Resilience in the Face of Agricultural Adversity

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2025 Virginia Governor's School for Agriculture, Virginia Tech

Abstract

Due to climate unpredictability and market imbalance, crop and animal resilience is an important concern in farming communities globally. Exposure to environmental stresses in the form of rising temperatures, flooding, droughts, and market instability is occurring in greater intensity and frequency for farmers. These stresses jeopardize food access and availability as well as the livelihoods of both small stakeholders and commercial farmers. As risks intensify, it is essential to develop and implement responsive practices. This paper outlines three major approaches through which farmers can reduce these risks and gain long-term stability: insurance-oriented instruments, institutional and financial support systems, and conservation farming practices. We explore how each of these strategies functions in practice, using examples from around the world. Weather index insurance and satellite-activated technologies, which help farmers minimize losses and invest in their farms with greater confidence, are evaluated as components of building agricultural resilience. Broader policy and finance-driven measures, e.g., government relief packages, access to credit, and risk pooling mechanisms like contracts and diversification of enterprise, are also examined. This includes recent United States legislation pertaining to agricultural policy. Lastly, we identify conservation agriculture and agroecology strategies such as farmers' decisions regarding tillage systems, crop rotation, and silvopasture (deliberate integration of trees and grazing livestock operations on the same land). This last group of strategies builds soil resilience and greater crop stability in extreme weather events. Instead of treating these tools in isolation, we argue that their integration through supportive policy, education, and infrastructure is essential for sustainable agricultural productivity.

Acknowledgements

We would like to thank the faculty and staff of the Virginia Governor's School for Agriculture at Virginia Tech for their guidance and support throughout this research project. Special thanks to our Global Seminar Leaders for their mentorship and encouragement, and to the educators who reviewed our work and provided thoughtful feedback during the revision process. We also appreciate the support of our families and schools for making this experience possible.

Introduction and Problem Statement

With the intensification of climate change and the increased frequency of environmental and economic shocks that are tied to it, risk management strategies have become essential to building the resilience of agricultural systems. Not only are the number of environmental shocks increasing, but the severity of each disaster is climbing as well. Rising temperatures and events associated with climate change are expected to lower agricultural yield and disproportionately

impact various regions. Furthermore, environmental effects such as droughts, floods, and animal pests worsen pre-existing economic strains (Altieri et al., 2015). On top of this, the global demand for food is rising, resulting in a need to either expand farmland, which can cause more stress on the environment, or increase crop productivity of the farmland in use (Elferink and Schierhorn, 2016). Instability stemming from environmental and economic shocks highlights the need for strategies to help build resilience for farmers. According to the Organisation for Economic Co-operation and Development, resilience is marked by the ability to absorb shock, recover from it, and adjust to the changes it causes (OECD, n.d.). This paper seeks to compile the most promising strategies for risk management. Sustainable Development Goal (SDG) 13: Climate Action, which aims to take urgent steps to combat climate change and its impacts, is aligned with agricultural resilience because farmers can implement risk management strategies to mitigate the effects of climate change. SDG 9 supports resilient infrastructure and innovation to support recovery from environmental and economic shocks. The information in this paper can also aid the Agriculture and Food Research Initiative in two priority areas of the Farm Bill, Agriculture Systems and Technology and Agriculture Economics and Rural Communities.

Methods

U.S. legislation, scientific studies, case studies with examples from several countries, and other literature reviews were used to investigate resilience strategies. Studies were utilized from a multitude of journal variations such as scientific and economic journals, as well as journals that specifically pinpointed the area of agroeconomics.

Strategies were divided into three main areas: insurance, financial and institutional planning, and on-farm practices. Insurance refers to financial policies that provide economic protection in the case of disaster and can be provided both privately and federally. The financial planning area focuses on strategies such as budgeting, contracts, savings practices, and government policies. The section discussing on-farm practices includes conservational farming methods and connects the dots between these tangible actions and the previous strategies to show the magnified impact they can have when utilized together. Examples and comparisons of successful utilization of these strategies are included to show progress and future growth areas of risk management in agriculture.

Background

Insurance-Based Strategies for Agricultural Risk Management

Insurance is a vital protection service that can aid in ensuring economic security in case of financial or environmental shock. There are several types of insurance that farmers can purchase for their land. Depending on the type, insurance provides various benefits, such as security from natural disasters and mitigating the financial impact of reduced crop yields. Since certain environments, locations, and types of farms will need to utilize disparate types of insurance, it is helpful that there is so much variety.

Index-Based Insurance as Climate Risk Buffering Tool

Weather Index Insurance (WII) is a type of farm insurance that insures against a particular weather component, such as rainfall, temperature, or vegetation cover, rather than a farmer's actual losses. Automatic payments are made to farmers once the weather index crosses a specific threshold. It is quicker, clearer, and less expensive than ordinary insurance; hence, this option flourishes, particularly in low-populated or poor farming areas.

Researchers in northern Ghana discovered that seed-only WII was a cheap and effective insurance product that insured first-stage crop production. This type of insurance safeguarded farmers against revenue lost in case of a climate shock because it protected "the first and most fragile part of production" (Adelesi et al., 2024, p. 7). Seed-only protection, which covers the most vulnerable phase of the cropping season, lowers the risk of total crop failure and the need for replanting, helping farmers avoid reliance on alternative income sources. Its affordability makes seed-only protection more economical and thus accessible to smallholder farmers, who are then more likely to purchase it.

Insurance as a Driver of Agricultural Investment

WII encourages farmers to put more resources into their farming activities. If farmers feel that their weather-related loss is insured, then aggressive high-yield practices can be practiced. In Kenya, for instance, this engagement in WII resulted in more use of fertilizer and improved seed use. District reports conclude that WII allows farmers to adopt input-intensive practices, easing farmers' fears of taking a financial hit due to unpredictable weather (Muleke et al., 2025, p. 9). WII effects become more prominent when accompanied by farmer training with the help of extension services. Analysis confirms that providing insurance and training to farmers leads to greater trust and adoption, ultimately contributing to more resilient agricultural practices (Muleke et al., 2025, p. 9).

Satellite-Driven Insurance and Technological Innovation

Enhanced accuracy and uniformity of WII has been achieved recently due to advances in satellites. Satellite data, including rainfall anomalies and vegetation indices, enable insurers to view environmental conditions at a large scale on a real-time basis. This data minimizes basis risk, where a farmer experiences losses without insurance coverage, as the index fails to activate. A global study admits that these technologies have "improved the accuracy and cost-effectiveness of insurance products" (Nguyen et al., 2025, p. 915).

Such projects as Ethiopia and Kenya's Index-Based Livestock Insurance (IBLI) demonstrate how satellite information can aid crop and animal insurance. While these benefits are significant, the efficiency of satellite-based WII may still be constrained by a mix of factors such as uneven distribution of resources across the land, challenges in fine-tuning performance indicators, and insufficient data on how the system is functioning (Nguyen et al., 2025, p. 920). Such factors call for a persistent need to invest in infrastructure and training to render satellite-based WII equitable and predictable.

As an origin-based product, WII is an effective and scalable solution to agriculture risk management. It can potentially deliver early financial protection against climate shock, promote productivity investment, and scale up further with satellite technology adoption. If well-informed and well-communicated, WII serves as a shock cushion and stepping stone to longer-term resilience for farm households that are increasingly exposed to climate and other environment-based shocks.

Financial, Institutional, and Government-Based Strategies

There are many different ways farmers can manage risk: through polycultures, keeping different types of crops or livestock on the same land; using future contracts; or creating a strong financial emergency action plan (EAP). Having a financial framework can even prevent the use of an EAP; according to a systematic review in *Financial Management in the Agribusiness Sector and the Implications for Economic Growth,* the best financial frameworks consist of an established budget, robust monitoring systems, and mechanisms to track financial performance against the budget (Idris, 2024). Additionally, economic policies and funding allocation help protect farmers when markets are unpredictable.

Institutional Practices

Institutional practices like polyculture and future contracts are extremely beneficial to a farmer and their business, because they stop them from going “all in”. This is known as Diversification, a strategy that, while having some underlying risk, has been proven to be beneficial to farms. Polyculture helps protect against soil degradation and increasing threats of pests, fungi, and harmful bacteria more than monoculture (Adamczewska-Sowińska & Sowiński, 2020). Also,the practice of polyculture has been around for thousands of years, just as the Iroquois have used the Three Sister method when planting their crops. Polyculture can help build agricultural resilience by slowing the weakening of farmland over a period of time. Future contracts help transfer risk to other parties involved in agribusiness (Ratnam & Thakur, 2024). By utilizing future contracts, farmers can use a risk assessment to see where they want to invest their resources without as much stress. This practice will also strengthen the agribusiness by giving the owner time to allocate resources where it's most needed depending on their business.

Government Policies

Another strategic way to build agricultural resilience is through researching government policy. Government policies can influence agribusiness and allow farmers to assess risks more thoroughly. For example, the One Big Beautiful Bill Act, passed July 2025, includes an increase in agricultural disaster aid (One Big Beautiful Bill, 2025). It also includes provisions to increase accessibility and coverage of crop insurance, which farmers can use to protect their income in case of a shortage, price change, or other economic jolt. These resources give farmers more flexibility in choosing locations of their business, and provides security of agriculture in areas vulnerable to natural disasters.

The American Relief Act, 2025 (2024) is another bill offering assistance after catastrophic events, providing $30,780,000,000 in agricultural aid in response to losses caused by disasters. Up to $2,000,000,000 was allotted for responding to losses in the livestock industry caused by droughts, wildfires, and floods within the years 2023-2024. With these funds for emergencies, farmers are able to utilize the money to act quickly in the event of environmental damage to farmland, thus demonstrating the benefits of understanding government policy for resilient business management.

In the United States, the USDA is responsible for risk management in agriculture, providing insurance, disaster aid, and emergency loans (OECD/FAO, 2021). The Farm Service Agency, which is under the USDA, provides Agriculture Risk Coverage and Price Loss Coverage to protect farmers from loss of revenue, including from changes in crop prices (USDA Farm Service Agency, 2025). Providing this insurance through the government means it is more widely available, and having government support is beneficial for supporting the agriculture industry.

Government policies like these offer protection and aid in the case of agricultural adversity. Farmers must be aware of such government policies so they can take advantage of them to safeguard their farms.

Financial Framework

A framework is a blueprint that a business owner can make in order to stay organized. To build agricultural resilience against unexpected events such as economic shock, having a financial framework in place is necessary. Because one of the major risks in agriculture is market volatility, having an extensive budget plan is important for a strong financial framework. Additionally, maintaining financial records and keeping good cash flow management are needed. A financial framework is imperative to all businesses, but because of the many risks within agribusinesses, proper management of finances can effectively resist financial shocks with secure stability during times of economic uncertainty. A study conducted in Tanzania showed there was a positive correlation between implementing financial management practices (FMPs) and the growth of agro-enterprises (Mang'ana et al., 2023). This finding shows that comprehensive financial literacy can not only improve agribusiness but also help it withstand financial strain.

Also a part of the main financial framework, it is important to have an Emergency Action Plan (EAP) in place. This is what farmers could follow in extreme circumstances. Unlike in environmental events, where there are anticipated responses, warfare is always changing and can be unpredictable. Depending on the geopolitical situation, it is not as simple to make evasive decisions. Creating an EAP will enable farmers to secure their financial stability during times of crisis. Specifically, plans to liquidate, access emergency funds, and reduce any unnecessary expenses for business operations. The EAP, which will be built into the financial framework, will be able to assist in times of imminent destruction. The EAP strengthens agricultural resilience because, in itself, it is a form of personal insurance. This will create more opportunities for better premiums and improved future contracts. In a study done in Lithuania, researchers analyzed business recovery after the Russia-Ukraine conflict. The context of this study was on agribusiness and energy, and the results showed that businesses recovered when they switched to more

sustainable sources, which was included in their plan. The sustainable sources led to a faster recovery of their businesses and shows the importance of an EAP (Uygur & Peyravi, 2025).

On-Farm Resilience Through Conservation and Agroecological Practices

Conservation agriculture is the use of environmentally friendly practices to help conserve the environment and mitigate the effects of global warming. Conservation agricultural practices are one way agriculture has been resilient to environmental shocks such as weather-related disasters. Conservation agriculture includes no-tillage to help prevent erosion, the use of cover crops in the off-season to prevent run-off and conserve nutrients, more efficient water use to prevent wastage, planting polycultures to improve plant diversity, and utilizing crop rotations to diminish insect and plant disease concerns.

Conservation Agriculture Practices

While the majority of these practices are cost-effective, such as no-till and utilizing crop rotations, others are more costly, such as cover crops and exclusion fencing. Funding from the local Soil and Water Conservation District offices and the United States Department of Agriculture helps make these opportunities more available to farmers. These practices are adapted regionally based on location (USDA, 2025b). For example, in Appalachia, the landscape is mountainous, so producers plant cover crops to help prevent erosion and reduce run-off into watersheds. Through a study of cotton plants, it was found that no-tillage has positive effects on yield rates over time, especially in times of uncertainty due to climate change (Nouri et al., 2021). Another option to help prevent erosion and run-off is streamside buffers, also known as riparian forest buffers. These buffers are described as a balanced and adaptive community of riparia, which is an organism that lives within the zone, and aquatic organisms that help to prevent erosion and runoff into watersheds (Stone & Thomas, 1991).

Other practices implemented to help with animal production are silvopastures, which are where people raise cattle in wooded areas. The paper analyzed the impact of silvopastures, a form of agroforestry, in Colombia that improves pastures by planting fodder shrubs at high density. These pastures were biodiverse, stored carbon, and helped manage risks with animal health by providing shade and water to animals on extremely hot days, especially when paired with rotational grazing, electric fences, and a permanent water source. The study also showed great resilience during hot and dry periods, compared to other cattle in the area (Altieri et al., 2015).

Another practice used in animal production is exclusion fencing, the practice of fencing cattle out of streams and ponds. The Chesapeake Bay Foundation highlights some of the environmental benefits of fencing livestock out of streams and lakes, such as keeping fecal matter out of water, reducing pollution, lowering soil erosion, and helping prevent the spread of waterborne diseases (Chesapeake Bay Foundation, 2025).

On-Farm Maintenance

It is also important for producers to keep proper maintenance on infrastructure and equipment. An article written by the USDA on Risk Management talks about the importance of producers maintaining their infrastructure, which includes buildings and their equipment, such as tractors and vehicles, so that the producer has liquidity (USDA, 2025b). Liquidity, which is the ability to generate cash promptly, can be enhanced by keeping cash on hand, having stored commodities, such as small grains, and other assets that can be converted to cash during emergencies.

Partnerships Between Programs

These conservation agriculture practices work best when paired with crop insurance, government policies, or both, by providing funding for the more costly programs, such as exclusion fencing and cover crops. The Big Beautiful Bill added $56.6B to safety net programs, like crop insurance, and conservation programs, like local Soil and Water Districts (Ayoub, 2025). The bill will help provide more farmers and agriculturalists with the opportunity to participate in these agricultural practices. When conservation practices are paired with crop insurance, it can help to provide financial support during times of drought or other natural disasters.

While environmental shocks have had increased effects on the weather, agriculture is becoming more resilient. The many practices used, such as no-tillage, crop rotations, polycultures, and cover crops, are helping to lower the effects of climate change on the environment. Animal producers can utilize silvoforestry, and exclusion fencing can be used to help keep watersheds clean and improve animal health. It is also important for farmers and agriculturalists to make sure producers have access to cash at all times in case of an emergency, through liquidity. When conservation agriculture is paired with crop insurance, government policies, or both, it can help make these practices more efficient by providing funding and lessening the effects of environmental shocks.

Future Research Direction

This paper outlines the most promising current strategies for existing farms to build resilience to environmental and economic shocks. An area for future study would be possible ways individuals starting farms could plan their design to be most resilient. This would include the layout, crops, and location. In addition, technological developments necessitate continued research of risk management strategies in order to provide the most up-to-date information for farmers and agricultural managers.

Conclusion

Insurance-based strategies, financial and government-based strategies, and on-site practices operate to continuously combat the many financial and economic struggles that farms may potentially face. By implementing various types of insurance for farms, farmers can financially secure their funds in order to minimize losses in profit. In case of environmental shocks such as floods or droughts, it can ensure security for agribusinesses. Governmental policies on a federal level will be able to aid farms nationwide and result in a more permanent solution. Lastly, on-site

strategies take tangible action against possible threats. While insurance-based strategies focus on economic protection, on-site strategies are ways farmers can take initiative in adapting their farms to potential threats, whilst utilizing financial tools, government policies, and conservation practices aid in creating a well-built framework for current and future potential problems.

Over time, there will be an inevitable advancement in technology. Incorporating advanced technology into resilience strategies will further improve their results. With increasing research in these areas, farmers will be able to further their knowledge on how to prepare for shocks. These efforts align with the United Nations Sustainable Development Goals, SDG 13 (Climate Action), SDG 12 (Responsible Consumption and Production), and SDG 9 (Industry, Innovation, and Infrastructure). These goals emphasize sustainability, innovation, and resilience against global challenges. The ultimate goal is sustainable agriculture that meets rising food demands through integrated strategies like insurance, sustainable practice, and policy support.

While each of these resilience tactics work well individually, utilizing these strategies simultaneously increases their effectiveness exponentially. Essentially, the ultimate goal is long-term agricultural sustainability. This means farmers will be able to meet the increased demand for food, despite rising challenges such as climate change, by utilizing multi-dimensional tactics such as insurance, conservative agriculture, and government policies. Considering the increase of economic and environmental shocks such as climate change, risk management must become a greater priority to adapt to a changing environment while also meeting the rising demand for produce.

Generative AI tools (e.g., ChatGPT) were used to brainstorm keywords and improve grammar in early drafts of this paper. All content and analysis reflect the authors' original work.

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