Pakistan: Environmental Impact of Cotton Production and Trade

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TABLE OF CONTENTS

LIST OF CHARTS

LIST OF TABLES

LIST OF BOXES

I. Background

1. Introduction

The purpose of this paper is to explore prospects and mechanisms for a transition to sustainable development in Pakistan (and more generally in the South), and the effect of international trade on such prospects. The context of the study is a globalizing world in which trade is expanding rapidly, production is increasingly for a global market, the autonomy of the state is shrinking at a time when its obligations are increasing, and there continue to be significant differences in the capacity of different producers to respond to incentives, opportunities, and constraints.

The specific case examined here is cotton and cotton products, which together constitute the largest and most important economic sector in Pakistan, with considerable trade exposure at every stage of production. It is a global activity involving economic and political interests around the globe; it has long been the subject of North-South trade negotiations, and is a prominent feature of negotiations over trade and the environment.

Recent years have seen growing concern in industrialized countries about the environmental impact of cotton production and processing. The bona fides of such concerns have come under question from various southern governments and academics, given that their emergence coincided with the efforts (specifically the negotiation of the GATT Agreement on Textiles and Clothing) to dismantle the single most significant trade barrier imposed explicitly by the North against the South. Some writers have argued, and many governments believe, that the environment is simply another means by which the North will try to restrict southern imports and thus protect its uncompetitive textile products. (CUTS 1997)

Be that as it may, it is a fact that conventional production methods (of cotton as well as textiles) are associated with significant and avoidable environmental or health-related costs--even if it is conceded, as claimed by Southern critics, that these costs are of a lower order of magnitude than of many Northern products or of synthetic alternatives.[1] Environmental costs derive from the use of agro-chemicals (especially pesticides) and water at the primary stage, and that of industrial chemicals at the secondary stage, especially in dyeing, processing and finishing of cloth. Earlier, the motivation for the concerns was the health of farmers and workers, quality of soil and water, and local

[1] Southern critics do not question the negative environmental impact of cotton production, especially for producing countries. They question rather the selective focus on southern industries, and lesser criticism of equally or higher polluting northern practices (eg energy intensive transportation systems). Others point out that cotton is more environmentally benign than its synthetic alternatives. For example, in a study prepared by the sports clothing firm, Patagonia Inc. (1991, cited in WWF/IISD 1997: 76), cotton had the lowest rating of environmental risk severity (3.45), followed by wool (4.36), and nylon and polyester (4.73 each). In citing this study, IISD/WWF warn of a possible conflict of interest given that Patagonia is a clothing manufacturer. However, probably a higher proportion of its revenues derives from clothing made from synthetic products.

biological diversity. The signing of the GATT agreement added other concerns, in particular the affect on consumers of carcinogenic dyes and chemicals (especially azo dyes), and production processes resulting from inadequate environmental safeguards and standards that create a competitive disadvantage for ‘cleaner’ industries in the North.

These concerns have led to a number of actions to induce a switch to such sustainable alternatives as organic cotton, integrated pest management, chemical-free textile processing,[2] and effluent quality standards. Actions include purely domestic ones, namely pesticide regulation, price intervention, and research and extension on integrated pest management (IPM). Internationally initiated actions involve the creation of trade barriers by the private sector and consumers (eg through eco-labelling), or governmentally imposed import restrictions on grounds of product or process measures. There is also (admittedly limited) technical assistance to selected producers by northern governments as well as businesses.

These initiatives are hampered by analytical blinders. Some approaches are technology-driven and assume that the only obstacle to sustainable production is the lack of knowledge of technological alternatives. Even others assume homogenous producers, equally capable of entering niche markets, altering their technological and managerial systems, and managing brand names. Far from being neutral, all of these favor the strongest segments of the chain, namely modern producers, operating at a relatively large scale, with preferential access to credit, technology, and governmental resources.

The reality is substantially different, albeit quite varied. In Pakistan, the cotton sector exhibits considerable diversity in terms of virtually every characteristic: unit size, formality of industrial structure, nature of competition, and underlying cultural and governance systems. At one extreme are 1.3 million cotton farms (of which roughly half are smaller than 2 hectares) competing in almost classic perfect competition, a vast majority operated as family farms by owners/ cultivators with limited literacy or access to technology. The main determinant of technological change in this sector is the governmental system of research and extension--which has become quite ineffective over time. At the other extreme are large scale textile processors and small scale garment manufacturers, both subject to the influence of large international corporations, and indeed a part of an internationally governed commodity chain. In the middle are large scale spinning units and small-scale, informal sector weaving units, the latter numbering in the tens of thousands, mostly operating as family enterprises, with virtually no recognized system of industrial governance.

The responsiveness of these groups to market driven as well as regulatory changes is likely to be highly varied. Without an understanding of the underlying system of governance, it is impossible to identify fruitful forms of intervention. To further such understanding, we use the framework of global commodity chains, especially the concept of industrial governance, as articulated by Gary Gereffi (1994) and his colleagues.

[2] For example, growing naturally coloured cotton, or using natural instead of synthetic dyes or bleaches.

The data for the study was collected from a number of official statistical publications, as well as a questionnaire survey and direct interviews with leading experts and practitioners around the country. Details on the published sources, experts, and the two questionnaires, one for cotton and the other for textiles are given in Annex 1.

Concretely, the paper makes the following arguments:

- The responsiveness of individual actors in a production chain to changing incentive structures is linked closely to the nature of governance in the chain. In the absence of an effective system of governance (as in cotton production, ginning, and spinning), transition costs are likely to be high as well as inequitably distributed.
- Given the nature of the commodity chain at the upper end of the market, the costs of transition will fall disproportionately on the manufacturers, while the benefits of changing consumer preferences will accrue to mass retailers who have a comparative advantage in labeling, packaging, advertising, and certification and inspection.
- The switch would be impossible without ready access to clean production technologies. Alternative technologies exist in some areas (eg processing), and are in an experimental stage in other areas (eg green cotton). In the remaining areas (eg IPM), while the meta-technology has been well developed, its contextual application and dissemination is not anywhere near the range of feasible options.
- A feasible program must seek to intervene in existing governance systems, and either strengthen them in order to facilitate the transition, or to transform them through investment and technical assistance to produce an orderly and equitable transition to sustainability.

2. The global cotton commodity chain

The cotton commodity chain can be divided into three broad stages: production, processing, and marketing. While conditions in the stages exhibit certain similarities, there are significant differences as well. In particular, while the governance structure of apparel manufacture is controlled by mass retail firms, and that of cotton growing by governmental institutions, albeit increasingly ineffectively, yarn and cloth production does not exhibit a coherent governance arrangement. Yarn production is in the large scale organized sector, where the manufacturers association can operate as a lobby to influence government policies. The weaving sector, however, is fairly anarchic in its composition. These differences are critical in evaluating the effectiveness of intervention in production systems.

The textiles and apparel industry is a classic example of what Gary Gereffi (1994) terms a buyer-driven global commodity chain, in other words one that is driven by large retailers rather than producers or processors. According to Gereffi, commodity chains have three main dimensions: 1) and input-output structure, 2) territoriality, ie spatial dispersion or concentration of enterprises of different sizes and types, and 3) a governance structure, ie the authority and power relationships that determine how financial, material, and human resources are allocated and flow within a chain. The purpose is to examine the nature of the relationships between various economic agents in order to understand the sources of stability and change.

The difference between producer driven and buyer driven commodity chains is primarily in terms of their governance structures. Producer driven chains are defined as those in which 'transnational corporations or other large industrial enterprises play the central role in coordinating the production system. This is most characteristic of capital- and technology-intensive industries like automobiles, computers, aircraft, and electrical machinery…. Buyer driven chains refer to those industries in which large retailers, brand name merchandisers, and trading companies play the pivotal role in setting up decentralized production networks in a variety of exporting countries, typically located in the Third World' (Gereffi 1994: 97). The main job of the core company in buyer driven chains is to manage production and trade networks. Profits derive not from scale economies and technological advances as in producer driven chains, but rather from unique combinations of high value research, design, sales, marketing, and financial services.

This distinction, and in particular the concept of governance, is helpful in examining the commodity chain and exploring the prospects for transformation of production processes. Governance can be described in a number of ways. A good definition is to think of it as an arrangement in which collective decisions can be made in a legitimate manner and with the minimum of conflict. As Gereffi has reminded us, in a market context, governance is derived from market power. Market power meaning the ability to control or influence markets, is mainly the result of industrial structure. Enterprises in oligopolistic or monopolistic have the ability, and as a result excess profits. In other words, it is linked closely with economies of scale, barriers to entry, and nature of industrial concentration.

Market power is self-reinforcing; in the sense that it provides actors with the ability to maintain their preferential position by actions that help create and sustain a favorable market environment. Typically, this has meant the control of ones competitors through collusion or price fixing (eg, the threat of predatory pricing), the control of the policy environment by 'managing' governmental actors, and the control of consumer choices through advertising and brand name development. All these actions create a bias in favor of large scale and established enterprises, even when the technology itself is scale neutral.

The concept of governance provides an additional dimension to such strategic action. This means managing ones suppliers or other intermediaries in such a way as to enhance total sector profits.[3] Such management requires strategies for the distribution of

[3] Gereffi (1994: 99) notes the relationship of his analysis with the concept 'flexible specialisation' (see Piore and Sabel 1984). Another related concept is that of 'collective efficiency' introduced by Hubert Schmitz and his colleagues at the University of Sussex. They see the informal sector organised in a manner as to enhance the collective efficiency and profitability of a community of producers. This is very similar to Gereffi's analysis, even though it suggests a decentralised form of governance. See Schmitz (1988).

benefits as well as threat of costs. Naturally, this requires the investment of financial and human resources in the management of economic relations with trade partners. It also means the creation of the ability to introduce changes in behavior, either by the promise of rewards or the threat of sanctions. Rewards and sanctions refer mainly to access to credit, markets, technology, and know how. Given the relationship of scale and profitability with the generation of such surplus resources, it is not surprising that producer driven chains are characterized by strongly oligopolistic production structures, whereas buyer driven chains are dominated by monopolistic or oligopolistic retail firms and brand name companies.

However, the idea of market-based governance is relatively new, and is in a sense the ‘privatization’ of activities that were traditionally the sole domain of government. Even now, wherever market power or an attitude towards governance is not in evidence, the only provider of governance remains the government. As such, to add to Gereffi’s categories, one could equally think of a ‘government-driven’ commodity chain. In this type of a chain, the flow of financial, material and human resources through a chain is influenced strongly by the policies and actions of government agencies. The agricultural system in Pakistan exhibits this kind of structure. The combination of agricultural research, extension, policy, credit, and input provision is used to influence the allocation decisions of farmers. As we shall observe in more detail below, this system has deteriorated over time, and is unable to perform its responsibilities effectively. It has also become somewhat captive to the actions of input suppliers.

Finally, one could also think of an ‘anarchistic’ or ‘governance-less’ commodity chain, where there is an absence of governing arrangements between producers. Typically, the informal sector in many southern countries exhibits such behavior. In Pakistan, the production of cloth is almost entirely in the informal sector.

An issue that must be raised here to address the special conditions in the farm sector, although it is perhaps not central to the segments examined by Gereffi, is that of the system of knowledge underlying production arrangements. Stephen Marglin (1990) in his analysis of the organization of work among informal sector weavers’ communities in Eastern India distinguishes between two approaches to knowledge. He terms these ‘*episteme*’ and ‘*techne*’. The former refers to knowledge that is cerebral, axiomatic, and universal, transmittable in transparent and internally egalitarian ways. The latter is tacit or embodied knowledge, contextual and personal, typically transmitted through experience and prolonged exposure, often through hierarchic arrangements. The two embody contrasting processes of innovation, diffusion, and legitimacy. *Episteme* derives its legitimacy from impersonal research practices, and *techne* from personal trust.[4]

It is fair to say that in the cotton commodity chain, the knowledge base in segments that correspond most closely to perfect competition correspond most closely to

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[4] Marglin is careful to say that these two ideal types are present in all forms of knowledge production. However, the modern world view views *episteme* as the only legitimate form of knowledge, and *techne* at best as practice waiting to be transformed into true knowledge.

Marglin's *techne*, while that of the large scale and modern segments is *epistemic*. The result is that intervention in perfectly competitive segments requires an alternative sensibility, an approach to knowledge as personal and based on trust, constantly seeking legitimacy.

To revert to the main theme of this paper, the following analysis will use the concept of industrial governance to motivate the discussion. This concept suggests that the prospects of transformation of industrial methods depend fundamentally on the nature of governance in that sector. In this sense, we could divide the cotton commodity chain into three broad segments:

- **Apparel and textiles** are characterized by buyer driven commodity chains, and strong governance arrangements. Here there the prospects for industrial transformation are relatively bright. However, the main issue here is that of equity, support for equitable distribution of costs and benefits from the transformation, and indigenous processes of transformation. Intervention in small-scale production will require personal and face to face interaction. The existing program of sustainable industrial development offers prospects of linking up with international processes to determine more equitable and efficient outcomes.
- **Yarn and gray cloth** are characterized by relatively weak forms of governance, albeit with significant differences between them. Yarn production is in the large-scale sector, where the manufacturers association acts as a lobbying group, while weaving is in the informal sector without a coherent collective structure. The prospects of transformation are more muted here, and precipitate actions will involve considerable social and economic inequities as well as avoidable costs. The agenda here is the institution of governance arrangements. However, the environmental costs of these stages of production are smaller than those of the others, and this could be viewed as a longer-term program.
- **Cotton growing** is still characterized by government driven initiatives built upon a vast complex of research, extension, input supply, and credit. These arrangements have become weak and non-optimal over time. Here the agenda is the restoration of the system of governance by investing in the research and extension network. Alternative networks will have to deal with the obstacle of developing trust and language to communicate with farmers.

3. Trends in the cotton industry[5]

Cotton is the largest revenue earning non-food crop produced in the world. Its production and processing provide some or all of the cash income of over 250 million people worldwide, including almost 7 per cent of the available labor force in developing countries. These activities are becoming highly concentrated over time; today, 77 per cent of global cotton output and 73 per cent of the cotton hectarage are accounted for by

[5]For a good description of cotton production, see IISD/WWF (1997).

China, the US, India, Pakistan, and the Central Asian Republics. Other features of the sector are:

- Cotton cultivation covers nearly 33 million hectares, equivalent to about 2.5 per cent of all cultivable land, in 82 countries. Southern countries produce 77 per cent of the world's cotton, and constitute 58 per cent of world cotton exports.
- Cotton textiles constitute approximately half the total textile fiber and arguably the largest industry in the world. It has been the leading industrial sector in many southern economies.
- Cotton trade in the 1990s averages about 6 million tonnes annually, representing one-third of the crop output, the remaining two-thirds either consumed domestically or exported in processed form.

Because of shifting comparative advantage, there has been a rapid expansion of the textile industry in the South, especially among cotton growing countries. Textile production has traditionally been the first industrial sector of many developing countries, and has paved the way for broad scale industrialization and economic expansion. The ten largest cotton producing countries (of which only one is in the group of industrialized economies) consumed 50 per cent of the global cotton output in 1986, and 77 per cent of a larger volume in 1996 (FAO 1997, cited in IISD/WWF 1997: 52). Similarly, the percentage of cotton traded internationally has fallen from 38 per cent in 1960-61 to 27 per cent in 1992-93.

Another stylized fact of the market for cotton and cotton products is the existence of special trade barriers against southern industrial products. Textiles are a labor-intensive industry, and provide a comparative advantage to southern producers. However, the shift of the industry to the south has been slowed down, and the interests of traditional northern manufacturers protected under various unilateral, bilateral, and multilateral agreements. As early as 1935, a voluntary export restraint on textile exports to the US was announced (de Vries 1995: 15). In 1973, the multi fiber arrangement (MFA) was adopted, which tied textile imports to quotas for individual countries. The elaborate systems of quotas set up under the MFA is only now being dismantled through the Agreement on Textiles and Clothing (ATC) negotiated in the GATT process. Under this agreement, products covered by the MFA will be reintegrated into mainstream WTO discipline over a ten-year period beginning in 1995. This is being done in four stages. 16 per cent of the 1990 volumes of products covered by the MFA were integrated at the signing of the WTO. Of the remaining, another 17 per cent will be reintegrated by 1998, 19 per cent by 2001, and the rest 49 per cent by 2005.

Critics have noted that the agreement is heavily biased in favor of importing countries (Low 1995). First, the end loading of the phase out means that the benefits will not be realized for several years. More importantly, the agreement gives maximum flexibility to importing countries to select how they will meet their phase out commitments. Third, even at the end, tariffs on textiles and clothing will be liberalized only by about 22 per cent as compared with 40 per cent overall in the Uruguay Round agreement. The bias is particularly acute for South Asian exporters, who face tighter restrictions on their exports, and although the gap will become narrower over the next ten years, it will remain significant.

Partly as a result of the ATC, and also because of changing market conditions and consumer tastes, the textile market has undergone a significant transformation in recent years. The role and profits of large retail corporations and brand name managers has become far more important. At the same time, the number of players has declined, and industrial concentration in these components of the market has increased. The large corporations have in turn developed closer inspection and other arrangements with their suppliers, who tend to be small scale and decentralized.

In the US, these include discounters (Wal-Mart, Kmart), mass merchandisers (Sears, Dayton Hudson, Woolworth), department stores (J.C. Penney, May department stores), Specialty stores (Melville, The Limited, The Gap, Toys 'R' Us), with sales running into tens of billions of dollars (Gereffi 1994: 106). Similarly, large European retail companies (Bo Weevil in the Netherlands, Otto BV in Germany, Hennes and Mauritz in Sweden and Stockmann in Finland) also have a strong influence on market conditions, although their markets are not as large as those of US retailers are.

These retail companies have gradually got into active overseas buying through agents or buyers. Some also provide technical assistance to producers in order to develop specialty products for niche markets (Caldas 1995). They engage in inspection and certification (generally for their own internal purposes) to ensure that their suppliers meet labor standards and other legal requirements of the importing country.[6]

The available evidence indicates very high retail margins for the big firms. Gereffi reports 48 per cent average retail markups for US fashion products in 1990, with only one third of the final value of output going to overseas producers. While similar evidence for mass produced goods or low end products is not available, there is an indication that garment manufacturers have been under considerable pressure from retailers to lower prices and speed up delivery schedules. The competitive nature of the supplier segment, and the increasingly concentrated nature of the retail segment make this possible. To a certain extent, the pressure has been limited by quotas under the multi-fiber arrangement (MFA). Given this, it is not clear whether the gradual elimination of the MFA will benefit Southern producers.

Another important feature is the rise of new concerns, especially those pertaining to environmental and social conditions. As is inevitable in a commodity produced on such a large scale, there are a significant number of negative environmental effects. Cotton plants are susceptible to a large variety of pests and diseases that can cause stunted growth, poor color, lower yields, or even death. Accordingly, there is a long history of

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[6] According to an expert interviewed by us, large retailers have inspection agents in various parts of the world. Pakistan is often covered by the agent located in Singapore or Hong Kong. These agents schedule inspection visits, and is the firm is rejected even for a small violation, it is almost impossible to get the company to schedule another visit.

pest control practices in cotton production. Traditional methods included a variety of labor-intensive practices (hand picking of pests, inter-cropping, crop rotation, and the burning or removal of cotton residues from the soil). Increasingly, however, over the last 100 years, these methods have been largely forgotten, and have been supplemented or transplanted by reliance on chemical pesticides.[7] Pesticide use in cotton alone is valued at US$ 2 to 3 billion annually, which is one quarter of the total insecticide consumption in the world. It has become a significant proportion of production costs, and constitute close to one tenth of the annual value of the cotton crop of US$ 30 billion (Murray 1994).

Besides this, environmental problems are also associated with prevailing agricultural practices as well as the use of other chemicals in the growing as well as processing stage. Water use and common tilling practices effect water quality adversely, and lead to water scarcity, soil erosion, and waterlogging and salinity. Chemical fertilizers cause soil and water contamination, and affect soil fertility. Some chemical dyes and chlorinates used in the processing stage have carcinogenic effects; others have adverse consequences for human health and water quality if discharged without proper treatment. In other stages of industrial production, although the degree of wastage is fairly low even in traditional production systems, and has been reduced even further in modern methods, problems remain with regard to worker health and safety from suspended particulate matter, especially in smaller plants.

4. The role of cotton in Pakistan

Pakistan is the fifth largest producer of cotton in the world, the third largest exporter of raw cotton, the fourth largest consumer of cotton, and the largest exporter of cotton yarn. 1.3 million farmers (out of a total of 5 million) cultivate cotton over 3 million hectares, covering 15 per cent of the cultivable area in the country. Cotton and cotton products contribute about 10 per cent to GDP and 55 per cent to the foreign exchange earnings of the country. Taken as a whole, between 30 and 40 per cent of the cotton ends up as domestic consumption of final products. The remaining is exported as raw cotton, yarn, cloth, and garments.

Cotton production supports Pakistan's largest industrial sector, comprising some 400 textile mills, 7 million spindles, 27,000 looms in the mill sector (including 15,000 shuttleless looms), over 250,000 looms in the non-mill sector, 700 knitwear units, 4,000 garment units (with 200,000 sewing machines), 650 dyeing and finishing units (with finishing capacity of 1,150 million square meters per year), nearly 1,000 ginneries, 300 oil expellers, and 15,000 to 20,000 indigenous, small scale oil expellers (*kohlus*). It is by any measure Pakistan's most important economic sector. Not surprisingly, government policy has generally been used to maintain a stable and often relatively low domestic price of cotton, especially since 1986-87 (Chart 1) through the imposition of export duties, in order to support domestic industry.

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[7] The term 'pesticides' includes insecticides, nematicides, fungicides, herbicides, defoliants, and desiccants, but not fertilisers. In southern countries, the most significant reliance is on insecticides.

In terms of cotton content, the bulk of the exports take place in the form of cotton yarn, of which about 45 per cent is destined for other countries. During the 1990s, the decline in cotton yields in some years forced net imports of cotton to meet the domestic spinning demand of about 1.4 million tonnes. Indeed, in 1993-94, although 0.3 million tonnes of cotton were imported to meet local demand, 150 mills had to close down because of shortage of raw materials. Exports of finished textiles have begun to expand since 1990. In recent years, the industry has been jolted by some trade restrictions based on environmental considerations. The most important of these pertains to the ban imposed by European countries on products made with azo dyes, which are feared to have carcinogenic properties.

In fact, the significance of the cotton sector far exceeds its contribution to GDP or exports. The rate of economic growth is correlated quite closely with the fate of the cotton crop. During the 1950s, when cotton yields were stagnant, economic growth was at best lukewarm. In the 1960s, as cotton yields rose by over 50 per cent, GDP growth also reached its highest decadal level of over 7 per cent per annum. The 1970s were turbulent years from the economy, the growth rate declining to 4 per cent per annum; it was also a period of fluctuating but stationary cotton yields. Growth reverted to over 6 per cent in the 1980s, at a time when yields began to increase dramatically, more than doubling in a decade. Finally, since 1991-92, both cotton yields and GDP have become sluggish. In other words, economic activity in the country is associated closely to the performance of the cotton crop. A bigger crop means not only a larger volume of exports (both raw and processed products), but also a subsidy to the textiles sector, leading to higher aggregate demand, higher employment, larger fiscal inflows, less pressure on the balance of payments, and thus less exposure to the dictates of international financial organizations.

These trends also exhibit an association of with political conditions, albeit not a simple one. The cotton crisis and the resulting economic instability of the 1970s were associated with political instability and growing unpopularity of the government. Likewise, the second cotton crisis of the 1990s and the accompanying economic decline has seen the dismissal of two governments and growing public disenchantment with government in general. On the other hand, the impetus provided by the cotton sector to the economy in the 1980s could be argued to have shielded and otherwise unpopular regime from overt civic unrest. However, the relationship is somewhat more complex than this, and rural unrest became high precisely when agricultural yields were rising dramatically in the 1960s and 1980s.

5. The commodity chain in Pakistan

Briefly, the production stage covers a sequence of activities from sowing to harvesting and ginning.[8] Cotton is produced on large as well as small farms with

[8] The entire range of activities includes residue disposal to control pests and return nutrients to the soil, preplant tillage, seedbed preparation (including fertiliser and herbicide application), planting (along with application of fungicides, herbicides, pesticides and fertiliser), weed and insect control (including defoliation if harvesting is by mechanical means), harvesting (by manual or mechanical means),

significant differences in farming methods and access to technology. In Pakistan, cotton is grown on 3 million hectares mainly in the provinces of Punjab and Sindh. More than half of the farms are less than 2 hectares in area, although they cover only 11 per cent of the area. However, less than 2 per cent of the farms covering 24 per cent of the area are larger than 20 hectares in size. Key actors in this segment of the chain are the 1.3 million farmers, 20 pesticide companies, 114 seed companies, government seed corporations, government seed certification department, the agricultural extension system, the cotton crop research institutes, the irrigation department, commission agents, ginners, and agricultural credit companies. While some of these are more organized than others (eg the pesticide companies), it is not clear whether there is a governance structure to influence inputs and outputs.

The processing stage covers activities involved in the transformation of cotton lint into cloth or garments for consumer use.[9] Textiles are a labor-intensive industry at the production stage, and employ proportionately more workers per unit of output than most comparable industrial sectors. The result is that economies of scale are not very significant, manufacturing is fairly competitive, and Southern manufacturers have an edge. On the other hand, the design and marketing stage is characterized by innovation-intensity, with considerable economies of scale and barriers to entry. This pattern corresponds closely to Pakistan's experience, where the majority of garment manufacturing and weaving units are in the small-scale, informal sector, although spinning and processing are done largely in medium to large scale integrated plants.[10]

An overview of the cotton commodity chain in Pakistan can be obtained from the costs and income figures given in Box 1. These figures are organized on the basis of cotton produced on one hectare of land. In brief, it shows that one hectare of land at current expected yield levels produces 581 kilograms of lint cotton, 1,162 kilograms of cotton seeds, 500 kilograms of cotton yarn, and 5801 square meters of cloth. If the entire crop were processed to produce cloth, it would be able to cover 58 per cent of the production area. In 1991-92, when yield levels were 32 per cent higher (769 kilograms), the cloth output would have covered 76 per cent of the area. Potential yield levels, however, can rise even higher, to as much as double the previous peak, and thus the cloth would be able to cover more 150 per cent of the land area producing the cotton.

The calculations also use existing prices to calculate the value added at various stages of the production chain. Under these assumptions, a hectare of land produced Rs 36,312 worth of cotton lint and Rs 8,715 worth of cottonseeds. If the cotton is processed,

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transportation, ginning (ie removing seeds from lint), and baling.

[9] The entire sequence of activities covers spinning (blowing, mixing, carding, combing, drawing, simplex, ring spinning, and cone winding), weaving (warping, sizing, weaving), processing (singeing, desizing, scouring, mercerizing, bleaching, dyeing, printing, and finishing), and garment manufacturing.

[10] This is consistent with broader evidence that shows that textile weaving and processing are undertaken by large integrated factories, while garment manufacturing is fragmented and small scale in structure (see Gereffi 1994: 101-2).

the result will Rs 46,200 of yarn or Rs 104,418 of gray cloth, or Rs 174,030 of finished cloth. The value added at subsequent points in the chain is likely to be even higher. In some market segments the exporters of cloth or apparel receive only one third of the market value of the final product, while over 50 per cent accrues to the retailers (Gereffi 1994).

Another way of looking at the figures is that of the Rs 174,030 value of the finished cloth produced by one hectare of cotton, only Rs 16,286 (or 9.36 per cent) accrues to the farmer as income, while another Rs 18,914 (or 10.87 per cent) is allocated as costs of production. In fact, the bulk of the rents are captured beyond the finishing stage--in the production of garments and retail sales to customers in the North. In this sense, the transformation of cotton production, even if it involves a doubling of unit costs, is not a market problem, since it adds less than 10 per cent to the cost of the finished cloth and even less to the price of finished garments. There is evidence that the market is willing to provide as much as a 20 per cent mark up on green cotton products.[11] In fact, the problem lies in the domain of governance and technology transfer rather than that of production costs and consumer preferences.

As mentioned earlier, the bulk of the production of cotton and cotton products is for export. According the calculations given below, between two thirds and three quarters of the cotton produced is exported in one form or another. The result is that this sector constitutes the most significant component of foreign exchange earnings for the country. The most recent year for which these figures were available is 1995-96, when the exports of cotton and cotton products were as follows (please see also Chart 2):

Table 1: Exports of Cotton and Cotton Products, 1995-96 (Rs billion)

Item	Value (Rs billion)	Per cent of total cotton
Cotton	19.44	13.24
Cotton waste	0.17	0.11
Cotton yarn	54.06	36.84
Cotton cloth	43.28	29.50
Specialty items	2.14	1.46
Garments	27.64	18.84
Total Cotton Sector	146.73	100.00
Total Exports	294.74	

Source: GOP 1997; the figures for garment exports appear to be incomplete, since they are significantly lower than those provided by the All Pakistan Textile Manufacturers Association (APTMA).

The following calculations are designed to bring out the relation between domestic production and exports at various stages of the production chain. Figures on cotton output and exports are available directly from government statistics, as are those of export of cotton products. These figures as well as those for yarn output are also available

[11] This assumes, however, that the reduction in total output will not raise final prices. In fact, the aggregate impact of the change on final prices is more complex and beyond the scope of this exercise.

from the annual review report by the Chairman, All Pakistan Textile Mills Association (APTMA). However, output data on finished cloth and other made-ups are somewhat confusing because of variable coverage. Most documents report data on cloth output only from the 503 units in the mill sector who report to the APTMA.

In the 1990s, cotton production reached a peak of 2.2 million tonnes in 1991-92 and a trough of 1.4 million tonnes in 1993-94. Of this, a variable amount depending upon the residual from the domestic demand of the yarn industry was exported, and the bulk of the cotton, between 1.3-1.6 million tonnes used domestically to produce 1.1-1.4 million tonnes of yarn. Of this, about 45 per cent, or 0.5-0.6 million tonnes were exported, and the rest used for producing cloth, towel, canvas, and other cotton products. As per our calculations, 500 kilograms of yarn produce 5,801 square meters of finished cloth, and a proportionately smaller quantity of canvas or towel. If the residual yarn production of 0.6-0.8 million tonnes were used exclusively to produce finished cloth, aggregate national output would come to between 7,000-9,000 million square meters. Against, this potential figure, the output of the organized mill sector is only 300-325 million square meters. However, the actual national production is much higher, since cloth exports alone range between 1,046 and 1,196 million square meters, canvas exports (in 1995-96) 90 million square meters (constituting over 90 per cent of output), and towel exports 400 million square meters.

Be that as it may, the fact is that up to 25 per cent of cotton production, 45 per cent of yarn output, and over 20 per cent of the potential output of cloth and made-ups is exported. Taking all this into account, it is fair to say that more than two-thirds (and possibly three-fourths) of the goods produced from the original crop is exported. In other words, out of a total cotton area of 2.7-3.0 million hectares, exports account for 0.15-0.59 million hectares in the form of cotton, over one million hectares in the form of yarn, over 200,000 hectares in the form of finished cloth (Table 2). The are corresponding to the export of canvas, towel, hosiery, and garments cannot be estimated directly, but is like to be higher than the area accounted for by cloth exports.

Table 2: Calculations of area used for export of cotton products

Year	Total cotton		Cotton exports		Yarn exports		Cloth exports	
	qty	yield	qty	area	qty	area	qty	area
	tonnes	m tonnes	m tonnes	mha	mn kgs	mha	mn sqm	mha
1990-91	1.638	615	0.283	0.460	501.1	0.948	1.056	0.172
1991-92	2.181	769	0.456	0.593	505.9	0.764	1.196	0.156
1992-93	1.540	543	0.265	0.488	555.3	1.188	1.127	0.208
1993-94	1.368	488	0.075	0.154	578.5	1.378	1.046	0.215
1994-95	1.479	558	..	..	522.1	1.087	1.160	0.208

Source: cotton yields, area, and exports: GOP (1997); yarn and cloth exports: APTMA (1996); estimate of conversion from quantities to land area: Box 1.

Another way of approaching this issue is by looking at the value of output produced at various stages, and comparing it to export values.[12] The value of the total cotton output from 2.997 million hectares at prices then prevailing is Rupees 108.83 billion, of which Rs 19.44 was exported, leaving a remainder for domestic consumption of Rs 89.39 billion. If the entire cotton crop had been processed to produce finished cloth, the value of this cloth would have been Rs 521.57 billion. A few simple calculations will reveal that of this volume, a little less than one third is consumed within the country and the rest exported.

The value of the yarn produced from this cotton would be 114 billion. Of this, Rs 54 billion was exported, leaving a residual of Rs 60 billion. This volume of yarn would produce gray cloth worth Rs 135 billion, and finished cloth worth Rs 225 billion. Of this, a total of Rs 45 billion was exported as cloth or specialty items, and 61 billion as garments and made ups. Assuming that only finished cloth is exported the cloth remaining in the country would be valued at Rs 179 billion. This is used to produce garments or household furnishings. From these, Rs 61 billion worth of ready made garments, hosiery, and made ups are exported. Assuming a 40 per cent mark up on garment production, the value of cloth in the garment exports would be Rs 44 billion, leaving Rs 135 billion worth of cloth for domestic consumption. This comprises 26 per cent of the potential cloth output (if the entire crop had been processed at home). These can be summarized as follows:

Table 3: Estimated share of domestic use and exports of cotton products

Segment	Production	Domestic Use	Export
Cotton	109	89	20
Yarn	114	60	54
Finished Cloth	225	179	46
Garments	251	61	190

This calculation yields a similar estimate, namely that roughly 30 per cent of the products of the cotton crop are consumed at home, and 70 per cent exported.

The relationship of the exporters with international buyers (as well as domestic ones) is extremely varied. Whereas garment producers (and some larger cloth producers) enter into direct relationships with international buyers, cotton, yarn, and cloth manufacturers sell their product to commission agents, who grade and sell it to domestic consumers as well as foreign buyers.

Even among garment producers, relationships vary depending on the type of product. In general, there are three types of consumer products: high-end fashion products, standardized mass-produced products, and non-standard informal sector output.

[12] These are very rough calculations, and should be treated with caution. They do not represent actual shares of domestic consumption and external trade in various segments of the cotton chain.

The former are specialty products, not suitable for mass production. These are generally produced in Third World countries through licensing or other arrangements with the brand name company. Standardized products are produced both in large scale manufacturing units located in the North (for example Levi Strauss and company), or through their licensing arrangements in which they ship US-made parts for sewing overseas. Since brand name managers have a similar degree of market power as mass retailers, their relationship with cloth suppliers is similarly unequal. Finally, at the lower end are non-branded, lower quality, and often non-standardized products manufactured by small-scale suppliers in the South, and imported by mid level or low-end retailers. The last sell mainly in domestic markets, or to small-scale buyers in the north. International retailers do not affect their behavior in the same way as that of the other two groups.

Within the country, there is a complex set of relationship between textile companies, yarn producers, ginners, farmers, suppliers of farm inputs (ie, seeds, fertilizer, and pesticides), credit companies, and traders or middlemen (called Commission Agents) who operate at every step of the chain. However, the absence of a monopolistic structure within the country is linked to absence of a coherent governance structure in products where the domestic segment is dominant, namely cotton production, . As a result, the management of input and output relationships from the farm to the textile mill is far less predictable than that between the garment manufacturers and importer.

In this regard, however, a significant role is played by collective organizations of producers as well as others that support or influence market condition, including interest groups, industrial lobbies, and regulating institutions. The All Pakistan Textile Manufacturers Association (APTMA), which represents mainly the interests of large scale spinning units, is widely considered to be the most powerful industrial lobby in the country. Given the size of the textile sector in the national economy, the Federation of Pakistan Chambers of Commerce and Industry (FPCCI), and some of its member chambers (especially the Faisalabad chamber) are also active promoters of textile interests. APTMA represents all textile manufacturers, but is dominated by yarn producers. A smaller body, the All Pakistan Textile Processing Manufacturers Association (APTPMA) is not as influential, but is more closely connected to the upper end of the production chain.

II. Cotton Production

In this section, we look at the main features of cotton production in Pakistan, the broad trends in output and yields, environmental problems, technological alternatives, the system of governance, and underlying system of knowledge. The goal is to identify mechanisms through which optimal technological choices can be introduced, and a change in production systems brought about.

6. Trends and descriptions

Cotton is an oil crop, though grown mainly for its fiber. The fiber consists of long, fine, flattened and convoluted hairs called ‘lint’, which can be detached easily from the seed. The value and quality of the cotton variety depends on the fineness of the fiber as well as its length. The longer and finer the staple the better its quality, since it can be used to produce thinner and lighter textiles without knots or uneven surfaces. A single fiber is a little less in diameter than a human hair, and is measured in micronaires. Five different staple lengths are distinguished: short (<21 mm), medium (21-25 mm), medium long (26-28 mm), long (28-34 mm), and extra long (>35 mm). The majority of the world production (about 60 per cent) consists of medium long staple. Medium staple is around 18 per cent, and short staple a mere 3 per cent, produced almost exclusively in South Asia. Longer staple lengths (long and extra long), comprise around 18 per cent of the world production of cotton (during 1977-78 to 1981-82), and can only be grown in more or less ideal conditions regarding soil, water, temperature, and light.[13]

Cotton production and yields have increased dramatically over the last century.[14] In 1834, estimates of total global production were 340,000 tonnes. By the end of the last century, they had risen almost tenfold to 3 million tonnes and by 1924-25 to 4.4 million tonnes (of which 93 per cent were produced by five countries: the US, India (including present day Pakistan and Bangladesh), China, Egypt and Brazil. Global output in the 1990s has varied between 18-21 million tonnes, a fourfold increase over the last half century. Three quarters of this increase is accounted for by increased yields, which have risen from an average of 200 to close to 600 kilograms per hectare (Table 4).

In Pakistan, the area under cotton has increased almost at a constant rate with minor fluctuations from a little over 1 million hectares at the time of independence in 1947 to 3.1 million hectares in 1996-97 (Chart 3). Between independence and the peak year of 1991-92, total cotton output increased more than eleven-fold, from 0.2 to 2.2 million tonnes. The most dramatic expansion took place in the decade of the 1980s, when output tripled from annual average of slightly over 0.7 million tonnes during the four year period 1979-82, to 2.2 million in 1991-92.

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[13] The vast majority of the longer staples are produced in only 5 countries: USA, Peru, Egypt, Sudan, and the former USSR. These varieties have higher water requirement and a longer growing period, the latter making it more susceptible to insects and diseases (de Vries 1995).

[14] Two-thirds by weight of the cotton plant consists of cottonseeds, which contain valuable nutrients (18-25 per cent fat and 29-34 per cent proteins), and are used as cattle feed or in the production of cooking oil. Average to moderate cotton yields of 1,500 kilograms per hectare of 'seed cotton' (ie including both seeds and lint) produce not only 500 kilograms of lint, but also 1000 kilograms of cotton seeds, which contain the same caloric content as a normal harvest (in Southern countries) of 600 kilogram of cereal from the same area. However, this creates some confusion over yield figures, which can refer to lint cotton (ie without seeds) or seed cotton (ie lint plus seeds). 1,500 kilograms per hectare is high if it refers to lint cotton, but moderate if it refers to seed cotton. Official documents typically refer to lint cotton yields, but some influential writings (eg Murray 1994) have used seed cotton yields without saying so explicitly.

Table 4: Average cotton output and yields, 1946-50 and 1991-95

Country	1946-50		1991-95	
	Output (000 tonnes)	Yield (kg/ha)	Output (000 tonnes)	Yield (kg/ha)
China	169.8	72.3	4,719.4	787.2
USA	2,609.4	303.3	3,670.5	747.6
Central Asia	519.9	357.0	2,320.0	784.6
India	543.6	105.8	2,192.8	290.1
Pakistan	**181.9**	**148.5**	**1,859.8**	**652.7**
Brazil	291.6	149.5	580.2	369.9
Egypt	311.4	563.2	328.2	866.0
Mexico	118.7	299.8	86.4	516.3
Other	570.1	123.8	3,361.2	516.3
Total	5,316.4	202.3	19,118.5	582.1

Source: IISD/WWF 1997: 8-9

Slightly more than half of the increase in total output is accounted for by yield expansion. Yield trends can be divided into five different phases (please see Chart 4).

- **1950s: constant yields**: In the 1950s, yields remained more or less constant for the entire decade, from 1949-50 to 1959-60, at around 200 kilogram per hectare.
- **1960s: steady growth**: the first spurt of growth took place in the 1960s, when yields rose steadily from 200 to 300 kilograms per hectare in 1970-71, and to 361 kilograms in 1971-72.
- **1970s: the first cotton crisis**: A severe and persistent attack of the American bollworm devastated the crop during the 1970s, resulting in wildly fluctuating yields between a high of 377 and a low of 233 kilograms, re-attaining the 1971-72 figure only in 1979-82.
- **1980s: rapid growth**: The 1980s saw a dramatic growth in yields, from 364 kilograms per hectare in 1982-83 to 769 kilograms in 1991-92. This was also a period when the major expansion in pesticide use took place.
- **1990s: the second cotton crisis**: Repeating the experience of 20 years earlier, the peak achieved in 1991-92 was followed by another severe and persistent pest attack, this time of the leaf curl virus and its disease vector, the whitefly. Yields dropped dramatically from 769 to between 500 and 600 kilograms per hectare.

Both periods of crisis in the cotton crop were associated with pest attacks, and with the emergence of pest resistance after a period of growing pesticide use and consequent yield expansion.

7. Pesticide use in cotton production

Traditionally, the major obstacles to the expansion of cotton yields have been the inadequacy of water and attack by insects. Overcoming these obstacles has been the central element of the strategy of increasing yields. However, this strategy is precisely the source of environmental degradation. The establishment of irrigation systems has often resulted in rising water tables, water-logging, salinization, and water wastage. More importantly, while the use of chemicals to control pest incidence has dramatically increased yield levels, at least in the short run, it has also been the major contributor to environmental degradation as measured in terms of adverse effects on human health, soil and water quality, local biodiversity, and ecological balance.

In this paper, we will focus primarily on the environmental impact of pesticide use even though cotton production is associated with other environmental hazards as well, pertaining mainly to the use of chemical fertilizer and irrigation water. In Pakistan, while the increased used of fertilizer and harnessing of irrigation water has environmental consequences, these are not particular to cotton. Cotton does a slightly higher quantum of fertilizer per hectare than other major crops (except sugarcane); the differences are not particularly striking. Cotton is grown on 15 per cent of the cultivable area, and consumes roughly 20 per cent of the 2.5 million nutrient tonnes of chemical fertilizer used in the country.

Similarly, although there are environmental costs associated with the excessive use of water, they do not appear to be exceptional for the cotton crop. Cotton is a highly water intensive crop, requiring 24 inches of water per hectare per year. In Pakistan, as in many other countries, the entire cotton crop is on irrigated land, and has often been used to justify the construction of irrigation systems. However, the average water use in cotton does not currently exceed the average per hectare water offtake in the country. The average annual water offtake from the Indus, including groundwater exploitation, comes to approximately 110 million acre feet (44 million hectare feet) for 21 million hectares. This yields an average figure of 25 inches of water per hectare, which compares quite favorably with figure for cotton. It should also be mentioned that in Pakistan, the irrigation system was developed in response to geopolitical considerations, namely the need to share river waters with India after independence. In that sense, the problems with irrigation have to be taken as a given, rather than as a consequence of cotton production.

To return to pesticides, their use goes back at least to the late nineteenth and early twentieth centuries, when cotton growers in the US and Latin America began using sulfur and nicotine to limit pest populations.[15] In the early 1900s, the USDA developed and promoted the use of calcium arsenate, whose production increased from 23 tonnes in 1918 to 20,000 tonnes in 1935. These chemicals were somewhat limited in impact because they had to remain on the plant in order to be effective, but the heavy rains that were fairly common in cotton growing areas made this difficult (Murray 1994).

[15]For a discussion of the role of various chemical inputs in cotton production, see IISD/WWF (1997: 11-12). Murray (1994) provides an excellent description of the growing dependence on pesticides in Latin America, and the health and other problems caused by them. This and the following two paragraphs are drawn mainly from Murray (1994: 12-16).

A major breakthrough came with the discovery in 1939 of the most famous organochlorine, DDT (which earned its discoverer, Paul Müller, the Nobel Prize for medicine in 1948). Hailed as a miracle substance that would produce a total victory on the insect front, DDT was used with great success during the second world war to protect combatants against malaria and typhus epidemics. Released for civilian purposes at the end of the war, it began to be used as a household disinfectant as well as an all-purpose insecticide. Its discovery was followed by the discovery of at least 25 other synthetic organochlorine compounds between 1945 and 1953, including BHC, chlordane, toxaphene, aldrin, dieldrin, endrin, heptachlor, parathion, methyl parathion, and tetraethyl paraphosphate. All these were used as pesticides for prophylactic uses as well as in response to pest outbreaks, as the then current agronomic wisdom aimed at the total elimination of pests. Pesticide sales jumped from $40 million in 1939 to $260 million in 1954, and cotton yields rose dramatically, by as much as 100 per cent in some areas.

By the 1960s, concerns began to emerge about the persistence of organochlorines in soil, water, and the food chain, and the effect this had on human health and the environment. As result, these substances were gradually phased out, and are today banned by almost all countries. In replacement, although the innovation process had begun earlier, chemical companies introduced less persistent (but often more toxic) alternatives, namely organophosphates (methamidophos, monocrotophos, methyl parathion, profenofos, methomyl), pyrethroids (cypermethrin, cyhalothrin, cyfluthrin, deltamethrin, biphenthrin), and carbamates (aldicarb, methomyl). Today, these have replaced the organochlorines, although some illegal of use of the latter persists because of lax supervision in some Southern countries.

Direct figures on the use of pesticides on cotton in Pakistan are not available. However, reasonably reliable estimates can be obtained from different sources. Since Pakistani farmers do not use herbicides or defoliants (since cotton is picked manually), the main source of concern is the use of insecticides. The ministry of agriculture in newspaper reports (cited in SDPI's *Cotton File*) gave an estimate of 14,950 tonnes of pesticide (with an active component of 6,000 tonnes) in 1996-97. In another report, the ministry (MinFA 1994) estimated that 65 per cent of the total pesticide use in the country was for cotton.[16] In 1993-94, total pesticide use was 20,279 tonnes, yielding a total for cotton of slightly over 13,000 tonnes. Finally, the experts surveyed for the project estimated that in 1996-97, cotton farmers used 3.5 to 4.5 liters of formulated pesticides. For the entire cotton growing area (3 million hectares), this will come to between 10.5 and 13.5 million liters (which is equivalent roughly to between 13 to 15 tonnes). In short, we can be reasonably confident that average pesticide use lies between 13,000 and 15,000 tonnes.

Although the volume and rate of pesticide use is somewhat less than in the high pesticide using countries, there are indications that the adverse impacts are just as severe. Murray (1994) reports figures for central America cotton producers of as high as 18

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[16] This is quite typical for southern countries, where cotton often uses up to 85 per cent of all pesticides. Global figures are variously estimated at between 11 and 25 per cent.

kilograms per hectare and as many as 20 to 30 sprays per season, as compared with between 8 and 13 sprays per season in Pakistan. However, there are indications that the country may already be on the pesticide treadmill. For one thing, pesticide use is about twice the level recommended by cotton researchers and extension staff. Second, the area covered as well as the number of sprays and volume of pesticides has increased dramatically over the last 15 years. The Ministry of Food and Agriculture reports that before 1983 only 5 to 10 per cent of the cotton growing area in the Punjab was treated with pesticides; by 1991, this had increased to between 95 and 98 per cent (MinFA 1995). Plant protection departments also report an almost fivefold increase in total pesticide spraying from 2.8 million hectares in 1982-83, to 13.119 million hectares in 1992-93.[17]

8. Environmental effects of pesticide use

Chemical pesticides affect human health as well as biological diversity and surface and groundwater quality. Although the full impact on human health is difficult to measure, especially in southern countries, the acute toxicity of the substances is not in question. In addition, the World Health Organization (WHO) has concluded that exposure to pesticides is probably carcinogenic as well as toxic. Some pesticides leave persistent residues in soil, groundwater, and the food chain, thus exposing the human population to slow and cumulative poisoning. Various studies estimate the impact to be as high as 20,000 people killed and 3 million poisoned every year (see IISD/WWF 1997: 12-13).

In general pesticide-related illnesses became serious as the earlier organochlorines (most notably DDT) became less effective and more problematic because of their long-term harmful consequences, and were replaced by more toxic organophosphates. Unlike the low levels of acute toxicity caused by the former, even brief oral or dermal exposure to the latter produces acute poisoning and even fatality (see Murray 1994: 44-5). Cotton field workers in Southern countries are most vulnerable because of lack of awareness of pesticide impact, lack of strict implementation of safety measures, lack of readily available running water, exposure to pesticide-contaminated water for drinking or cleaning. Other sources of pesticide contamination are through animal feed (seed cake), water contamination through run offs or fine mist during spraying, improper use of empty pesticide containers for other purposes, and inadequate or illegal disposal of expired or unused pesticides.

Typical pesticide poisoning symptoms include stomach cramps, dizziness, vomiting, and heavy sweating. However, since these symptoms are not exclusive to pesticide poisoning, the incidence of pesticide poisoning is likely to be underestimated. This is compounded by the absence of proper treatment and record keeping facilities in Southern countries. Murray (1994) documents the case of the department of León in Nicaragua, where improvements in the record keeping system led to the discovery of

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[17] Presumably, the area figures represent multiple spraying, since the area covered by commodities that use pesticides (cotton, fruits and vegetables) is far less than the total reported area. Cotton is grown on roughly 3 million hectares. The total area allocated to fruits and vegetables is less than 900,000 hectares between 1991 and 1996.

massive under-reporting of pesticide illnesses in official records. The officially reported incidents of pesticide illness increased from 200 in 1983 to 1,266 by 1987. The increase was considered more a product of improved reporting than an actual increase in the incidence of poisoning. This discovery led researchers to conclude that only 23 per cent of the cases occurring in the countryside appeared in official reports. The revised estimates of 4,777 to 10,343 poisonings for 1989 among a rural population of 300,000 is higher than the reported rate of malaria, and makes pesticide poisoning by far the leading cause of work related illness and injury (Murray 1994: 47-8)

Pesticides also affect wildlife, domestic animals, and biological diversity. Given the prevailing agronomic wisdom of the times, cotton farmers in the last half-century sought to transform the ecological system to eliminate insects altogether. The result of this all-out war was a severe reduction in soil quality and fertility (Murray 1994, IISD/WWF 1997, Edwards 1993, Dinham 1993). Other effects include mortality of birds and aquatic organisms. Although there are no precise estimates, there is considerable evidence of fish stock reduction in pesticide intensive areas. Finally, human health as well as biological diversity is affected by contamination of surface and groundwater due to agricultural runoffs.

Another consequence of pesticide use is what is termed as the ‘pesticide treadmill’. This refers to the situation whereby higher and higher doses of pesticides are required to control pest populations because of the development of resistance in pests and in the elimination of pest predators. An indication of this is the recurrence and persistence of pest attacks and volatility in yield statistics. Initially, the use of DDT and other organochlorines in the 1940s and 1950s increased yields dramatically for about a decade or so. But this resulted in the development of pest resistance, which induced farmers to use larger and large volumes of pesticides, thus increasing their costs, further damaging the ecological balance between pests and their natural enemies, and increasing pest resistance. The elimination of beneficent insects by excessive use meant that farmers could not afford to step off the treadmill because of anticipated crop losses. On top of this, the increasing demand for pesticides also led to increasing prices, thus raising costs even further.

This constitutes an economic argument for reducing or eliminating dependence on pesticides. Given that pesticides raise yields in the short run, only to lower them in the medium run along with an increase in costs due to excessive use, an argument could be made for elimination of pesticides altogether. However, this option is not available to individual farmers, and requires a collective effort on behalf of entire regions in order to be effective.

In Pakistan, there are indications of the emergence of the pesticide treadmill. The most direct evidence is the development of pest resistance to major chemicals. Recent laboratory experiments at the Central Cotton Research Institute (CCRI), Multan, reveal that the two major cotton pests, the American bollworm and the whitefly have developed resistance against common pesticides. In particular, applications of monocrotophos had be increased by 19 to 720 times to control these two pests, 26 to 168 fold increased applications of cypermethrin were required for the bollworm, and 40 to 492 fold increase in methamidophos, and 104 to 725 fold increase dimethoate for the whitefly. Indirect evidence is provided by the long-term yield cycle as described in Section 6. Yields increased significantly in the 1960s with the introduction of pesticides, but dropped suddenly with the attack of the American bollworm in the 1970s. This attack was overcome eventually because it was restricted to the deltapine variety of cotton; as the use of this variety was discontinued, the yield levels began to recover, and reached their earlier peak after a gap of ten years. Subsequently, in the 1980s, yields registered dramatic increases, only to collapse again because of the attack of the leaf curl virus and the whitefly. This attack has still not worked its way through the system.

The leaf curl virus was first observed in Pakistan in Multan in 1967 on a few plants (Hussain and Ali 1975), and occasionally thereafter until the first major outbreak in 1983 (Hussain and Mahmood 1988). The incidence increased dramatically after 1989 and reached epidemic proportions in 1992-93. The reasons for the outbreak are not fully known, but based on similar experiences in other countries, it is reasonable to assume that the excessive use of pesticides was a major contributing factor.[18]

Very little work has been done on the pesticide cycle or on the effect of pesticides on non-target organisms. However, a number of studies have found pesticide residues in water and soil samples, seed cake, and among people exposed to pesticide poisoning directly (eg cotton pickers). However, the studies do not appear to have been subjected to adequate screening and review. For example, Jabbar et al (1993) found small concentrations of monocrotophos, cyhalothrin, and endrin in groundwater samples taken from Samundri in the cotton-growing region. They also found traces of pesticides in soil samples. Although most of the concentrations were below the WHO limits, the indications are that persistent chemicals have deposited themselves in the soils and groundwater. Similarly, a PARC study conducted in 1992 found that 71 per cent of the samples of cottonseed were contaminated with pesticides, including 39 per cent above the WHO maximum residue level (PARC 1992). Since 60 per cent of the edible oil in Pakistan uses cotton-seeds, this constitutes a serious health hazard.

A more serious concern is that of pesticide poisoning. There is no regular program for monitoring this issue. The standard tests use blood acetylcholinestrase inhibition (AChE). A study conducted by the Central Cotton Research Institute (CCRI), Multan (Masud and Baig 1992) found that out of 88 female cotton pickers, only one had a sufficiently low AchE level (below 12.5 per cent), 74 per cent had moderate pesticide poisoning (AchE levels between 12.5 and 50 per cent). One quarter of the sample had dangerous level AchE levels (50-87.5 per cent). The comparative figures for the 33 male cotton pickers were 12, 51, and 36 per cent respectively.

[18] For example, heavy use of DDT, methyl parathion, and toxaphene to combat the American Bollworm in El Salvador contributed to the outbreak of the whitefly. The poor contact of the sprayed insecticides with nymphs and pupae of the whitefly (which are on the under side of the leaf) is a reason for its resurgence.

In countries like Pakistan another source of pesticide poisoning is the lack of information on pesticide handling. There are reported instances of obsolete and banned pesticides, lack of information or safeguards for cotton pickers, and improper disposal of pesticide containers. The Agricultural Pesticides Act 1972, which regulates the use of pesticides in the country, does not address the issue of safety standards, and lack of information with farmers as well as chemical industry workers.

9. Alternatives to conventional cotton[19]

While technological solutions that promise a more sustainable and environmentally friendly agriculture do exist, they have not yet been experimented with on a sufficiently large scale. These solutions range from such techniques as genetically engineered cotton, integrated pest management (IPM) integrated crop management (ICM), low external input sustainable agriculture (LEISA), to biodynamic agriculture which requires cultural as well production change.

9.1 Genetically engineered cotton

Work on the breeding of insect resistant varieties is being undertaken at various research facilities. It includes modifying plant characteristics (eg shape and size of leaves which form the source of nutrients for insects), the speed of ripening (thus limiting the exposure to insects during the vulnerable stage), and the introduction of insect repellent genes into the plants. However, much of this is still in an experimental stage, and their economic viability as well as net environmental benefit has not yet been fully demonstrated (IISD/WWF 1997).

In Pakistan, since the attack of the leaf curl virus in the late 1980s, the focus of research has shifted to the development of varieties resistant to it. The varieties FH-682, MNH-147, BH-36, and CIM-240 have shown partial resistance to the virus in laboratory conditions. In fact, in 1995-96, the original crop estimate of 1.8 million tonnes was based on the assumption of virus resistant varieties. However, the subsequent downward revision of the estimate (by 20 per cent) indicated that the degree of resistance was not adequate. However, this is a reactive strategy based on developing resistance after an outbreak of pest disease.

9.2 Integrated Pest Management

Integrated Pest Management (IPM) is a common-sense method that builds on practices that farmers have used for centuries, for example, using varieties resistant to pests, altering time of sowing and harvest, hoeing, removing crop residues and using botanical pesticides (eg neem and tobacco extracts). The name, IPM, goes back at least to the 1960s. In 1967, FAO defined IPM as 'a pest management system that, in the context of the associated environment and the population dynamics of the pest species, utilizes all suitable techniques in as compatible a manner as possible and maintains the pest population at levels below those causing economic injury'. It seeks to reduce pest

[19] Based on material provided by van den Grijp (1998).

populations to economically manageable levels through a combination of cultural control (eg crop rotation, inter-cropping), physical controls (hand picking of pests, use of pheromones to trap pests), and less toxic chemical controls. However, it allows the use of chemical pesticides, even synthetic and toxic ones, when there is a need. IPM techniques are specific to the agro-ecological production conditions in any given location, and may involve the use of pesticides. As a result, few general principles can be applied and no absolute standards set for production.

In one study in India (Kishor 1992, cited in de Vries 1995: 46-7), it was found that the use of IPM resulted in higher yields and lower costs, resulting in a decline of unit costs by 28 per cent—although these are guesstimates rather than precise estimates. Thus, IPM use is found to be both economically efficient and environmentally beneficial. It also creates additional employment, since the technique is more labor intensive than conventional methods.

A closely related alternative that is gaining ground is Integrated Crop Management (ICM). As in the case of IPM, this alternative too permits artificial fertilizer and pesticides when absolutely necessary, but aims to minimize them in favor of natural predators, crop rotation and hand weeding. It differs from IPM, however, in that it goes beyond pest management to include issues of fertility, soil quality and crop management. Like IPM, it too cannot be defined precisely, and has not yet become the basis of legally binding rules or practices.

While IPM is a promising alternative, and in some studies at least has been show to be on the whole profitable for the farmers, it has not been very successful on a broader scale. Some reasons for its inability to replace conventional production may have to do with the fact that it involves more (and changing) work on the same area over time. Also, farmers might be reluctant to enter into a new concept because of a fear of unknown consequences. Also, it requires additional skilled labor, which might not be available. At the level of the enabling environment, reasons may have to do with the lack of an adequate service (ie research and extension) structure, uncertain initial costs of switching (because of a lack of received knowledge), and lack of region specific knowledge of the pest complex. More importantly, it pits relatively low paid and poorly motivated public officials and scientists against employees of powerful pesticide companies. Murray (1994) concludes his review of repeated promising but ultimately unsuccessful attempts to introduce IPM in Latin America, by arguing that alternative approaches to pest control and sustainable agriculture need to be rooted in an alternative, participatory, egalitarian, and small scale agriculture, based on traditional knowledge. While sympathizing with the longer-term thrust of his remarks, it needs to be said that for the short run, conventional approaches to the introduction of IPM do not offer much hope.

In Pakistan, research on IPM has a fairly long history. This was initiated as early as 1971 at the PARC research station in Rawalpindi, first as a seven year PL-480 funded project on bollworms, and a 3-year PL-480 project on the whitefly, and an institutional support project on integrated pest management, funded by the Asian Development Bank.

However, these projects have not had a serious impact on production methods. A major reason is the limited nature of the project, without efforts to mainstream it in the functioning of the major research institutions, especially the system of cotton research institutes. Second, the extension system is not equipped to handle results from the IPM research, since there are hardly any avenues for training of extension staff in this technology. Finally, the educational institutions (especially the entomology departments of agriculture universities) do not provide training or specialization in IPM, to ensure a steady stream of experts for staffing research, education, and extension departments.

9.3 Organic agriculture

One of the most environmentally friendly production methods which is gaining ground is organic agriculture, namely the production of cotton without the use of any chemical inputs whatsoever. Instead it relies on natural processes to increase yields and disease resistance and enhance soil quality. At present, this is the only type that has an internationally recognized, independently assessed label for its products. Producers who do not meet the certification criteria but produce in an environmentally less harmful manner may not call their product organic, although they are allowed to use such other terms as clean, green, or natural. In 1993, total global production of organic cotton was estimated to be between 6,000 and 8,000 tonnes, ie less than 0.04 per cent of the total global cotton output. Of this about 75 per cent was in the US and the rest in several countries, including 272 tonnes in India (in 1994-95). However, organic cotton is reported to be a rising trend (by as much as 50 per cent in 1994).

In principle, organic cotton can be grown under the same conditions as conventional cotton. However, there are a number of caveats. First, it requires the farmer to make a considerable investment in studying the ecosystem of the area—although this could also be done by an effective and professional extension service. Second, current evidence suggests that organic methods will entail yield reductions of variable degree, which are not likely to be fully offset by the reduction in costs. Third, in some cases the yield reductions might be so large, because of large natural population of pests that organic methods might never be able to compete with conventionally grown cotton. Fourth, even otherwise farmers will have to be prepared to meet initial losses because of a lack of balance in the production area; in particular, natural enemies of pests will not be abundantly available on first switching from conventional, chemical-dependent cotton. Finally, farmers will have to invest in crop certification, isolation of organic cotton from conventional produce, and cleaning of machinery and implement before use.

Although organic agriculture has simpler and more precise definitions and certification arrangements, there is nevertheless some variation across countries and regions, and at least one hundred regional or national standards have been developed so far. The EU and several national governments developed framework legislation for organic agriculture. In the USA a national law for organic products, the Organic Foods Production Act 1990, has been in preparation for many years, and will be finalized by 1999 along with the organic standards for production, processing and labeling, accreditation, and importation. However, it will only allow the label 'made with organic fiber' for organically grown cotton, pending deliberation on the definition of organic textiles which shall include approved dyeing process standards.

The International Federation of Organic Agricultural Movements (IFOAM) has also developed international minimum standards. This is a worldwide umbrella organization of over 570 active member groups in 100 countries. IFOAM membership is open to associations of producers, traders, and consultants as well as institutions involved in research and training committed to organic agriculture. Its accreditation system will ensure the existence of minimum levels for national or regional standards.

Until very recently, a three year transition period from conventional to organic production was required for certification, presumably to ensure enough time for the abatement of pesticide and chemical residues in the soil. Cotton produced organically during the waiting period is described variously as 'transitional', 'pending certification' (California), or 'organic B' (Australia). However, in late 1994, IFOAM regulations were changed to a one-year transition period where levels of chemical inputs are lower.

Given the small size of the organic cotton sector, reliable estimates of longer-term productivity and economic trends are not fully available. De Vries (1995: 54-9) reports that the switch to organic cotton will involve an initial yield reduction of about 50 per cent, but after some seasons, the net decline will be significantly smaller, probably around 30 per cent.

Some studies show yields rising to conventional levels, but this is rare, and is restricted to areas where insects did not play a large role in yield determination in the first place. The results from a micro study of one such area,[20] a Turkish cotton project, is cited by de Vries (1995). This study (Zeegers 1993) shows seedcotton yields declining from 3,160 to 1,500 kg/ha in the short run (ie shortly after the transition), before stabilizing at 2,750 kg/ha by the time soil fertilization had improved. During this period unit production costs rose from 100 to 211.4 before settling at 132.2, although later calculations for the same project are said to have yielded a unit cost escalation of only 11 per cent. In other words, the switch to organic cotton involves a unit cost increase of between 11 and 33 per cent even in the long run for an area with minimal insect presence. Other studies give conflicting results. In some cases, a unit cost escalation of between 50 and 150 per cent is reported (de Vries 1995: 58-9). On the other hand, an UNCTAD study by Alexander Daniel and Boudewijn van Elzakker (forthcoming) on organic cotton production in India concludes that unit costs will rise by about 20 per cent. They also suggest that the difference will narrow further with an expansion of the sector.

There is no recorded information on organic cotton production in Pakistan. However, at least three successful projects have been introduced in India, which has similar institutional and environmental conditions. These are small-scale projects,

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[20] As evidenced by the fact that pest control involved only 2.5 per cent of the variable costs (excluding land costs) under conventional methods. Normal levels of pest control costs range between 7 and 57 per cent of variable costs. See de Vries (1995: 55-56).

introduced with technical assistance from bilateral donors as well as marketing chains, in Madhya Pradesh, Gujarat, and Maharashtra states. Technical assistance is provided by Swiss, Dutch, and German institutions respectively. The assistance has included investment in extension services, access to credit, and certification. Although these projects involve yield reductions, these are offset by the guaranteed cost premia of 20 per cent (Madhya Pradesh) and 10 per cent (Gujarat).

Given the small size of the market, organic cotton will face other costs as well. Foremost among these is the higher cost of spinning. This results from the fact that spinning machinery will have to be cleaned between running conventional and organic cotton. Also, given the small volume of the product, there might not be enough fiber of a particular length to make it economically feasible for dedicated spinning machinery. Also, the volume might not be sufficient to blend different fibers to produce consistent quality.

Data on the premium enjoyed by certified organic cotton is quite varied. Some studies indicate a doubling of price over conventionally grown varieties. The Indian studies mention a premium of only 20 per cent, although the hidden subsidies on extension and access to credit are also equivalent to an additional premium. It appears that while European consumers are prepared to pay the higher prices entailed in the switch to green cotton, the demand in the US is fairly subdued.

9.4 By way of a summary

To summarize the above discussion, there is sufficient evidence that technological alternatives do exist to promise a switch from conventional cotton production to more sustainable methods. However, these alternatives are fairly limited in spread, anywhere in the world. The question to be explored is that of mechanisms through which they can spread further. For this we have to revert to the issue of governance.

10. System of governance

As mentioned, by the ‘governance system’ is meant a set of arrangements and institutions that enable independent actors to make collective decisions in a legitimate and acceptable manner. To explore this concept further in the case of cotton farming, we have to look at the manner in which farmers make allocative decisions, and in particular how their decisions are affected by various interest groups. The first point to recognize is that farmers come into contact with three groups of actors who can influence them in making their production decisions. These are input suppliers (especially pesticide suppliers), purchasers (mainly commission agents), and government extension agents. Of these, only the government extension agents and input suppliers make an explicit effort to influence farmers' decisions. There is no history of commission agents trying to influence these decisions. Their role hitherto has been confined to purchasing cotton at market prices, sorting and classifying it, and selling it (generally after ginning) to spinners.

Let us begin with the issue of the farmers' incentive to modify production decisions. The simplest assumption is that this decision will be based on an assessment of the costs and benefits of various alternatives. In this scenario, farmers will switch to green alternatives if they become more profitable than conventional production practices. This can happen either because of trade restrictions on conventionally produced output, or premiums on green alternatives (eg because of eco-labeling), or finally because of awareness of the long-run adverse environmental and social consequences.

However, matters are rarely so simple. First, the uncertainty of crop yields means that the risk to farmers of a switch is going to be higher than that indicated by the aggregate figures. In other words, farmers will not only have to change production methods to unfamiliar ones, but will also have to assume the risks of yield variation. Second, the risks are likely to be even higher in the early years of transition, making it impossible for the demonstration effect of the innovation to influence lagging farmers to adopt the new technology. Third, the switch requires awareness of market opportunities and access to privileged markets. Since Pakistani cotton sells at a relatively low price in international markets, there is no evidence that farmers have tried to take advantage of high value niche markets. It is not clear that the stimulus is there to take advantage of the green cotton niche. In any event, if it requires detailed technical assistance and extension by technical staff, the absence of such staff in the country means a lack of confidence in the ability to undertake the transition smoothly. Fourth, unlike the transition to chemical based crop production in the 1960s, the success of the shift to green alternatives depends critically on the spread of the new technology. The larger the number of farmers adopting the new technology, the more productive will it become. This places a burden on the extension efforts far beyond what was experienced during the green revolution.

This last is a classic example of externalities faced by farmers in the form of the actions of other farmers. Classic economic theory bases its analysis of production decisions on the assumption of profit maximization. Given perfect competition, this yields completely independent decisions by farmers. However, even with these simple assumptions, the decision of each actor can depend critically and explicitly on those of others. In economic terms, this dependence is an 'externality', which can stem from market conditions,[21] scale economies in access to inputs (seeds, fertilizer, water, credit),[22] and information (technology, learning by doing), and collective environmental impact (water and soil quality, the pest complex). These externalities create incentives for collective input into decision making.

In the traditional farming systems, such collective input tended to be highly localized, since the marketable surplus of most crops was fairly limited, and production was dominated by subsistence considerations. Cotton, however, has long been an exception to this pattern, and the expansion of output since the 19th century has been driven by export demand, initially in the British textile industry, and later in the global

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[21] For example, if the value of the crop depends on its perceived quality, the decisions of others will affect the revenue received by a single farmer. These types of externalities are determined by such factors as reputation, homogeneity, costs of transportation, location of markets.

[22] A large number of farmers purchasing a single input will make it profitable for suppliers to supply it in bulk and presumably at a lower cost.

industry. However, this pattern is now found in all major crops, where the marketable surplus has grown rapidly with the advent of the green revolution in the 1960s. The result is a growing role of intervention in farming decisions by governmental research and extension departments.

Governmental input and advice to farmers did not start in the 1960s, however. The colonial government initiated programs of agricultural research and extension, albeit much smaller in scope and ambition, almost a century ago.[23] Initially, they focused on farmer education towards greater rationality and economic efficiency, better time management, the use of standardized of weights and measures, and adoption of best practice or husbandry. The attention was on the process of production and attitudes towards production rather than on inputs as such. Seed production, manuring, and pest control was still primarily in the hands of farmers rather than specialized organizations. In the 1950s and 1960s, this began to change, as governmental agencies suddenly found a composite product to sell, and began to get involved more directly in decisions over inputs and technology. As a result, the quantum and nature of scientific input into farming system changed by an order of magnitude in the post independence, post world war period. Yet, the historical age of extension programs was important in legitimizing the more broad-based intervention.

This 'composite product' was the combination of inputs and practices that goes by the name of the ‘green revolution’. Technologically, it was simply the introduction of high yielding varieties of major crops, combined with ‘optimal’ application of fertilizers, water, and other inputs. Besides raising per hectare yields to record levels, this also transformed the entire system and culture of agriculture production in the country. For the first time, it shifted the source of knowledge production from farmers to government bureaucrats and scientists. It privileged landlords over tenants, large and medium farmers over smaller ones, and governmental officials over farmers. It created a demand for transportation networks, markets, market intermediaries (commission agents), financial institutions, and input supplying corporations. It also aimed, somewhat less successfully, to reproduce in agriculture an ‘industrial model’ of operation, namely the creation of a controlled human and natural environment in which productivity could flourish.

It is important to emphasize three points, first, that the green revolution took hold because it demonstrated success in raising farm revenues and profits. Second, that it expanded 'organically'--in other words, it spread to a few farms, whose success led others to imitate them, and so on, until the entire process was completed in about ten years for wheat and rice, and 20 years for cotton. Third, that it involved earning of legitimacy and trust, to overcome a dissonance in the systems of knowledge between farmers and scientists.

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[23] For an interesting anthropological analysis of the changing nature of agronomic advice in Western India, see Appadurai (1990). He notes that while ‘agriculture’ is a form of ‘culture’, namely a way of thinking that integrates values and behaviour, the subject of the programme was ‘agronomy’, namely technological knowledge of agricultural system, independent of the cultural context.

In the initial years, the most striking successes were obtained in the wheat and rice sectors, based on research done at CIMMYT in Mexico, and IRRI in the Philippines. While average cotton yields grew by 50 per cent in the decade of the 1960s, the major breakthrough in cotton arrived only in the 1980s, with a doubling of yields and tripling of output in 10 years. Also, unlike the other crops, yield growth in cotton was far more difficult to sustain because of the changing nature of the pest complex.

As mentioned, the program aimed not merely at the introduction of new or different inputs into the production process, but rather at the transformation of the process itself. It is not surprising, therefore, that it was led not by the invisible hand of the market but by the visible hand of a set of interlocking institutions--of agricultural policy, extension, research, credit, inputs (certified seeds, fertilizer, water), and education. Significant governmental and technical assistance resources were channeled into existing agricultural research institutions and additional ones were established, the governance of the research network was integrated and formalized through the established of the Pakistan Agricultural Research Council. New agricultural schools and colleges were established and older ones expanded and upgraded into universities. New government owned corporations were set up to supply seeds (PASSCO), credit (ADBP), and fertilizer (NFC). The agricultural extension network was expanded, and pamphlets, brochures, and regular radio programs on agricultural knowledge were produced.[24]

Today, the number of institutions that influence agricultural allocation decisions runs into scores if not hundreds. To list only the most prominent of these, the Pakistan Central Cotton Committee (PCCC), the system of Cotton Research Institutes (CRIs), the Pakistan Agricultural Research Council system, the Textile Commissioner, the Agricultural Prices Commission, the Federal Seed Certification Department (FCSD), various agricultural universities, and the Export Promotion Bureau (EPB). The country has 4,000 agricultural scientists, 500 agricultural extension agents, and proportional numbers of officials in seed certification and supply, agricultural machinery provision, policy development and agricultural pricing, and agricultural credit, all in the public sector.

While farmers do not have an organized association, they are represented heavily in national and provincial legislatures, and on cabinets of ministers. Since cotton farmers are concentrated in southern Punjab and upper Sindh, they are able to act in concert through an interesting union of ethnic and sub-nationalist grouping and economic interest. In recent years, a non-governmental organization, the Farmer Associates Pakistan (FAP) has been established as a lobby of the larger farmers. Most of the constituents (ie, most large farmers) as well as the main leaders ofd this organization come from the cotton

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[24] The institutions did not cover all significant aspects of the production process, however, and the current agricultural crisis is associated directly with the areas where the institutions either did not exist or remained outside the self-reinforcing circle. These areas are water (which remained with a completely independent department of irrigation), social, economic and equity issues (for which there are specialised institutions within the PARC system, but neither well integrated nor well regarded by the research establishment), and environment (which was not given any importance).

growing area. It is not clear whether this group has had any influence beyond that exercised by the political leaders through their presence in national and provincial legislatures.

However, corporate lobbying in the cotton production sector does exist, not by farmers, but by input suppliers. The Pakistan Agricultural Pesticides Association (PAPA), is a powerful lobbying group, the bulk of whose activities are concentrated in the cotton system. Large seed corporations are also said to be involved in advocacy, lobbying, and pressuring the government to deploy policies favorable to their interests.

To return to the green revolution, this system was driven by a simple philosophy: maximize yield. Researchers were directed to produce high yielding varieties of crops, and extension agents mobilized to disseminate the information to farmers. Simultaneously, credit agencies were instructed to supply credit for expanded ‘working capital’ demand, input suppliers to ensure that the recommended inputs were in fact available. Behind all this was an orchestrated government policy aimed at subsidizing the cost of inputs and research, and maintaining stable output prices to maintain market stability.

The government used a combination of pricing policies, taxes and tariffs, and investment both to subsidize inputs in chemical-based agriculture, and create a stable market for its output. Beginning in the 1960s, explicit subsidies were introduced on fertilizers, pesticides, and agricultural machinery, as well as complementary inputs (especially irrigation water and agricultural credit). Initially, fertilizer and pesticides were supplied directly by government agencies at controlled prices, which were generally lower than the market. Pesticides in particular were made available virtually free of cost in the beginning, and agricultural self-sufficiency was closely linked to the amount of pesticide used. In 1986, a process of liberalization was started to bring input and output prices in line with international market conditions. Still, prices were held down by a combination of low tariffs (the entire demand for pesticides is met through imports), free technical input (through research and extension agencies), and liberal regulations. Gradually, the tariffs on pesticides were also brought in line with the overall tariff levels, and today equal about 27 per cent of import value.

This process also coincided with the grant of permission to the private sector to supply agricultural inputs. As a result, the private sector now has a free hand in the manufacture, import and marketing of pesticides. Extension agents of pesticide companies try constantly to induce farmers to use more pesticides, and farmers have no choice but to accept this advice since none other is available. On the one hand crops have become susceptible to a broader spectrum of pests, and on the other hand, pesticides are becoming increasingly expensive due to the monopoly of multinational companies. Moreover, most of the key pests have developed resistance against pesticides and their larger populations pose an increasing threat despite the ever-increasing usage of pesticides every year.

This situation contains hidden subsidies for pesticides, in the form inadequate information to farmers on the comparative costs of pesticides and their alternatives. Farmers lack knowledge on the side effects of pesticides, and governments are loath to provide this knowledge, presumably out of fear that it may obstruct the goal of maximizing yield. This proves harmful to agricultural productivity in the long run. As pest numbers and population increased because of excessive use, a switch to other policies and practices was warranted but did not take place. Instead, there is a tendency to increase the intensity of use to compensate for the loss of effectiveness.

In retrospect, if one ignores the environmental and social costs and focuses on the yield levels alone, the green revolution program could claim to be extremely successful. It led both to the introduction of new inputs and the replacement of an existing system of knowledge with another one. Today, high yielding varieties of wheat, rice, and cotton cover virtually the entire cultivated area (although as much as 50 per cent of the seeds used are not 'certified'). In the mean time, the use of chemical fertilizers has grown at about 7 per cent per year, and the application of chemical pesticides from a minuscule amount in the 1950s to over 20,000 tonnes in the 1990s (now amounting to 15 per cent of total production costs in cotton). Supporting these initiatives is the irrigation network, which has more than doubled in reach.

The result is a rapid transformation of agriculture as a cultural and social activity. First, the landlord-tenant relationship came under severe stress in the 1960s and again in the 1980s, leading to peasant uprisings, armed conflict, and periods of lawlessness and open civic unrest in the rural areas. Although other factors[25] also contributed to the emergence of unrest, the most significant is the green revolution. On the one hand, it raised incomes, thus requiring a rewriting of the traditional agreements for the sharing of the benefits. On the other hand, it undermined peasants' knowledge, which was the basis of their bargaining power with the landlords, and replaced it with scientists' knowledge to which the landlord had a preferential access.

Second, the collective knowledge of traditional agricultural practice, which is viewed by many scholars as more environmentally benign, has more or less died out over vast areas, and has been replaced with a growing dependence on external institutions and experts. This is especially the case with regard to crops vulnerable to pest attacks, ie cotton, fruit and vegetables. Initially the external institutions were strong and well supported financially and politically. Over time, they have deteriorated in quality or have been captured by the powerful interest groups. The responsibility of some institutions (eg, PAASCO, NFC, and the Cotton Export Corporation) has shrunk in proportion to the expansion in the private sector. Others have been debilitated by years of mismanagement and corruption (eg ADBP). All organizations are threatened by the generalized crisis of governance in the country; declining salary levels and poor monitoring systems have led to a dramatic deterioration of the efficiency, integrity, and transparency of government

[25] Especially the emergence of strong political movements, democratic and egalitarian rhetoric of nationalist political parties, expanding education and information, population growth, and the strengthening of the mass media and other organs of civil society generally.

organizations. This is especially true in areas (such as research or extension) where output cannot be monitored directly. Finally, a number of functions are under threat of capture by specialized interest groups. Foremost amongst these is the pesticide supply system.

It is important to reiterate here that notwithstanding its growing weakness, the governmental system of agricultural support functioned in a manner that is strikingly similar to and perhaps more ambitious than the role ascribed by Gereffi (1994) to large retail corporations in buyer driven commodity chains. The government behaved as a large corporation whose goal is to maximize the output produced by its constituents, and thus to maximize the total earnings for the country from this output. Unlike retail corporations, the stake of the governmental system is not directly pecuniary, nor has it expanded disproportionately with the increase in the total value of output. Yet, it must be emphasized that the government does have a stake in this output, given a higher agricultural output means a higher GDP, exports, imports, tax revenues, greater political stability (at least in urban areas), and thus less demand on resources in the hands of the state. This is both a pecuniary and a political interest.

The similarities end here. Unlike retail corporations, however, whose goal is the maximization of profits, the goal of the governmental system is the maximization of yields. Thus, while the former adapted to changing market conditions, the latter had the freedom of being more conservative. Actions that enhance *net* output (after deducting all social and environmental costs) could have been forced upon a corporation by market considerations, but can be ignored by the government if they go against the grain of the explicit national goal. This is certainly the case with sophisticated interventions (such as IPM) that are supposed to raise net profitability even though they depress yields and output. Although a small number of agricultural scientists have studied this issue, and have made considerable progress in selected areas, their research has not been disseminated properly, nor its significance to farmers demonstrated properly.

Secondly, as mentioned already, governmental action has the tendency to become captive to strong vested interests. The supply of pesticides is in the hands of powerful multinational corporations, who employ highly paid researchers and extension agents (sales representatives) for their products, and are also believed to influence governmental policy in their favor. IPM and organic cotton do not have a similar profit motive behind them.

A major stumbling block is the very size and inertia of the agricultural establishment. The vast majority of researchers and extension agents are schooled in the old style 'maximize yield' philosophy. Switching to IPM involves a significant personal investment by these individuals, for which there is no institutional or other incentive. In contrast, sales representatives of private companies (dealing with pesticides, seed, fertilizer, agricultural machinery) have an incentive to keep up with the research to promote their products (and therefore their careers).

However, of all the agencies that have a direct personal contact with farmers, and who try to influence the farmers' allocative decisions, the government research and extension is the only one that has the potential of influencing the switch to cleaner production. Private pesticide and fertilizer companies face precisely the reverse incentives, namely to maintain and even intensify the current production practices in order to increase the demand for their products. The purchasers of cotton, who might be viewed as having a private stake in improved varieties, have neither a history of interaction and extension with farmers, nor that of responding to new market niches. Also, they are neither organized collectively, nor have a sufficiently concentrated structure to enable leading firms to act as innovators and price leaders.

In other words, of the four groups, two (the farmers and the purchasers) do not exhibit a corporate structure or mentality, making it difficult for their collective interests to find expression or be enforced. A third group (the input suppliers) recognize their interest clearly and enforce it effectively through advertising, extension, and research; but this interest is contrary to the logic of sustainable agriculture. The third group (the government) interprets its collective interests to lie in the maximization of yields, and pursues this objective with a certain degree of historical inertia if not with great efficacy. However, since this does represent the public interest, including the interest of farmers, it is quite conceivable that its interpretation of the collective interest changes. That will raise the issue of whether it has the institutional strength and political will to pursue the collective interest in the face of opposition from vested interests.

A feasible program of transition to sustainable agriculture will therefore involve the following characteristics:

- The transition cannot be based on market incentives alone, since there is no technical and informational link between final consumer markets and farmers.
- Given the low level market niche of Pakistani cotton, and the enormous size of the cotton output, it is unlikely that the transition can be led by the lure of high-end market niches. It is therefore better to focus on medium or low end cotton production as the goal. This can mean a concentration, at least in the first stage, on IPM rather than organic cotton as the goal of the transition.
- Since definitions of IPM are even looser than organic cotton, they cannot be readily converted into advice to farmers. There is a need to start a process for defining IPM more precisely.
- The transition to IPM must involve the research and extension system of the government in a central manner. This cannot be done through marginal investment in IPM research.
- This involvement can be obtained only if it is in the interest of the research establishment to undertake IPM activities. This can be done through the establishment of career paths, research and training opportunities, international exposure, and even commercial opportunities for researchers.
- Similarly, there must be clear incentives for extension officials and university faculties to switch to IPM based education and practice.

- Finally, the transition must involve pesticide companies in a central manner. This can be done on the lines of the business government roundtable introduced to clean up the textile processing industry (Section III). It may involve providing incentives to chemical companies to introduce IPM technology.
- Finally, there is a need to establish crop insurance programs to reduce the farmers' risk during the transition.

III. Textiles

11. Introduction [26]

The textile industry is generally sub-divided into three sectors, namely spinning, weaving, and composites or processing. Lint cotton, separated from seeds is fed into spinning mills, which produce yarn exclusively. The yarn is supplied to weaving mills, which produce gray cloth exclusively. Finally, gray cloth is supplied to processing mills, which produced finished cloth. Alternatively, lint or yarn is supplied directly to composites, which are vertically integrated facilities that produce a variety of products ranging from yarn to printed and finished and dyed products. A fourth sector that has taken off in recent years is that of apparel and knitwear, which produces ready made garments, hosiery, and other made up products. Cotton processing is a highly polluting industry, utilizing a number of chemicals in desizing, mercerizing, bleaching, dyeing, and finishing of cloth.

A good description of the cotton processing stages can be found in IISD/WWF (1997), or SDPI (1995). Briefly, the spinning stage consists of blowing and mixing, carding, combing, drawing, simplex, ring spinning, and cone winding. The weaving stage comprises warping, sizing, and weaving. Finally, the processing stage covers singeing (burning to remove loose threads), desizing (removing a flexible film, called 'sizes' from the fabric), scouring (immersion in caustic soda to remove impurities), bleaching (using chlorine, hydrogen peroxide, or sodium hypochloride to whiten it), heating, washing, drying, mercerizing (immersion in cold caustic soda to improve affinity to dyes), washing, dyeing, washing, drying, printing, drying and finishing (eg to obtain wrinkle free or water repellent clothing), and calendering. Each step involves environmental costs because of the characteristics of the effluent discharged from it. However, methods are available for minimizing and even eliminating the environmental costs of the processes. The finished cloth is used in further steps along the chain, namely garment manufacture.

The various steps in the production chain correspond to particular industrial structures. The yarn-producing sector comprises mainly large-scale units. These are organized collectively under auspices of Pakistan's most powerful industrial lobby, the All Pakistan Textile Manufacturers Association (APTMA). Yarn exports go mainly to Asian markets in large volumes. APTMA's strength translates into considerable influence

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[26] This section is based on SDPI (1995).

on the government's policies on prices, international trade, and credit in favor the spinning sector.[27] The net result of these policies is a high degree of protection to the yarn sector through low cotton prices and high yarn prices. This protection has nurtured a relatively inefficient industry, which has not been able to graduate beyond coarse quality yarn after 40 years of development. 80 per cent of the total yarn production in the country still falls in this category. The result is Pakistan has remained an exporter of low quality fabrics and garments.

The weaving sector is mainly an informal sector industry, without adequate collective representation. However, 10 per cent of the weaving units are in the organized 'mill' sector, and are also influential in APTMA. Yet, the weight of the industrial lobby is in the spinning sector. Cloth exports go mainly to European and American markets, and is demanded both by large importers and garment making operations (such as Levi-Strauss and Co.).

The textile processing and composite units are organized under the All Pakistan Textile Processing Mills Association (APTPMA), a smaller body with considerably less clout in policy circles. Similarly garment manufacturers have their own collective association, the Pakistan Cotton Fashion Apparel Manufacturers and Exporters Association (PCFAMEA), but also one with less influence. These garment manufacturers are generally tied to international retail houses. Their goal is to obtain long-term supply contracts with large retailers.

In Pakistan, at the time of independence in 1947, despite the existence of thriving cotton farming, there was very little industrial activity using cotton. Only 6 spinning factories, 80,000 spindles and 3,000 weaving machines processed cotton and supplied about 8 per cent of the domestic demand. Today, the textiles sector accounts for about 19 per cent of value added in manufacturing, 64 per cent of exports, and 40 per cent of manufacturing employment. It is by far the largest industrial sector in the country, out of a much larger industrial sector. Since 1947, the share of value added in industry has risen from a negligible level to over 27 per cent, exceeding the share contributed by agriculture.

The installed capacity in the formal, large-scale yarn producing sector alone has increased to 8.7 million spindles, 143,000 rotors, 14,000 looms, and 1,312 shuttle-less looms, in 503 production units. Beyond this stage, the textile sector comprises 650 textile processing units (including some state of the art machinery), about 10,000 knitting machines in 600 knitwear units (including 80 fully integrated firms), 6,500 towel looms, 225,253 weaving units (mainly in the informal sector), and 1,000 garment manufacturers.

As in many southern countries, textiles has been the engine of growth for the Pakistan economy. The industrialization process in the country started with yarn production, from where it expanded into weaving, dyeing and finishing of cloth, and most

[27] For example, over 50 per cent of the credit from government-controlled development finance institutions (DFIs) goes to spinning units. Similarly, higher duties on inputs of processing and finishing units render them less attractive than spinning units.

recently into made ups, hosiery, and garments. Yarn production increased from 0.43 million tonnes in 1980-81 to 1.37 million tonnes in 1993-94. During this time, cloth production in the mill sector was stagnant, ranging between 325 million square meters in 1980-81 to 322 million square meters in 1993-94. However, the value of exports of yarn and cloth grew at similar rates between 1982-83 and 1995-96, from Rs 3.56 billion and Rs 3.62 billion to Rs 54.08 billion and Rs 45.42 billion respectively (Chart 2).

While similar output figures for garments are not available, export values increased dramatically in the 1980s. In 1994-95, the combined foreign exchange earnings from the last stage of production was Rs 61 billion, compared to Rs 49.57 billion from yarn exports, Rs 34.99 billion from cloth exports, and Rs 4.06 billion from cotton exports. Nevertheless, the full potential from this sector has not yet been achieved. A major source of retardation is the slow growth in Pakistan's textile quotas under the MFA.

The textile industry is the largest source of foreign exchange earnings in the country. In 1994-95, for example, yarn contributed 18.8 per cent of total exports, cloth 13.3 per cent, hosiery 8.5 per cent, cotton made-ups 8.0 per cent, and ready-made garments 7.9 per cent. This yields a total of 56.5 per cent from the export of processed cotton products. The major markets for cotton yarn are Japan, which imported $362 in 1994-95, Hong Kong ($310 million), South Korea ($169 million), Dubai ($46 million), and Canada ($33 million). Cloth exports went mainly to Hong Kong ($163 million), USA ($111 million), Bangladesh ($80 million), Australia ($57 million), UK ($51 million), Belgium ($50 million), South Korea ($49 million), Dubai ($45 million), and Japan ($42 million).

The market for cotton products is influenced by supply as well as demand factors. On the supply side, the main features of the textile industry in Pakistan are as follows:

- **Size of informal sector**: An important feature of this sector is its non-mill component, consisting of independent, small scale weaving units, which account for as much as 90 per cent of all fabric production. While the small size of the individual units provides an advantage in terms of greater flexibility, it also means poor management, weak financial capacity, and poor and outdated machinery.
- **The mill sector**: Approximately 40 per cent of the members of APTMA are integrated mills, namely mills that perform spinning, weaving, and in some cases processing as well. In 1997, these mills had a total of 14,000 shuttle looms and 1,312 shuttle-less looms. In addition to this, the informal, non-mill sector consists of independent, small-scale weaving units, and power looms. In 1997, there were 13,340 independent weaving units, and 202,000 power looms. As a result, roughly 90 per cent of the weaving capacity is in the small-scale sector.
- **Integrated sector**: In recent years, the country has also acquired state of the art weaving machinery with some facilities for procuring modern dyeing and printing equipment. There are approximately 650 firms in this sector, with an installed capacity for producing 1,150 million square meters of finished cloth every year.

- **Knitwear sector**: This sector comprises about 600 units, housing 10,000 knitting machines. 80 of the firms are major integrated units with knitting, dyeing, and sewing processes, while 60 per cent of the output is in the small-scale sector.
- **Garment manufacturers**: The garment manufacturers number about 1,000. Most of them are small-scale household units, with less than 50 machines each. 550 firms are members of the PCFAMEA, including 250 small-scale firms (ie, less than 50 sewing machines) and 300 bigger enterprises (with 50 to 300 machines each).

The demand side is influenced by international as well as domestic considerations. On the domestic front, an estimated population growth rate of over 3 per cent per year, and a growth of income per capita of 2-4 per cent per year translates into a demand growth of 3.5-7 per cent per year for cotton products. While figures for income elasticity of demand are not available for Pakistan, various estimates suggest a figure between 0.5 and 1.0 for low-income countries, probably closer to the lower figure. This means that demand will double over the next 20 years. If yield expansion can keep up with the previous trends, output would at least double during this period, yielding a significant surplus for exports. Even if yields remain stagnant, the share of exports in the total cotton crop will decline from its current 70 per cent to roughly 40 per cent by 2015. However, this might be accompanied by a shift towards higher end products.

A major factor in influencing demand conditions is the recent GATT Agreement on Textiles and Clothing (ATC). Under this agreement, the trade restrictions under the Multi Fiber Arrangement (MFA) concluded in 1974 would be phased out over a period of ten years starting in 1995. Trade restrictions on cotton products by northern countries have a long history, going back to 1925. The goal of these restrictions was to protect declining northern manufacturing industries from competition with lower cost producers of textiles in southern countries. The first international agreement on cotton textiles was negotiated in 1961 at the behest of the US. Under the agreement signed in October 1962, quotas were imposed on cotton exports from southern to northern countries for a period of 10 years. It allowed bilateral negotiations over quotas and in some cases even unilateral imposition of quotas.

A more elaborate agreement, the MFA was signed in 1974. Its scope was expanded both functionally (to include synthetic fibers), as well as geographically (to include newly industrializing countries). Successive rounds of agreement made the quotas even tighter and expanded coverage to include other fibers. Since the 1980s, the growth rates of Pakistan's quotas have been reduced below their target level of 6 per cent per year, and additional products have been brought under the purview of the restrictions. Since 1985, Pakistan's quota utilization rates have been extremely high, ranging on average between 82 and 96 per cent for the US and (except for one year) between 105 and 119 per cent for the European Union. Item wise quotas have also been high, at 100 per cent or higher in 5 categories and over 80 per cent in 12 categories for the US. This suggests that the MFA is a binding constraint for Pakistan's exports, and the elimination of the quotas will provide a stimulus to exports.[28] However, given the nature of international competitiveness in this sector, the eventual results cannot be predicted with precision (Ingco and Winters 1995, Low 1995).

On the other hand, in recent years, the textile industry has gone through a series of crises. A major contributing factor is the decline in cotton yields and output after the peak year of 1991-92, coinciding with an increase in international cotton prices and a reduction in the global cotton crop in 1993. However, this is not the only factor, and plant and machinery obsolescence, and inefficient management protected by years of favorable policies, have also contributed to the crisis. In any event, the increase in domestic cotton prices has been quite significant. Coupled with the scarcity of raw cotton, it led to a decline in the dollar value of exports in 1992-93 and 1993-94. From around Rs 10.62/lb in 1991-92, the price of domestic cotton rose to Rs 27.39/lb in 1994-95, an increase of 158 per cent in three years. This compares to a world price increase of 46 per cent in the same period, and a general wholesale price increase 45 per cent (Table 5).

Table 5: Price increase in cotton

Year	Cotton (Rs/40 kg)			WPI (1990-91=100)	Cotton WPI (1990-91=100)
	K-68	NIAB-78	MNH-93		
1991-92	933.10	908.36	951.59	109.84	106.04
1992-93	1052.10	1001.20	1060.38	117.92	119.20
1993-94	1688.60	1625.13	1722.72	137.26	168.20
1994-95	2253.57	2060.82	2290.29	159.22	207.62
1995-96	2221.20	2113.04	2245.84	176.90	210.57
1996-97	2685.61	2536.13	2688.95	199.92	242.89

Source: GOP 1997

The crisis in the textiles sector can also be discerned from the movement of share prices (Chart 5). In the 1980s, the stock market was gradually liberalized and expanded, with a big push coming in 1990-91. This process accompanied a booming market throughout the 1980s, and a dramatic rise in 1990-91. Share prices of cotton stocks tripled in 1989-90, leading a generalized expansion of the share price index. However, the collapse of the cotton crop and political turbulence in 1992-93 resulted in a market crash, led again by a 50 per cent decline in cotton prices. The restoration of political stability produced a temporary revival in 1993-94, but since then prices have continued to fall, and the cotton share price index has consistently fallen below the general index.

12. Environmental problems

As in the case of cotton production, the textile industry is also associated with a number of environmental problems. The main source of pollution is the discharge of untreated effluents into water bodies and soils. Liquid effluents from washing, dyeing, and bleaching operations contain organic and inorganic chemicals, as well as suspended

[28] Pakistani yarn exports registered an increase after Pakistan joined the WTO in April 1994, and benefited from an enhancement in the yarn quota to the European continent from 9,000 to 15,000 tonnes.

solids (such as fiber and grease). Effluents are generally hot, alkaline, smelly, and colored by chemicals used in the dyeing process. Some chemicals are toxic. The effluents lower dissolved oxygen levels in receiving water-bodies, threaten aquatic life, and damage the esthetic value as well as quality of water downstream.

We can distinguish between two types of environmental costs, those that affect the health of the final consumer, and those that affect the local environment in the production process. The former effects are cause generally by particular persistent organic chemicals used in the production process. Recent attention has focused on azo dyes, which are favored by textile manufacturers because of their brilliant colors and qualities of adhesiveness. These dyes are believed to cause cancer, and have been banned by a number of European countries. However, information has not quite filtered down to producers, and laboratory tests in receiving countries reveal a high proportion of fabrics made with azo dyes.

The German government has banned the import of any products that may be in contact with the skin for prolonged periods--such as garments (including outer garments)--if they contain traces of azo dyes. Contravention of this legislation will be treated as a criminal offense, and will be subject to severe penalties including the burning of seized shipments at the manufacturer's expense. This legislation was contested in the European Court of Justice, as it constituted a trade barrier. However, the ban was upheld by the Court, and has led to similar legislation being passed in France, Sweden and the Netherlands. However, random tests conducted by German authorities on textile imports revealed that 48 per cent of Chines exports, 34 per cent of Pakistani, 22 per cent Indonesian, 19 per cent Italian, and 13 per cent Indian goods contained the banned azo dyes and amines.

In the future, European importers are likely to require exporters to test shipments against azo contamination before exporting. Expressions of resentment against these measures have surfaced in the industry on the suspicion that they are meant not to protect final consumers but the uncompetitive European industry as the earlier protection provide by the MFA is phased out. Be that as it may, efforts have begun to comply with the new laws. The Pakistan Export Promotion Bureau has held seminars and workshops to apprise producers of the problem and its solutions, and plans are afoot to establish a state of the art testing facility in Lahore.

The prospects of product and process measures are quite different. On the one hand, there is an evidence of successful use of such measures by US retailers in the case of labor standards, which are conceptually analogous to environmental standards. On the other hand, this experience is limited to the garments industry, and does not cover the full range of activities. Its application in other industrial sectors (carpets, leather, and surgical instruments) has been less effective. Before we discuss this issue in detail, a brief description of major environmental concerns is in order.

Industrial pollution can be categorized either according to the medium through which it enters the environment--air, water, and soil--or to the processing stage. Of the three major industrial processes in textile processing--spinning, weaving, and finishing--environmental problems are associated mainly with the last stage. Spinning entails mostly dry processing and virtually no harmful effects are generated. In the weaving process starch is applied to the fabric to impart filter strength and stiffness, resulting in waste waters that contain large amounts of starch with high BOD values. The finishing stage uses a variety of chemicals, including acids, alkalis, wetting agents, and chemical dyes. These effluents require proper treatment before being discharged to an external drain.

Air pollution and air borne wastes are not a major problem in textile production. The effect of air emissions are fairly limited and localized, although if not properly managed, they can be harmful to the health of workers. These can be classified into four categories: oil and mists, dust and lint, solvent vapors, and odors. Dust and lint problems are peculiar to the spinning stage. However, the yarn-spinning sector in Pakistan is generally equipped with self-contained waste recovery units. These units reduce particulate emissions and health risk to workers, and improve working environment as well as the net profitability of the enterprise. By virtue of these units, lint losses in the spinning section are virtually nil. A typical spinning firm processes 60 tonnes of yarn per day, out of which 11 per cent is recoverable as salable yarn waste, and another 9 per cent recovered and converted to low grade yarn. Similarly, these units maintain temperature, humidity, and noise levels well within safe limits.

However, small textile units in the unorganized sector do face a serious air pollution problem, due to the lack of modern plant and machinery. Workers at these units remain exposed to contaminated air, and thus to the risk of lung disease and asthma.

Textile processing includes a number of wet processes--bleaching, mercerizing, dyeing, and finishing--which produce liquid effluent with varying waste composition. Environmental quality standards are most developed in the case of liquid effluent. At present, the majority of the textile mills, including modern, integrated facilities do not have adequate arrangements to treat their effluent before discharging into an external drain. Since in many cases, the external sink is an irrigation canal, the untreated chemicals can effect the quality of irrigation water. Also, textile processing is a heavy user of water.

An average integrated textile mill produces 15 tons of finished cloth per day. It uses a total of approximately 3,840 cubic meters of water per day, including 1,680 cubic meters for finishing and processing, another 960 cubic meters for steam generation, and an equivalent volume for serving the workers colony and other domestic uses of water. The water used for finishing and processing results in contaminated liquid effluent of approximately 1,500 cubic meters per day. In addition, the water used for domestic use is emitted with household sanitary wastes.

Environmental quality standards are classified into aggregate measures, and maximum allowable concentrations of specific chemicals.[29] The aggregate measures are the pH value (which determines acidity or alkalinity of the effluent), temperature, the biological oxygen demand (BOD),[30] the chemical oxygen demand (COD),[31] the total suspended solids (TSS) or non-filterable residue, total dissolved solids (TDS),[32] and color.

Estimates of characteristics of industrial effluent and the cost of chemical treatment to bring them within allowable limits have been carried out in Pakistan in a small number of projects. The most notable amongst these is an innovative project led by the Sustainable Development Policy Institute (SDPI). The project, entitled Technology Transfer for Sustainable Industrial Development (TTSID), is funded by the Swiss Federal Office for Foreign Economic Affairs. Some results are provided in Table 6.

Table 6: Textile industry pollution levels and environmental standards

Parameters	**Measured level**	**Pakistan NEQS**	**World Bank guidelines**	**Other standards**	
				Indian	**USEPA**
	mg/l	**mg/l**	**mg/l**	**mg/l**	**mg/l**
pH	8-9	6-10	6-9	5.5-9	6-9
BOD	112-120	80	58	150	58
COD	430-480	150	524	..	524
TSS	26-1,200	150	157	100	157
TDS	2,300-3,600	3,500	..	..	..
Chromium	0.05-0.30	1	0.90	2	0.9
Phenol	not detected	0.1	0.90	1	0.9
Sulfides	0.07-15.0	1	1.75	2	1.75
Temperature •C	52	40	5+ambient	40	5+amb

Source: SDPI (1995: 25)

The average Pakistani mill a gray-colored liquid effluent with high pH value (8-10), BOD (112-120), COD (430-480), TSS (25-1,200), TDS (2,300-3,600), and temperature (52 Celsius). These are generally outside the range of environmental standards in Pakistan, and also in comparable countries. The effluent also contains variable amount of sulfides and chromium.

[29] The most important chemicals for the textile industry are sulphides, phenols, and chromium.

[30] BOD is a measure of biodegradable materials that consume dissolved oxygen during microbial utilisation of organic materials. High BOD or COD reduces dissolved oxygen in receiving waters, and thus affects aquatic life adversely, releasing obnoxious odours and toxic sulphides, and killing most aerobic organisms including fish.

[31] COD is a measure of non-biodegradable materials in an effluent or water body, which react with dissolved oxygen. Its effects are similar to those of a high BOD.

[32] Suspended solids increase turbidity, reduce light penetration in the water and restricting plant production. They also settle in the water and destroy spawning grounds, plug fish gills, and destroy benthic organisms. High TSS can make water unfit for irrigation or drinking purposes.

13. Treatment options

The treatment recommendations presented here are derived from a roundtable process involving representatives of industry, labor, environmental NGOs, government regulatory and financial institutions, technical experts, environmental NGOs, technology suppliers, and journalists. To this end, a series of detailed environmental audits of selected industrial units were conducted. The results of the audits were presented to the business-government roundtable process initiated under the national conservation strategy of Pakistan. The roundtable process involved over 100 individuals from the functional groups listed above.

The roundtable participants were presented with the results of the environmental audits, and recommendations for action by government agencies as well industrial units. A set of consensus decisions was finalized and submitted to the Pakistan Environmental Protection Council, the highest policy making body on environmental issues in the country. The Council approved the recommendations, and constituted two standing committees to work out the details. These are the committee on national environmental quality standards (NEQS), and standing committee on technical matters. The committees worked out the details for implementation of NEQS in consultation with industry representatives, and submitted its final recommendations. Some elements of these recommendations were subsequently enacted as part of a new Environmental Protection Act. Others were issued through executive orders.

The recommendations fell into three groups, financial incentives for pollution abatement, the imposition of a pollution charge on effluent that does not meet quality standards, and the initiation of a proper system for monitoring and assessment.

According to the SDPI study, a switch to cleaner production would require the introduction of in-plant control mechanisms as well as end of pipe treatment. The latter would be more significant in existing industrial units. The treatment of industrial effluent can be classified into primary, secondary (or biological), and tertiary (or advanced physico-chemical) processes.

Primary treatment includes processes such as screening, neutralization, aeration, equalization, and gravity sedimentation. The purpose of primary treatment is to remove suspended matter (including oil and grease) and to achieve uniform flows and concentrations. As the suspended matter is removed, BOD and COD levels are also reduced. An important component of primary treatment is the use of chemicals to neutralize the effect of other chemicals. Sulfuric acid is used to bring down the pH level of the effluent, and oxidizing chemicals (chlorine, sodium hypochlorite, calcium hypochlorite, and ozone) are used to reduce color through the oxidation of dye molecules. Similarly, lime, ferric chloride, alum, and ferrous sulfate are used to react with dyes and form coagulants, which settle down in the treatment bed.

Secondary or biological treatment involves the development and cultivation of microorganisms on food or substrate available in the effluent to lower its BOD. The process can be aerobic (ie in the presence of oxygen) or anaerobic. The most popular method is activated sludge treatment. It consists of a primary sedimentation tank, an aeration tank, and a secondary sedimentation tank in a series. Provision is made to recycle settled biological sludge from the under-flow of the secondary sedimentation unit into the aeration tank to maintain the desired level of microbial population. Generally low energy options are preferred because of lower operating costs and higher reliability in Pakistan's institutional environment. Primary and secondary treatment of textile effluent can reduce BOD levels by 94 per cent, and COD levels by 80 per cent.

Tertiary treatment involves a full chemical recovery of the effluent contents. It uses a high rate multi-layer granular filtration with flocculation. The system consists of two pressure filters in series (double filtration) and the addition of chlorine, alum, and polymeric flocculation. Each granular layer has three strata consisting of anthracite, quartz sand, and garnet, which differ in density and granule size. Tertiary treatment can reduce BOD by 98 per cent, and COD by 90 per cent.

Various in-plant control measures can substantially reduce the generation of wastewater, and thus reduce treatment costs. These measures include shutting off water supply to equipment not in use, installation of automatic shut-off valves on water lines, avoidance of spillage and preparation of only the required amount of chemical solutions. Many of these measures are being practiced by the integrated Pakistani manufacturers.

The roundtable process recommended that in the initial stage, industry be made to focus on reducing BOD, COD, and TSS to within allowable limits. This could be accomplished by primary and secondary treatment alone. It is estimated that tertiary treatment and full chemical recovery would involve a capital costs of Rs 160 million. In comparison, a conservative estimate of the cost of primary and secondary treatment for an average (1,500 tones per day) integrated textile-processing unit comes to Rs 38.75 million in 1995. Of this, Rs 22.65 million is for the purchase of plant and equipment (including imports of Rs 8.3 million), Rs 9.90 million for local costs for civil works and installation, and Rs 6.20 million costs for interest costs during construction. In addition, the plant would require annual operating costs of Rs 3.14 million. The annualization of capital costs depends on assumptions regarding interest costs, import duties, and other taxes. These will range between 0 (in the case of an outright grant) to Rs 7.28 million per year. This yields a total annual cost ranging between Rs 3.14 million and Rs 10.42 million. To obtain perspective on these figures, note that such a plant produces approximately 20 million square meters of cloth per year. In other words, the annual operating costs of treatment facilities are between Rs 0.16 and Rs 0.52 per square meter of finished cloth. Given an average sale price of Rs 30 per square meter, total revenues are Rs 600 million per year, and total annual treatment outlays (including capital cost) constitute between 0.5 and 1.5 per cent of the revenues.

The Roundtable proposal recommended a pollution charge of up to Rs 0.50 per square meter of finished cloth on polluting industries, and a series of financial incentives to induce voluntary compliance with environmental standards.

14. System of governance in the textile industry

In order to assess the feasibility and efficacy of alternative interventions to promote a shift to sustainable industrial development, it is useful to examine the nature of governance system in the textile industry. To recapitulate, this system would inform us on the mechanisms and processes that influence the allocative decisions of a single entrepreneur.

At the outset, it must be stated that the governmental machinery pertaining to the industrial sector is neither as sophisticated nor as complex as that for the agricultural sector. While there is a national system of industrial research institutions, the Pakistan Council for Scientific and Industrial Research (PCSIR) it is neither as goal driven nor as well integrated into the production system as its counterpart, the Pakistan Agricultural Research Council. Second, there is no integrated system for determining industrial policy, especially when it comes to environmental considerations. Third, the system of industrial education (both engineering and business schools) are more or less completely divorced from the research and policy institutions. Finally, although the environmental agencies have tended to focus on the industrial sector, their clout as well institutional strength is far from adequate given the size of the task.

Having said all this, it must be reiterated that the very weakness of the policy and research establishment in the industrial sector has made it possible for inroads to be made in designing environmental policy. In the agricultural sector, the research and policy establishment is at this moment an obstacle to proper policy development. However, the existence of an organized industrial association made it possible for such an initiative to have legitimacy and influence. This can enable us to distinguish between three different types of governing structures in the textiles sector.

For this purpose, it is useful to recall the distinction between various segments of the industry. As mentioned earlier, the yarn spinning industry is large-scale and well organized, and is represented nationally by a strong lobbying group, APTMA. These units sell their products to importers or to local exporters. There is not much evidence of a consumer driven commodity chain in this segment. The relationship between buyer and seller is typically arms length and transitory. The most direct route to influencing the spinning sector is APTMA.

Weaving is an 'anarchic' sector, dominated by small-scale, informally organized firms. They do not have a strong lobbying presence at the national level, nor are their links with cloth buyers of a longer run nature. These two sectors are not of major environmental concern.

The area of most concern is the textile-processing sector, which has effluent treatment obligations under the new laws. It is also subject to restraint because of the ban on azo dyes. This is a relatively small sector, consisting of large, professionally organized firms. The experience of the roundtable suggests that these units are susceptible to influence by government policy. In this case, the relative lack of influence by the organized association and the absence of a coherent governmental policy-making structure can allow a governing system to emerge. This system would be a coalition of various stakeholders in the process. As evidenced already, such a collective system has the potential of influencing production behavior.

Given that all these segments are tied into the global market, another potential source of influence is the Ministry of Commerce and the Export Promotion Bureau. However, so far, these agencies have played a servicing rather than a leading role in the industry.

The segment that is closely tied into the global commodity chain is that of garments and apparel production. In this segment, market conditions are determined by a small number of international retail chains. In recent years, these retailers have developed mechanisms to influence in-plant allocative decisions of even small firms. Much of the recent concern has focused on labor standards issues. All major retailers have arrangements through which to evaluate compliance with international labor standards within their suppliers. The assessment is carried out through scheduled visits by designated buyers from the region (often East or Southeast Asia). Large retailers generally do not schedule repeat visits by their buyers for a firm that fails inspection. The object of the assessment is to examine occupational health and safety considerations, child labor requirements, and compliance with other labor standards.

The successful record of garment buyers in establishing working relationships with foreign vendors is in marked contrast to the experience of similar industries: surgical goods, and carpets. In both these cases, the local market structure is very similar. The industry is dominated by small-scale, informally organized firms, without adequate national collective organizations. In both, there has been problems stemming from violation health and safety requirements, or child labor legislation. However, in neither case has there been a successful resolution.

This brings us back to Gereffi's (1994) idea that industrial concentration is linked with the emergence of governance system in commodity chains. Given the presence of such a market structure, the large northern retailers have the capacity to influence production processes in an effective manner. However, their reach extends only to garment suppliers, and there is very little interaction with other units.

15. Prospects of a transition

The main question before is the mechanism through which the system of production can be transformed in order to become more sustainable. One mechanism is through consumer influence, as exerted in the form of price differentials, boycotts, or even trade restrictions to reflect consumer preference. Another mechanism is the use of technical assistance, research, extension, and specialized inputs as in the green revolution.

Clearly, where it is possible for an indigenous agency to play the role of underwriting the system of governance, the second option might be both feasible and efficacious. On the other hand, where the system of governance is led by large retailers, who can set up their own technical assistance and information clearing arrangements, the transformation van be brought about by the threat of consumer action.

In this sense, the government and the retailers are quite alike, since both require the existence of the threat of sanctions to be effective. The government uses its access to national resources, increasingly limited as they might be, and the threat of legal action. Corporations use their access to markets, and the threat of exit to discipline suppliers. The systems work well only where inspection systems and information flows are relatively efficient.

The prospects of transition to sustainable industrial growth depend crucially on the nature of governance in the specific segments of the industry. Segments that are well organized--spinning, processing--can take advantage of emerging opportunities and protect themselves from adverse changes. However, the history of their interaction has been one of pressuring the government for protection rather than adapting to changing market conditions. Still, there is considerable scope for action by the government to influence their behavior. The SDPI initiative has chalked out a mechanism through which such intervention can become legitimate as well as effective.

In the case of the garments industry, changes can indeed be brought about directly This can be most effective where the issue is one of incremental rather than systemic change, as for example in the case of the azo dyes. Given that switching from one kind of dye to another does not require a transformation of the production system it is likely that the transition will take place smoothly and efficiently to comply with the demands of the international importers. However, changes of a systemic nature require broad-based technical assistance to upgrade management and production arrangements.

The absence of strong backward institutional linkages means that the ability of consumer driven chains to drive the entire system is fairly limited. In this case, it might be more appropriate to redesign an alternative mechanism that borrows from the green revolution model of technical change. Instead of a pre-established network of research and extension dominated by the government, this would rely on improved communication between stakeholders, and the establishment of links between existing institutions of research and extension.

ANNEX 1: Data sources

The data for the study was collected from published sources as well as primary research. The latter consisted of a questionnaire sent to a number of experts around the country. The questionnaires were followed up with individual interviews. Details are as under:

- **Published Sources**

1. ***Cotton Review, PCCC, 1996-97*** is a monthly cotton bulletin published by the Marketing and Economic Research Section, Pakistan Central Cotton Committee (PCCC), Karachi. It reviews every month's cotton trade statistics including ginning operations, position of textile mills, raw cotton (lint) prices, cotton seed prices, cotton seed cake spot prices, cotton seed oil prices, cotton yarn prices, cotton yarn export, cotton cloth export, cotton waste export, and synthetic fiber and yarn import. Data on cotton ginning and the lint rates were taken from this source.

2. ***Support Price Policy for Seed Cotton 1996-97*** is published by the Agricultural Prices Commission, government of Pakistan, Islamabad. Keeping in view the importance of cotton crop, the Agriculture Prices Commission announces support prices of seed cotton and lint in order to ensure a guaranteed minimum income to producers and to maintain market stability. The report provides an annual review of support prices, cost of cotton production, yield and the seed cotton rates.

3. ***Pakistan Census of Agriculture, 1990*** is published by Agricultural Census Organization, Statistics Division, Government of Pakistan, Gulberg- III, Lahore. Its first section contains introduction to the objectives, scope, geographic coverage, methodology and the definitions of various terms used in the census. The second section presents the salient findings of the census and the third one contains census regulations. It covers all sectors of Agriculture. Data regarding size of cotton farms are taken from this source.

4. ***Cotton Production Plan 1992-93, PCCC, Karachi*** is issued by the Pakistan Central Cotton Committee, Karachi, every year in order to guide extension and research workers in the planning of their activities for the next cotton growing season. It reviews statistics for the previous season, and provides projections for the next, including input requirements, production technology, pest management, harvesting arrangements. Agronomic data on cotton production (such sowing and harvesting times) is taken from this source.

5. ***PAPA Bulletin, Karachi*** is a monthly bulletin of Pakistan Agricultural Pesticides Association (PAPA), Karachi. PAPA is a powerful group representing manufacturers of agricultural pesticides. These manufacturers invest a significant amount of money in advertising, technical advice and extension, and after-sale service to the growers. The bulletin is an integral component of such extension work, and contains data on pesticide use as well as technical articles on agriculture and plant protection.

6. ***Economic Survey 1995-96*** is a review of the performance of Pakistan's economy. It covers all major sectors of the economy and provides the government's assessment of the impact of policy measures and reforms on the development of the country. It is published by the Economic Advisor's Wing, Finance Division, government of Pakistan, Islamabad. Time series data on area under cotton, production and yield are taken from this source.

7. ***Agricultural Statistics of Pakistan, 1994-95*** is an annual publication of the Economic Wing, Ministry of Food, Agriculture and Livestock (MINFAL), government of Pakistan, Islamabad. It covers all sectors of agriculture including time series data on cotton area, production and yield.

8. ***The Cotton File: 1995-96, SDPI, Islamabad*** is an SDPI publication containing a selection of news clippings on cotton for the fiscal year 1995-96. Data on total annual use of pesticides on cotton in 1996 were taken from this source.

➢ **Experts**

1. ***Dr Zahoor Ahmad,*** Director, Central Cotton Research Institute (CCRI), Multan, is the country's leading expert on cotton production. He heads a team of about 40 scientists engaged in crop research on cotton. In June 1997, Dr Ahmed and one of the key members of his team, ***Mr Tanveer Javed***, Principal Scientific Officer, CCRI, were interviewed over the phone and responded to faxed questions on technical issues on cotton production (including data sources, production costs, and agricultural aspects).

2. ***Mr Siddiqui Akbar Bokhari,*** a progressive cotton grower and owner of Bokhari Farms in Multan, was interviewed in Islamabad in July, 1997. He provided valuable information on practical issues of cotton production and cotton ginning.

3. ***Mr Faqir Hussain,*** Deputy Director, Federal Seed Certification Department (FCSD), Islamabad, has the responsibility within the government of Pakistan for the certification and registration of cotton seed. He is an expert on cotton production besides being an experienced cotton grower himself. The FSCD registers and certifies cotton seed procured by public seed corporations and private seed companies before distribution to the farmers; it also registers and monitors various private seed companies. Mr Hussain was interviewed several times, in person as well as on the telephone, during May and June 1997. He provided overall information regarding the production and marketing of cotton in Pakistan, including recent data on seed production agencies, total sales, and seed prices.

4. ***Mr M. Idrees,*** Textile Commissioner, Karachi, is an expert on the textile industry in Pakistan. He was interviewed in person in Karachi on 17 December, 1997, and his comments on the economics of various stages of cotton processing (including ginning, spinning, weaving and cloth processing) recorded.

5. ***Mr Shafqat Khan***, President, Gable Industries, Lahore and New York. Mr Khan is a former banker, who has set up a successful apparel manufacturing and exporting firm in Lahore.

Mr Idrees Ahmed Sheikh, Director, Rashid Textile Mills, Faisalabad, is a leading industrialist, interested in pollution control and sustainable industrial development. He was one of the few industrialists who responded to requests for advice and information sent out in May/June 1997. Others who responded were **Mr G.R. Arshad**, Chairman and Managing Director, Rauf Textile and Printing Mills (Pvt.) Ltd, SITE, Karachi, and **Mr M. Anees**, Director, Superstar Textile and Garments, Faisalabad. Mr Sheikh in particular provided invaluable assistance regarding data on the economics of ginning, spinning, weaving and cloth processing

ANNEX 2: The SDPI Questionnaires

THE SDPI QUESTIONNAIRE FOR COTTON PRODUCTION

1. Area under cotton?
2. Average size of a cotton farm?
3. Average population in each cotton farm households?
4. How farmers get the cotton seed, from where (self/ private/ Govt.) and on what price?
5. Total of quantity of seed sown every year?
6. Govt. and private agencies providing seed and their prices?
7. List of major companies and their sale per year including Govt. agencies?
8. Govt. and private agencies providing advice and extension services?
9. Sowing and harvesting dates of cotton?
10. Water use per ha (average) for cotton?
11. Total quantity of pesticides being used in cotton every year and its cost?
12. Various pesticide companies involved in cotton and their other activities such as extension, advertisement, sale resources and volume?
13. Rates of seed , water, fertilizer, pesticides per ha?
14. How they harvest: by machine or by manual labour?
15. How farmers sell the seed cotton (phhutti), to whom and on what price?
16. Prices of various varieties of cotton during last season?
17. Average cost of cotton production per ha?

Operations & Inputs	**Cost per ha in Rs.**
• Land preparation	
• Seed and sowing operations	
• Irrigation	
• Labour for irrigation and water course cleaning	
• Inter-culture (weeding/thinning)	
• Plant protection including application	
• Farm yard manure including application	
• Fertilizers including application	
• Management charges for 8 months	
• Land rent for 8 months	
• Land revenue including local rate chaukidara, etc.	
• Payment to pickers	
• Cutting of cotton sticks	
• Gross cost	
• Value of cotton sticks	
• Net cultivation cost	
• Marketing cost (transport, octori, tax, development cess etc.)	
• **Total cost of production at market/ginnery level**	

THE SDPI QUESTIONNAIRE FOR TEXTILE SECTOR

GINNING

- On what price (average) ginner's purchase seed cotton?
- Average ginning cost per 40 kg of seed cotton including all sort of expenses?
- From 40 kg of an average variety of seed cotton, how much lint and seed is achieved?
- On what price (average) ginner's sell lint and cotton seed and to whom?

SPINNING

- On what price (average) spinner's purchase lint (currant rate) and from where?
- Average spinning cost per bale (170 kg) of lint for an average count including all sort of expenses?
- How much yarn (of an average count) is produced from one bale (170 kg) and how much expense is incurred to produce this much yarn?
- On what price (average) spinner's sell yarn and to whom?

WEAVING

- On what price (average) weaver's purchase yarn of an average count (currant rate) and from where?
- How much expense are incurred to produce grey cloth (of an average weight and width) from one bale of yarn bundle (4.54 kg) including all sort of expenses?
- How many M2 (meter square) of grey cloth (of an average weight and width) are produced from one bundle of yarn (4.54 kg)?
- On what price (average) weaver's sell cloth of an average weight and width and to whom?

PROCESSING (DYING, PRINTING AND FINISHING

- On what price (average) Textile/Processing Mills purchase grey cloth of an average weight and width (currant rate) and from where?
- Average processing (dying, printing and finishing) cost per M2 of cloth of an average weight and width, including all sort of expenses?
- On what price (average) Textile/Processing Mills sell finished cloth of an average weight and width and to whom?

ANNEX 3: Cotton: Socio-Economic Profile

Area under cotton in 1995-96: 2,997,000 ha (*Economic Survey 1995-96: 10)*
Number of cotton farms (1990): 1,308,696 covering 2,666,362 hectares
(Pakistan Census of Agriculture, 1990: 6)
S**ize of cotton farms:** The majority are between 3 and 10 hectares, although farm sizes range between 0.5 and 60 hectares. *(Pakistan Census of Agriculture 1990: 6)*
Population per farm: Up to 3 families with an average of 6 members per family.
(SDPI Case study)
Sowing time : Mid February to end June.
(Support Price Policy for Seed Cotton 1996-97: 17)
Harvesting time: August/September up to February
(Support Price Policy for Seed Cotton 1996-97: 17)

INPUTS
1. SEED
Rate: 20 kgs/ha, at an average price of Rs 30/kg = Rs. 600/ha *(Expert interviews)*
Total quantity of seed (1995-96): 3 million ha @ 20 kg/ha = 60,000 tonnes
Seed agencies, sales and prices:

Agencies		% of total	Price per 40 kg
Government:	PSC & SSC	20%	Rs 1,000
Private Sector:	114 Companies	30%	Rs. 1,200-5,000
Self :	Small growers only	50%	Rs 300

(Federal Seed Certification Department, Islamabad)

2. FERTILIZER
Fertilizer application rate (per ha): 175 kg nitrogen, 57 kg phosphorus, and 62 kg potassium.
(Expert interviews)
Fertilizer application cost per ha: Punjab Rs 2,165, Sindh Rs. 2,153.
(Support Price Policy for Seed Cotton 1996-97: 86)
Prices of fertilizers (per 40 kg bag): Urea Rs 340, DAP Rs 565, TSP Rs 456, SOP Rs 540.
(Survey data)

3. PESTICIDES
Recommended application rate: 5-7 sprays per season. *(Expert interviews)*
Actual application: 8-13 sprays per season *(Expert interviews)*
Quantity per hectare: 3.5-4.5 litre of formulated pesticides. *(Expert interviews)*
Pesticide (weedicides & insecticides) cost including application cost per hectare:
Punjab Rs 2,815, Sindh Rs 1,030 (*Support Price Policy for Seed Cotton 1996-97: 86)*
Total annual use of pesticides on cotton (1996): 14,950 tons of formulated pesticides, including 6,000 tons of active ingredients. *(Cotton File: 4)*

3. WATER
No. of irrigations per season: 5-6 times (*Expert interviews)*
Water use per ha for cotton : 24 inches, cost Rs 1,422 per ha (including canal and private tubewell water) in the Punjab, and Rs 520 in Sind. *(Survey data)*

Cotton yield: kgs of seed cotton per ha (1996-97): Punjab:1,482, Sindh:1,092
(Support Price Policy for Seed Cotton 1996-97: 86-87)

Support price of seed cotton (*phhutti*) per bag (40 kg ea):
NIAB-78, NIAB-86, MNH-147, CIM-109, FH-87, CRIS-9: Rs 500
MNH-93, S-14, K-68, Rehmani, MS-94, Shaheen, Reshmi: Rs 540
(Support Price Policy for Seed Cotton 1996-97: 13)
Market price of seed cotton (*phhutti*) per bag (40 kg ea): Rs 750-900 (*Survey data)*

GINNING
Seed cotton arrivals in 1996-97 : 7,366,339 bales *(Cotton Review, 1996-97: 1)*
Ginners' average purchase price of seed cotton per bag (40 kg): Rs 800
(Expert interviews)
Average ginning cost per bag (40 kg) of seed cotton: Rs.70
(Expert interviews)
Support price of cotton lint per bag (40 kg):
- NIAB-78, NIAB-86, MNH-147, CIM-109, FH-87, CRIS-9: Rs 986
- MNH-93, S-14, K-68, Rehmani, MS-94, Shaheen, Reshmi: Rs1,055

(Support Price Policy for Seed Cotton 1996-97)
Spot market rates (monthly averages) per bag (40 kg), December, 1996:

NIAB-78:	Rs. 2,578.39
MNH-93:	Rs. 2,801.84
K-68:	Rs. 2,784.24
Cotton seed:	Rs. 269.14
Cotton seed cake:	Rs 223.72
Cotton seed oil:	Rs 1,175.33

(Cotton Review, Jan 1997: 4)
Average sale price of lint (per 40 kg bag) from ginners to commission agents:
Rs 2,500 *(Expert interviews)*
Average sale price of cotton seed (per 40 kg bag) from ginners to oil expellers:
Rs 300 *(Expert interviews)*

SPINNING
Spinners' average purchase price of lint (per 40 kg bag) from commission agents:
Rs 2,600 *(Expert interviews)*
Average spinning cost per bale (170 kg): Rs 669 *(Expert interviews)*
Spinners' average sale priceof yarn per bundle (4.54 kg) to commission agents: Rs 420
(Expert interviews)
Market price of cotton yarn per bundle (4.54 kg): Rs 490 *(Expert interviews)*

WEAVING
Weavers' average purchase price of yarn per bundle (4.54 kg) from commission agents: Rs 490
(Expert interviews)
Average weaving cost per yarn bundle (4.54 kg): Rs 152 *(APTMA: 117)*
Weavers' average sale price for grey cloth per sq meter (76X68/40X60):
Rs 18 *(Expert interviews)*
Market price of grey cloth per sq m (76X76/40X60): Rs. 20 *(Expert interviews)*

TEXTILE PROCESSING, DYEING & PRINTING
Textile mills average purchase price of grey cloth per sq m (76X76/40X60): Rs 20 *(Expert interviews)*
Average cost of processing, dyeing, and printing, per sq m (76X76/40X60): Rs 8 *(Expert interviews)*
Weavers' average sale price of finished cloth per sq m (76X76/40X60): Rs 30 *(Expert interviews)*
Market price of finished cloth per sq m (76X76/40X60): Rs 35-40 *(Expert interviews)*

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Box 1: THE COTTON CHAIN IN PAKISTAN

Cotton Production and Processing: Costs, incomes, and net profits
(Rupees per output produced from cotton produced on one hectare)

Growing (Rs per ha)	**Ginning** **per 1,760 kg seed cotton**	**Spinning** **per 581 kg lint**	**Weaving** **per 500 kg yarn**	**Processing** **per 5,801 m^2 cloth**
Costs: Pesticides: 2,815 Fertiliser: 2,165 Seeds: 640 Water: 1,422 Land: 5,500 Other: 5,602 Marketing: 770	**Costs:** • Raw material (seed cotton): @ Rs 20 per kg = 35,200 • Ginning cost: @ Rs. 70 per md (40 kg) = 3,080 • Sale commission: @ Rs. 27 per md (40 kg) = 1,188	**Costs:** • Lint: 581 kg @ Rs 2,500 per md (40 kg) = 36,312 • Spinning: @ 669 per bale (170 kg) = 2,286	**Costs:** • Yarn: 110 bundles of 4.54 kg each @ Rs 420 per bundle = 46,200 • Weaving: @ 152 per bundle (4.54 kg) = 16,720	**Costs:** • Grey cloth: 5,801 m^2 @ Rs 18 per m^2 = 104,418 • Processing: @ Rs 8 per m^2 = 46,408
Total: Rs 18,914	**Total costs: Rs 39,272**	**Total costs: Rs 38,598**	**Total costs**: **Rs 62,920**	**Total costs**: **Rs 150,826**
Output (Yield/ha): 44 md (1 md = 40 kgs) or 1,760 kg seed cotton	**Output:** 1,760 kg seed cotton = 581 kg lint, 1,162 kg cottonseed, plus 18 kg waste.	**Output:** 581 kg lint = 500 kg yarn plus 81 kg waste	**Output:** 5,801 square meters (m^2) of grey cloth of size 76X76/40X60	**Output:** Finished cloth: 5,801 m^2
Income: 44 md @ Rs 800 per md (40 kgs), or 1,760 kgs at Rs 20 per kg	**Income:** • Lint: 581 kg @ Rs. 2500 per md (40 kg) = Rs 36,312 • Cottonseed: 1,162 kg @ Rs 300 per md (40 kg)= Rs 8,715	**Income:** 500 kgs = 110 bundles of 4.54 kg each @ Rs 420 per bundle	**Income:** 5,801 m^2 @ Rs 18/ m^2	**Income:** 5,801 m^2 @ Rs 30/ m^2
Total: Rs 35,200	**Total: Rs 45,028**	**Total: Rs 46,200**	**Total: Rs 104,418**	**Total: Rs 174,030**
Net Profit: 35,200-18,914 = 16,286	**Net Profit:** 45,028 - 39,272 = 5,756	**Net Profit:** 46,200-38,598 = 7,602	**Net Profit:** 104,418-62,920 = 41,498	**Net Profit:** 174,030-150,826 = 23,204

Box 2: Production Costs Per Hectare (1996-97)

1. Punjab

Operation/Inputs	**Rs per ha**
• Land preparation	1,370
• Seed and sowing operations	640
• Irrigation	1,422
• Labour	400
• Intercuture (weeding/thinning)	1,170
• Plant protection including application	2,815
• Farm yard manure including application	120
• Fertilizers including application	2,045
• Management charges for 8 months	460
• Land rent for 8 months	5,500
• Payment to pickers	2,202
• Cutting of cotton sticks	300
• Gross cost	18,444
• Value of cotton sticks	300
Net cultivation cost at farm level	**18,144**
• Marketing (transport, octori, tax, development cess)	770
• **Total cost of production at market/ginnery level**	**18,914**

2. Sind

Operation Inputs	**Rs per ha**
• Land preparation	1,514
• Seed and sowing operations	846
• Irrigation	520
• Labour	330
• Intercuture (weeding/thinning)	763
• Plant protection including application	1,030
• Farm yard manure including application	35
• Fertilizers including application	2,118
• Management charges for 8 months	459
• Land rent for 8 months	2,608
• Payment to pickers	1,377
• Cutting of cotton sticks	100
• Gross cost	11,700
• Value of cotton sticks	100
Net cultivation cost at farm level	**11,600**
• Marketing (transport, octori, tax, development cess	770
• **Total cost of production at market/ginnery level**	**12,370**

(Source: Support Price Policy for Seed Cotton 1996-97: 86-7)