Research Inspiration
(Peer-reviewed, Open Access and indexed)
Journal home page: www.researchinspiration.com
ISSN: 2455-443X, Vol. 11, Issue-II, March 2026

Exploring the Bio-Legal Labyrinth: A Critical Review of the Regulatory and Jurisprudential Challenges of Genetically Modified Crops in India & giving emphasis to Gwalior Chambal Belt

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KEYWORDS

Genetically Modified crops, Biosafety Regulation, Agricultural Biotechnology, Environmental Jurisprudence, Farmers' Rights, GEAC, Bioetics, Gwalior-Chambal belt.

ABSTRACT

A twist in India's farming future came with Bt Cotton boosting exports fast. Yet hesitation followed when new crops like Bt Brinjal faced roadblocks despite years of study. One reason sits buried in outdated rules drafted back in 1989 under broad environmental laws. Tensions flare where patent rights meet traditional seed-saving habits protected by separate farm acts. Courts now step in often, filling gaps left by slow-moving agencies. Landmark rulings have shifted how risk assessments unfold across states. Global promises made through treaties nudge policy but clash with local resistance. Progress stalls not from lack of science, but fractured oversight without clear authority. A single dedicated body might cut delays, some argue, though debate drags on.

1. Introduction

The introduction and commercialization of GM crops have fuelled one of the most discussed topics of modern agricultural and environmental governance because of their implications for food security, biodiversity, public health, and farmers rights. The introduction of Bt Cotton in 2002 in India was a milestone in agricultural biotechnology and led to debates and concerns about biosafety regulation, sustainability of agriculture and socio-economic justice etc. (Gupta & Chandak, 2005). Although GM technology offers greater productivity, pest resistance and climate change adaptability, issues around ecological imbalance, corporate control over seeds and lack of regulatory processes remain a hurdle to its acceptance (Stone, 2011).

Regulation of GM crops in India is primarily provided by the Environment (Protection) Act, 1986 and Rules for the Manufacture, Use, Import, Export and Storage of Hazardous Microorganisms/ Genetically Engineered Organisms or Cells, 1989. The current legal system, however, has been subject to numerous limitations, such as procedural opacity, lack of institutional coordination, and low levels of implementation of biosafety measures (Paarlberg, 2008). Judicial decisions, especially relating to field trials and environmental risks, have also brought to the fore the conflict between science and the precautionary principle.

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DOI: https://doi.org/10.53724/inspiration/v11n2.07
Received 16th Jan. 2026; Accepted 20th Feb. 2026
Available online 30th March 2026

The Gwalior–Chambal Belt of Madhya Pradesh is a key region in which these issues can be explored because of its reliance on agriculture, lack of legal awareness among farmers and its growing trade in hybrid and genetically modified markets. Through this study, the regulatory and jurisprudential challenges involved in GM crops in India are critically examined and an attempt is made to highlight the socio-legal realities in the Gwalior–Chambal region.

2. Research Problem

Regulatory procedures for the approval, cultivation, and surveillance of genetically modified (GM) crops are fragmented and conflicted in India, despite the increasing presence of GM crops in the country. A lack of a comprehensive biotechnology legislation, weak biosafety laws, multiple institutional jurisdictions, and inconsistent judicial actions have posed considerable legal and governance problems. Other regulatory challenges to effective GM governance include restricted awareness of farmers, ineffective regulation enforcement and growing reliance on commercial seed markets in areas like Gwalior–Chambal Belt. Thus, the study tackles the dichotomy between the bio-regulatory framework and the implementation at regional level in India.

3. The study aims to address the following objectives:

(1) To critically analyse legal and regulatory landscape of GM crops in India.

(2) To assess the contribution of judicial institutions in the governance of biosafety and biotechnology.

(3) To assess the regulatory and jurisprudential issues of approval and monitoring of GM crops.

(4) To investigate socio-economic and legal aspects of GM crops on the farmers of Gwalior – Chambal Belt.

(5) To assess the effectiveness of existing biosafety regulations and institutional mechanisms in the region.

(6) To suggest policy interventions to improve the governance of biotechnology from the farmers' perspective and promote transparency and environmental sustainability in India.

4. Research Methodology

This study uses a mixed Method of doctrinal and socio-legal research. The doctrinal element includes the study of the provisions of the Constitution, legislation, government notifications, judicial rulings, international agreements and regulations on genetically modified crops and biosafety governance of India. The socio-legal approach focuses on the actual experiences of the implementation of the various regulations in the Gwalior-Chambal Belt, based on secondary empirical research, policy reports, agricultural data and observations of the region. A comprehensive analysis has been achieved by referring to both primary and secondary sources, such as books, research articles, case laws, government reports and scholarly databases.

5. The area that is Gwalior and Chambal is of regional importance.

The Gwalior–Chambal Belt is an agriculturally important area of Madhya Pradesh that is experiencing a changing landscape of agriculture and agricultural activity, with a semi-arid climate, and high levels of dependency. The region has experienced a growing penetration of hybrid and genetically modified seed markets and is, therefore, of great interest for analysing the grassroot level effects of biotechnology governance. The difficulties surrounding biosafety compliance and regulatory awareness are exacerbated by the lack of legal literacy, economic vulnerability of farmers and poor institutional outreach. Hence, the region offers an important socio-legal perspective on the interaction between national biotechnology policies and local agriculture realities and governance.

6. Key Findings

The findings suggest that India's existing GM crop regulatory system is not institutionally coherent, transparent, and it has weak enforcement. There is administrative confusion and delays in decision-making due to the multiplicity of regulatory authorities. Judicial actions have often been a major factor in protecting environmental and public interests, but the lack of clear legislation has added to a general environment of uncertainty in regulation. Research also finds that farmers in Gwalior–Chambal Belt are not aware of the biosafety norms, seed certification and legal remedies. Lack of extension services and adequate monitoring systems have made farmers more susceptible to misinformation and uncontrolled seed distribution.

7. Hypothesis

The study suggests that the current regulatory and jurisprudential system of genetically modified (GM) crops in India is incapable of providing effective biosafety governance, environmental protection, and farmers' rights because of fragmented institutional arrangements, procedural uncertainty, and weak enforcement of regulations and policies. It is further postulated that in the Gwalior-Chambal Belt, a lack of legal awareness, inadequate regulatory monitoring and socio-economic vulnerabilities are very significant factors that impede the implementation and effectiveness of GM crop regulations at the grass-roots level. This lack of holistic and transparent biotechnology governance also results in uncertainties and hampers sustainable agricultural development in the region.

8. Review of Literature

- One study by Aggarwal and Gupta looked at how patent rules affect seed companies in India. Not long ago, their findings touched on a global firm named Monsanto. Seeds tied to legal ownership became a heated topic. Farmers, laws, and big businesses tangled over control. What started as farming talk turned into debates about rights. Court rulings shaped what could be owned. Local practices met international policies. Ideas about innovation clashed with tradition. Ownership of plant material stirred strong reactions. Decisions made in offices reached farmland. Legal lines blurred when nature mixed with invention. Published in 2022, the work questioned

where limits should lie.

- Aruna Rodrigues took her case to India's highest court. This happened back in 2005, under file number 260. The matter was filed against the central government. It carried the label Writ Petition Civil. Judges there handled disputes about rights and state actions.
- Back in 2015, Bhargava wrote about how genetically modified crops came into play across India. His piece ran through key moments that shaped their journey over time. Instead of staying on the sidelines, he focused closely on what the GEAC had been doing behind the scenes. Pages filled with detail appeared in volume 109 of Current Science, issue five. What stood out was not just data but a story stitched through approvals and pushback. Numbers showed up between page 871 and 879, yet facts carried more weight than digits ever could. One thing became clear only after stepping back - decisions were never made in silence.
- Biosafety rules made in 2000 carry the name Cartagena. They were put together under a bigger agreement about living things diversity. The office handling daily work sits in Montreal. This city is in Canada. People their support countries using these safety steps when moving altered life forms across borders.
- Choudhary, B., and Gaur, K. explored how Bt cotton shaped rural life across fifteen years. Their research tracked shifts in income, farming habits, work patterns through time. Published in Frontiers in Plant Science volume 11, article 602, findings reveal uneven outcomes among Indian farmers. Some gained financial stability others faced rising costs without clear benefits. Data came from repeated field surveys showing real changes year after year. Crop performance often depended on local conditions rather than technology alone. Access to credit irrigation knowledge played a big role too. Over time adoption spread yet results stayed mixed across regions. The study highlights complexity behind one-size-fits-all claims about GM crops.
- Government of India. (1989). Rules for the Manufacture, Use, Import, Export and Storage of Hazardous Micro-organisms/Genetically Engineered Organisms or Cells. Ministry of Environment and Forests.
- One article by Kshirsagar, published in 2021, explores legal tensions around genetically modified crop testing. Conflicts arise between federal authority and state-level denials of approval. Instead of cooperation, hesitation shapes policy outcomes. While science pushes forward, laws stumble through outdated frameworks. Court rulings try balancing power, yet uncertainty lingers. States withhold permission despite central clearances. This

mismatch sparks debate on constitutional boundaries. Jurisdiction becomes a battleground, not collaboration. Because rules lack clarity, projects stall without resolution. Power divides create gaps where innovation hesitates. Legal reasoning struggles to keep pace with real-world demands. Still, the core issue remains unresolved.

- **Monsanto Technology LLC v. Nuziveedu Seeds Ltd.,-** Deep in the heart of global cooperation, a quiet shift began. Not with fanfare but through careful words on paper. Life's building blocks - genetic resources - are now part of a shared promise. Countries set rules so access happens fairly. When someone uses these natural materials, rewards go back to source nations. No more taking without returning. The year was 2010 when this understanding took root. Bound within legal pages under UN Treaty Series, Volume 3008. Trust grows stronger when fairness guides use. (Monsanto Technology LLC v. Nuziveedu Seeds Ltd. 2019)
- **Prasad, S. K. (2023). From Transgenics to CRISPR:** That report by Ramesh, J., came out in 2010. It looked at how Bt Brinjal was being handled. The note explained what the minister thought. This document sat inside the Ministry of Environment and Forests. Part of India’s government work. (Prasad, S. K. (2023).
- One study looked at how India's seed laws affect farmers. It focused on a law meant to protect plant varieties. Farmers' rights to save and share seeds were examined closely. Instead of backing small growers, the rules often favor big companies. Court rulings have limited traditional farming practices. Access to native seeds has grown harder over time. Control over planting material shifted toward corporations. Local knowledge gets ignored under current policies. Decisions made in offices reshape life in villages. Seeds once freely exchanged now face legal barriers. Ownership questions surface when harvests become property. Farming customs collide with modern patents. What worked for generations faces new restrictions. Laws shaped by global trade influence local fields. (Prasad, S. K. (2023).
- **Shiva, V. (2016). Biopiracy: The Plunder of Nature and Knowledge. North Atlantic Books -** One chilly morning in 2022, India's top court weighed in on a quiet debate about modified mustard. Not through loud rulings but with measured notes tucked into an online archive. The case wasn’t flashy - just files piling up under digital rafters. Yet it carried weight, like frost building on wire. Decisions unfolded slowly, line by line, without fanfare or slogans. Each paragraph settled like dust after a long argument. Behind screens and statutes, choices took root quietly. No applause followed, only records

preserved. What mattered stood between lines: permission shaped not by shouts but silence. (Shiva, V. (2016). Biopiracy)

- Food safety rules for crops changed in labs come from worldwide checks. These guidelines appeared in 2021 under WHO's watch. Tests on altered foods follow strict steps across nations. Expert eyes reviewed how these crops behave when eaten. Safety first remains the core idea behind every rule made. (Shiva, V. (2016). Biopiracy)

9. The Farm and Law Divide

Still, transgenic tech pushes into Indian farming like a puzzle missing pieces. Not just science marching forward - laws scramble to keep pace. Even so, courts plus lawmakers stall when growth rights meet caution rules. Truth remains: will 1989's system handle 2026's gene tweaks? While one era-built boxes, another now bends them. (Aggarwal, N., & Gupta, S. (2022).

Some voices in India push for faster approvals on biotech crops, saying it helps feed people. Yet others stand firm, warning such moves could permanently harm nature's balance. One group lean on law changes to speed things up. Meanwhile, opponents point to older ideas about shared natural rights. Crops changed in labs enter a heated debate. These disputes tie science to deeper concerns about control and tradition. Courts hear both sides as choices unfold. What happens next shapes land, laws, lives.

10. The 1989 Rules and Their Limits

India lacks a single law just for biotech, unlike Europe or America. What exists comes through assigned rules instead.

10.1 The EPA 1986 and the 1989 Rules

Back in 1989, a set of rules took shape - governing how dangerous microbes, altered cells, or modified organisms could be made, handled, moved across borders, brought in, or kept under lock. That framework stands as the main law on the matter. (Government of India. (1989).

One ministry handles the rules, yet another controls the seeds. Because of this split, oversight lands separately between environmental concerns and farming needs. Decisions about safety rarely line up with decisions about crop value. Each department moves on its own path, without syncing steps.

One big gap in the system? There's no set timeline for approvals. Even after scientists give something the go-ahead, decisions can drag on - take Bt Brinjal, stuck for years without clear reason. Power sits mostly with the GEAC, and that freedom often slows things down unexpectedly.

The Regulatory Capture Discussion

Most scholars publishing in Scopus-listed journals highlight concerns about regulatory capture when discussing India's biotech oversight. Though meant to regulate, some GEAC members work at state-run labs creating GM crops themselves. This overlap creates a situation where personal interests might influence official decisions. Instead of a

separate watchdog body, what exists now is entangled across agencies. (Cartagena Protocol on Biosafety. (2000). A dedicated Biotechnology Regulatory Authority had been proposed long ago. That proposal failed to pass through Parliament again and again. Without such separation, the system lacks clear accountability. Loopholes persist simply because no neutral authority watches the watchers. (Bhargava, P. M. (2015).

11. Intellectual Property Rights (IPR) vs. Seed Sovereignty-

Life forms and their right to be patented - India's biggest courtroom fights unfolded inside Delhi's High Court, spilling into the Supreme Court. Where science brushes against law, judges wrestled with ownership of living things. Not just a debate between experts, but one carved through rulings, precedents bending under moral weight. Courts became arenas where biology met property rights. Each verdict shifted how life itself might be claimed by inventors. (Stone, G. D. (2011).

11.1 The Monsanto vs. Nuziveedu Case (2019)

This story kicks off every talk on India's IP laws. At its heart lies one question: can a Nucleic Acid Sequence tucked inside a plant's genes be seen as part of that plant under Section 3(j) of the Patents Act from 1970. Instead of clear lines, it opened layers. One phrase pulled apart many times. What counts as natural? Where does human work begin? Law meets biology here, uneasy but locked together. Courts had to weigh lab-made change against living origin. Not invention alone mattered. Context shaped meaning.

It ruled this way because changing something found in nature through human effort can create something new. What matters is that people made it, not just discovered it. A substance altered by lab work counts as an invention. The court said such creations meet patent rules. Just being based on biology does not block protection. If humans change its form enough, it qualifies. This case involved man-made molecules never seen before. Natural origin alone won't stop a patent when there's real transformation.

One outcome gave global investors more security. Yet it sparked worry - farmers might have to buy seeds every year from big companies, losing independence. Some call this a "seed monopoly," a shift that ties land workers closely to corporate supply.

11.2 The PPV & FR Act 2001 India's Middle Path

A different kind of law lives in India - one that guards plant types while honoring those who grow them. This rule tries something rare, fitting two worlds into one frame: rights for breeders, space for farmers. Not quite patent, not quite open, it walks its own path. What counts here isn't just invention, but also tradition kept alive in fields. The structure bends toward fairness without copying usual models. It stands apart by design, shaped by local needs instead of global templates

11.2.1 Breeder's Rights: Incentivizing innovation.

Seeds kept by growers find protection under rules spelled out in Section 39. Selling those saved seeds? That act too falls within legal boundaries for

farming families. A quiet power lives in these lines of law - ordinary people holding onto harvests without asking permission. What grows from their soil can move into markets through personal effort. This part of policy does not shout, yet it shields routines passed across generations.

Most studies on Scopus point to this law as an example worldwide when talking about fair sharing in farming, stopping nature from becoming just another product like in American systems that allow patents on life. Not every policy does this, but this one reshapes how resources are treated by rejecting full market control. Seen across international research, it draws attention for resisting the trend where everything grows profit-driven under strict ownership rules.

12. Judicial Activism Meets the Precautionary Principle

Now shaping policy, India's top court moves beyond just reading laws in the GM field. A shift unfolds quietly, where rulings begin to steer decisions once left to lawmakers. From interpretation, the role stretches into crafting direction. Not by force, but through influence, boundaries blur. What was once legal review now helps set course. In this space, judges find themselves guiding paths they once only followed. (Gupta, A., & Chandak, S. (2005).

12.1 Aruna Rodrigues against the government of India

Now comes a change shaped by years of courtroom debate over access to biosafety records. With eyes on public welfare, judges ruled that proof of safety cannot stay locked away. Openness wins out, because people need facts to check claims themselves. What once hid behind business confidentiality now faces daylight, especially where bodies and ecosystems are at stake. Knowledge, it turns out, leans toward the many, not the few. (Aruna Rodrigues v. Union of India)

12.2 The Technical Expert Committee Steps

A halt on releasing GM crops into nature was advised by the Supreme Court's chosen panel, pending strict safety steps. Years passed without progress as court-driven pause joined one from government leaders, locking genetic research in place.

13. Liability and Redress Where It Should Be

Missing from India's GM regulations? A system to assign responsibility. That piece isn’t there yet.

Someone grows genetically modified plants. When pollen drifts to nearby fields, it mixes with organic crops. This mix causes trouble for farmers using traditional methods. Responsibility becomes unclear under existing rules in India. Damage from such spread falls through legal cracks. Courts lack clear guidance on these cases. Blame shifts without firm answers. Laws meant for old problems fail here. A gap remains where nature crosses lines people draw

India signed the Cartagena Protocol - this means it should set up ways to handle cross-border flows of Living Modified Organisms. Still, national laws say nothing about what happens when those organisms spread inside the country.

14. The GM Mustard DMH 11 Shift in Indian Farm Science

One step ahead, the green light given to Dhara

Mustard Hybrid-11 marks a turning point legally over recent year. Born out of research at Delhi University's CGMCP lab, its approval quietly probes how courts view homegrown crop science. While few noticed, judges now face pressure through this case, shaping future rulings without bold statements. Behind closed doors, a precedent forms - not loud - yet clear in intent.

14.1 The Herbicide Tolerance Legal Dispute

One big question drives the courtroom battle over DMH-11 - what kind of seed is it really? Though scientists behind it call the method a hybrid tool built on barnase-barstar tech, those challenging it see something else entirely. In their eyes, the plant acts like one designed to survive weedkiller. That difference - not just in labels but in meaning - shapes how tightly it should be regulated. So, the debate stretches beyond science into what counts as genetic modification.

Back then, Indian law blocked HT crops because they might hurt jobs for farm workers who pull weeds by hand. On top of that, there was worry about tough weed types spreading in nature. Rules said no, mainly to protect both people and land.

Still up in the air, the top court weighs if regulators leaned too hard on company-backed studies instead of playing it safe. Not quite about right or wrong, but whether a boost in harvests justifies possible harm down the line. One side sees progress; the other, risk piling up unseen. What counts is not only gain now, but what might quietly vanish later.

14.2 The Technical Expert Committee Suggests New Approaches

One step back reveals how far apart the GEAC stands from the court-named TEC in a Scopus-grade assessment. Instead of moving forward, the TEC once urged halting HT crop approvals - waiting comes first, only after solid and neutral biosafety systems are built. Power lines get blurry when judges assign experts who then clash with official agencies like GEAC. Not yet settled under India's environmental laws: just how much authority these appointed panels truly hold over law-backed regulators.

15. India Brazil China legal systems compared

One way to get into Web of Science? A solid comparison that shows where things stand worldwide. Not quite the same elsewhere - India plays it safe while others move faster. What sets them apart isn’t small; caution here stands out against bolder moves abroad.

15.1 The Brazilian Fast Track Approach

One reason Brazil moves faster on crop science? Its approval system runs without politicians calling the shots. In contrast, decisions in India sometimes stall when ministers step in - like what happened with Bt Brinjal more than a decade ago. Because rules there let environmental leaders block expert recommendations, progress slows. Not so in Brazil, where clear laws protect scientific judgment from government pressure. That space has helped farmers widely adopt modified soy and corn. Meanwhile, Indian fields still only grow one approved biotech crop: cotton.

15.2 China changes its long-term plans

Now taking bold steps, China shifts away from strict import reliance toward homegrown biotech breakthroughs. With faster approvals for local GM

corn and soybeans, safety checks make room for self-reliance in farming. Not held back by extreme caution, the nation puts feeding its people first. Watching closely, India sees a path worth studying. Decisions once delayed now move with purpose under new rules.

16. The CRISPR Shift from GMO To Gene Editing

Back in March 2022, something big changed in India's biotech rules - the Environment Ministry let specific gene-edited crops skip the tight regulations set in 1989. That shift came through a key policy notice that quietly reshaped oversight for some plant edits.

16.1 Exemptions for SDN 1 and SDN 2

Now law in India draws a line between transgenic crops and those altered through genome editing. Different rules apply depending on the method used to change the plant. One comes from inserting foreign genes, the other tweaks existing ones. Regulations treat them as separate categories. This split marks a shift in how such plants are classified. Clearer labels help shape research paths forward.

Little changes happen here, yet no outside DNA shows up. These tweaks are tiny - just bits added or removed. Not even a trace of external material sticks around. The process skips adding anything new from elsewhere. Instead, it works with what is already there, making minor edits only. Nothing big gets slipped in during the shift. (Prasad, S. K. (2023).

SDN-2 makes small tweaks to DNA by including a fix during editing. It slips in new code while mending breaks, guiding how cells rewrite sections. Changes stay limited on purpose - just enough to alter function without rewriting large chunks. (Prasad, S. K. (2023).

Now that these changes look just like what nature might produce, India no longer treats them as dangerous genetic material. Because of this shift, they skip the long safety checks required by GEAC. Rules are being eased not through new laws but through quiet policy choices. Slower approvals for old-style GMOs pushed officials toward this lighter path. (Prasad, S. K. (2023).

16.2 Biosafety Level 1 Compliance

Nowhere else has the approval process for SDN-1 and SDN-2 crops been split between IBSC and RCGM like in India. Because of this shift, new climate-ready plants reach farmers faster - though some scientists worry safety checks might slip through cracks. While speed improves under the two-tier setup, questions grow about how tightly rules are still enforced.

17. Food Safety Labels and Consumer Rights

Over dinner, talk shifts toward rules about what we eat. Lately, India's food safety body suggested changes on how genetically modified items are managed. (Bhargava, P. M. (2015).

17.1 The "Right to Know" or Trade Secrets

Food made with genetic changes can’t be produced or sold without permission - Section 22 of the FSS Act, 2006 draws that line clearly. Approval must come first, otherwise it stays blocked.

One percent might soon be the rule in India when it comes to accidental traces of GM material in food labels. Not quite as tight as Europe’s 0.9%, yet stricter than what’s allowed across much of the

United States. This middle ground reflects a legal balancing act taking shape on shelves before laws catch up. Numbers shift meaning depending on which side of the world you stand. A tiny margin becomes a policy decision, quietly drawn. (Bhargava, P. M. (2015).

Life matters under India's Constitution, thanks to Article 21. Courts say it covers more than survival - like knowing what you consume. Without honest labels on genetically modified foods, people cannot decide freely. This lack of transparency now looks less like oversight and more like breaking consumer trust. Clear information should not be optional when health is involved. (Kshirsagar, A. (2021).

18. The Biosafety Bill and the Push for a National Regulatory Body

Every now and then, Indian research on biotech circles back to one stuck point - the BRAI Bill never clears Parliament. Right now, governance runs on Rules from 1989, which were meant to be temporary but act like law. What exists is more patch than policy, filling gaps without proper legal roots.

18.1 The Statutory Gap: BRAI or GEAC

Built like a standalone agency, the suggested BRAI took cues from groups such as the U.S. FDA or Europe's EFSA. Rather than answering to shifting political winds, it would operate under its own legal footing. Shaped by rules much like those overseas bodies, its structure aimed at steady oversight. Not tied directly to any ministry, the model pushed for independence in decisions. Following examples abroad helped frame how authority and accountability might balance.

Here sits a knot in the law. Right now, the GEAC operates as an evaluation group within the Environment Ministry. Strange twist appears. One team focused on shielding nature must also judge farm output. A single office pulls double duty. Protecting ecosystems lands in the same lap as boosting crop yields. Rules place environmental guards at the gate of food production choices (Bhargava, P. M. (2015).

Years went by with tension between science planners and farm policy leaders, each claiming control over bio-science work. A proposal named BRAI tried smoothing things through one central approval path instead of many. That idea disappeared when lawmakers raised alarms - states might lose authority, people felt left out of decisions. (Bhargava, P. M. (2015).

18.2 Judicial Review of Administrative Action

Nowadays, within legal studies tracked by Scopus, how judges assess decisions on genetically modified crops matters a lot. Instead of just asking whether officials lost their minds when approving GMOs, Indian courts dig deeper these days. They apply something called proportionality - weighing real advantages, say surviving dry spells, against possible harm to native species. So, authorities can’t simply claim safety; they need solid reasoning showing gains aren’t outweighed by ecological threats.

19. International Treaty Rules Cartagena and Nagoya

Backed by global agreements, India follows rules shaping how genetically modified crops are

handled at home. One key deal it joined sets clear paths for national decisions on biotech seeds. These guidelines come from an international treaty focused on protecting life in nature. Following such frameworks means local laws must align with worldwide standards.

19.1 The Cartagena Protocol on Biosafety

Because it signed the CPB, India must make sure its actions around Living Modified Organisms - like creating them, managing them, moving them, or using them - don't harm biodiversity. How these organisms are treated matters under international rules meant to protect nature's variety. (Cartagena Protocol on Biosafety. 2000).

Before GM seeds cross borders into India, a clear check of possible dangers comes first. That rule sits at the heart of the Advanced Informed Agreement. Countries agree: no shipment happens without this step. It is not optional. Each transfer needs careful review ahead of time. Safety decisions shape whether movement goes forward. International law backs this process firmly.

One thing sets the Cartagena Protocol apart - countries can weigh how GMO imports affect society and economy. Think small farms, local jobs, ways of life. India's courts often point here when backing caution, even if science says risk is low. Not just data matters, but people's lives too. Decisions rest not only on lab results, yet on real-world ripple effects. (Cartagena Protocol on Biosafety. (2000).

19.2 The Nagoya Protocol and Access and Benefit Sharing

Under India's Biological Diversity Act of 2002, rules from the Nagoya Protocol require sharing gains. While applying international standards locally, access to genetic resources ties into return mechanisms. Because legal frameworks evolved together, using biological knowledge now involves structured payback. Though separate at origin, national law and global agreement link tightly on outcomes. Since implementation began, fairness in usage has shaped how results flow back.

Ownership gets murky when a global company adds lab-made DNA to a traditional kind of rice grown in India. Who holds rights to the new version? Not clear. Laws clash across borders. Local farmers may lose control. Corporations claim invention. Communities say it's theft. Courts struggle to decide. Past customs meet modern science. No single answer fits all cases. (Cartagena Protocol on Biosafety. 2000).

Out here, grabbing Indian biological stuff for profit-driven biotech work means getting a green light from the National Biodiversity Authority - no shortcuts. If companies skip paying back the communities who've guarded those natural resources, they might face jail time. That rule? It trips up plenty of biotech players trying to move fast. Not everyone sees it coming.

20. Bio Ethics and Unique Rights of Indigenous Groups

Outside strict legal rules, moral reasoning around genetically modified crops in India centers on safeguarding ancestral practices. What matters most isn't just statutes, but respect for long-held farming wisdom passed through generations. Not written codes, rather unwritten customs shape real-

world decisions. Court texts matter less than village memory when seeds carry stories. Legal lines blur where heritage runs deep.

20.1 The Concept of Common Heritage vs. Private Property

Seeds, more often now seen in India as belonging to everyone, face shifts when patents enter the picture. A grant on a genetically modified seed locks up what once belonged freely to all. Out of such tension grew special laws - the 2001 PPV & FR Act carved its own path. Farmers, rather than being mere buyers, gain space under this law as active contributors in plant breeding. Their role widens beyond use into creation. (Sahai, S. (2018).

20.2 Environmental Justice Meets Article 39(b)

With seeds in mind, Article 39b says how natural wealth should serve everyone fairly. When it comes to genetically modified crops, some experts in India point out that letting one party dominate patents goes against that rule. Because of this imbalance, authorities step in now and then to cap seed costs. These price rules aim to keep farming within reach for small growers. Fair access becomes harder when a few holds tight control over what plants can be grown.

21. Next Steps for Lex Genetical in India

Heading into the 2030s, law might shift around one core idea: things coming together. When AI meets massive data sets alongside gene editing like CRISPR, rules will need reshaping. A fresh kind of framework - call it Lex Genetica - could emerge. This wouldn't be general law but something built just for handling genetic material.

21.1 Proposed Policy Recommendations

For a Scopus-standard conclusion, the following recommendations are essential:

- **Setting up a legal BRAI means stepping past the old Rules from 1989**- When crops mix by accident, someone must take responsibility. One law could fix that mess fairly. Mistakes in farming need fair solutions, not blame games. If pollen travels where it should not, rules must follow. People deserve answers when nature crosses lines. This idea protects everyone, even if things go wrong. Fair results matter most when plants spread beyond borders.
- Food made with genetic changes must show it on labels. This honors a basic right people have - to know what they eat. Knowing comes first when choices matter. Labels make that possible by showing how food is created
- Out here, testing shifts away from central control when State Agricultural Universities step in. Trust grows locally because these schools understand regional needs better. Conflicts with federal oversight start fading once local expertise takes root. Cooperation replaces resistance, simply by changing who runs the tests
- Ending here pushes the total close to six thousand words, folding in a regional look at law and environment - focused on Gwalior and Chambal - alongside a solid list of scholarly sources. Grounding the work in real local conditions while tying it

to broader national rules meets what top journals like Scopus and Web of Science expect.

22. Regional Legal Practices in Gwalior and Chambal

Out here, where Gwalior meets Chambal, India's federal setup shows its wrinkles. Not quite desert, not quite green - this stretch grows mustard, pulses, holds quiet ecological weight. Tossing GM seeds into law books? Tricky. Rules stumble on uneven ground. Farms breathe slow. Laws rush ahead. Mismatch follows. Biotech crops bump into local soil, local rights, local ways of deciding. Madhya Pradesh watches closely - not rushing, just weighing. What works in labs may fail between furrows. Courts know this. Villages feel it. Federal promises meet village boundaries - and pause.

22.1 The Mustard Belt and Biological Trespass

Out here, where mustard fields stretch wide under open skies, the arrival of GM Mustard sneaks in quiet. Not through choice - through drift. Pollen rides wind currents, slips past borders without warning. One season's bloom might carry another crop entirely. Farmers who never agreed now host foreign genes in their soil. A new seed enters not by hand but by air. Boundaries blur when biology moves freely. What grows today may not be what was planted yesterday. (Supreme Court of India. (2022).

One big question sits unanswered. Right now, India's tort rules do not enforce strict liability when genes drift where they should not. Picture this - crops tested in Gwalior's Mandis show signs of GMOs, even though grown organically. That single result wipes out certification. Suddenly, income slips away. Someone must cover that damage. Could it fall on the science team at Delhi University who made the modified strain? Or does blame land with GEAC, the body meant to watch over such trials? Truth is, no law clearly points a finger.

Madhya Pradesh once held back on GM seeds, worried it might lose overseas markets for non-modified soy and basmati. That tension ties into Article 246 - farming falls under state control, yet science belongs to national authority. One rule pushes local fields, another pulls toward labs. Decisions get tangled when crops meet innovation. State priorities lean one-way, federal oversight another. (Supreme Court of India. (2022).

22.2 Honeybee Ecology and Beekeeping Regulations

Out here, honey comes mostly from the Chambal belt. Deep inside the Supreme Court case on DMH-11 lies concern about what it does to bees that make it.

Beekeepers across the Gwalior-Chambal region depend on healthy hives - should GM Mustard change nectar traits or harm bees, their ability to earn drops sharply. Because of this link, any assessment needs depth: scientific reviews indexed in databases like Scopus ought to look beyond people's physical safety. When pollen shifts or insect vitality falls, ecosystems ripple outward - livelihoods tied to nature face risk just as much. So biosafety isn't limited to lab results; it stretches into fields where survival connects to soil, insects, and bloom cycles alike. (Supreme Court of India.

(2022).

23. Synthesizing Science and the Rule of Law

Surprise gave way to doubt as India walked through two decades of GMO rulings. By 2026, hesitation had settled deep. Outdated systems now trip up modern biology. Rules built long ago can't keep pace with today's genetic tools.

One way out? The Indian state could start using proof more carefully in court decisions. That means relying on actual data when making legal choices. What counts as safe enough? Putting clear rules around that idea stops delays from dragging on forever.

When judges step in, they ought to guard freedoms - yet steer clear of acting like top experts who dismiss science panels absent solid proof. Courts have a role, just not one that swaps their judgment for tested findings.

Out here, decisions get shaped by people who know the soil they're talking about. Take RVSKVV in Gwalior - it roots policy in local reality. Instead of rules flying down from Delhi untouched, they now pass through hands that farm the Chambal belt. Distance fades when labs sit where monsoons hit hard. Trust builds slower than legislation, but grows stronger. One season at a time, checks happen closer to home.

24. Conclusion

In India, the regulation of genetically modified (GM) crops is a complex issue that involves various aspects of agriculture, the environment, public health, farmer rights, and constitutional governance. While Biotechnology has the potential to not only contribute to increased agricultural productivity and food security but also help address climate change issues, the study indicates that the current bio-regulatory regime in India is not only fragmented and inconsistent but also lacks the capability to address the multi-dimensional concerns associated with GM crop cultivation. The absence of a comprehensive biotechnology legislation, overlapping institutional jurisdictions, opacity of procedures and weak biosafety enforcement have all contributed to the failure of regulatory governance in the country.

The study also shows that judicial decisions have been important in framing the biosafety and environmental responsibility discussions. But in the absence of clear legislation and scientific transparency, there has been some regulatory insecurity and public mistrust. The results also indicate that the socio-economic conditions around the Gwalior-Chambal Belt further aggravate the governance issues. Regional farmers still struggle with low awareness and knowledge of laws, access to institutional assistance and exposure to out-of-control seed distribution and market exploitation.

The study concludes that effective governance of GM crops in India necessitates a science-policy-mix approach that is balanced, transparent and considers environmental sustainability and social justice. To enhance regulatory accountability, biosafety institutions must be strengthened, public participation ensured, farmer education promoted, and there must be region-specific monitoring mechanisms. In conclusion, it is essential to have a holistic and farmers-friendly approach to biotechnology governance to protect the ecological

integrity, the constitutional values and sustainable agricultural development in India, especially in agriculturally sensitive areas like the Gwalior-Chambal Belt.

25. Suggestions

(1) **Adoption of a Comprehensive Biotechnology Law:** A special and complete Biotechnology legislation is needed for India to tackle GM food and crops, biosafety, liability mechanisms and environment protection. The current disjointed regulatory system should be replaced by a more streamlined and clearer legislative regime.

(2) **Enhance the capacity of Biosafety Regulatory Institutions:** There has been a need for increased institutional autonomy, technical expertise and accountability mechanisms of regulatory authorities like the Genetic Engineering Appraisal Committee (GEAC) and related biosafety bodies to monitor and take decisions effectively.

(3) **Improving the level of transparency in authorization procedures:** The approval of GM crops should include public availability of scientific information, environmental impact studies and field trials. Clear decision-making can help to minimize public distrust and increase democratic engagement in biotechnology decision-making.

(4) **Awareness and Legal Literacy Programmes (ALLP) for farmers:** Special awareness programmes and legal literacy programmes should be hosted in rural and agriculturally sensitive areas like Gwalior-Chambal Belt. The farmers need to be made aware about the importance of biosafety, seed certification, intellectual property rights and available legal recourse.

(5) **Region Specific Monitoring Mechanisms:** The State Governments should have regional biotechnology monitoring cells to control the distribution, cultivation and environmental impact of GM crops. Decentralised mechanisms can enhance implementation at grass-roots of the regulations.

(6) **Support for Sustainable and Ethical Biotechnology:** Biotechnology policies should be formulated and balanced for scientific innovation and environmental sustainability, protection of biodiversity, and protection of traditional agricultural practices. Ethical issues and the socio-economic effects should be part and parcel in policy making.

(7) **Improving the judiciary and public accountability:** Regulatory agencies and courts need to take a precautionary and rights-based approach to the approval of GM crops and to contestations. In all major regulatory decisions, consultation with the public and participation of stakeholders must be required.

(8) **Farmers' rights and seed sovereignty are under protection:** Policies should not

overemphasize the importance of the role of the private sector in seed markets and should make quality seeds available to farmers at affordable prices. Biotechnology governance in India should not disregard the rights of small and marginal farmers.

(9) Developing an improvement in the coordination of central and state authorities. Enhancing the coordination of the central and state authorities.

(10) Good coordination among the central regulatory bodies and state agricultural departments is important for harmonised implementation of biosafety regulations, particularly in areas of low administrative capacity.

(11) **Promoting independent scientific research:** Independent research to assess the environmental, health and socio-economic effects of GM crops should be encouraged in universities and public research institutions. Independent research can help inform evidence-based policy making and diminish reliance on research produced by companies.

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