amount and sold it at a considerable profit.

e) **Cotton processes other than spinning**

There have been many evolutionary developments in all fabric manufacturing and finishing processes in recent years. Their impact on exports from developing countries - raw fibre, yarn and fabric - can be summed up quite simply: a high quality of product is required.

The quality factors which relate to fibre have already been described. For yarns, quality means uniformity from inch to inch and from cone to cone, high strength, uniform dyeing behaviour, freedom from impurities and especially from foreign fibres, conformity to specification, etc.

For fabrics, quality means very few faults of any type, consistency of width, few short (less than 40 metre) pieces and conformity to specification. A typical maximum fault rate quoted is 1 minor fault per 10 metres of fabric. The specification assumes major faults have been removed or avoided by the supplier.

SUMMARY

1. Although cotton growers must continue to improve yields and reduce production costs, they must pay comparable attention to the quality of the fibre.

2. For all spinning systems, the basic requirements are clean fibre, a high level of maturity and a low percentage of broken fibres.

3. Ring spinning still accounts for about 80% of all short staple yarns. Fibre requirements are, in order, good length and length uniformity, strength and fineness.

4. The only other short staple spinning system in significant commercial use today is rotor spinning which accounts for about 20% of all yarns produced.

5. For satisfactory rotor spinning, fibre requirements are in order, strength, fineness, cleanliness and length.

6. The newer systems - air jet and friction spinning - will probably require fibre properties similar to those for rotor spinning.

7. Attention should be paid to the implications of high volume testing and the influence it will have on the marketing of raw cotton.

8. Full advantage should be taken of recent findings to select those cotton varieties in which the fibre can be separated easily from the seed. Such varieties should gin easily and fibre breakage should be minimised.

9. Many of the exports from Group 77 countries are eventually sold to processors, retailers and customers in developed countries. It cannot be emphasised too strongly that all these groups are demanding a higher standard of product which has to be maintained from delivery to delivery.

This paper has concentrated on technical considerations but the traditional commercial factors involved in successful trading must not be overlooked. A buyer will often prefer a prompt delivery of a slightly faulty product to a late delivery of perfect quality!

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COTTON PRODUCERS IN THE GROUP OF 77
(1000 metric tons)

Country	Average Production 1984-7	Average Yield (kg/hectare)	Average Consumption 1984-7	Average Exports 1984-7	Average Imports 1984-7
Afghanistan	25	368	12	10	nil
Angola	4	310	2	1	nil
Bangladesh	4	168	41	nil	41
Benin	35	509	2	30	nil
Burma	22	83	22	1	4
Burundi	2	317	-	2	nil
C.A.E	13	144	2	13	nil
Chad	37	240	2	37	nil
Yemen,D	5	400	1	4	nil
Egypt	413	842	287	128	29
Ethiopia	21	344	20	2	nil
Ghana	2	197	7	nil	6
India	1722	207	1608	118	4
Indonesia	7	180	160	nil	159
Iran	110	479	92	15	nil
Iraq	7	480	28	-	25
Cote d'Ivoire	88	510	20	67	nil
Kenya	10	52	9	1	4
Madagascar	16	394	20	nil	4
Malawi	9	233	6	3	nil
Mali	70	522	9	56	nil
Morocco	7	448	22	nil	17
Mozambique	16	142	8	8	nil
Niger	1	276	2	nil	1
Nigeria	18	54	63	nil	47
Pakistan	1176	441	553	523	3
Philippines	4	295	26	nil	26
Senegal	14	335	4	8	nil
Vietnam	53	480	92	nil	44
Somalia	2	672	1	-	1
Sudan	173	419	21	159	nil
Syria	147	797	58	89	nil
Thailand	28	359	180	9	169
Togo	28	554	2	21	nil
Uganda	12	20	3	8	nil
Cameroon	44	461	7	32	nil
Tanzania	42	107	17	30	nil
Burkina Fasso	49	445	2	40	nil
Yemen	9	320	4	4	nil
Zaire	7	108	11	nil	4
Zambia	29	548	9	6	nil
	TOTAL	AVERAGE	TOTAL	TOTAL	TOTAL
WORLD	17,272	476	16,715	4,810	4,891

COTTON EXPORTERS IN THE GROUP OF 77

Country	Average exports 1984/7 (1000 metric tons)
Afghanistan	10
Benin	30
Central African Empire	13
Chad	37
Egypt	128
India	118
Iran	15
Cote d'Ivoire	67
Mali	56
Pakistan	523
Sudan	159
Syria	89
Togo	21
Cameroon	32
Tanzania	30
Total	1,328

Total world exports averaged 4,810,000 metric tons in the same period and hence the share of the Group of 77 was about 28%

COTTON IMPORTERS IN THE GROUP OF 77

Country	Average imports 1984/7 (1000 metric tons)
Bangladesh	41
Egypt	31
Ethiopia	47
Indonesia	159
Iraq	25
Korea Rep.	378
Korea D.R.	53
Malaysia	51
Morocco	17
Nigeria	47
Philippines	26
Thailand	169
Tunisia	12
Vietnam	44
Total	1,100

Total world imports averaged 4,890,000 metric tons in the same period and hence the share taken by the Group of 77 is about 22%. It should however be noted that three countries (Indonesia, Korea Rep, and Thailand) account for almost two thirds of these imports.

COTTON PROCESSORS IN THE GROUP OF 77

Country	Average Mill Consumption 1984/7 (1000 metric tons)
Afghanistan	12
Bangladesh	41
Burma	22
Egypt	287
Ethiopia	20
India	1608
Indonesia	160
Iran	92
Iraq	28
Cote d'Ivoire	20
Madagascar	20
Morocco	22
Nigeria	63
Pakistan	553
Philippines	26
Vietnam	92
Sudan	21
Syria	58
Thailand	180
Tanzania	17
Zaire	11
Not cotton producers	
Korea, D.R.	55
Malaysia	47
Korea Rep.	361
Total	3,816