



When Algorithms Fail the Farm: Rethinking Liability Frameworks for AI in Agriculture — A Comparative Study of India, the EU, and the United States

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Abstract. The emerging technological intelligence (AI) is rapidly transforming agriculture. Whether it is precision farming, predictive analytics or biotechnology integration, the agricultural sector is evolving with these technologies. While being promising by enhancing agricultural productivity and sustainability, the integration of AI has also introduced complex risks when algorithmic systems fail. This paper explores the legal issues surrounding liability for damage caused by AI in agriculture by analyzing case studies in India, EU, and the United States. It amicably argues that how existing liability frameworks rooted in tort law, product liability and limited criminal doctrines are not corresponding to this grey area that addresses the distributed, opaque and autonomous nature of AI systems and agricultural failures.

Keywords: Artificial Intelligence, Agricultural AI, Algorithmic Accountability, AI Liability, Product Liability, Precision Agriculture, AI Governance, Comparative Law.

1 Introduction

The integration of artificial intelligence (AI) and agricultural practices marks an essential transformation in global food production. Historically, agricultural sector was driven by experiential knowledge of the farmers, climate patterns round the year and speculative manual decision-making. But now these speculative practices are being reshaped by data-driven technologies, predictive analytics and automated systems. AI-enabled tools like precision irrigation systems, crop health monitoring apps and autonomous farming machinery and genomic analytics are redefining the speculative predictions. AI is enabling management of agricultural inputs, assessment of risks and optimize productivity.[1]

While these transformative tools benefit the agricultural sector, we cannot ignore the chances of technical led failures of these systems. Like in the United States, AI-guided drone spraying systems misread geospatial boundary data and discharged pesticides onto neighboring plots which triggered crop contamination and inter-farm disputes. These disputes were barely resolved by tort law due to the indeterminate origin of the

algorithmic error.[2] In India, the farmers borrowed yield prediction applications based on historical monsoon datasets which predicted false harvest forecasts leading to unrecoverable financial losses with no identifiable defendant.[3] Autonomous irrigation systems responding to faulty sensor inputs have waterlogged standing crops. [4] The cases illustrate that while the harm was clear, the fault was not clearly identified among all the actors involved (such as the sensor manufacturer, the cloud platform provider and the provider of the AI model). All of them had no formal obligations under the law. These are not corner conditions. They're consequences of powerful technologies being deployed in a legal context that wasn't designed to control them. The technological advances are promising for improving agricultural productivity and sustainability but also new technological risks are emerging for vulnerable farmers. The authors do not argue that we shall continue following the traditional agricultural methods. They affirmatively see the future of the agricultural sector brighter in the light of technical upgradations. Through this paper they highlight the urgency of addressing the challenges in legally governing the product liability. Specifically, focusing on world's largest agrarian economies which have actively embraced digital transformation in agriculture and farming practices.[5] The absence of a rational and unified legal framework governing AI-induced harm in agriculture exacerbates the vulnerability, raising concerns regarding fairness, access to remedies and distributive justice.

2 Objectives:

This paper pursues following interlinked objectives:

- To map and critically evaluate the existing legislative and judicial framework with respect to Agricultural-AI-liability legal frameworks in India, EU and the USA.
- To examine India's readiness while referring to Digital Personal Data Protection Act (2023) [6], the draft National Strategy for AI and Agri-tech liability rules.[7]
- To construct a comparative liability matrix with respect to attribution rules, evidentiary burdens, available remedies, regulatory enforcement mechanisms and farmer-accessibility of legal redressal.[8]

3 Existing Framework for “liability”

Smart farming applies information technologies for the optimization of complex farming systems. It incorporates information and communication technologies to improve agriculture production systems. Combining AI approaches and traditional agricultural methods, smart agriculture is being used to improve national economies by monitoring crop growth using the principles of precision farming.[9] There are various challenges that AI brings in smart agriculture:

- **Algorithmic Bias and Epistemic Defects:** Machine learning models are often trained on datasets representing large-scale industrial farms. This creates a "bias" against smallholders or region-specific crops, leading to unsuitable recommendations. For example: A pest detection algorithm trained on Western crop datasets may misclassify diseases in Indian crops, leading to incorrect pesticide use.
- **Technical malfunction and failures:** the malfunctioning of any parts of the technical device (such as sensor failure, connectivity issues or software bugs) can disrupt AI systems and its predictions.
- **Decision Making Errors of autonomous systems:** The Advanced AI systems are making decisions using the probabilistic models, and are operating without much human intervention. These models are working on past patterns and datasets. However, in agriculture there are a number of natural factors that foretell which is not guaranteed all the time. For instance: An AI advisory system suggests to harvest earlier based on predictive analytics, but due to unforeseen weather changes yield is lost.

Knowing how these challenges will create a liability, whether that's for the developer or the person that has deployed those AI tools and techniques. The most comprehensive approach to liability is in tort law. Product Liability provides an alternative that is more convenient for claimants as it requires only to prove fault, rather than strict liability of manufacturers for damages arising from faulty AI products. However, it is yet to be proven in the field of AI software. Traditionally, tortious liability is upheld against damages caused by tangible and static goods; an AI which works on machine learning model and continuously learns and updates itself does not map clearly with the category of manufacturing or design defect.[12] Abnormally dangerous activities have been reserved under strict liability regardless of the fault or intent of the wrongdoer. Several researches and scholars have argued to extend the strict liability to high-risk AI deployments on the basis that developers who profit from systems with known unpredictability should internalize the associated risks.

Beyond the question of doctrinal adequacy, there are three structural features of AI systems that generate a gap between them and the existing liability frameworks to be applied;

- Technical opacity commonly described as the "black-box" problem refers to the practical impossibility of fully tracing the inferential path by which a deep learning model arrives at a given output.[13] The untraceable conditions that influenced the AI system require effectively shielding legal framework for developers from accountability behind algorithmic complexity.[14]
- Autonomous decision making and post-deployment learnings compound the opacity problem. Such systems adapt their behavior through continuous learning and retraining. They may produce outputs at the point of harm that differ substantially from what the developer designed and the deployer tested.[15].
- Multi-stakeholder vineyard- A single crop-advisory AI product may involve a sensor hardware manufacturer, a satellite data provider, a cloud infrastructure operator, a model developer, an agronomic data licensor, and a last-mile distribution platform. Each of these contribute an input to the system's output which are contractually insulated from downstream liability.[16]

4 Comparative Analysis of AI Liability Frameworks in Agriculture

The analysis of AI Liability frameworks in agriculture is being studied across 3 jurisdictions: India, EU and USA. *A liability matrix has been proposed by the authors with respect to the legislative landscape existing.*

4.1 India: A Governance Landscape in Transition

The Indian legal response to AI-fueled agricultural loss or damage needs to be set against two concurrent facts: India is one of the most advanced adopters of AgriTech in the developing world and is one of the least equipped to govern the failures of that technology. There is no specific AI liability law. The Information Technology Act, 2000 (IT Act) is the primary law governing Information Technology in India. Limited liability for intermediaries and cyber offences is provided for in the Act. It does not include anything on AI generated harm, algorithmic negligence or AI autonomous decision-making in agricultural systems; it is based on a notice and takedown framework. It is not structurally appropriate for a situation where it is the embedded inference engine that is the source of harm, throwing a faulty irrigation schedule suggestion. The Digital Personal Data Protection Act, 2023 (DPDP Act) is India's most recent legislative intervention in the digital domain which identifies privacy-related-liabilities.[18] The working of agricultural AI requires relevant provisions concerning the processing of farmers' agronomic data like soil health records, crop histories, geospatial field data by AgriTech platforms. The DPDP Act contains the requirements and obligations related to consent and the ability of data principals to seek grievance redressal in relation to data processing. But it doesn't cover the downstream impact of

the processed data on the creation of AI models, and it doesn't provide any mechanism for assigning blame when the output of an AI model trained with the data is harmful. The AI Governance Guidelines 2025 are the country's first official guidelines on AI Governance, which are based on fundamental principles, non-binding, and focus on transparency, accountability, and human oversight. They are a significant normative message, but they are not backed by enforcement systems, nor do they create any industry-specific obligations for any developer of AgriTech, nor do they give any cause of action for affected farmers. Agricultural losses due to AI can be dealt with by the dispute redressal commission under the Consumer Protection Act, 2019, which is the most practically accessible alternative to farmers' grievances for losing agricultural crop due to AI. In principle, the definition of "deficiency in service" and "defective product" in the Act is sufficiently wide to include failures in algorithms. The important point is that a link has to be established between AI tools used and the loss suffered.[21]

4.2 European Union: The Most Advanced Regulatory Architecture

The EU has introduced the most robust framework for AI accountability worldwide. The liability falls on the developer(s)/deployer(s). The EU AI Act (2024) has a risk-based framework, which categorizes AI systems based on the risk of harm that they pose and levies proportionate requirements. [22] For agricultural AI, the Act's most consequential provision is its Annex III high-risk classification framework. AI systems used in the management of critical infrastructure, a category that the Act's recitals expressly extend to agri-food supply chains and systems that make or materially influence decisions affecting individuals' economic interests are subject to the full suite of high-risk obligations. These include mandatory conformity assessments conducted prior to market placement, comprehensive technical documentation requirements, post-market surveillance and incident reporting obligations and the maintenance of automatically generated audit logs that record system inputs, outputs, and operational parameters.

The Revised Product Liability Directive (2024) completes the EU's liability framework by closing the most significant doctrinal gap in its predecessor.[23] This new Directive, expressly defines "product" to include digital manufacturing files and software. [24]

There are two types of strict liability within the EU. In terms of the product itself, the revised Directive does not require the manufacturers to take any responsibility for the damage if the product is defective. The high-risk classification regime at the systemic level introduces a presumption of defectiveness as a consequence of non-compliance with the requirements of the AI Act both in terms of regulatory obligations and civil liability, further reducing the burden of proof for the farmer.

4.3 United States: Fragmentation as a Structural Condition

There is currently no federal AI liability law in the United States and there appears to be no legislative proposal in the near future. Its legal protection against the agricultural damage caused by AI is rather a collection of state tort laws, federal agency guidance, and industry-specific regulations, which still create ample space for

agricultural sector. Agricultural AI liability claims are still to be made under State Tort Law. The tort law approach, being applicable in agriculture sector presents many issues such as software as a service rather than product is subject of multiple jurisdictions and even were treated as product, the proof of defect in software is difficult. The last problem is multiple stakeholders being involved in the process.[26] NIST's AI Risk Management Framework (2023) is the most comprehensive federal government effort to date to address AI governance. Precision Agriculture Contracts are the most practically important governance structure affecting AI liability allocation in US agriculture, and are structured almost exclusively to the farmer's detriment. [27]

5 The AgriAI Liability Matrix

The AgriAI Liability Matrix presented below is an original analytical instrument developed to enable systematic cross-jurisdictional comparison of liability frameworks as they apply specifically to AI-induced agricultural harm. Seven dimensions are evaluated: liability trigger, applicable standard, burden of proof, available causes of action, accessible remedies, cross-border enforceability and farmer accessibility of redress. Each dimension is assessed across India, the European Union and the United States.

Table 1: The AgriAI Liability Matrix

Dimension	India	European Union	United States
Liability Trigger	Deficiency in service or defective product under Consumer Protection Act 2019; negligence under tort law; data breach under DPDP Act 2023; no AI-specific trigger.	Defective product (incl. software) under revised PLD 2024; non-compliance with EU AI Act high-risk obligations; GDPR automated decision-making breach.	Manufacturing/design defect or failure to warn under state product liability law; negligence; FTC deceptive practice; no federal AI-specific trigger.
Applicable Standard	Primarily fault-based (negligence); strict liability available under Consumer Protection Act in limited circumstances; no AI-specific standard.	Strict liability for defective products under PLD 2024; fault-based negligence for service providers; risk-based compliance obligations under AI Act.	Predominantly fault-based negligence; strict liability available in limited jurisdictions for ultrahazardous activities; no federal AI standard.

Burden of Proof	Entirely on claimant farmer; no disclosure obligation on developer; no presumption of causation; technical complexity practically prohibitive.	Partially reversed under PLD 2024: claimant establishes plausibility of defect; court may order developer disclosure; AI Act non-compliance raises presumption of defectiveness.	Entirely on claimant; no mandatory developer disclosure in most states; expert testimony required to establish design defect in AI systems; high litigation cost.
Available Causes of Action	Consumer complaint; civil tort suit; IT Act complaint; DPD grievance; no AI-specific cause of action.	Product liability claim; AI Act regulatory enforcement; GDPR Article 22 challenge to automated decision; national tort claim.	State product liability suit; negligence; FTC enforcement action; state consumer protection statute; no federal AI cause of action.
Accessible Remedies	Compensation via Consumer Commission; civil damages; injunction; limited to domestic defendants; enforcement against foreign AgriTech developers practically absent.	Compensatory damages for material and non-material loss; regulatory fines under AI Act up to €35 million or 7% of global turnover; GDPR fines; injunctive relief.	Compensatory and punitive damages; injunctive relief; class action available; mandatory arbitration clauses in AgriTech contracts routinely extinguish these rights.
Cross-Border Enforceability	Severely limited; no mutual recognition treaty with EU or US for AI judgments; jurisdictional gaps where developer is foreign-incorporated.	Strong intra-EU enforceability; Brussels I Recast Regulation governs cross-border jurisdiction; GDPR has extraterritorial reach; limited bilateral enforcement with non-EU states.	State-level fragmentation; no federal cross-border AI enforcement mechanism; limited treaty framework for agricultural AI harm; extraterritorial claims rarely succeed.

Farmer Accessibility of Redress	Very low: high evidentiary burden, technically complex litigation, absence of specialized tribunals, rural judicial infrastructure constraints, cost-prohibitive for smallholders.[29]	Moderate to high: Consumer ADR Directive provides accessible dispute resolution; national AI authorities provide regulatory complaint pathway; legal aid available in most Member States.	Low to moderate: class actions improve access for widespread harms; mandatory arbitration clauses and litigation costs restrict individual farmer claims; no specialised agricultural AI tribunal.
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The matrix above thus indicates that, at least in theory, none of the three jurisdictions today would deny a right to be compensated for harm caused by AI, under tort, product liability, or consumer protection doctrine. All three jurisdictions face the same structural problem: the multi-stakeholder agency chain that is typical of commercial AgriTech platforms splits causal attribution, which liability doctrine demands.[31]

6 Conclusion and Suggestions

In this paper, they posed a question: who, apart from the farmer, is responsible in law when an AI system fails him/her? In each of the three jurisdictions studied, the answer is, in large part: no, no and no. The comparative analysis revealed that the liability frameworks used in India, EU, and the United States are all based on the assumption of identifiable defendants and identifiable cause. Neither of these assumptions holds true for the use of AI in agriculture. The AgriAI Liability Matrix makes this apparent along seven dimensions and within each, the farmer takes the remaining loss that law does not take elsewhere. So, to solve the problem the authors propose a liability framework for AI in agriculture and also a structured road map for India.

6.1 Implementation map for India:

Given the India's position as the jurisdiction with the most acute governance gap and the largest exposed farming population, a phased implementation roadmap is proposed for India:

- 1 **Phase 1 (0–2 Years):** Issue binding AI governance guidelines for agricultural applications under existing MEITY authority, converting the 2025 voluntary guidelines into mandatory compliance obligations for commercial AgriTech platforms. Amend the Consumer Protection Act 2019 to include algorithmic harm within the definition of service deficiency.
- 2 **Phase 2 (2–4 Years):** Suggesting introduction of a dedicated AgriTech Accountability Act establishing the hybrid strict liability.

- 3 **Phase 3 (4–7 Years):** Emphasis on international engagement wherein India should engage with international organizations and other countries to establish its footing in the AgriTech sector.

Now, as far the **liability framework** is concerned, the requirement is a strict liability model for India which places accountability on the developers. Following suggestions are made:

- *A Hybrid Strict Liability and Safe Harbour Model:* A hybrid strict liability regime with a structured safe harbor, designed specifically to address the fault-attribution problem that renders existing tort-based frameworks inadequate for AI agricultural harm while preserving proportionate incentives for responsible innovation. The presumption is rebuttable, but the burden of rebuttal rests with the defendant rather than the claimant farmer.
- *Mandatory Explainability and Audit Standards:* The opacity of AI systems is not merely a technical inconvenience, it is, as this paper has argued throughout, the primary mechanism by which developer accountability is practically extinguished. A liability framework that does not directly address explainability is a framework with a structural immunity embedded at its core. This paper therefore proposes mandatory explainability and audit standards as a freestanding pillar of the model framework, enforceable independently of whether a specific harm has occurred.
- *Tiered Explainability Standards* should be defined according to the risk profile of the agricultural AI application, drawing on the risk-classification logic of the EU AI Act, while adapting the threshold criteria to agricultural contexts. Three tiers are proposed. Tier 1 covers informational tools market price forecasting, weather-based advisories, general crop calendars for which a basic explanation of the factors informing a recommendation is sufficient. Tier 2 covers decision-support tools like soil nutrient recommendations, irrigation scheduling, disease detection for which the system must provide a factor-level explanation identifying the primary variables that drove each specific output, expressed in terms accessible to a non-expert user. Tier 3 covers autonomous execution systems like automated irrigation, drone-guided pesticide application, autonomous harvesting machinery, for which full pre-deployment disclosure of model architecture, training data provenance, and performance benchmarks is required, together with a mandatory human override mechanism that cannot be contractually disabled. Independent Technical Audits should be required for all Tier 2 and Tier 3 systems prior to market placement and at defined intervals, not less than every two years, during operational deployment.

Therefore, what we need to understand is that AI will not wait for law to catch up. The task is not to halt deployment but to ensure that when the algorithm is wrong, the farmer is not the only one who pays for it.

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