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Biotechnology through a Samaj-Sarkaar-Bazaar lens

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Takshashila Discussion Document 2025-10
Version 1.0, May 2025

Biotechnology is deemed as a critical technology, capable of providing strategic and economic value to national power. Its development within a country depends on how the key stakeholders play out their responsibilities. This paper looks at biotechnology through a Samaj-Sakaar-Bazaar lens, identifying key roles for each actor and recommending specific application-based responsibilities for the optimal growth of biotechnology in India.

Recommended Citation:
Shambhavi Naik, "Biotechnology through a Samaj, Sarkaar and Bazaar lens," Takshashila Discussion Document No. 2025-10, May 2025, The Takshashila Institution.

Executive Summary

The Samaj (Society), Sarkaar (Government), and Bazaar (Market) framework offers a way to understand how interactions between society, government, and markets influence societal progress. This paper applies the framework to examine developments in biotechnology, assigning distinct roles to each actor and illustrating their real-world dynamics through case studies. It argues that in emerging technologies like biotechnology, evidence-based reasoning should serve as the primary guiding force, while the roles of the other actors should adapt based on the specific context to steer growth effectively.

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Disclosure
The author has utilised ChatGPT for structuring this document.

I. Introduction

In the Samaj, Sarkaar, and Bazaar framework, Samaj is seen as the foundational pillar that holds Sarkaar and Bazaar accountable (Figure 1). Under the Indian Constitution, Sarkaar gains legitimacy from Samaj (which, in this context, includes Bazaar, as both influence governance through voting) and remains accountable to it. Bazaar, in turn, derives legitimacy from Sarkaar through regulations, policies, and guidelines and is held accountable by both Sarkaar (as an enforcer of the policies) and Samaj (via judicial mechanisms).

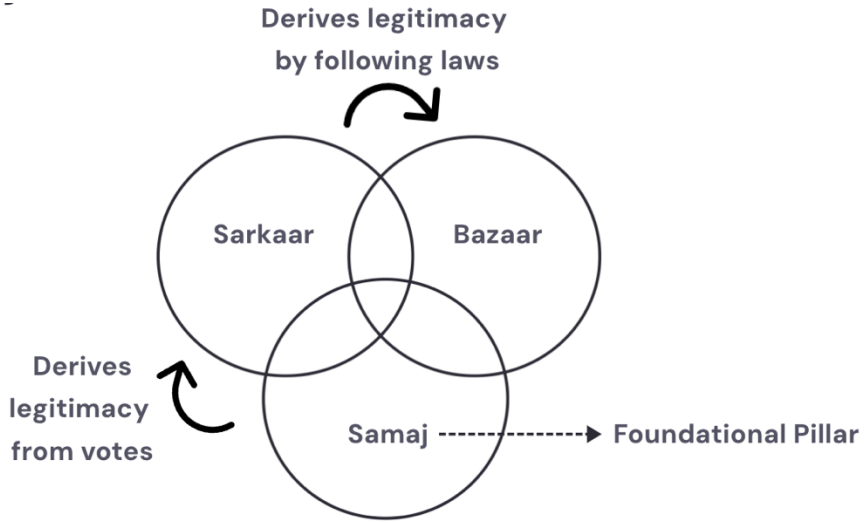

Figure 1: Samaj as the foundational pillar of the framework (Author's Illustration).

However, the relationships among these entities—as well as with the media and judiciary, which may be subsumed in Samaj and Sarkaar respectively—are more fluid and dynamic. An important caveat of this framework is that a Sarkaar primarily extends influence over its domestic Bazaar, but Bazaar need not remain limited to a single nation-state. A domestic player's interaction with an international Bazaar, outside the purview of the national Sarkaar, may also be an important determinant of its behaviour (Figure 2).

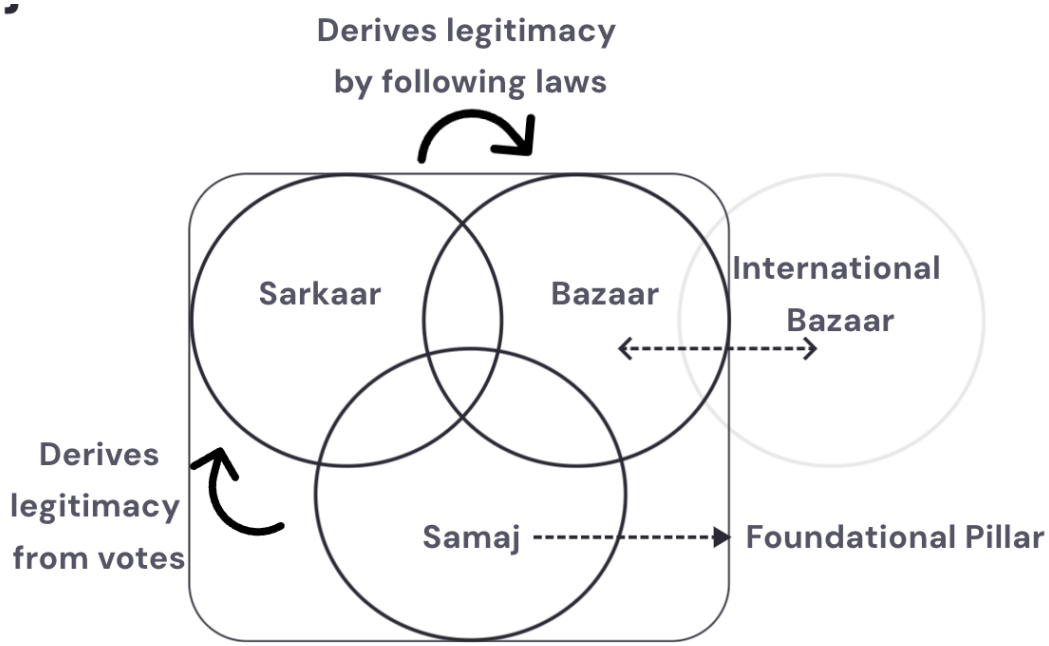

Figure 2: The sphere of influence of Sarkaar and interactions between a domestic and international Bazaar (Author's Illustration).

Interestingly, Samaj is the only pillar without a formal accountability structure. However, its inherent self-interest and drive for progress may be assumed to serve as an internal check, ensuring that it continually pushes both Sarkaar and Bazaar in a direction that benefits the ecosystem as a whole. It therefore follows that for this dynamic to work, the system requires an active and self-aware Samaj. When the framework has to engage with emerging technologies such as biotechnology, the Samaj does not need to only look at self-interest in its current time but should be able to anticipate the needs of the future. This paper explores the current state of biotechnology using this framework and posits that for biotechnology to prosper in India, the Samaj needs to be more active in its demands from the Sarkaar, the Sarkaar needs to equip the Bazaar with the correct policies to usher development and the Bazaar needs to focus on innovation in addition to production.

II. Who are the Samaj, Sarkaar and Bazaar?

Before understanding how the three pillars influence the development of biotechnology, this paper would like to assign key characteristics to the three pillars in order to avoid confusion. This is because there are times when Sarkaar may become part of the Samaj (as highlighted in the vaccine

example) or be part of the Bazaar (as highlighted in the Biofuels example). It is important to note that not only is there any overlap between the three pillars, but that the overlap is also not static and subject to change according to context. In the case of such ever-changing dynamics, who are the Samaj, Sarkaar and Bazaar when studying biotechnology? Instead of looking at entities and agencies, this paper assigns characteristics that would define the responsibilities of the three pillars. This paper proposes three key roles for each pillar in the context of developing biotechnology.

1. Sarkaar

a. Set standards - The Sarkaar should set standards for safe development and deployment of biotechnology products.
b. Monitor and enforce standards - The Sarkaar should have capacity to monitor and enforce these standards. As a corollary, the Sarkaar (and judiciary) should have mechanisms for grievance redressal.
c. Intervene when there is a market failure - Biotechnology products have positive externalities and strategic use-cases that may require governmental intervention if there is a market failure.

2. Bazaar

a. Innovate products - The Bazaar's role is to innovate and develop applications using emerging technologies.

b. Produce goods and services - The Bazaar should produce goods and services according to standards set by the Sarkaar.
c. Determine price - The Bazaar should determine prices of products based on supply and demand.

3. Samaj

a. Create demand - based on self and future societal interest.
b. Hold Sarkaar and Bazaar accountable - by voicing complaints, voting, etc.
c. Set ethical standards - for the functioning of Samaj and Bazaar and also for the use of controversial applications of technologies.

Before elaborating upon how these functions are performed, the paper will explore the landscape of the biotechnology industry in India.

III. Biotechnology In India

India's biotechnology industry is worth over $150 billion, with an ambition of contributing $300 billion to the Indian economy by 2030. There are various segments to the industry that can be categorised under three main heads - bioagriculture, biomanufacturing, and bioservices. Figure 3 provides an overview of the development of these segments in terms of technology readiness, manufacturing readiness, and market readiness in India.

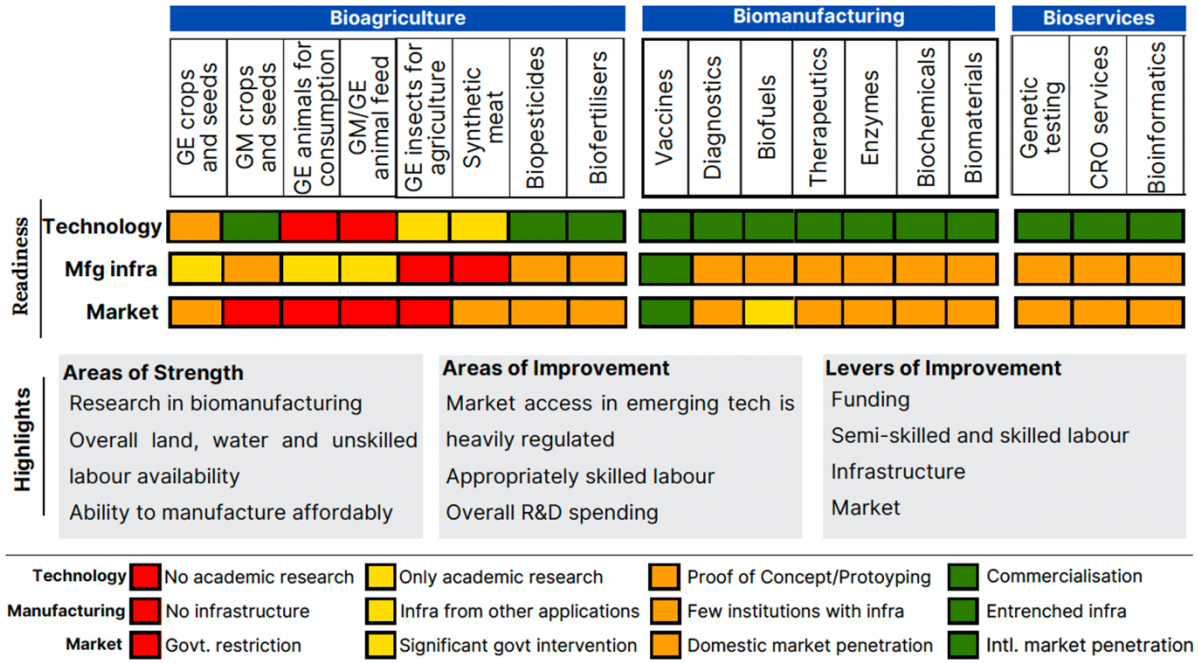

Figure 3: Overview of India's biotechnology industry.

This assessment suggests that even in areas where India may have sufficient biotechnology research, there is not enough translated into manufacturing or market maturity for biotechnology-based products. However, this assessment does not study the role of Samaj or the interactions between the three pillars of Samaj, Sarkaar, and Bazaar that might influence the lack of market maturity.

This paper attempts to use three case studies to explore the interactions between the Samaj, Sarkaar, and Bazaar in accordance with the characteristics defined in the previous section. These case studies which focus on vaccines, genetically modified (GM) crops, and biofuels are limited to use cases where there is significant interaction between the three actors. This framework does not apply to use cases where biotechnology-related consumables or equipment are manufactured for sale within the industry (for example, enzymes that are used for fermentation) or for import only, without any impact on Indian consumers. This paper is meant to be an academic exercise into understanding how the interaction between the three actors can impact the growth of the biotechnology industry.

IV. Case studies

1. Vaccines - when the Sarkaar intervenes in both Samaj and Bazaar

The vaccine market in India is worth approximately $20 Billion. Vaccines can directly reduce personal healthcare expenses and increase human productivity (that would otherwise have been lost to recovering from diseases). For certain infectious diseases, vaccines have positive externalities, protecting even non-consumers through herd immunity. In addition to

contributing to the bioeconomy, it is also a strategically important industry. India being the world's biggest vaccine manufacturer was highlighted during the global pandemic response. Also the biggest contributor to WHO, India fulfills up to 70% of the WHO's total demand for Diphtheria, Tetanus, and Pertussis (DPT) and Bacillus Calmette–Guérin (BCG) vaccines and 90% of the WHO's demand for the measles vaccine.

Given the strong benefits of vaccines for individuals, one would expect that there would be Samaj-driven demand for them. Yet, in 2012, vaccine penetration in India—of even the most routine vaccines—was less than 50% of households. Moreover, vaccines in India are predominantly bought and disbursed by the Indian government through its Universal Immunisation Programme. Through the bulk buy process, the Sarkaar actually plays the role of Samaj, and negotiates more effectively by buying bulk volumes.

The Indian government's approach of being a welfare state when it comes to vaccines was also demonstrated in the way it handled the COVID-19 vaccines. The government was involved directly in the development of the indigenous COVID-19 vaccine with Bharat Biotech and also procured COVID-19 vaccines at an estimated cost of approximately INR 36,000 crores. During critical times, the Sarkaar also restricted the Bazaar, limiting the exports of vaccines to other countries and agencies. In both cases, the government intervened in functions not originally designated as its primary functions. Although the pandemic response is over, government

procurement of other vaccines continues, while the society's lack of adoption of vaccines has been attributed to a lack of awareness, purchasing power or trust in the science or approval process.

Sarkaar			Bazaar			Samaj		
Set Standard	Enforce standard	Inter-vene if market fails	Innovate	Produce	Deter-mine price	Control demand	Voice compl-aints	Set ethical standard
Sarkaar	Sarkaar	Yes	NA	Bazaar	Sarkaar/ Bazaar	Sarkaar	?	?

Table 1: Share of roles and responsibilities for vaccines.

The development of the indigenous COVID-19 vaccines also raised questions of ethical processes, post the deployment of the vaccine. Allegations have been made that trial participants were not aware of their rights or risks involved in the process. The vaccine itself was approved without the clinical trial data being made publicly available. Though there has been a loss of interest in this topic post the pandemic, the long-term impact of this erosion of public trust may yet remain to be seen. Parallels may be drawn from incidents where poor drug quality has resulted in damage or loss of life. The Samaj in this case has been left with no robust

platform to bring up their grievance, despite there being a welfare state at the helm.

The Sarkaar's role in setting standards for emerging technologies is also unclear - India still does not have a clear mRNA vaccine policy, with the only mRNA COVID-19 vaccine developed in India supported by the government's Department of Biotechnology. The lack of a clear regulatory framework and standards hampers development, as the industry has to clarify the next steps and approval standards for the product they are making.

Under an ideal scenario, the vaccine demand should come from the Samaj, supported if needed through philanthropic or civilian group funding. The government would have the capacity to set and enforce standards, and support only those groups bereft of access to vaccines. The Bazaar would compete to provide vaccines at the lowest cost and put money into researching novel vaccines to meet the demand of the Samaj, not the Sarkaar. By intervening in the Bazaar and playing the role of the Samaj, the Sarkaar may actually be hindering the development of India's vaccine industry.

2. Biofuels - when the Sarkaar creates an artificial Bazaar

Unlike vaccines, biofuels do not provide any direct personal benefit to the consumer. However, if generated appropriately, they may impact carbon emissions and may help with climate action. Thus, there are positive externalities associated with the use of biofuels. This case study will look at the use of biofuels in the transport industry in India. Globally, transport is responsible for 15% of the world's greenhouse gas emissions and 23% of total energy-related carbon emissions.

India is the world's third-largest producer and consumer of ethanol. India's National Policy on Biofuels (2018) has set blending targets for ethanol (20% blending by 2030) and biodiesel (5% by 2030). Beyond blending targets, India has also established guaranteed pricing, long-term ethanol contracts, subsidised infrastructure investment, and created technical standards and codes. The biofuel policy unifies efforts across 11 different government ministries to reach the goal of ethanol blending. In a 2022 update on the policy, the Indian Government fast-tracked the 20% volume blending target for ethanol forward by five years to 2025-26. On 25 November 2023, the Ministry of Oil, Petroleum and Natural Gas announced indicative

blending targets of 1% by 2027 and 2% by 2028 for international flights leaving India.

Through these policies, the Union Government has artificially created a demand for biofuels in India. It is unlikely that in the absence of this mandate, there would be a high demand for biofuels, considering that biofuels are 70-130% more expensive than fossil fuels. In addition, modifications may be required for car engines to make them more suitable for using blended ethanol. Biofuels is an example of Sarkaar imposing an ethical standard on the Samaj, creating an artificial demand for the Bazaar and intervening with prices in the Bazaar.

Sarkaar			Bazaar			Samaj		
Set Standard	Enforce standard	Inter-vene if market fails	Innovate	Produce	Deter-mine price	Control demand	Voice compl-aints	Set ethical standard
Sarkaar	Sarkaar	Yes	Subsidy	Bazaar	Sarkaar	Sarkaar	?	Sarkaar

Table 2: Share of roles and responsibilities for biofuels.

Such an approach also has unintended consequences for both the Samaj and the Bazaar. For example, sugarcane is widely used for biofuel generation in India. Sugarcane is a water-intensive crop, and there are fears of water supply misuse and soil degradation as a result of rampant sugarcane

cultivation. There is also a possibility that farmers may change the purpose of agricultural land use away from food crops to biofuel feedstock to cater to the increasing demand. Changes in land use and the use of food crops for biofuel generation can eventually lead to increased food prices. Further, the purported benefits of reduced carbon emissions by using biofuels depend on sustainable practices for growing the crops and their processing. However, life cycle assessments have found that GHG emissions from Chinese ethanol and biodiesel were 40 percent and 20 percent higher than petrol and diesel respectively because of the relatively higher use of fertilisers, higher process energy consumption and the coal-dominated energy mix.

In an effective Samaj-Sarkaar-Bazaar framework, the Samaj needs to hold the Sarkaar more accountable for the end outcomes of the biofuel policy. Questions about food prices, environmental impact, and monitoring of greenhouse emissions need to be asked and resolved. In the biofuels case, we see an integrated Bazaar - one where farmers sell to biofuel companies and a parallel one for food crops, with cross-cutting impacts. The Sarkaar component for both Bazaars may be different agencies, and the Samaj segments they cater to may also differ. It therefore becomes important for the different Samaj segments to also come together and think of wider issues and long-term consequences of the policies.

3. GM crops - when the Samaj pulls the trigger

Bt cotton was one of the first genetically modified crops to be cultivated in India. The earliest Bt cotton preceded the Union Government approval for GM crops. In addition, over several years, the government has not been transparent with the safety and efficacy data of GM crops. While Bt cotton was eventually approved and is the dominant cotton crop in the country, GM food crops have still not been approved for use. This is despite India indigenously developing two GM food crops - brinjal and mustard. GM crops have received tremendous backlash, although a number of safety studies have shown they are safe for human consumption and the environment. This is a rare case where entities within the Samaj have successfully stalled the development of biotechnology, causing unintended consequences for the Bazaar.

Sarkaar			Bazaar			Samaj		
Set standard	Enforce standard	Inter-vene if market fails	Innovate	Produce	Deter-mine price	Control demand	Voice compl-aints	Set ethical standard
Sarkaar	Samaj	NA	Sarkaar	NA	NA	Sarkaar/ Samaj		Sarkaar/ Samaj

Table 3: Share of roles and responsibilities for GM crops.

The GM food crop industry in India is negligible and as a consequence, India has not been able to make use of this technology to reduce its food imports. Other countries which banned the use of GM crops such as Kenya and Sri Lanka had to revoke their bans and resort to the import of GM and non-GM food to meet their food requirements. GM crops are an example of how a Samaj-led framework may disregard science and dictate terms to a Sarkaar. While such an approach may be the correct way for a democracy, it is also an example of why the Samaj needs to be more informed of its interests.

V. Lessons from Biotechnology for Samaj, Sarkaar and Bazaar

These case studies from biotechnology show that for technology development there needs to be harmony between Sarkaar, Bazaar, and Samaj to achieve common goals. The Samaj needs to be more informed and active in understanding its self and future interest; the government needs to be kept accountable to safeguard citizens' rights and promote free markets; and the Bazaar needs to account for domestic markets in an increasingly nationalised world. The key constraints faced by the three pillars are the ability for collective thinking by the Samaj, the capacity for governance by the Sarkaar, and competition by the Bazaar. For emerging technologies, a useful framework (Figure 4) would be to consider the nature of the problem and actors involved in deployment of the solution. These parameters can guide the actions needed to be taken by different actors.

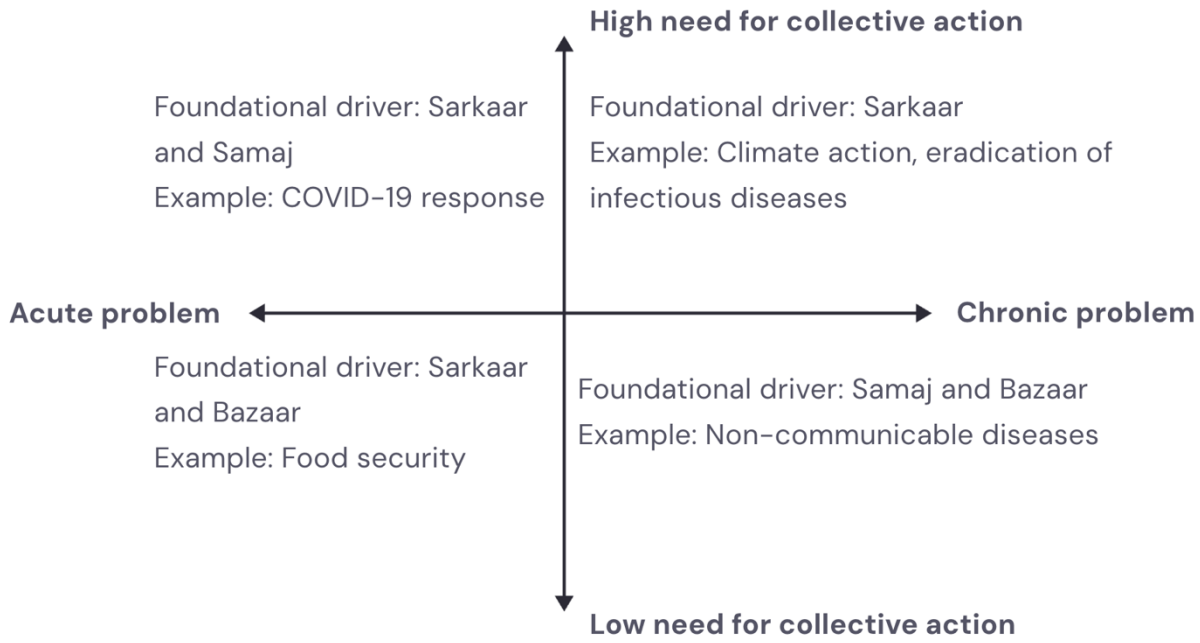

Figure 4: A framework to guide actions of various actors for the optimal adoption of emerging technologies such as biotechnology.

For example, the Sarkaar needs to be the foundational driver for any biotechnology-led solution that requires collective action for a chronic problem. It is unlikely that the Samaj would rise to act against such issues – for example, climate action –, given the costs involved with consistent actions. On the other hand, if the problem is acute, as demonstrated by the COVID-19 pandemic response, it is likely that the Samaj would willingly cooperate and even co-lead with the Sarkaar to reach a resolution. For problems where collective societal response is not required, the Bazaar can

take on a more active role. If the problem is acute, the Sarkaar would be required to issue directions on adoption of biotechnology-led solutions to tide over the problem. If the problem is chronic, the Samaj would need to co-lead the development of solutions with the Bazaar.

In any situation, for biotechnology and other emerging technologies, science should be the foremost priority to guide governance (Figure 5). A well-informed society can use the scientific method to assess its own interests. Transparency from the government can help build trust in the Samaj and make the Sarkaar more accountable to the Samaj.

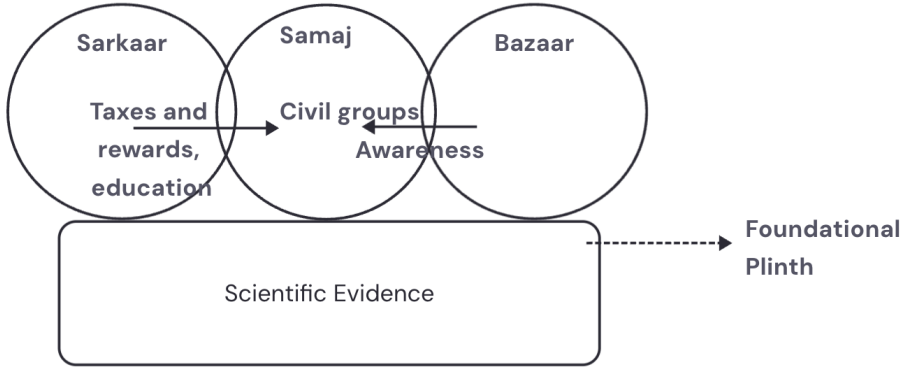

Figure 5: A modified Samaj-Sarkaar-Bazaar framework for emerging technologies (Author's Illustration).

Taxation such as the pollution tax may help keep the Samaj also accountable for its actions. The Bazaar can be held accountable by the

Samaj, but also needs to realise that as countries move to more nationalistic manufacturing, the international market may shrink, and products may need to be made for a domestic market. Overall, the Samaj, Sarkaar, and Bazaar framework should not be a unidimensional framework with the society as a foundation - for biotechnology the foundation should be sound science (and economics) that guides an interconnected web of the Samaj, Sarkaar, and Bazaar.

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