When the Ocean Decides Your Harvest: Farming in the Age of El Niño and La Niña

Divya Rana[1]*, Nivedita[1] and Meenakshi[2]

[1]*Department of Soil Science, CSKHPKV, Palampur, HP, 176062*
[2]*Department of Agronomy, CSKHPKV, Palampur, HP, 176062*

Corresponding Author
Divya Rana
Email: ranadivya25113@gmail.com

OPEN ACCESS

Keywords

El Niño-Southern Oscillation (ENSO), El Niño, La Niña, socioeconomic and inflationary cascades

How to cite this article:

Rana, D., Nivedita. and Meenakshi. 2026. When the Ocean Decides Your Harvest: Farming in the Age of El Niño and La Niña. *Vigyan Varta* 7 (11): 101-105.

ABSTRACT

Sea surface temperature fluctuations in the tropical Pacific Ocean-collectively known as the El Niño-Southern Oscillation (ENSO)-shape global agricultural productivity, rural incomes and international commodity markets. This article reviews the mechanical physics of El Niño and La Niña, evaluates their asymmetric impacts on major global crop yields (soybeans, maize, rice and wheat), tracks the socioeconomic and inflationary cascades that follow, and outlines practical climate-smart adaptation strategies necessary to build agricultural resilience in an increasingly volatile climate landscape.

INTRODUCTION:

1. The Pulse of the Pacific: Why Remote Oceans Dictate Global Agriculture

For a smallholder farmer transplanting rice seedlings in the rain-fed plains of India or a commercial grower sowing maize across the vast African savanna, the primary arbiter of success is not always their seed selection, fertilizer input, or tractor power. Instead, it is the temperature of a vast, remote stretch of water thousands of miles away in the equatorial Pacific Ocean. The fluctuations of this oceanic giant shape the wind patterns, direct the rain clouds, and effectively write the rules for each agricultural season.

Historically, the understanding of this atmospheric connection began centuries ago. Peruvian fishermen first noticed periods of

abnormally warm ocean water that caused fish populations—especially anchovies- to plummet. Because these disruptions typically emerged around Christmas, they dubbed the warm phase "El Niño" (the Christ Child). In the 19th Century, as records improved, British climatologist Sir Gilbert Walker documented a consistent atmospheric link: when high barometric pressure and drought choked northern Australia, low pressure and heavy rains saturated French Polynesia. Walker named this seesaw the Southern Oscillation. It was only in the mid-20th century that scientists fully connected oceanic warming to Walker's atmospheric pressure shifts, giving birth to the modern scientific concept of the El Niño-Southern Oscillation (ENSO) cycle.

In our modern, interconnected agricultural economy, ENSO is recognized as the single most powerful climate driver of food production. Extreme ocean temperatures in the Pacific trigger atmospheric domino effects that dictate rainfall variability and crop yields worldwide, shifting the global supply curves of staple grains and immediately affecting food prices and rural stability.

2. The Physics of the Sea: Demystifying El Niño and La Niña

To comprehend the immense power of ENSO, one must look at the physical feedback loop between ocean water and the overlying winds. In a neutral state, strong easterly trade winds blow from east to west across the equator, pushing warm surface water toward Asia and the western Pacific. This causes cool, nutrient-rich water to rise—or upwell—off the western coast of South America.

The Two Extremes of the ENSO Pendulum

The ENSO cycle oscillates between two opposing phases, typically recurring every two to seven years and lasting nine to twelve months, though recent decades have seen intervals grow increasingly unpredictable:

El Niño (Warm Phase): When trade winds weaken, the warm water pooled in the west begins to slosh back eastward, building an expansive blanket of abnormal warmth across the central and eastern Pacific. This warmth changes where tropical rainstorms form, shifting them eastward and redirecting jet streams that steer storm systems across North America, South America, Asia, and Africa.

La Niña (Cold Phase): Conversely, during La Niña, the trade winds strengthen dramatically, pushing warm water even further westward. This intensifies the upwelling of cold water in the eastern Pacific, dropping sea surface temperatures well below normal. The atmospheric consequences are often the mirror image of El Niño, bringing excessive rains to areas that would otherwise face drought, and parching regions that usually receive ample rainfall.

Because these oceanic shifts have profound trade implications, meteorologists continuously refine their tools. In February 2026, the National Oceanic and Atmospheric Administration (NOAA) adopted the Relative Oceanic Niño Index (RONI). This new metric improves the classification of ENSO events by accounting for background ocean warming, allowing farmers, agronomists, and commodity traders to forecast localized precipitation anomalies with higher accuracy.

3. The Asymmetric Impact: How ENSO Reshapes Crop Yields

The most critical insight from decades of agronomic research is that ENSO does not affect crops uniformly. Instead, its impact is highly asymmetric, creating winners in some regions and devastating losers in others. Understanding this asymmetry is essential for managing global trade flows.

According to a landmark study by Iizumi et al. (Nature Communications, 2014), El Niño is highly favourable for global soybean yields,

boosting the global-mean yield by 2.1 % to 5.4 %. This occurs primarily because El Niño brings cooler, wetter conditions to the US Midwest and South America (Argentina and southern Brazil) during critical reproductive phases. However, the impact on other major food staples is overwhelmingly negative. Global maize, rice, and wheat yields during El Niño years tend to decline by - 4.3 % to + 0.8 %, with the brunt of the losses borne by rain-fed farms in South Asia, Southeast Asia, and Sub-Saharan Africa.

La Niña presents a different set of risks. Under La Niña, the global-mean yields of all four major crops (soybeans, maize, rice, and wheat) tend to fall below normal, with losses ranging from -4.5 % to 0.0 %. As South America has grown to become the dominant exporter of corn and soybeans, La Niña-induced droughts in southern Brazil and Argentina have shifted commodity price dynamics. Historically, La Niña was considered bearish for prices, but since 2010, the consolidation of South American export dominance means La Niña events now consistently trigger bullish commodity market rallies.

Global Crop Yield Deviations During ENSO Phases

The following table highlights the severe divergence of ENSO impacts on staple grains. Note how soybeans stand out as the sole beneficiary during El Niño, while other crops suffer widespread losses-a key vulnerability for global nutrition.

Staple Crop	El Niño Impact (Global)	La Niña Impact (Global)	Key Impacted Regions
Soybeans	+2.1 % to +5.4 %	- 4.5 % to 0.0 %	Favorable in US Midwest; dry in North Brazil/La Niña South America
Maize (Corn)	- 4.3 % to + 0.8 %	- 4.5 % to 0.0 %	Droughts in Southern Africa (El Niño); dry in Argentina (La Niña)
Rice	- 4.3 % to + 0.8 %	- 4.5 % to 0.0 %	Monsoon failures in India/SE Asia (El Niño); flooding (La Niña)
Wheat	- 4.3 % to + 0.8 %	- 4.5 % to 0.0 %	US Plains benefit (El Niño); dry in Australia and South Asia

4. Socioeconomic Ripples: Food Inflation and Rural Demand

When weather anomalies degrade global harvests, the consequences ripple far beyond the farm gate, triggering significant macroeconomic and social disruptions. For developing countries, where food expenses comprise a vast portion of household budgets, agricultural shocks translate directly into inflation spikes.

A clear demonstration of this dynamic occurred in mid-2026. Driven by monsoonal fluctuations linked to a developing Pacific warm phase, India's consumer retail inflation (CPI) edged upward from 4.38 % in June to 4.45 % in July. The driving force behind this shift was food price pressure, with food inflation rising sharply to 5.52 %. Crucially, the impact was distributed unevenly, with rural CPI inflation climbing to 4.84 % compared to just 3.96 % in urban areas. This rural-urban divergence highlights the double-sided risk that weather shocks pose to agricultural economies.

The transmission of a weather shock works in two directions simultaneously. First, reduced harvests increase food prices, compressing the real purchasing power of both urban and rural consumers. Second, crop failures directly reduce farm incomes, which in turn weakens rural demand for manufactured goods and services. The resulting combination of elevated consumer prices and suppressed rural consumption creates a severe headwind for national economic growth.

5. Two Crops, Two Continents: Africa's Maize and Asia's Rice

To appreciate the human and systemic scale of ENSO's impact, one can look at two specific crop vulnerabilities: maize in Southern Africa and rice in the ASEAN+3 region of Asia.

Southern Africa's Maize Crisis

Maize is the primary caloric staple for millions of households across Southern Africa. During the powerful El Niño of 2023-2024, extreme drought parched fields in several countries. According to the Food and Agriculture Organization (FAO), more than 60 million people were affected by climate disruptions during this period. In Southern Africa, nearly 45 % of maize-growing areas suffered major losses, leaving communities dependent on food imports and humanitarian aid. When the warm phase returns, as models predict could happen as early as late 2026, these rain-fed systems are thrown into immediate peril.

Asia's Rice Cultivation Challenges

In the ASEAN + 3 region, rice is not just a staple crop; it is the cornerstone of food security and rural livelihoods. Under El Niño, the region faces reduced rainfall and prolonged drought, resulting in severe water stress during critical vegetative phases. Furthermore, elevated temperatures accelerate the rice ripening process, which compromises grain quality, lowers grain weight, and ultimately diminishes total yield. Extreme heat waves can dry out paddies completely, leading to widespread crop failures and soaring domestic rice prices, as seen in Indonesia and India during recent cycles.

Conversely, when La Niña arrives, it brings the opposite challenge. While increased rains can initially seem beneficial for thirsty paddies, they frequently manifest as torrential downpours. The resulting waterlogging and severe flooding drown standing crops, erode fertile topsoil, and foster high-humidity environments that accelerate the spread of agricultural pests and fungal diseases.

6. Climate-Smart Agriculture: Building Rural Resilience

Because humanity remains powerless to stop the ocean's thermal pendulum, the global agricultural sector must pivot from reactive emergency responses to proactive, climate-smart adaptation. Building resilience is no longer an option; it is an existential necessity.

Irrigation as Economic Insurance

The traditional method of evaluating irrigation projects is to measure the additional crop output they generate. However, comprehensive assessments by India's National Council of Applied Economic Research (NCAER) reveal that irrigation's value extends far beyond productivity. Irrigation serves as a robust form of economic insurance. While it cannot completely insulate farmers from severe droughts, reliable access to water significantly reduces the probability and magnitude of crop failures. NCAER data demonstrates that agricultural command areas record substantially higher agricultural incomes and markedly lower income volatility than comparable non-irrigated regions. This stability allows farmers to diversify into horticulture and livestock, sustaining their livelihoods even during periods of extreme rainfall stress.

Water Harvesting and Early Sowing

In rain-fed areas, active water management is vital. In Sri Lanka, agricultural authorities advise smallholders to harvest surface runoff into localized farm ponds during heavy rain phases (such as the wet Maha cultivation season) to serve as buffer water supplies during parched phases (such as the dry Yala season). Advancing the sowing calendar to match altered monsoon onset dates further reduces the likelihood of crops hitting moisture-sensitive reproductive phases during peak dry spells.

Crop Diversification and Drought-Tolerant Seeds

Relying on a single staple crop makes smallholders exceptionally vulnerable to crop failure. Agricultural extension programs, such as Zambia's Fertilizer and Input Support Program (FISIP), now incorporate legume seeds alongside traditional fertilizers to actively encourage crop diversification. Since legumes and alternative grains have higher tolerances to water stress than maize, diversification buffers farm incomes. When paired with drought-tolerant seed varieties that maintain cellular function during dry spells, climate-smart farming converts a potential climate disaster into a manageable seasonal challenge.

REFERENCES:

Bandyopadhyay, S. (2026) 'When El Niño hits the farm, inflation follows: Why irrigation matters for rural resilience', *Down To Earth*, 20 August.

Food and Agriculture Organization [FAO] (2025) *La Niña: Anticipatory Action and Response Plan, January 2025 update – Mitigating the expected impacts of La Niña-induced climate extremes on agriculture and food security*. Rome: FAO.

Iizumi, T., Luo, J., Challinor, A. J., Sakurai, G., Yokozawa, M., Sakuma, H., Brown, M. E. and Yamagata, T. (2014) 'Impacts of El Niño Southern Oscillation on the global yields of major crops', *Nature Communications*, 5: 3712.

Li, D., Kitsios, V., Newth, D. and O'Kane, T. J. (2025) 'Machine learning projection of climate and technology impacts on crops key to food security', *Environmental Research: Climate*, 4(2): 025003.

Miyarnis, M., Harahap, L. H. and Jabat, Y. Y. L. B. (2026) 'Regenerative Agriculture Practices and Their Effect on Soil Health and Agribusiness Profitability in Indonesian Farming Systems', *International Journal of Science and Environment (IJSE)*, Deli Serdang, Indonesia.

Skees, J. R. and Collier, B. (2010) *New Approaches for Index Insurance: ENSO Insurance in Peru*. Focus 18, Brief 11. Washington, D.C.: International Food Policy Research Institute.