

Crop Insurance in the Era of Climate Change

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INTRODUCTION

Agriculture is one of the most climate-sensitive sectors of the economy. Farmers depend heavily on favorable weather conditions for successful crop production. However, climate change has increased the frequency and intensity of extreme weather events such as droughts, floods, heat waves, cyclones, hailstorms, and unseasonal rainfall. These climatic uncertainties cause severe crop losses, reduce farm income, and threaten food security.

India is particularly vulnerable because nearly half of its cultivated area is rainfed and highly dependent on monsoon rainfall. Small and marginal farmers, who constitute the majority of the farming population, possess limited financial resources to cope with crop failures. Crop insurance has therefore become a vital component of climate-resilient agriculture. It provides financial protection against unforeseen losses and encourages farmers to continue agricultural production despite increasing climatic risks. With advances in technology, crop insurance systems are becoming more accurate, transparent, and efficient through the use of satellite imagery, drones, remote sensing, and artificial intelligence (AI), Geographic Information Systems (GIS), and weather forecasting. These innovations are transforming crop insurance into an effective climate adaptation strategy.



Source: <https://www.ewg.org/research/>

2. Concept of Crop Insurance

Crop insurance is a financial risk management mechanism designed to compensate farmers for losses resulting from natural disasters, adverse weather conditions, pest infestations, diseases, and other uncontrollable events affecting crop production.

The principle of crop insurance is based on risk sharing, where farmers pay a small premium and receive compensation when insured losses occur. It transfers agricultural production risk from individual farmers to insurance companies, supported by government subsidies and reinsurance mechanisms.

Crop insurance not only protects farm income but also contributes to agricultural sustainability by reducing economic uncertainty associated with climate variability.

3. Need for Crop Insurance in the Era of Climate Change

Climate change has significantly increased the vulnerability of agriculture by causing frequent droughts, floods, cyclones, heat waves, cold waves, hailstorms, and cloudbursts. These extreme weather events damage crops, reduce yields, and create financial uncertainty for farmers. Irregular rainfall patterns, including delayed monsoons, prolonged dry spells, and excessive rainfall, further disrupt sowing, crop growth, and harvesting. Rising temperatures shorten crop growth duration, increase water demand, and lower productivity, while changing climatic conditions promote the spread of pests, diseases, and invasive species, leading to additional crop losses. As a result, farmers experience unstable incomes, increased indebtedness, and reduced capacity to invest in quality seeds, fertilizers, and improved technologies. Crop insurance provides a financial safety net by compensating farmers for climate-induced losses, enabling them to recover quickly and continue agricultural production. It also encourages the adoption of climate-smart farming practices, improves access to institutional credit, strengthens rural livelihoods, and supports national food security

by ensuring stable agricultural production despite increasing climate-related risks.

4. Objectives of Crop Insurance

The major objectives include:

- Protect farmers against crop losses.
- Stabilize farm income.
- Encourage adoption of modern technologies.
- Improve access to institutional credit.
- Reduce dependence on disaster relief.
- Promote investment in agriculture.
- Enhance resilience to climate change.
- Improve livelihood security.
- Support sustainable agricultural development.

5. Types of Crop Insurance

5.1 Yield-Based Crop Insurance

Yield-based crop insurance compensates farmers when the actual crop yield falls below the historical average yield of a defined area due to natural calamities, pests, or diseases. It provides direct financial support for production losses and covers multiple agricultural risks. However, it requires extensive crop-cutting experiments for yield assessment, making claim settlement time-consuming and increasing administrative and operational costs.

5.2 Weather Index Insurance

Weather index insurance compensates farmers based on predefined weather parameters such as rainfall, temperature, humidity, or wind speed rather than actual crop losses. It enables quick claim settlement, reduces operational costs, ensures objective assessment, and minimizes disputes. However, its major limitation is basis risk, where weather data may not accurately reflect the actual crop damage experienced by farmers.

5.3 Area Yield Insurance

Area yield insurance provides compensation based on the average crop yield of a defined geographical unit rather than individual farm losses. The insurance unit may be a district, block, village, or Gram Panchayat. If the area's

average yield falls below a predetermined threshold due to natural calamities, all insured farmers in that area become eligible for compensation.

5.4 Revenue Insurance

Revenue insurance protects farmers against losses resulting from both reduced crop production and declining market prices. Compensation is provided when the actual farm revenue falls below a guaranteed income level due to adverse weather, natural disasters, or price fluctuations. This insurance offers comprehensive financial security by safeguarding both yield and income, thereby

reducing economic risks and promoting stable farm livelihoods.

5.5 Parametric Insurance

Parametric insurance provides compensation based on predefined climate thresholds rather than actual crop losses. Payments are automatically triggered when specific weather conditions, such as rainfall below 50 mm, temperature above 42°C, or wind speed exceeding prescribed limits, are recorded. This approach enables faster claim settlement, greater transparency, and reduced administrative costs, making it an effective climate risk management tool.



6. Importance of Crop Insurance under Climate Change

Crop insurance plays a vital role in protecting farmers from the increasing risks posed by climate change. It provides financial protection by compensating for crop losses caused by natural disasters and adverse weather conditions. Insurance helps maintain income stability, reducing fluctuations in farmers' earnings and encouraging continued agricultural production. It promotes investment

in quality seeds, fertilizers, irrigation, and modern farm machinery by reducing financial uncertainty. Insured farmers also gain better access to institutional credit, as banks consider them less risky borrowers. Furthermore, crop insurance supports climate adaptation, reduces rural poverty, prevents distress sales of assets, strengthens agricultural resilience, and contributes to sustainable rural development and food security.

7. Climate Risks Covered under Crop Insurance

Modern crop insurance covers a wide range of climate-related risks that threaten agricultural production. These include drought, floods, cyclones, heavy rainfall, dry spells, hailstorms, lightning, landslides, pest attacks, disease outbreaks, fire (under some schemes), and localized natural calamities. By providing compensation for such losses, crop insurance reduces farmers' financial risks and enhances resilience against climate-induced agricultural disasters.

8. Technological Innovations in Crop Insurance

Technological innovations are transforming crop insurance by making it faster, more accurate, and transparent.

- Remote sensing uses satellite imagery to monitor crop health, estimate yield, and assess production losses over large areas.
- Drones provide rapid field-level surveys after natural disasters, enabling quicker damage assessment and claim settlement.
- Artificial Intelligence (AI) analyzes weather forecasts, satellite images, historical yield records, and climate data to estimate risks and improve insurance decisions.
- Geographic Information System (GIS) maps climate-vulnerable regions and supports efficient planning of insurance coverage.
- The Internet of Things (IoT) employs field sensors to monitor soil moisture, rainfall, temperature, and humidity, providing real-time data for accurate loss assessment.
- Mobile applications allow farmers to register policies, report crop damage, track claim status, and receive digital payments.
- Big Data Analytics integrates weather, soil, crop, and historical information to

improve premium calculation, risk prediction, fraud detection, and overall efficiency of climate-smart crop insurance systems.

9. Crop Insurance and Climate-Resilient Agriculture

Crop insurance complements several climate adaptation strategies:

- Climate-smart agriculture
- Conservation agriculture
- Precision farming
- Integrated farming systems
- Water conservation
- Crop diversification
- Drought-resistant varieties
- Early warning systems
- Weather forecasting
- Sustainable land management

10. Crop Insurance in India

India has implemented several crop insurance schemes over time.

National Agricultural Insurance Scheme (NAIS)

The National Agricultural Insurance Scheme (NAIS) was introduced by the Government of India to protect farmers against crop losses caused by natural calamities, pests, and diseases. It provides financial compensation when crop yields fall below the threshold level, helping stabilize farm income, encourage agricultural investment, and reduce farmers' vulnerability to production risks.

Modified National Agricultural Insurance Scheme (MNAIS)

The Modified National Agricultural Insurance Scheme (MNAIS) was introduced to improve the effectiveness of crop insurance by reducing the insurance unit size to village level, enabling more accurate loss assessment. It also ensured faster claim settlement, covered prevented sowing and post-harvest losses, and encouraged wider farmer participation through better risk coverage.

Weather-Based Crop Insurance Scheme (WBCIS)

The Weather-Based Crop Insurance Scheme (WBCIS) compensates farmers based on predefined weather parameters such as rainfall, temperature, humidity, and wind speed instead of actual crop yield assessment. It enables faster claim settlement, minimizes disputes, lowers administrative costs, and provides timely financial support to farmers affected by adverse weather conditions.

Pradhan Mantri Fasal Bima Yojana (PMFBY)

The Pradhan Mantri Fasal Bima Yojana (PMFBY), launched in 2016, is India's flagship crop insurance scheme that provides comprehensive coverage against crop losses due to natural calamities, pests, and diseases. It offers low farmer premiums, government-supported subsidies, technology-based claim assessment, and timely compensation, enhancing farmers' financial security and agricultural resilience.

Major Features

- Low farmer premium
- Comprehensive risk coverage
- Government premium subsidy
- Use of smartphones
- GPS technology
- Remote sensing
- Satellite monitoring
- Faster claim settlement
- Coverage from sowing to post-harvest losses

11. Challenges of Crop Insurance under Climate Change

Despite its growing importance, crop insurance faces several challenges under climate change. Low farmer awareness limits participation, while delayed claim settlement reduces farmers' trust in insurance schemes. Basis risk in weather index insurance may result in compensation that does not reflect actual crop losses. Increasing climate variability has also led to higher insurance premiums, making coverage less affordable. Limited coverage of certain crops and regions restricts the scheme's

effectiveness. Data limitations, including inadequate weather stations, affect accurate loss assessment. Additionally, small and fragmented landholdings, moral hazard, and adverse selection complicate risk management and insurance implementation.

12. Strategies to Improve Crop Insurance

Several measures can strengthen crop insurance systems:

- Expand automatic weather station networks.
- Increase farmer awareness through extension services.
- Use satellite and drone technology.
- Promote digital insurance platforms.
- Improve weather forecasting.
- Integrate AI and machine learning.
- Reduce claim settlement time.
- Enhance transparency.
- Encourage public-private partnerships.
- Develop customized insurance products.
- Link insurance with climate advisory services.
- Improve premium subsidies for vulnerable farmers.

13. Future Prospects

Future crop insurance will become increasingly technology-driven.

Emerging developments include:

- Artificial Intelligence-based loss estimation
- Blockchain-enabled transparent insurance
- Real-time satellite monitoring
- Hyperlocal weather forecasting
- Smart contracts
- Mobile-based instant claim processing
- Climate risk modeling
- Personalized insurance products
- Integration with precision agriculture
- Carbon farming insurance
- Ecosystem-based risk management

CONCLUSION

Crop insurance has become an indispensable component of climate-resilient agriculture in the face of increasing climate variability and extreme weather events. It safeguards farmers against financial losses, stabilizes farm income, promotes investment in improved technologies, and enhances food security. Technological advancements such as remote sensing, drones, artificial intelligence, GIS, IoT, and digital platforms are making crop insurance more accurate, transparent, and efficient. However, challenges such as delayed claim settlement, basis risk, inadequate awareness, and limited infrastructure must be addressed through policy reforms, technological innovation, and stronger institutional support. A well-designed and inclusive crop insurance system, integrated with climate-smart agricultural practices and effective extension services, can significantly strengthen the resilience of farming communities and contribute to sustainable agricultural development in the era of climate change.

REFERENCES

- Diffenbaugh, N. S., Davenport, F. V., & Burke, M. (2021). Historical warming has increased US crop insurance losses. *Environmental Research Letters*, 16(8), 084025.
- Falco, S. D., Adinolfi, F., Bozzola, M., & Capitanio, F. (2014). Crop insurance as a strategy for adapting to climate change. *Journal of Agricultural Economics*, 65(2), 485-504.
- Marzen, C. G., & Ballard, J. G. (2016). Climate change and federal crop insurance. *BC Env'tl. Aff. L. Rev.*, 43, 387.
- Schuurman, D., & Ker, A. (2025). Heterogeneity, climate change, and crop yield distributions: Solvency implications for publicly subsidized crop insurance programs. *American Journal of Agricultural Economics*, 107(1), 248-268.
- Sinnarong, N., Kuson, S., Nunthasen, W., Puphoung, S., & Souvannasouk, V. (2022). The potential risks of climate change and weather index insurance scheme for Thailand's economic crop production. *Environmental Challenges*, 8, 100575.