

AI in Agriculture

Unlocking New Frontiers for Crop Diversification in India

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Image: Banashree Thapa / CEEW

Executive summary

Indian agriculture must evolve to meet Viksit Bharat aspirations. A shift from monocultures toward diversified cropping is essential to address import burdens, enhance nutritional security, and build climate resilience. While states like Haryana, Punjab, and Odisha have implemented per-acre direct benefit transfers (DBTs) to promote diversification away from paddy cultivation. However, scaling these efforts is hindered by two critical bottlenecks: insufficiency of incentive amounts and a lack of trust among farmers due to delays in incentive payments or poor grievance redressal, and among policymakers due to fraudulent claims and challenges in manual verification of farm-level crop shifts.

We propose the following recommendations to address these bottlenecks:

- **Financial repurposing & differentiated DBT:** States can increase incentive pools for crop diversification by converging schemes and “recycling” fiscal savings from reduced power and fertiliser subsidies. We propose a shift from uniform payments to differentiated DBT models where incentives reflect the “true transition cost” and income gaps of specific alternative crops.

- **AI Intelligence layer for Agri Stack:** We recommend integrating AI-based geospatial image-processing tools with India's foundational Agri Stack—specifically the Farmer, Farm-plot, and Crop Sown registries. By enabling remote verification of plot-level crop shifts, agricultural land classification, AI can support slower manual checks with real-time monitoring, enabling timely, stage-linked payments.
- **Phygital policy sandboxes:** Proposed AI delivery mechanisms must be stress-tested through “phygital” sandboxes. These should prioritise states with high land-record digitisation, leveraging multilingual NLP-based grievance redressal and drone-based ground-truthing to restore trust and ensure inclusivity for tenant farmers.

Ultimately, while AI streamlines delivery, sustainable diversification will need parallel investments in markets, value chains, and 360-degree transition support for farmers.

1. Agriculture sector as a catalyst for Viksit Bharat

The agriculture sector remains central to India's transformative journey towards Viksit Bharat. It contributes 18 per cent of the nation's GDP and employs 46 per cent of the country's workforce (BUR-4 2024). Between 2017 and 2023, the sector grew at an average rate of 5 per cent, marking the highest sustained growth rate since Independence (PIB 2025a). However, this progress has been accompanied by severe ecological and fiscal consequences. Agriculture currently accounts for 14 per cent of India's GHG emissions (MoEFCC 2024) and over 87 per cent of total annual groundwater extraction (CGWB 2022; Chachei 2024).

India's cropping pattern remains heavily skewed towards a few staples. Rice, wheat, and sugarcane together occupy 45–48 per cent of total agricultural area (MoAFW 2023) and absorb the majority of the annual INR 1.6 lakh crore fertiliser subsidy bill (0.5 per cent of GDP) (PIB 2025b). This concentration of crop inputs has accelerated soil degradation, which now affects 30 per cent of India's geographical area (MoEFCC 2023).

This pattern also undermines India's nutrition, health security, and farmers' livelihood security ambitions. Cereal-heavy diets are associated with 56 per cent of India's total disease burden (Shah et al. 2024). Pulse imports contributed to the INR 34,000 crore import bill in 2022–23 (Reuters 2024). At the farm level, climate change has constrained real farm income growth to 0.33 per cent



for men and 0.45 per cent for women during 2014–22 (Sneha et al. 2024). As rising temperatures and erratic rainfall intensify due to climate change, this creates livelihood risks for monoculture farmers due to lack of diversified crop alternatives.

Crop diversification emerges as a solution to address these multiple challenges simultaneously. Evidence shows that diversified cropping systems can deliver significant benefits: 24 per cent higher soil organic carbon, 118 per cent higher water-use efficiency, and up to INR 40,000 per ha higher economic returns for farmers (Mahanta et al. 2025). Thus, transforming India's production system from a monoculture-dominated system to a diversified one is not merely an agronomic choice but an opportunity to strengthen agriculture's role in advancing Viksit Bharat aspirations.

2. Green Revolution architecture hinders large-scale crop diversification measures

The policy intent towards diversification is already evident. Central initiatives, such as the Mission for Aatmanirbharta in Pulses, the National Food Security and Nutrition Mission, and the National Mission on Edible Oils – Oilseeds (NMEO–Oilseeds), alongside state-level policies, aim to shift cropping patterns to address nutrition security, *Aatmanirbharta*, and Viksit Bharat goals. However, these efforts compete with legacy public support structures rooted in the Green Revolution, which support rice–wheat monoculture and input-intensive cultivation. Fertiliser and food subsidies cumulatively cost the exchequer INR 3.7 lakh crore (Union Budget 2026), disproportionately anchoring agricultural support to specific crops and regions while crowding out resources for diversification-focused schemes.

Repurposing subsidy and procurement-based support measures towards per-acre direct benefit measures has been cited as a more effective strategy to free the agriculture system from its monoculture-driven legacies (Gulati and Thangaraj 2026). The latest national Economic Survey (2026) further validates this argument, highlighting the utility of repurposing inefficient government expenditures to enable a calibrated approach to scaling crop diversification in India (MoF 2026). States have already experimented with several price-based mechanisms, such as deficiency payments and procurement at minimum support price (MSP), and income-based mechanisms,



such as DBTs, to counter systemic biases and offer incentives that favour rice–wheat dominance. Between price-based and income-based support, evidence suggests that the latter is more effective in driving intended policy outcomes with minimal market distortions (Manikanta and Shailaja 2025; Baghla 2025). Over the past decade, several states, including Haryana, Punjab, and Odisha, have already recognised the potential of DBTs to deliver on crop diversification outcomes and have integrated them at the core of their agricultural strategies.

Thus, in this study, we aim to:

- identify the key bottlenecks in scaling DBT schemes for crop diversification in India,
- assess opportunities to address these bottlenecks via a) repurposing existing budgetary allocations towards crop diversification and b) leveraging artificial intelligence (AI) and geospatial data for scheme delivery.

3. Learnings from state-level crop diversification schemes

Haryana and Punjab – legacy Green Revolution states – together account for 25 per cent of India’s wheat production and 18 per cent of national rice output, where price support continues to reinforce monoculture (DoAFW 2026a). In contrast, Odisha illustrates an emerging MSP-driven transition, where aggressive procurement is driving a steep increase in rice cultivation (Mohanty 2026). Crop diversification schemes in these

states aim to reduce the income and market risks associated with shifting away from water-intensive crops by offering DBTs.

Table 1 summarises three such policy approaches across selected states. These state-level policies serve as case studies for understanding the challenges posed by direct incentivisation approaches.

Table 1. Existing policy initiatives for crop diversification

States	Scheme	Implementation approach	Challenges faced/Limitations
Haryana	<i>Mera Pani, Meri Virasat (DoAFW 2020)</i>	<p>Target area identification: Districts/ blocks with critically low groundwater levels are selected.</p> <p>Farmer registration: Unified portal (Meri Fasal Mera Byora) for farmer registration, beneficiary identification, and incentive delivery (DoAFW 2026b).</p> <p>Land ownership validation: Web-based Haryana Land Record Information System (Web-HALRIS) to verify land ownership (DITECH 2026).</p> <p>Crop shift monitoring: In-person validation of crop shifts and land records by block/district-level agriculture and revenue officers. Geospatial verification via the Haryana Space Applications Centre (HARSAC) (ESRI India 2025).</p>	<p>Insufficient incentives relative to profits from paddy cultivation fail to motivate farmers to shift to crop cultivation (Gupta and Mitra 2025; Singh et al. 2024; Deswal 2025).</p> <p>Incorrect beneficiary identification creates risks of DBT allocation to fraudulent claimants (Deswal 2024).</p> <p>Physical verification requirements by agriculture officers for crop shifts have led to delayed payment delivery (Jose and Ponnusamy 2023).</p> <p>Grievance redressal of technical glitches and exclusion errors is delayed.</p>

States	Scheme	Implementation approach	Challenges faced/Limitations
Odisha	<i>Mega-Lift Irrigation Project – Crop Diversification (DA&FE, 2024)</i>	<p>Target area identification: Cluster identification of suitable upland agricultural land is done by liaising with the agriculture and water department, paired with a baseline survey of the major non-paddy crops grown and cultivation inputs required within the cluster.</p> <p>Crop-specific DBT estimation: Crop-wise differentiated DBT amounts are outlined in the policy.¹</p> <p>Farmer registration: Physical form-based registration Only farmers of below 2 hectare (ha) are eligible.</p> <p>Land ownership validation: Land records are physically verified with revenue records by the agriculture officers.</p> <p>Crop shift monitoring: Physical verification by agriculture officers. 50% DBT disbursement post-sowing of alternative crops directly to the bank account 50% DBT released after harvest based on prior verification of field surveyors.</p>	<p>Manual verification process delays incentive disbursement.</p> <p>The policy reduces the incentives over a three-year period, with the expectation that farmers would have established market linkages in this period for alternative crops, but with no clear mechanism to validate this assumption and monitor long-term adoption of the alternative crops.¹</p>
Punjab	<i>Kharif Maize Pilot Project (2025) (Punjab Development Commission, n.d)</i>	<p>Target area identification: target districts selected by the agriculture department.</p> <p>Crop-specific DBT estimation: INR 17,500/ha for farmers keen to diversify to maize.</p> <p>Crop shift monitoring: Punjab Remote Sensing Centre (PRSC) utilises data from Sentinel-1 to monitor crop rotations and acreage shifts, but unsure whether they have been leveraged for this project.</p>	<p>Current incentive for switching away from paddy monoculture needs to be ~2.5 times higher in order to encourage farmers (Singh et al. 2024; Gupta and Mitra 2025).</p>

Source: Authors' compilation

These challenges noted in Table 1 point to **two key bottlenecks** (see Figure 1) that limit the success of DBT-enabled crop diversification away from legacy input-intensive crops:

- **Insufficiency of incentive:** Incentive levels continue to fall short of the difference in per-hectare incomes of farmers when shifting from highly profitable

monoculture crops, such as paddy, to the proposed alternatives, as seen in Punjab and Haryana (Singh et al. 2024; Gupta and Mitra 2025). Shifts towards cotton, bajra, maize, and other crops are reported to have varying but significant profitability gaps (INR 36,000–67,000 per ha) and require higher direct incentive amounts, calculated based on the true cost of cultivation (inputs, labour, machinery) and

¹ Different incentive amounts in the form of DBTs are offered to farmers for cultivating pulses, oilseeds, millets, cotton, maize, vegetables, and other horticultural crops. The incentive tapers off progressively over three consecutive years, by the end of which farmers are expected to have achieved improved soil health, water-use efficiency, and established market linkages.

market prices (Singh et al. 2024). However, under Haryana’s farmers Mera Pani, Meri Virasat (MPMV) scheme, farmers receive INR 7000 per acre irrespective of whether they cultivate maize, pulses, cotton, or oilseeds (DoAFW, Haryana 2020). In comparison, Odisha offers differentiated direct incentives based on crop type. However, current limitations in the ability to validate farm-level crop shifts in a timely manner pose challenges around tailoring DBT and rolling out differentiated incentives based on crops grown. For farmers, the insufficiency of incentives undermines the motivation to shift away from rice and wheat.

- Lack/Loss of trust in scheme effectiveness:** For farmers who enrol in crop diversification initiatives, persistent challenges in the incentive delivery process erode trust in the schemes. Policymakers, meanwhile, remain concerned about fraudulent claims and the limitations of manual verification mechanisms.

For farmers, key concerns include:

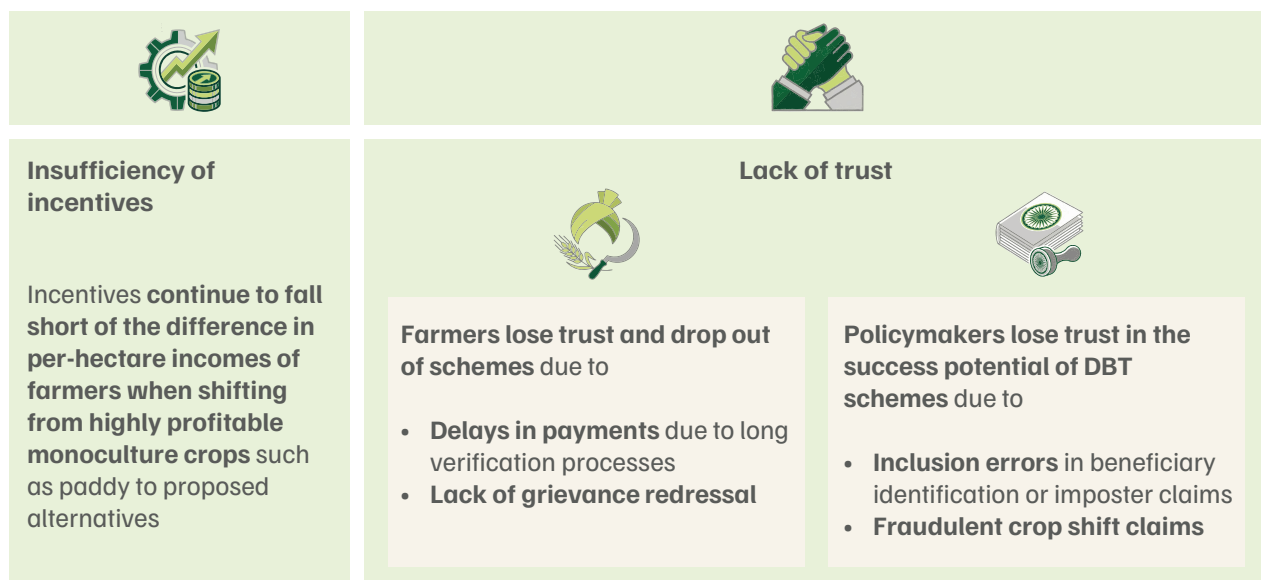
- Delays in incentive disbursements due to manual verification of crop shifts.
- Lack of effective and timely grievance redressal mechanisms in case of delays and inclusion errors.

For policymakers, key concerns include:

- Malicious actors who claim crop shifts on non-agricultural land or impersonate plot owners (often digitally challenged farmers who are unaware of the scheme’s benefits).
- Fraudulent claims by eligible farmers who have not actually initiated or achieved an actual crop shift on their plot.

The resulting loss of trust has cascading second- and third-order effects such as systemic narratives of distrust, undermining the credibility of both current or future programmes regardless of their actual merit (MSC 2022).

Figure 1. Two key bottlenecks in scaling up effective direct benefit transfer for crop diversification



Source: Authors’ synthesis based on Table 1

4. Addressing the insufficiency of incentives via differentiated DBT amounts and repurposing the expected savings

For a sector comprising of 86 per cent smallholder farmers, ensuring that crop shifts do not risk livelihood security remains the central challenge (Agricultural Census Division 2016; Apsara et al. 2025). Providing adequate incentives to attract farmer participation for crop diversification is therefore critical. However, state exchequers must identify mechanisms to front-end these transition costs while recovering them through systemic savings from crop diversification over time – such as reduced inefficiencies in rice and wheat procurement, lower water use for irrigation, and corresponding savings on power subsidies – so as to avoid budgetary deficits.

We propose that states begin by converging schemes in agriculture and allied sectors (such as water and rural development) to direct additional government support from existing schemes towards crop diversification. The Pradhan Mantri Dhan-Dhaanya Krishi Yojana (PMDDKY) exemplifies this by integrating 36 existing central schemes across 11 different ministries and departments to enable crop diversification and other development outcomes (PIB 2025c). Such convergence mechanisms can improve policy coherence and attain broader outcomes across the interconnected domains of food, land, and water.

Next, to maximise the impact of available crop diversification funds, DBTs should shift from uniform per-hectare payments to a differentiated incentive

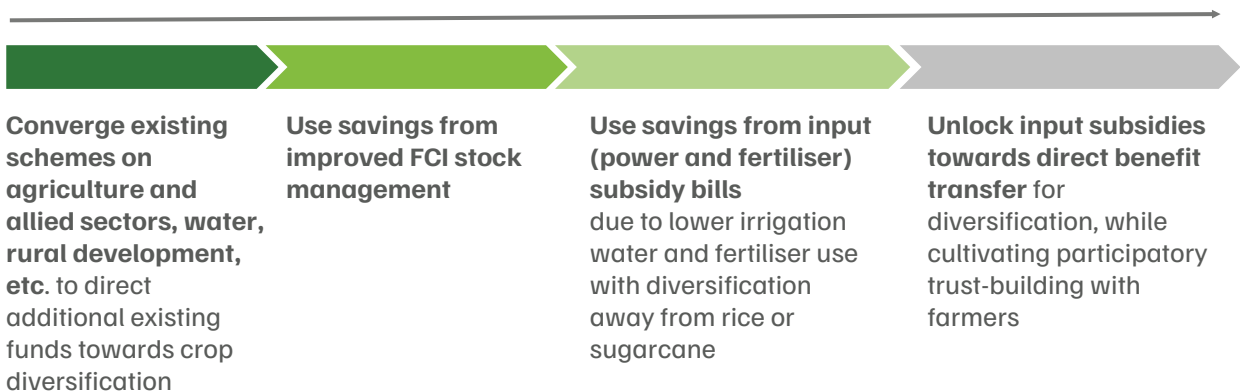
model, in which DBT values are tailored to the income differences arising from farmers' specific crop shifts. For example, when farmers shift from paddy to relatively more remunerative crops, such as moong, as shown by Singh et al. (2024) in Punjab, the incentive provided may be smaller than the average per-hectare support. These savings can be used to provide above-average incentive amounts to farmers who shift to less remunerative crops that are nevertheless critical to India's nutritional security, such as millets.

To enhance the pool of funds to incentivise crop diversification, the Economic Survey of India 2026 proposes a calibrated strategy for crop diversification (MoF 2026) that utilises fiscal savings from improved stock management by the Food Corporation of India (FCI), including reduced carrying costs, particularly from rationalising excess buffer stocks of rice. The shift towards less input-intensive crops will eventually result in savings on power and fertiliser subsidies, which can further help states recover initial expenditures.

Ultimately, strengthening trust with farmers through consultative processes and establishing a track record of effective scheme delivery can also encourage states to repurpose and replace input-linked subsidies with direct outcome-linked incentives, such as DBTs, for crop diversification. We recommend a path forward as summarised in Figure 2.

Figure 2. Unlocking funds for calibrated repurposing of existing support to agriculture

Increasing the pool of funds that can be unlocked for crop diversification through convergence of central + state schemes for agriculture




Source: Authors' analysis

5. AI-based solutions can address challenges in the delivery of direct benefit transfer

India’s Agri Stack initiative is already digitizing the foundational “who, where, and what” of farming through its federated Farmer, Farm-plot, and Crop Sown Registries (DoAFW n.d.). These registries are built in a decentralized manner, with individual states maintaining records that are updated seasonally through the Digital Crop Survey (DCS) (ibid). This process relies on smartphone-based ground surveys where physical observations are captured with mandatory geotagging and time-stamped crop photographs to ensure plot-level accuracy (ibid).

In Table 2 and Figure 3, we outline how high-resolution geospatial data and AI- or machine learning (ML)-based image-processing tools can be integrated into these foundational layers. By utilizing data from satellites, sensors, and drones, these tools can automate and support the verification of crop shifts, reducing the current reliance on manual field checks and accelerating the delivery of targeted, stage-linked Direct Benefit Transfers (DBT).

Table 2. Potential AI-enabled mechanisms to address key challenges in current schemes

Challenges	Current delivery mechanisms	Potential solutions enabled via geospatial data and AI-/ML-based tools
 <p>Identification of eligible beneficiaries</p>	<p>Land ownership data is self-declared by farmers during registration. Validation of ownership/tenancy rights remains challenging due to broken linkages in land revenue records.</p> <p>Where land records are digitised, incorrect classification of land parcels as ‘agricultural’ or ‘urban use’ leads to inclusion of ineligible applicants claiming benefits.</p> <p>Currently, verification of land and beneficiaries is done in person by revenue officers or agricultural officers, which limits transparency and leads to delays.</p>	<p>Map plot-level field boundaries with land records using high-resolution satellite data and AI-based image processing to:</p> <ul style="list-style-type: none"> • create a geo-spatial farmer-plot registry linking land parcels with beneficiaries (owners, tenants), • correct classification of land use in digitised records, and • reduce reliance on manual verification, lowering implementation costs and speeding up DBT approvals. <p>Existing use case: Google’s Agricultural Landscape Understanding (ALU) supported the modernisation of land records for the Government of Maharashtra’s Department of Land Records, reduced mismatches in ownership claims, and created a georeferenced mapping system to inform land governance. (Dua et al. 2024).</p>

Challenges	Current delivery mechanisms	Potential solutions enabled via geospatial data and AI-/ML-based tools
 <p>Monitoring whether incentives have translated to crop shifts</p>	<p>Verification of crop shifts relies on physical field checks, which is constrained by the availability of human resources. Surveyor-based field audits and geo-tagging of crop shifts have been attempted, but risk fraudulent reporting.</p> <p>Geospatial tools are used in some states, but reliance on medium-resolution satellites (Landsat-8/9 or Sentinel-1/2), limits the accuracy of correctly identifying crop-level shifts on the plot.</p>	<p>Deploy high-resolution (15–30 cm) satellite-based time-series monitoring complemented with drone-based ground truthing. Feed data into AI models for crop classification, enabling high-accuracy of crop stages identification to unlock:</p> <ul style="list-style-type: none"> • outcome-linked DBT disbursement based on observed crop growth; • early detection of non-adoption to prevent wasteful allocation of DBT. <p>Existing use case: AMNEX Infotechnologies’s Agrogate platform uses high-resolution satellite data (Planet + Landsat-8 + Sentinel-2) to deliver high-confidence identification of non-monoculture crops like pulses, oilseeds and vegetables. For the Government of Gujarat, this enabled yield estimation across nearly 2 lakh land parcels and delivered timely MSP procurement for groundnut farmers².</p>
 <p>Timely processing of incentives</p>	<p>Disbursement follows a two-tranche approach: 50% allocated post-sowing and 50% allocated post-harvest. Bureaucratic approvals are delayed by manual and field-based verification.</p>	<p>Integrate remote crop establishment verification with weather data (e.g., IMD rainfall, seasonal advisories) and sowing window to:</p> <ul style="list-style-type: none"> • allow earlier confirmation of crop presence and seasonal progression; • reduce dependence on field verification cycles. <p>Existing use-case: Google’s AMED³ detects sowing, tilling, harvesting, and crop growth stages at 15-day intervals.</p>
 <p>Grievance redressal mechanisms</p>	<p>Manual mechanisms must contend with high volumes of unclassified claims awaiting redressal.</p>	<p>Integrate Natural Language Processing (NLP) models to:</p> <ul style="list-style-type: none"> • sort grievances by issue types • prioritise urgent or high-impact cases • resolve routine queries through AI-assisted agents • tag complex or disputes cases to ground-level officers • enable querying of geospatial crop and beneficiary records to fast-track resolution by grievance officers. <p>Existing use case: Wadhvani AI’s Kisan-eMitra chatbot for PM-KISAN has resolved over 5 million grievances across 28+ states and union territories, providing multilingual AI support and reducing the burden of manual query resolution. (PIB, 2025d).</p>

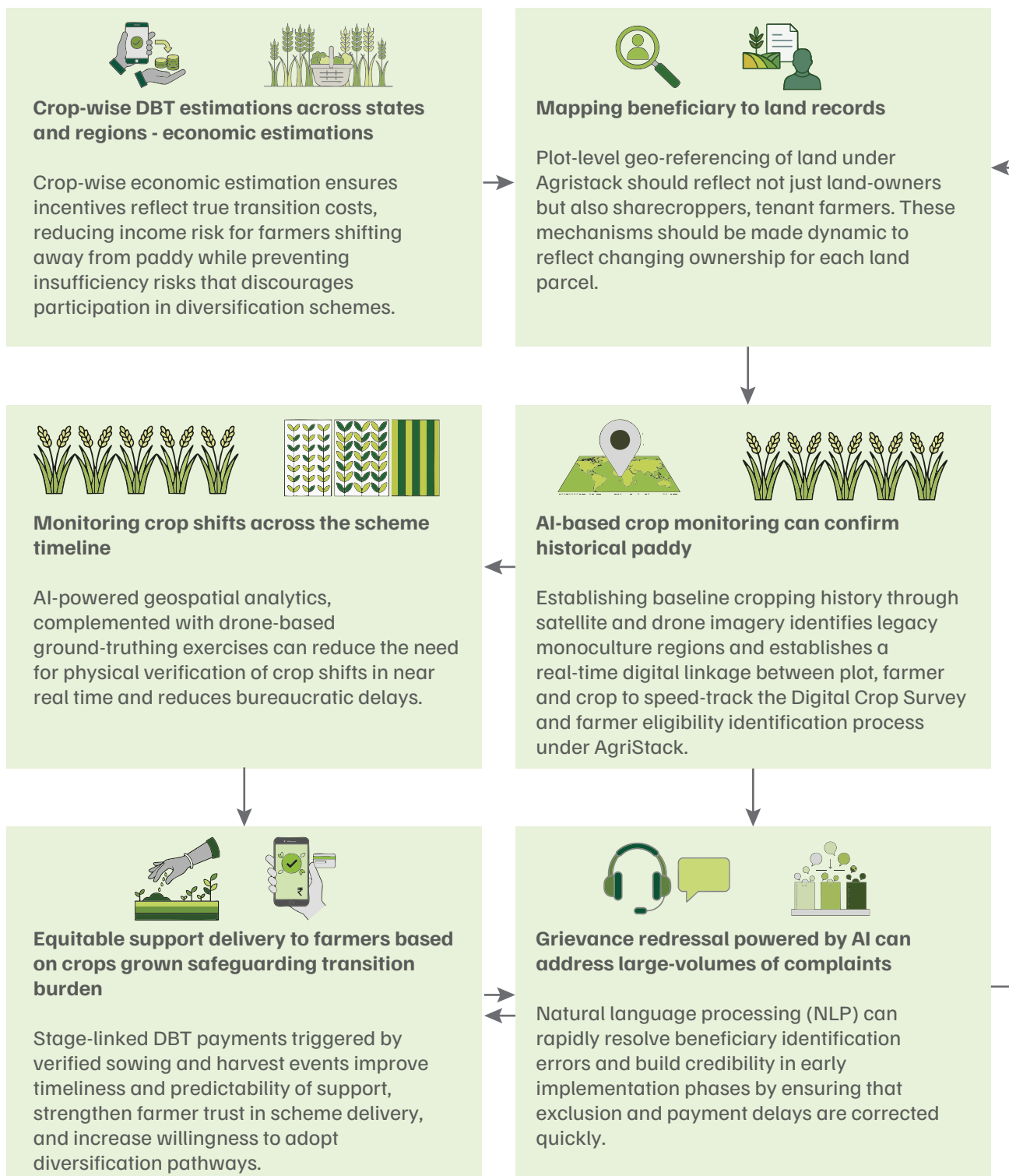
Source: Authors’ analysis

Note: IMD - Indian Meteorological Department

2. Stakeholder consultations.

3. The AMED API builds on ALU, providing historical and current in-season crop monitoring at 10m resolution, using Sentinel-1 and Sentinel-2 satellites.

Figure 3. Proposed changes in the incentive design and delivery mechanisms



Source: Authors' analysis

6. Risks will need to be identified, monitored, and mitigated

The proposed AI-enabled incentivisation mechanism will need systematic identification, monitoring, and

mitigation of associated risks. We outline these in Table 3.

Table 3. Potential risks and mitigation measures

Theme	Risk	Emerging opportunities and mitigation measures
Effectiveness of solely relying on DBT-based incentivisation for diversification	Direct incentivisation alone yields limited success in stimulating diversification, in the absence of upstream support (input availability, access to credit, insurance, etc.), on-farm advisory on pest management, best practices, etc., and downstream linkages such as access to markets/procurement, storage, processing, or value-chain support for diverse crops.	<p>Crop diversification policies must adopt a 360-degree approach to ensure transition support throughout the value chain for diverse crops.</p> <p>AI-enabled innovations can enable/support this 360-degree approach. For example, large language models (LLMs) that interact in regional languages and dialects can provide advisories on new cultivation practices required for diversification. The recently announced Bharat-VISTAAR (Virtually Integrated System to Access Agricultural Resources) tool in the recent Budget offers this opportunity (Union Budget 2026).</p>
Choice of alternative crops to be incentivised	Currently, some states have designed crop diversification schemes to primarily address groundwater depletion challenges (e.g. Punjab, Haryana) without a strategic framework that also considers competing policies, agroecological crop suitability and impact on outcomes – such as the national import burden for edible oils and pulses, trade-offs between nutrition and fuel security, and implications for feed and fibre demand. For example, maize cultivation has been spurred by the biofuel policy and may compete with pulses, oilseeds, millets, soybeans, and cotton - potentially leading to food security risks and threatening nutritional deficiency (MoF 2026).	State policies must generate options of alternative crops to incentivise, based on a scientific and participatory approach for crop suitability analysis that considers farmers preferences along with multiple regional and national goals, and expand beyond groundwater conservation alone.

Theme	Risk	Emerging opportunities and mitigation measures
Bias in inclusion or skew in better accuracy in geospatial identification towards larger landholding sizes, monoculture regions/crops	<p>Due to India's smallholder farm sizes, diverse terrain, and agroclimatic conditions, farms may be misclassified as non-agricultural land, resulting in higher error rates in crop identification.</p> <p>Similarly, crops grown in intercropping, multi-cropping, agroforestry, and silvipastoral systems may not be identifiable by current AI models. Skewed incentives for only identifiable crops may further entrench monoculture practices (Cieslik, 2025).</p>	<p>Agri-tech players must invest in extensive model training and ground-truthing of results using diverse datasets across agro-climatic zones, cropping patterns, and landholding conditions.</p> <p>State departments must retain in-person verification of crop shifts for farms where alternate crops are grown in intercropping, multi-cropping, agroforestry, and silvipastoral systems, and invest in research and development (R&D) for developing algorithms to geospatially identify them</p> <p>Create phygital sandboxes to test for systemic exclusion/inclusion errors.</p>
Benefit disbursement based on Aadhaar linkage with bank accounts; exclusion of tenant farmers without formal leases	<p>A large proportion of tenant farmers in India hold informal leases with landowners that may not be digitised and linked to land records.</p> <p>Aadhaar penetration across India stands at 95%, with states such as Bihar (89%), Jharkhand (90%), Odisha (96%), and Nagaland (63%) faring below the national average (UIDAI, 2025).</p> <p>Although women constitute 64% of the agricultural workforce, 46% don't have a personal mobile phone, and only 22% of those with mobile phones use them for financial transactions (NFHS 2019–21).</p>	<p>Adopt a phased implementation approach, starting with regions with high Aadhaar coverage and a high ratio of personal mobile phone connections among women and marginal farmers. Expand digital and Aadhaar coverage before scaling to other regions.</p> <p>Incorporate mechanisms to identify tenant farmers/sharecroppers, learning from schemes such as the Krushak Assistance for Livelihood and Income Augmentation (KALIA) in Odisha (DaFE 2023).</p>
Enhancing the speed of delivery by automating beneficiary identification	<p>Reliance on AI models may lead to a lack of accountability in the proper inclusion or exclusion of eligible farmers.</p>	<p>Retain manual oversight, enable overrides, and have legally mandated 'guardrails' within which models operate (for sensitive decisions).</p> <p>Use open licensing for core algorithms, such as beneficiary identification, to enable external audits and accountability.</p> <p>Create DBT-specific frameworks through participatory methods.(Sanyal et al. 2024)</p>



Source: Authors' analysis

7. The way forward

To realise the proposed transformation in scheme delivery mechanisms highlighted in the above sections while addressing potential risks and building trust

among farmers and policymakers to scale up crop diversification, we suggest the following steps, as outlined in Table 4.

Table 4. Recommendations

Theme	Activities
 <p data-bbox="172 748 400 808">Build trust through sandboxes</p>	<p data-bbox="440 613 1406 703">The proposed AI-enabled delivery of DBT schemes will need stress testing via phygital policy sandboxes with participation from multiple departments (agriculture, land records, revenue, finance, etc.).</p> <ul data-bbox="440 725 1423 1122" style="list-style-type: none"> • States that have high levels of digitised land records and high digital access among farmers can be prioritised for such sandboxes. For selected states, AgriStack must be expanded beyond recorded landowners to include verified sharecroppers and tenant cultivators, drawing from Odisha’s KALIA model. • State geospatial departments should partner with leading academic institutions and private-sector technology providers to incorporate high-level geospatial visualisation to existing Digital Crop Surveys (DCS) for diversification-linked DBTs. • NITI Aayog or an independent oversight body should conduct an evaluation and reporting framework for sandbox states to validate their effectiveness in driving crop shifts, reducing leakages in transfers, identifying and excluding false claims, improving farmers’ enrolment, and documenting implementation lessons before national scale-up.
 <p data-bbox="172 1301 411 1397">Reimagine the role of human resources in scheme delivery</p>	<p data-bbox="440 1158 1414 1247">With the proposed AI and digitally-enabled scheme delivery, governments will need to reimagine the role of human resources across departments (which are generally short-staffed) to make them more effective. This shift should start with:</p> <ul data-bbox="440 1270 1423 1800" style="list-style-type: none"> • Embedding multilingual NLP-based grievance systems within digital farmer portals to automate grievance sorting and accelerate resolution. However, they must retain human oversight, verification, and grievance redressal by the agriculture and revenue departments for complex cases. • Formally integrating the Namo Drone Didi scheme to support extension agents in periodically ground-truthing and verifying data collected via the Digital Crop Surveys and the proposed AI-enabled remote crop monitoring mechanism. • Leveraging National Institute of Agricultural Extension Management (MANAGE), Krishi Vigyan Kendras (KVKs), and Revenue Departments to jointly lead national capacity-building programmes to transition extension agents from manual inspection roles to digitally enabled verification, farmer facilitation, and dispute resolution. • Reallocating the time unlocked for field-level functionaries (by incorporating remote farm and crop verification activities) toward trust- and capacity-building outreach/demonstrations for alternative crop cultivation and effective grievance redressal.

Theme	Activities
 <p>Invest in innovation and championship for effective incentive delivery</p>	<p>To keep learning and evolving programmes, governments will need to invest in scientific research and development and cultivate state champions.</p> <ul style="list-style-type: none"> • MoAFW should constitute a national technical consortium led by Mahalanobis National Crop Forecast Centre (MNCFC) to develop district- and block-level agroecologically suitable crop maps for diversification by integrating climate and biophysical parameters. • State governments should establish multi-stakeholder committees, including actors such as the National Institute of Agricultural Economics and Policy Research (NIAP), the Indian Council of Agricultural Research (ICARs), State Agriculture Universities (SAUs), local civil society organisations (CSOs), and farmer representatives, to consultatively estimate the true cost of diversification and thus DBT amounts for selected crops within their diversification schemes. • MeitY and DST should create a dedicated agri-AI innovation window within existing schemes (e.g., IndiaAI Mission, Atal Innovation Mission) and fund academic institutions/ incubate startups developing the capability to detect challenging interventions such as intercropping and multi-cropping. • NITI Aayog should establish a national performance and learning platform for diversification-linked DBTs, enabling states to report progress, benchmark implementation quality, and compete on innovation in incentive delivery.

Source: Authors' analysis

8. Conclusion

A calibrated crop diversification approach will require sufficient and effective incentive delivery to build trust and raise adoption of schemes among farmers. State and Central governments must strategically leverage and strengthen India's digital public infrastructure with AI-powered tools to deliver targeted, timely, accurate, and leakage-proof incentives. This whitepaper outlines a reform pathway that aligns fiscal efficiency with farmer confidence, ensuring that diversification-linked

investments translate into measurable crop shifts. Yet, digital delivery is only one pillar. Sustainable diversification will remain incomplete without parallel investments in markets, value chains, procurement reform, and agronomic support to enable a full 360-degree transition support for farmers. Our proposed phygital policy sandboxes should be the first step in testing these ideas.

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