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Integrated Policy Strategies and Regional Policy Coordination for Resilient, Green and Transformative Development: Supporting Selected Asian BRI Partner Countries to Achieve 2030 Sustainable Development Agenda

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Micro-sectoral Study on Dyeing and Finishing Industry

Contents

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Introduction

Textile Industry is considered the backbone of Pakistan's industrial structure, as it contributes 8.5% to the national GDP, employs over 40% of the industrial workforce, and is responsible for approximately 59.53% of the annual national exports (Pakistan Economic Survey, 2023). The textile industry is the largest exporter of Pakistan, exporting products worth $22.1 billion in year 2022. Of this, 75% - 80% of the exports are of HS codes 60 to 63, which represents textile made-up sector. The primary textile export destination for Pakistan is Europe; $6.62 billion (approximately 30%) destined to Germany, United Kingdom, Spain, and Netherlands. The second largest importer of textile is USA, with the total export volume of textiles at $5.23 billion. This is important since the push factors for green industrialization play a crucial role in bringing about changes in the production process.

Pakistan is considered amongst the most at-risk countries due to climate change, and the policy makers have been made aware of that by increased frequency of devastating environmental changes in the recent past. Pakistan is a signatory to various international agendas and agreements related to climate change, and the Textile Industry needs to fast track implementation of various decarbonizing and GHG emissions reduction strategies for the country to achieve its commitments. Furthermore, with various binding agreements soon coming into force in leading markets, particularly EU, the greening of the textile industry is also important for its own viability as a major exporter in the global market. Thus, Pakistan has specifically mentioned textile and cement sectors in from the industrial base for bottom action to reduce production of Green House Gases in its updated nationally determined contributions, 2021 (Government of Pakistan, 2021).

2. Current Situation and Trend

Textile industry has a long and complex value chain, making this industry a leading source of Green House Gases (GHG) emissions. Globally, textile industry is responsible for 7%-10% of global annual GHG emissions, and over 20% of annual industrial water pollution (European Parliament, 2023). In Pakistan, the textile industry is responsible for approximately 6% to 9.5% of country level GHG emissions. Pakistan's contribution to global greenhouse gas emissions has increased over the past two decades from 0.68% in 2000 to 0.96% in 2020 (World Bank Group, 2024). The textile sector around the world is projected to account for 25% of World Carbon Budget by 2050, consuming 300 million tons of oil as compared to 98 million tons of oil in 2017, and adding 22 million tons of microfibers in oceans, ceteris paribus (Ellen MacArthur Foundation, 2017). The dyeing and finishing (36%) contributes approximately two thirds of carbon emissions in the textile sector globally (Quantis, 2018)).

This industry in Pakistan consists of a large number of SME units, as well as a smaller number of large industrial units. There are 10 large and estimated 625 small units (estimated because many of them are not registered). The produce of the small units tend to primarily cater to the domestic market, while the larger units are export oriented as well as supplier to major domestic clothing and other brands. The SME textile made-up sector consists of very small shop-like setups to medium industrial units, and primarily use older technologies which are high in emissions as well as water pollution. The large industrial units use modern technologies with lower environmental damage per unit of

output produced. However, due to their volume of output, their total environmental impact is significant.

Since the larger units tend to have better access to credit, they typically bring newer technology to Pakistan, which is later emulated by the medium and smaller units. Another relevant aspect is that these larger units are more likely to abide by the regulations (both domestic as well as international) and the enforcement is also more trackable due to their size and corporate structure. Thus, policy intervention focused at larger units, while difficult to enact due to the political economy, is more likely to bear fruit due to the volume as well as the down-stream effect. Separate policy intervention is still desirable, albeit needed, for the SME sector as their nature is significantly different than the larger units, and they tend to hold lesser sway over the political process.

The Hosiery & Knitwear industry was, until a couple of decades ago, predominantly export oriented producing medium to high quality products for leading brands in the world. Due to increasing competition from China and Bangladesh, some of these high end brands have reoriented their sourcing strategies, negatively effecting exports of this sector from Pakistan. In recent years, the domestic market for hosiery and knitwear has picked up, allowing this industry to direct their product towards the local market.

3. Policy landscape

The updated Climate Change Policy (Ministry of Climate Change, Government of Pakistan, 2021), named the textile sector as one of the key players to achieve green industrialization targets. Some of the relevant measures recommending by the policy include:

a) Incorporating economic incentives to promote emission-reduction by upgrading industrial processes and technologies
b) Prepare voluntary “Corporate Social Responsibility” (CSR) guidelines and encourage the corporate sector to create a CSR fund to cover carbon emission reduction efforts in industrial sector
c) Detailed aerosol emission impact assessment studies must be made a requirement prior to the installation of any new small and large industry that may be considered a potential source of pollution
d) Promote integration of the “Cleaner Production” strategy in the Industrial sector by making more efficient use of inputs such as energy, water and raw materials
e) Encourage the industrial sector to have periodic “Energy Efficiency Audits”
f) Develop capacity to monitor and estimate emissions locally for each industry
g) Explore and introduce incentives for industries to adopt low- emission technologies e.g. dual- functional materials for Carbon capture, utilization, and storage (CCUS)

Pakistan’s National Action Plan on Sustainable Development Goal-12 (SDG-12) (2017) suggests need to develop mitigation measures to encourage adoption of clean production technologies, implementation of eco-standard, incentivize carbon trading between industries to limit the production of GHGs, promote bottom up actions by private sector, and develop plans for emissions reductions form major sectors particularly cement and textile.

Various other initiatives are also coming into effect. For instance, the “Decarbonizing Textile Manufacturing” project is a joint effort by the Ministry of Climate Change, Ministry of Commerce, and the WWF-Pakistan. It was approved in 2022, titled “Decarbonizing Textile Manufacturing” and it estimates to mitigate 345,000 tons of CO2e over five years. This initiative has a two prong approach: providing financial cooperation, and technical cooperation. Through financial cooperation, a fund will be established to provide loans to manufacturers at reduced rates for adopting EE and RE technologies. Furthermore, it aims to catalyze development of domestic financial instruments aimed at small and medium enterprises. The technical cooperation aims at providing advisory support for policy design, enforcement and implementation. (Mitigation Action Forum, 2024).

4. Diagnostic analysis

Dyes are types of colorants (the general name for materials used to impart color) which bind with molecular structure of textile fibers. To enable this chemical binding, mordants (e.g. chromium) are used which are extremely toxic and significantly damage the wastewater. Alternatively, pigments are colorants with no affinity to the fibers, so they are bound using various types of glues, called binders. Thus, the dyes and pigments used to color a textile depends upon the type of fiber used to produce the fabric, as well as the final use of the textile.

Until 1850s, only natural dyes were used around the world. Synthetic dyes have better durability, lower cost, and more controlled production process as compared to natural dyes, which is why synthetic dyes are now preferred over natural dyes.
To achieve a consistent dyed color, the material is thoroughly cleaned; a process that typically involves gassing, de-sizing (for woven fabrics), scouring, bleaching, mercerizing, heat setting, and cellulose enzyme treatments. After cleaning, dyes or pigments are applied to the yarn or fabric. The type of process used for colorants application depends on the nature of textile and the desired output. The type of dye used depends upon the fiber type the textile is made of. For instance, cellulose based fibers (cotton, wool, etc.) can be dyed, while for most synthetic fibers, pigmentation is preferred. After colorant is applied, the textile is finished with various chemicals to achieve the desired finish. The type of dye / pigment as well as mordant / binder used, equipment, processing time, and disposal of waste significantly impact the cost structure.
Since the process uses over 10,000 different chemicals, an exhaustive profile of their use and effect on environment is not relevant. Instead, following is a short list of toxic chemicals which can be avoided.

4.1. Environmentally polluting chemicals in the sector

4.1.1. Bleaching (Sodium hypochlorite vs. hydrogen peroxide)

For bleaching, hydrogen peroxide should be used, which chemically breaks down into oxygen and water. Instead, many firms in Pakistan use Sodium Hypochlorite since it costs less than hydrogen peroxide. It is categorized as a pollutant if left un-neutralized in the waste water. In Pakistan, most firms have not installed neutralizing facilities, so this polluted waste water ends up in water channels. Its neutralization also requires great care and expertise, since chlorine gas is toxic and has a tendency to liberate.

Ministry of Climate Change, Government of Pakistan, in 2016 has notified Sodium hypochlorite as hazardous, but it continues to be used, and gets released into the environment without proper neutralization. Hydrogen peroxide is produced in Pakistan,

to promote its use in the sector, policies should be directed at facilitating the local producers of hydrogen peroxide to bring its cost at par with sodium hypochlorite.

4.1.2. De-sizing (Polyvinyl alcohol)

During the weaving process, the yarn (warp) is sized to prevent damage to it at the loom during the weaving process. Polyvinyl alcohol is used frequently in sizing, which is a plastic pollutant. It is removed from the textile during the cleaning process before dyeing, and is recyclable. However, it is majorly not being recycled, because a large number of dyeing as well as weaving units are independent of each other. Hence, the dyeing units often find no use of the recycled polyvinyl alcohol, and eventual dispose it with wastewater. Environmental damage caused by this chemical can be reduced by promoting the use of green sizing techniques, or promoting the recycling of polyvinyl alcohol by establishing a market for it.

4.1.3. Heavy Metals

Certain heavy metals are also used in the dyeing process, for instance chromium, mercury, lead, cadmium, etc. These heavy metals are well established causes of certain kidney and liver diseases, and cause damage to crops when found in water channels. Their use should be banned, and instead use of organic substitutes needs be promoted.

4.1.4. Colorants (Azo dyes)

Most colorants use some form of Azo dyes, which can quiet easily lose their bond with the fabric and release aromatic amines, proven to cause cancer. Such dyes have been banned in EU and some parts of the world, but not everywhere. For instance, in USA (Pakistan textiles major export market), use of Azo dyes is banned only in the state of California. Hence, such dyes continue to be employed in Pakistan's textile dyeing and finishing industry. Instead, use of biogenic dyes needs to be promoted. This would require setting up large biogenic dye producing units. Pakistan's climate is suitable for such industrial manufacturing of biogenic dyes, and local solutions have already been developed in research laboratories.

4.1.5. Finishing (Formaldehyde)

In the finishing process, various toxic chemicals are used to achiever a certain finish. Formaldehyde, a volatile organic compound, is used to produce wrinkle-free / finish. Through advocacy, fashion trends can be influenced to reduce the demand for wrinkle free textile made ups. In addition, a certain cap/limit needs to be imposed on the maximum permissible use of formaldehydes per unit of output, as has been initiated in certain countries (e.g. USA).

Some of these chemicals can be replaced by organic substitutes. For instance, **bees wax and aloe vera** are good alternatives to certain fabric softeners and finishers. Aloe vera can be cheaply cultivated in Pakistan, as it requires relatively less care. Such a shift would be significantly beneficial to the environment, and would increase productivity due to increased production of Aloe vera.

4.2. Water preservation

Water scarcity has become a serious concern for Pakistan. Renewable water resources per capita have depleted drastically, from 5,238 m^3 per inhabitant per year in 1962 to 1.253 m^3 per inhabitant per year in 2017 (latest data). This puts renewable water availability in 2017 at 23.9% of what it used to be in 1962, an alarming state. In comparison, this statistic over the same time horizon is at 30.98% for Bangladesh and

34.9% for India. As previously mentioned, the dyeing and finishing process is extremely water intensive. Resultantly, not just that the water itself gets polluted, it also acts as a carrier of hazardous chemicals, enabling wider dispersion. **Air dyeing technologies** have been invented over the past decade. In the long term, a move towards air dyeing should be incentivized. In the short to medium term, reducing and recycling of water shall be promoted. For instance, rinsing can be done in a series of tanks with gradually cleaner water. Overtime, the cleaner water is moved to the next tank and so on, reducing the total water use.

4.3. Challenges to green industrialization

There are a variety of hurdles to lack of green industrialization practices, many of which have been identified in literature (for details, see (Govindan, Kaliyan, Kannan, & Haq, 2014), (Ghazilla, et al., 2015). The key hurdles can be categorized into:

a) Lack of economic incentives
b) Lack of enforcement

The **economic incentives** are driven by low to no customer interest in green products, high implementation costs, lack of access to capital, and the complexity of green industrial processes. Similarly, the **lack of enforcement** is driven by loopholes in the laws, lack of guidance for the firm, and insufficient deterrence. These hurdles have differing impact on the firms based on the size and target customer group.

4.3.1. Lack of economic incentives

4.3.1.1. Lack of Customer Interest

Textile products are omnipresent, but individual pieces are relatively cheap. Thus, unlike automobiles and other visible pollutants, customers do not pay attention to the environmental damage caused by the textile industry. Moreover, a significant population appears oblivious to the damage to the quality of life caused by environmental degradation. As a result, the producers can continue to engage in environment damaging practices with no consequence. This phenomenon is of less significance for the export oriented industry due to regulations in the importing country. Pakistan's largest export destination for textiles is the Europe area, where regulations related to environmental damage are significant and fast coming into effect. USA is the next biggest market, where the new elected regime is likely to reduce the impact of such regulations.

4.3.1.2. High Implementation costs

The costs of transition to sustainable industrial practices are significant and daunting. Moreover, due to the competitive market structure of the produce of the dyeing and finishing industry, the increased costs are often not matched with proportionate increase of the price of the commodities produced. This requires support of the larger society, since environment is a public good. Its protection is a social concern. Therefore, it would be impractical to assume that the producers will willingly reduce their surplus towards this end. Either the prices of the output will increase, which seems unlikely given the competitiveness in the market, or these costs need to be subsidized.

4.3.1.3. Lack of access to Credit

As discussed above, transition to green industrialization practices requires significant capital expenditure. Since a large number of dyeing and finishing units in Pakistan are categorized SMEs, they often lack access to credit in a less developed financial sector

of Pakistan. Moreover, the volatile discount rate policies in Pakistan over the past two decades (Central Bank discount rates have touched a high of 22% and low of approximately 5% during the last 8 years) implies extremely difficulty in the financial planning for the firms, especially SME types since they traditionally lack in financial expertise.

4.3.1.4. Complexity of Green Industrial Processes

Environmentally sustainable industrial processes and practices are more complex than the traditional ones, which is why they were not adopted to begin with. Transition to these processes is limited by the availability of solutions, as well as the resistance by the labor force. Globally, there is now a push for economic solutions. Some of these solutions could be incorporated across the globe, while others will require either localization or a completely home grown solution. Local research and development, both in house as well as in dedicated research institutions, needs to be initiated and facilitated.

The other hurdle is the inertia in the systems and people to transition. Numerous academic publications and experiments have highlighted various reasons for such inertia; for instance, drop in efficiency, productivity based compensation system, fear of replacement, etc. These concerns are more related to the SME type units, where blue collar workers hold more sway over the management as compared to more organized corporate large units. Directed vocational training can help overcome this impediment.

4.3.2. Lack of enforcement

4.3.2.1. Gaps in Policy and Regulation

Textile sector in Pakistan is led the early industrialization process. It was facilitated and subsidized, and overtime, the sector has become the largest exporter, employer, and tax revenue generator. Hence, the political economic role of this sector is significant and complex. The dyeing and finishing sector comprises of large units owned and run by the largest and most significant players of the overall textile sector. Overtime, the laws and regulations created had significant inputs from the textile sector, led by the major industrial houses. Over the past three decades, they have developed significant inroads into the power corridors.

The gaps and loopholes in the laws and regulations are due to, a) limited resources at the disposal of policy makers often out-numbered by the industry, and b) influence of the textile industry over the policy makers. This is discussed in detail in the section 4.4. on “gaps in policy and regulation”.

4.3.2.2. Lack of guidance and awareness amongst SME sector

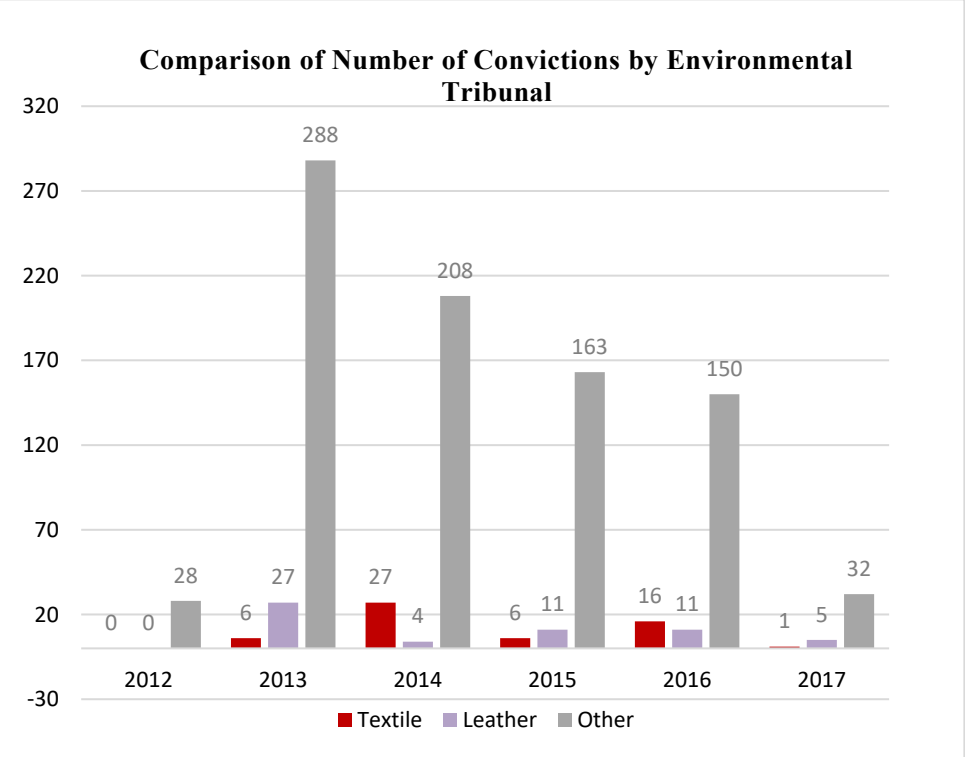
Especially for the SME units, the management interviewed were often found lacking the requisite understanding of the environmental hazards associated with certain practices, as well as solutions already in use in other parts of the world. Management at large units were much better informed, at times more than the policy makers. However, even they at times failed to understand the urgency of the matter, and the impact they can create. Management at export oriented firms were found to be the most aware and driven, mostly due to the regulations coming into effect in the Euro zone.

It appeared that the dyeing and finishing industry requires continuous guidance, both to introduce and implement global best practices, and to emphasize and reinforce the urgency of the matter.

4.3.2.3. Ineffective enforcement and convictions

In cases where sufficient laws exist and the firms still indulge in willful environmentally hazardous practices, the conviction rate as well as the penalties are often insufficient to act as a significant deterrence. World Wide Fund for Nature (2018) states that there are no environmental audits for medium sized firms, and no penalties at any level. Sattar and Akhtar (2022) show that the number of convictions for textile industry is significantly lower than others.

Figure 1. Comparison of Number of Convictions by Environmental Tribunal



5. Way forward and Policy Recommendations

The following table summarizes the nature of intervention needed against the challenges of green industrialization discussed in section 4.3. as per the scale of industrial units:

Table 1. Nature of intervention needed against the challenges of green industrialization

	SME UNITS	*LARGE INDUSTRIAL UNITS*
ECONOMIC INCENTIVES		
- **LACK OF CUSTOMER INTEREST**	Advocacy	
- **HIGH IMPLEMENTATION COST**	Targeted financial instruments, directed subsidies	
- **LACK OF ACCESS TO CAPITAL / CREDIT**	Special credit lines	
- **COMPLEXITY OF GREEN INDUSTRIAL PROCESSES**	Training	R&D
ENFORCEMENT		
- **LOOPHOLES IN LAWS / REGULATIONS**	Cyclical law-making process	

- **LACK OF GUIDANCE FOR THE FIRM**	Advocacy	Reinforcement
- **INSUFFICIENT DETERRENCE**	Effective penalties, advocacy	

This study proposes the following policy recommendations for lean and green production:

1) Lean production – producing more from less. This has to do with the internal mechanism of the production firms. The role of policy in this regard can be threefold:

a) Localize best practices from around the world as well as find new ways to improve lean production.
b) Educate the local industry about the benefits of adopting such lean practices, and assist with their adoption
c) Create incentive structures (tax the waste, incentivize efficiency)

2) Green production – transition towards green production processes. The firms are likely to resist adoption of green production processes unless it leads to increase in profits. A policy framework will only bear fruits if it incorporates this fundamental principle. Following are various scenarios, and relevant policy choices.

a) Replacement of equipment / machinery requires capital investments. An existing firm is certain to consider the net benefit of such investment. If the production life of the existing machinery is far from ending, the transition towards new machinery implies increased fixed cost, and hence, increase average cost of output (unless the new equipment incurs lower variable cost). Policy prescription, in this scenario, is either regulation (banning use of older technology), or incentivizing the new investment (tax holidays, reduced cost of capital expenditure), etc.

b) Procedural changes: In some cases, a transition towards green production is possible be changes in the procedures, without any significant capital investment. This would include use of different categories of inputs, procedures related to use and disposal of raw materials, etc. Labor used to a certain process has inertia to change, as adoption to new processes implies increased effort or lost efficiency, both of which increase the total personal input expanded by the workers. Multiple experiments in the technology adoption literature have shown these two aspects, leading to slow or no technological change even when it leads to improved profits. Policy prescription is to introduce and enforce regulations, nudging the firm's management to overcome these obstacles in house in order to adopt greener production processes.

3) Non-production activities – In case of absence of any known method to reduce the environmental impact of production, the firms can invest in greening efforts (tree plantations, etc.) to compensate for the environmental damages caused. Advocacy, incentives, and regulations are all applicable to achieve this transition.

Transition towards an environment friendly textile industry is riddled with barriers. Due to a wide array of stakeholders, the policy space to overcome these barriers is very limited as most choices adversely impact at least some players. Hence, a pareto-improvement

appears to be an impossibility. However, given the swiftly deteriorating climate conditions, it is imperative that a transition be made towards climate friendly manufacturing processes.

An important aspect related to reducing the impact of industrial production on climate change - often overlooked - is **lack of awareness**, especially amongst the small and medium enterprises. This can be overcome by strong and consistent advocacy for better practices. A recent study shows that in case of Vietnam, consumer awareness impacted transition towards demand for "green product consumption" (Nguyen, 2023). Similar findings have been made for other countries, showing that the demand for better environmental practices come from the consumers due to their knowledge of the disastrous effects of the business-as-usual practices. Strong advocacy for better practices will make the producers as well as consumers more cognizant of the dangers of environment degradation.

In case of Pakistan where law enforcement is lax, and the **textile industry has strong clout over policy making**, an organic change in the behavior of the producers as well as consumers is likely to bring about a more sustainable change to the production practices. This can include advocacy against use of wrinkle free / resistant fabrics. By lowering the demand for such products, the use of formaldehyde can be mitigated. Similarly, increase in customer awareness will dissuade shop based dyers to adopt environment friendly dyes and fasteners. Lastly, **promoting green tags**, or other such initiatives, can help dissuade dyeing and finishing units from using toxic chemical dyes and finishing chemicals.

Technical and technological advancements can also lead to adoption of better practices. There are two ways to bring about such change: either through forced enforcement in the large firms with downstream adoption to follow, or through direct intervention by the policy makers to onshore the latest technology directly are various levels of production value chain. Large dyeing and finishing units are already using the most recent technologies and machineries. These technologies shall be localized, so that they could be produced for smaller scale and parts become readily available. This would lead to adoption of these latest machineries by small and medium sized units.

Recycling innovations are already underway, with significant emphasis being laid on the **RRR (reduce, resale, recycle) approach**. Some producers interviewed stated that a couple of decades ago, their focus used to be on acquiring international certifications like ISO. Overtime, they have realized that these certification standards keep evolving, causing a continuous change in the production process, which is often costly. More recently, they claim that they have developed in-house expertise to understand global long term trends, for instance SDGs, which are now included at the strategic planning stage. Resultantly, they find it easier to acquire the required certifications without much change in their existing strategies and plans. For instance, US group (one of the largest manufacturer and exporter of apparel) has provided funding for a project at the Institute of Polymer and Textile Engineering, University of the Punjab, Pakistan, to convert cotton cloth into liquid and back into a fiber to recycle cotton. Master Textile, another major textile exporter, has entered into an MoU with the Government College University, Lahore, to plant 2 acres of urban forest on the latter's campus. This will help achieve net zero standard for the Master Textiles. Similar initiatives are being taken by many other large scale textile manufactures. However, such initiatives are primarily being taken only by large export oriented firms. The RRR approach is one such example, where firms understood the future of the textile value chain and planned their capital investments accordingly. The data on such investments in Pakistan is rare and the estimates are

generally not reliable, since the transformation towards RRR approach is still in its early days and now widely applied. Similarly, there is discussion around **reshoring / nearshoring** to shorten the supply chain as well as satisfying the new laws coming into effect, particularly in Europe, regarding Environmental labeling.

Textile industry in Pakistan is beneficiary of many subsidies, with the export subsidy leading the way (Pakistan Economic Survey, 2023). This **taxation and subsidy structure** needs closer inspection and readjustment to give high priority to environmentally friendly business practices. A carefully calibrated taxation policy can incentivize the cottage industry and small firms towards a step-by-step objective approach towards a sustainable future. **By tying the tax and other financial incentives with use of biogenic instead of chemical dyes, green industrialization can be promoted.**

Industrial change is generally slow due to build in **systemic inertia**. In case of a transition towards environment friendly manufacturing practices, the inertia is further enhanced since the goal is betterment of a public good at the expense of private costs. Furthermore, the key players argue that Pakistan is responsible for under 1% go GHG emissions, so the transition to an environment friendly, but more expensive production process, will reap no benefit until the entire world doesn't correct its course. This argument, and the resultant resistance to change, is ultimately about their income statement bottom line concerns. This argument supports the potential efficacy of incentives, provided that they are well designed and well directed, along with appropriate regulations.

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