

TIMES EVOKE

A HARVEST OF CHANGE

We live in an age of deepening food insecurity. The FAO's latest data shows food prices at a decade-high, with average food prices globally in 2021 being the highest in 46 years. Some of this is geopolitical but a great deal is due to climate change. The World Economic Forum finds even in 2007, 30% annual fluctuations in crops were due to weather changes. As farmers stand bewildered before record rising temperatures and extreme weather events now — 'once in a decade' droughts are happening 70% more often — food production and prices have grown increasingly volatile, leaving, as the World Bank finds, 9% of the world's population hungry.

Alongside, nature is starving too. The IPCC finds the world's current food system, intensely reliant on deforestation, monocultures and chemicals, creates a quarter of all greenhouse gas emissions. Half of the world's habitable land is used for agriculture, with over three-quarters given to livestock and animal feed. Industrial agriculture uses 70% of global freshwater and causes 78% of eutrophication or the pollution of waterways with chemicals. As Earth suffers, so do its many children — of 28,000 species facing extinction, 24,000 are threatened by agriculture. The World Bank estimates the environmental and human health costs of such food systems amount to \$12 trillion annually. An extraordinary irony entwines itself around these facts — to feed a growing global population, food production must increase 50% by 2030. Yet, these food systems are following out the ecosystems which create food security.

However, as Times Evoke's global experts emphasise, multiple mitigations are possible. These include soil restoration through regenerative farming, perennials and mixed crops reducing atmospheric CO₂. The IPCC calculates that sustainable farming and agroforestry could mitigate one-third of all greenhouse gas emissions by 2050 — in Colombia, farmers practising silvopasture, combining trees with pastures, have already found increased carbon sequestration and higher crop productivity. Consumers play a key role by supporting organic agriculture, wholesome grains and local foods. Join Times Evoke on a journey of discovering new food systems which can make Earth and ourselves healthier. The adage, 'You are what you eat', has never rung truer.

'Climate change will impact food production — consumers can help establish timely adaptations'

Prabhu Pingali teaches at Cornell University's Dyson School of Applied Economics and Management. Speaking to Srijana Mitra Das at Times Evoke, he discusses the repercussions climate change could have on food systems:

What is the core of your research?

I teach applied economics at Cornell University and I'm also the director of the Tata Cornell Institute for agriculture and nutrition. This focuses on understanding malnutrition and poverty in India and studies opportunities for improving agricultural productivity, nutritional outcomes and rural incomes.

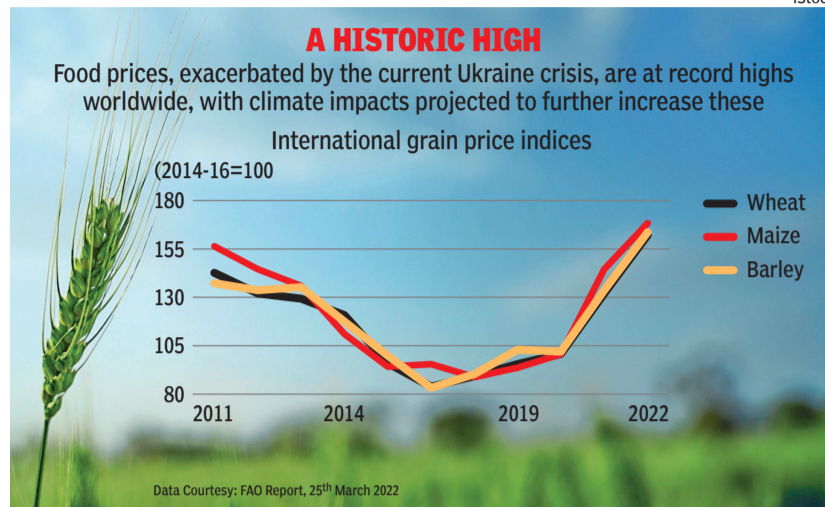
You research food systems globally — what exactly are these?

I've worked in the field of agricultural development for 40 years now. Initially, when we talked about farming, much of the discussion was around food production and ways of improving this — there wasn't much attention given to the consumer end or how to get



food from producers to consumers through the value chain. The idea of a food system is to take a holistic look across this entire spectrum, from the producer all the way to the consumer as well as the outcomes that occur in terms of improved nutrition, health, etc.

The food system concept thus looks at the entire value chain, from who produces food to how this is generated, transported, stored, processed and moved to higher-level markets like urban ones, the demand for different foods among consumers there, food quality, nutritional results and so on. All these



different topics coalesce in the concept of a food system.

What are the most important challenges confronting food systems in a world of climate change?

There are significant challenges from rising temperatures. Consider traditional staples like rice and wheat — as temperatures increase, we will see a drop in these yields. Climate change will also bring an increased incidence of droughts and floods. These extreme events have major impacts on food productivity,

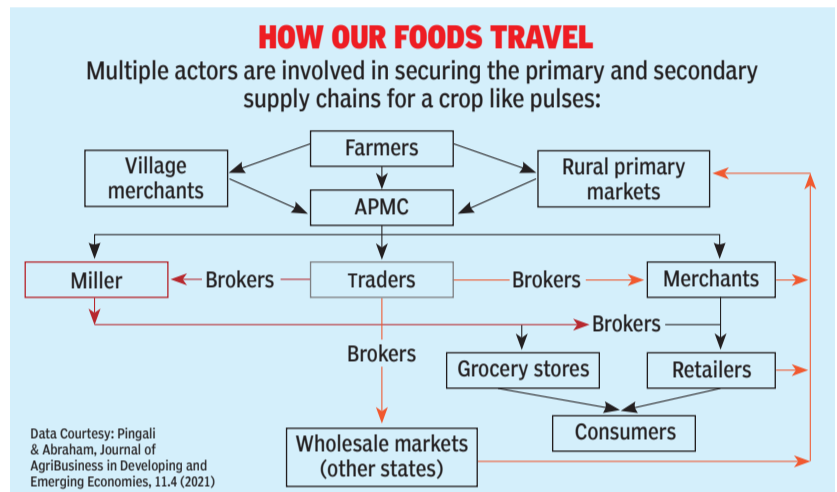
supply and prices. We need to develop adaptations which can protect both farmers and consumers from these.

How vulnerable is India's food system to such climate impacts?

India is quite vulnerable to rising temperatures. Think of the entire Indo-Gangetic plain from Punjab to Bengal — this is the main rice and wheat belt for the country. As you go over eastern Uttar Pradesh into Bihar and Bengal, you find areas of productivity but also high rural poverty. As temperatures rise, we will see declining productivity across this belt — the people most affected will be the small and marginal farmers in eastern India. The significant impacts on their income will affect their food security. More prosperous regions, like Punjab and Haryana, will also likely see a lowering of productivity — this could cause an overall drop in food supplies in the market and in procurement for the public distribution system. This will again impact the poorest consumers who depend on the PDS for food.

How does climate change also impact nutritional security?

Nutritional security requires thinking of overall diversity in the food system and not just rice and wheat. More nutritious foods, like vegetables, fruits, pulses, dairy and millets, must be accessible to consumers. As we go through climate



WHAT'S ON YOUR PLATE

- 26% of global greenhouse gas emissions come from how food is grown, with 58% coming from animal products — food production emissions consist mainly of CO₂, nitrous oxide and methane used or released
 - Food systems have large carbon footprints or the total amount of greenhouse gas emissions a person, organisation or product causes — food accounts for up to 30% of a household's carbon footprint in the US
 - The highest emissions are caused by animal products but sweets can leave an aftertaste as well — 1 kg of chocolate produces 19 kgs of greenhouse gases (GHGs) driving global warming and climate change
 - Scientists find 1 kg rice generates up to 4 GHG while wheat, which needs a high application of chemical fertilisers, can emit up to 200 kgs of CO₂ per tonne produced
 - Locally grown fruits and vegetables have the lowest carbon footprint on Earth — 1 kg of apples causes only 0.4 GHG, 1 kg of bananas causes 0.7 GHG while 1 kg of tomatoes causes 1.4 GHG
- Research: CNN, BBC, Encyclopaedia Britannica, Smithsonian Magazine



A WORLD WITHOUT THEM
● As human populations expand, agriculture threatens the cheetah which faces the loss of its open grasslands — as fields cut into these, the cheetah population globally has shrunk to estimatedly just over 6,700 adults and adolescents. Conservationists estimate that cheetahs, once found widely across southern and eastern Africa, now occupy 10% of their historic range — only 5% cubs make it to adulthood



● Scientists find 1,469 bird species face extinction due to industrial farming — as monocultures expand, using pesticides and fertilisers and cutting down wooded groves, farmland birds like skylarks, lapwings and corn buntings in Europe face an existential threat. Globally, 74% of threatened birds face habitat loss and lower nutrition due to the intensification of agriculture

● Over 41% insect populations declined by three-quarters in the last 25 years, due to pesticides and land use change. Many insects consume only one type of plant and cannot survive if these are cleared for industrial farming — while 58% butterfly species have collapsed on farmlands in Britain, 37% dragonfly pollinators are endangered. Interestingly, humans are dependent on such pollinators to create food and could only survive for a few months without insects

Research: National Geographic, The Guardian, IUCN



'CO₂ levels, the highest in history now, are impacting crop nutrients'



Samuel Myers is principal research scientist at Harvard University's TH Chan School of Public Health. Speaking to Times Evoke, Myers outlines how crops are becoming less nutritious as CO₂ rises — and the health implications of this:

My research is in the field of planetary health which studies the human health consequences of the degradation of nature and natural systems. My work most relevant to India looks at how rising CO₂ concentrations in the atmosphere are reducing key nutrients in staple crops like wheat and rice — this is raising the risk of micronutrient deficiencies in many countries, and particularly in India.

At the increased CO₂ levels expected by mid-century, there could be reductions of five to 15% in iron, zinc and protein within rice, wheat, maize and soy. With modelling, we've found these decreases could push 200 million people into new risks of nutrient deficiency, while exacerbating existing deficiencies in one billion people. In India, about 15 million people would be at new risk of zinc deficiency, causing a significant public health problem.

Zinc is important for our immune systems — populations deficient in it have higher rates of mortality from infectious diseases which particularly impacts children. Iron is also extremely important — people with less levels of iron tend to suffer from anaemia, higher maternal and infant mortality, lower work capacity, reduced IQs and stunting in children.



SUPERHERO IN A RED CAPE: Amaranth, an ancient grain, offers both better nutrition and climate adaptation



HOW THE LAND LIES: South Asia relies intensively on rice for providing nutrition. As its micronutrients fall due to rising CO₂, this will impact millions of people

This is very worrying for populations which depend on these crops for nutrition — these are mostly lower-income groups in South Asia and sub-Saharan Africa. We've also found that around half a million lives are lost annually because there aren't enough pollinators left to optimise crops dependant on them — this impacts eastern Europe, parts of the former Soviet Republic and middle-income nations which are vulnerable to heart disease and cancers and were protected by consuming the fruits and vegetables which pollinators provide.

However, timely mitigations can protect our food systems — and our health. The most vital is to reduce carbon dioxide emissions. It is also possible to fortify diets by adding nutrients to foods or providing supplements but these haven't been hugely successful so far. It is important to encourage more diverse diets — India has subsidies for refined grains like rice and wheat. Subsidising traditional grains like millets, amaranth, etc., could strengthen nutrition and climate adaptation.

CO₂ concentrations are higher now than ever before in humanity's history. Before the Industrial Revolution, these were 280 parts per million (ppm) — they are now 410 ppm. One of my colleagues examined goldenrod, a wild plant in

North America. He studied samples from the 1800s, his research showing a 33% reduction in the protein content of the goldenrod's pollen since then, with rising atmospheric CO₂ responsible for this. So, significant shifts could have already occurred in the nutrient content of other plants.

We are at an incredible inflection point in history. We must double food production to keep up with demand over the next 40 years — but our food production system is the single largest driver of environmental change, biodiversity loss and climate change. The good news is, there are ample opportunities to change this — consider the protein revolution underway with plant-based meat products or fermentation which can produce synthetic proteins like milk. These can disconnect protein production from animal livestock. There is also sustainable aquaculture, precision agriculture which shows great promise in reducing inputs like water and fertilisers and regenerative practices which encourage pollinators to return.

We need enlightened government policy now — and a recognition that this is truly one of the most important challenges of our lifetime. There is an abundant terrain of solutions before us — mobilising the will for these can yield far more sustainable results.

THE POWER OF A PLANT

THE SEEDS OF AN IDEA

'Climate mitigation needs India's ancient food and farming wisdoms'

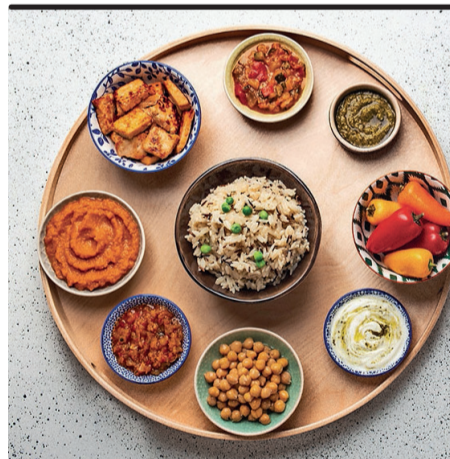
Vandana Shiva is an environmental scholar and activist. She tells Times Evoke about the vulnerabilities industrial farming cause — and the Indian wisdoms which can heal these:

The 'Indian food system' means about twenty diverse ways of farming and many ages coexisting. India has genetically modified agriculture and Green Revolution crops alongside indigenous systems which value agroforestry and biodiversity. There are huge differences therein. The farming of genetically modified varieties relies on fossil fuel products like chemical

fertilisers — these are made by burning fossil fuels at very high temperatures. This gives ammonium nitrate used for explosives and urea. One kilogram of such urea thus requires two litres of diesel.

In contrast, Indian farmers know how to fix nitrogen in the soil through pulses which nurture soil rhizobium through plant roots. This sustained the environment for centuries. Chemical fertilisers were an abrupt break — these also emit carbon dioxide and the even more damaging nitrous oxide. They also demand more water while damaging soil organisms that hold water, causing a deeper crisis.

To weather climate impacts now, we need to grow water-holding capacity in the soil — around 0.5% organic matter increases the soil's water-holding capacity by about 80,000 litres per hectare. This explains how in India, organic farming could once be done even in non-irrigated areas and in the rabi season. Chemical agriculture reduced this to irrigated areas and the monsoon season. We forgot our water and soil — but these are the elements which give us resilience.



BALANCING A MEAL

- Ayurveda, which means 'the science of life', prescribes six different tastes in every meal, with each taste adding a particular health benefit
 - A sweet taste, found in bananas, mangoes, pumpkin, etc., is meant to build tissue and calm nerves while a sour taste, found in yoghurt, lemon, tamarind, etc., can help to increase mineral absorption
 - Saltiness from sea vegetables, olives, etc., aids digestion while a bitter taste, found in fenugreek, turmeric, bitter gourd, etc., can detoxify. Pungency, from chillies, ginger, cardamom, etc., can stimulate metabolism while astringency in legumes, green beans, turnips, etc., absorbs water and tightens tissues
- Research: Charak Samhita, CNN, Science Direct

An important mitigation is to encourage the consumption of millets, about which my organisation Navdanya has been spreading knowledge for years — millets are both drought-resistant and build the soil's water-holding capacity.

We also need a commons for indigenous seeds. When I began Navdanya in 1987, I understood our ancestors' foresight in evolving certain seed varieties — we developed seed banks with these salt and flood-tolerant varieties. We've distributed these when cyclones impacted the Bay of Bengal and these indigenous innovations have saved thousands from what Naomi Klein terms 'disaster capitalism' or the exploitative conditions that befall farmers upon an earthquake or flood.

India's forgotten indigenous systems are vital in the era of climate disasters. We should revive our organic farming methods, privilege biodiversity over mono-

cultures and use climate-resilient and nutritionally dense seeds. Only these can feed a large population sustainably. The richer the soil's biodiversity, the more its phytochemicals and the nutrition in food. Soil biodiversity literally feeds Earth — and all its life. If we adopt biodiverse and organic farming, we could feed millions of Indians with adequate nutrients and without dependence on foreign debt caused by fossil fuel supply chains for fertilisers.

Chemical farming also has very real current costs. The externality costs for environmental damage and human health consequences caused by these chemicals runs into trillions of dollars annually. While impacting our GDP thus, this also harms farmers — our research has found that on average, a farmer using indigenous seeds, working organically and selling on their own terms earns more than commodity-chasing farmers who

get locked into debt for chemical fertilisers and pesticides. That farmer retains a tiny percentage of what the consumer pays but confronts a far greater debt, which explains the numbers of farmers who go hungry — and even end their lives in desperation.

Consumers can help change this situation. We need to eat wisely, so that we don't harm the planet, cause climate change or disease for oneself since the same factors drive all of these. We should eat organic foods and link to farmers and organisations working with them to source these. Also, we should heed Indian dietary wisdom which said we need six tastes in every meal to protect our gut microbiome. Another wisdom is to eat fresh, seasonal foods and not seek produce outside their season. Processed foods use chemicals which cause chronic diseases, so turn to artisanal foods and support rural dhanis and chakkis which provide fresh oil and healthy produce, nurtured by India's ancient wisdoms.

READERS WRITE

Dear Times Evoke,
It was heartening to read scientist Anusha Shankar (2nd April) on the anatomical feats of hummingbirds. This article inspired me to learn more and I thank TOI for providing TE.
—Dr GSS Murty, Sr. Scientist (Retd.), Bhabha Atomic Research Centre, Mumbai

I'm now in admiration of the little hummingbird. Its feats are amazing to us human beings, supposedly the 'most advanced' creatures but living amongst such astonishing and wondrous species.
—Mohan Nair, banker, Bengaluru

Saturday is Times Evoke time for me! Being a science teacher, I cite the hummingbird's wing beats to teach about soundwaves. Hats off to Times Evoke for these wonderful articles!
—Geetha Akhlesh, Chennai

Times Evoke has become a fascinating part of my reading as it brings out a new perspective about the world in such an interesting way! Thanks, TOI, for making Saturday special through the aesthetic TE.
—Manisha Gada, Ahmedabad

I am a fan of TOI's beautiful Times Evoke! When I read about Anusha Shankar's research on hummingbirds, I remembered Arizona, Phoenix, where I regularly watched these birds from my daughter's home. These tiny birds are so fast, they escaped my camera! Their colours were beautiful though as is their elegant beak. I never miss reading Times Evoke and this article was richly informative.
—Y. Suryanarayana, Delhi

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