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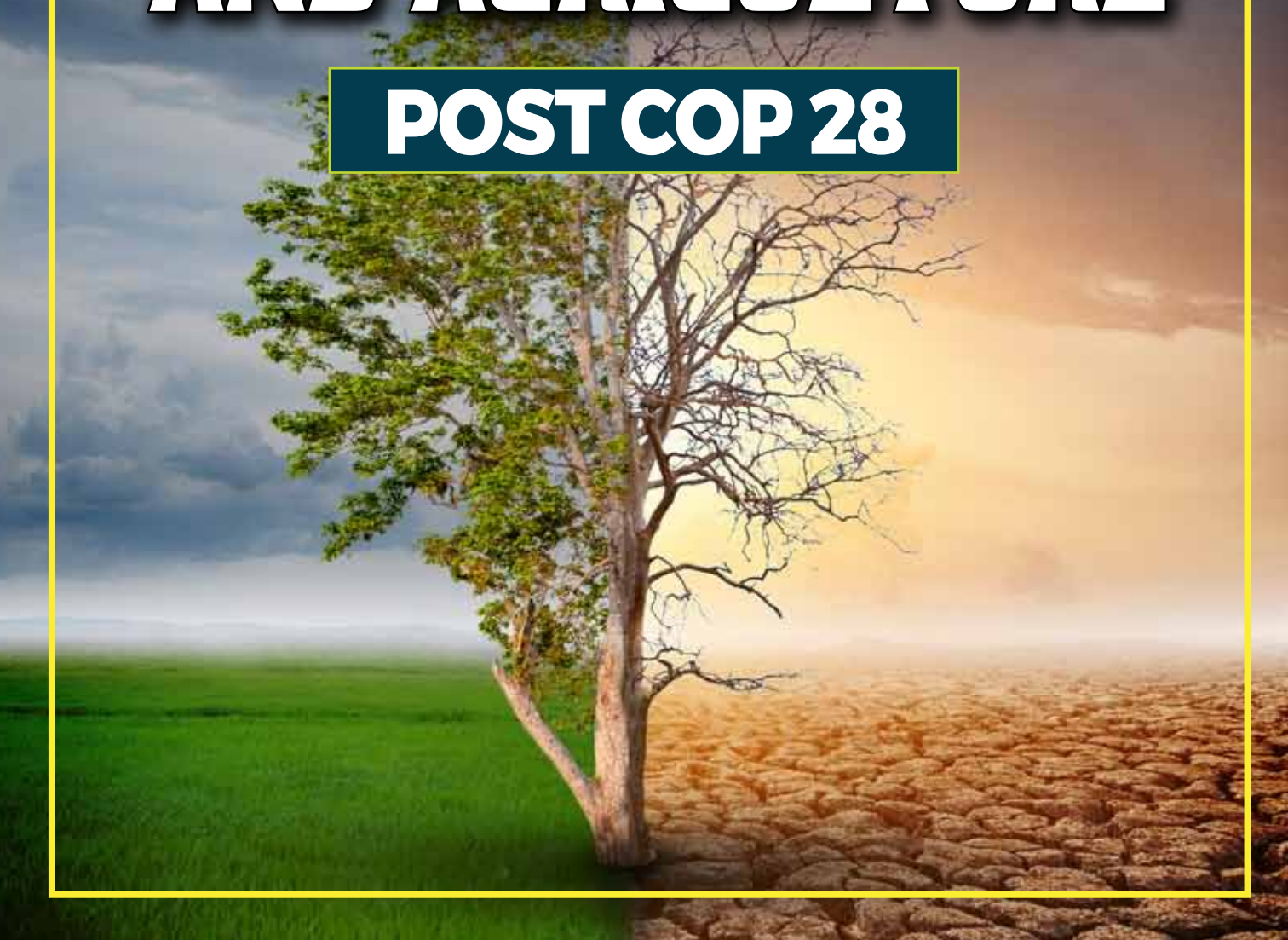
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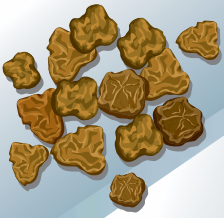
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CLIMATE CHANGE AND AGRICULTURE

POST COP 28





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TOWARDS CLIMATE RESILIENT AGRICULTURE

Climate change and agriculture are intrinsically related. Agriculture contributes to one third of the anthropogenic Green House Gas emissions. Animal based farming leads with almost 60% of food-related emissions. Climate change has also invariably affected the production and productivity of agriculture. Drought, temperature extremities at critical crop stages, floods, salinity to name a few climatic aberrations have affected yields to a great extent. The onset of monsoon has been erratic since the last few years putting at risk the generally followed crop calendar, jeopardizing the rhythm of agriculture vocation in India. As climate gets more and more out of hand, certain measures need to be adopted to acknowledge the changes and adopt a corrective course of action.

The recently concluded COP28 did the first part with the promising adoption of the UAE Declaration on Sustainable Agriculture, Resilient Food Systems, and Climate Action. In addition to this, for the first time at a COP, an entire day was dedicated to Food Systems. This is positive sign. Although, the mitigation aspect was completely left out in the global stocktake draft, considerable difference can be brought out by adopting adaptation strategies.

Indian agriculture is dominated by small holder and marginal farmers for whom farming is an important source of livelihood. Most of their farming systems have a wide array of crops and livestock. Also note, that in India, the largest milk producing country in the world, the bulk of milk comes from these small scale farmers who both farming and dairying. So for India, it is a challenging task of balancing environmental commitments with economic needs.

So the stress at least in the beginning will be on adaptation strategies. Fortunately, there are a number of means and methods by which countries with large agricultural sectors like India, can address climate changes. In this edition, Agriculture Today has reached out to different stakeholders in agriculture to find out what should be our climate adaptation strategies keeping at center the deliberations in COP28. After all there is light at the end of the tunnel!

We were fortunate to get in touch with experts and practitioners, whose ideas were not only brilliant but doable. This edition of Agriculture Today is a compendium of climate adaptation and mitigation strategies and addresses agriculture sector post COP28. I hope it can start off a discussion and a series of interventions.

Thank you






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AGRI EDUCATION

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FSII GETS NEW LEADERS

The Federation of Seed Industry of India (FSII), a 40-member association led by the plant science industry, is a crucial research and development body of India. With specialization in producing high-quality seeds for food, feed, and fiber sectors in India, FSII strives to contribute to the vision of increasing farmers' income. Affiliated with global organizations such as the International Seed Federation (ISF) and The Asia and Pacific Seed Association (APSA), FSII plays a crucial role in the international seed community.

The New Leadership Team

With a new leadership team in place, FSII plans to drive progress and enhance its position as a knowledge-driven federation of research-based seed companies in India.

Ajai Rana, the newly appointed Chairman has over 32 years of experience in agriculture, including roles at Monsanto and Ricetec. He is currently the CEO for Savannah Seeds. Rajvir Rathi, the Vice Chairman is the Head of Agriculture Policy & Stakeholder Affairs at Bayer Crop Science and he brings with him extensive experience in agriculture. Shirish Barwale, Vice Chairman, has almost 2 decades of experience in agriculture sector and he is the current MD of MAHYCO. Dr. Venkatram Vasantvada, Finance Director, is the MD & CEO of Seedworks International Pvt Ltd and will be contributing his financial expertise to the leadership team.



Ajai Rana



Rajvir Rathi



Shirish Barwale



Dr. Venkatram Vasantvada

Challenges in Seed Industry

The appointment comes at a crucial time when the seed sector is facing some crucial challenges. Climate change is a major factor influencing agriculture today and it has become vital for the industries to develop seeds which can withstand climate variability and extreme weather events. In India, small and fragmented land holdings make it challenging

for seed companies to reach a large number of farmers efficiently. This can affect the economies of scale in production and distribution. Inadequate infrastructure and logistics, including storage and transportation facilities, can lead to seed quality deterioration and increased costs. Strict regulations and lengthy approval processes for new seed varieties can hinder the

introduction of innovative and improved seeds. Compliance with various seed quality standards and regulations adds complexity to the seed production and distribution process. Transparency across the business value chain is the top business challenge in seed production. Balancing transparency with competitive safeguards remains crucial.

INITIATIVES AND APPROACHES TO COMBAT CLIMATE CHANGE IN INDIAN AGRICULTURE SECTOR

Climate change is the dominant environmental challenge of the current times threatening not just agricultural production, but human civilization on earth in general. However, the impact of climate change on agriculture can prove highly critical, as it is the sector that generates food & fodder that meet the basic physiological requirements of human and livestock populations. This primary sector also generates fuel and raw materials that cater to large number of agro-industries which provide employment and income to large section of the society.

Climate Change – Its Effect on Agriculture

The variation in climate, negatively influences the yield & quality of crops, horticultural crops, livestock, fisheries & aquaculture, and challenge food security. Interestingly, increases in temperature and CO₂ can increase some crop yields in some

The warming trend in India over the past 100 years points to an average temperature increase of 0.60°C. While the Paris Agreement targeted to limit the projected rise in temperature to a maximum of 1.5 degree Celsius, the recent CoP 28 at Dubai expressed the fear that the world already seems to have reached this threshold. The temperature increase is only likely to get worse, putting at risk life on earth, in water and in atmosphere. Other negative outcomes of climate change already being experienced are increasing number of weather extremes, that include changes in rainfall intensity & patterns causing simultaneous floods & droughts etc. which are expected to be further exacerbated.

places. But to realize these benefits, nutrient levels, soil moisture, water availability, and other conditions must also be met. However, rise in temperature has a deleterious impact on water and seasonal crops like wheat which is an important cereal in the Indian food basket.

Changes in the frequency and severity of droughts and floods challenge the farmers critically constraining nation's food safety. It can be said, that climate change could make it more difficult to grow crops, raise animals, and catch fish in the same

ways and same places as done in the past. The effects of climate change also need to be considered along with other evolving factors that affect agricultural production, such as changes in farming practices and technology. Hence, appropriate and timely interventions including mitigation & adaptation are necessary to neutralise/minimize the negative influence of climate change on agriculture in general, and food & fodder security in particular.

Government Interventions to Combat Climate Change

In 2008, the Government of India adopted the National Action Plan on Climate Change (NAPCC), which outlined eight National Missions addressing climate change. Among the eight missions, the National Mission on Sustainable Agriculture (NMSA) came to be operationalised in 2014-15. The focus interventions of the Mission include Soil Health Management (SHC), Integrated Farming Systems (IFS), integrated animal components, and Water Use Efficiency (WUE), particularly in drylands or rainfed agricultural areas to address the negative impacts of climate change in agriculture and allied sectors. In consonance with the overall NMSA strategy, there have been several government interventions through policy, programs, scheme, and even research & development (R&D) routes.

NITI Aayog has been designated as the nodal agency for coordination of SDGs, and Ministry of Environment, Forest and Climate Change (MoEFCC) has established the Apex Committee for Implementation of Paris Agreement (AIPA) to oversee and drive climate-related actions.

The Indian Council of Agricultural Research (ICAR) initiated National Innovations on Climate Resilient Agriculture (NICRA) network project in 2011, and has been addressing the



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While adaptation is an anticipatory and planned process, managed through policies, technologies and developmental activities, mitigation practices are important to reduce the drivers of non-sustainable practices and events such as climate change in the long run.

specific challenges posed by climate change on Indian agriculture. The learnings from this project have been found to be relevant for replication across dryland region.

In addition, given the predominance of rainfed agriculture in the country, the government is committed to encouraging rainfed agriculture practices including watershed development approach, organic & natural farming practices, more productive & sustainable integrated farming systems etc. All these initiatives have been collectively contributing to the broader strategy of combating climate change, and promoting sustainability in agriculture and allied sectors of the Indian economy.

Takeaways from COP28

At the recent COP28 Summit in Dubai, food and agriculture emerged as a focal concern, with over 130 global leaders signing a declaration to prioritize their food systems in national strategies, ranging from production to consumption. The COP28 UAE Declaration on Sustainable Agriculture, Resilient Food Systems, and Climate Action outlines the commitment of these leaders to mobilize over \$2.5 billion to tackle climate issues related to agriculture. This funding aims to scale up adaptation and resilience efforts for farmers, alongside initiatives to transform production practices, as stated in the official declaration.

This Declaration at COP28 can be expected to facilitate technology transfer in India involving acquisition of advanced agricultural practices, resilient crops against drought, and efficient water management techniques enabling minimization of yield losses, and realising optimal productivity across the agricultural sub-sectors. The declaration could encourage the possibility of rewarding nations that effectively cut greenhouse

Programmes and Schemes

These includes Pradhan Mantri Krishi Sinchayee Yojna (PMSKY), Pradhan Mantri Fasal Bima Yojna (PMFBY), Soil Health Card (SHC), Green India Mission (GIM), National Water Mission (NWM), Paramparagat Krishi Vikas Yojna (PKVY), Agricultural Contingency Plans and National Innovations on Climate Resilient Agriculture (NICRA), Sub-mission on Agro-forestry (SMAF), National Livestock Mission (NLM), Blue Revolution (Neel Kranti Mission), Fodder Development Scheme, National Biogas and Manure Management Programme (NBMMP), National Mission on Himalayan Studies, Agro-Advisory Services, Neem Coated Urea etc.

gas emissions within the agricultural sector as it has the potential to encourage the uptake of practices that decrease emissions while sustaining agricultural productivity. One can in consequence expect support for adoption of climate-smart farming methods, development of infrastructure, and enhancement of farmers' capabilities. Promotion of eco-friendly practices can be expected to fetch higher demand and more remunerative prices. The exchange of knowledge between Indian scientists and farmers and global experts is also expected to be mutually beneficial.

What COP28 left out

While the declaration is promising of several advantages vis-à-vis agriculture including that of knowledge access from outside the country, it does not address negative

impact of industrial-centric agriculture on the ecosystem. The declaration could have been emphatic about offering financial support to the smallholder farmers, whose significance it recognizes in food production system, and their pivotal role in safeguarding ecosystems and ensuring global food security.

Concerned as India is about the negative impact on the country's rice cultivation and substantial livestock sector if radical changes are effected to the farming system, it does not accept targeted commitments. However, India is committed to addressing climate change issues, and adopts an approach to combat climate change in the agriculture sector by rolling out both adaptation and mitigation strategies. While adaptation is an anticipatory and planned process, managed through policies, technologies and developmental activities, mitigation practices are important to reduce the drivers of non-sustainable practices and events such as climate change in the long run. In the short run, adaptation strategies are important from the perspective of small & marginal farmers. The government is committed to promoting a cafeteria of strategies and practices that encompass crop/cropping system-based technologies, resource conservation-based technologies and socio-economic and policy interventions.

The COP28 UAE Declaration on Sustainable Agriculture, Resilient Food Systems, and Climate Action outlines the commitment of these leaders to mobilize over \$2.5 billion to tackle climate issues related to agriculture.

CLIMATE CHANGE, AGRI-FOOD SYSTEMS AND HEALTH

Climate change is not only a major public health challenge for the world, but an existential crisis for humanity. Climate change directly and indirectly impacts our nutrition and health through many pathways including our agri food system, access to safe water, exposure to vector borne diseases and to extreme weather events. Malnutrition is one of the worst outcomes of climate change. NFHS 5 showed that the level of stunting among children under 5 years in India has marginally declined from 38 to 36% between 2015-16 and 2019-20. Stunting is higher among children in rural areas (37%) than urban areas (30%). The prevalence of anemia among all six population groups covered in the National Family Health Survey 5 was > 52%, except for men and adolescent boys where it was 25-30%. Further, both under nutrition and overweight and obesity occur within the same family, community and even in the same individual sometimes, with anemia being pervasive. All nutrition and health indicators are worse in the lower socioeconomic groups.

Lack of Access to Nutritious Food

The current contribution of food production to Green House Gas (GHG) emissions is 26% i.e., one-quarter of the world's GHG emissions of which 18% is contributed by supply chains, 31% Livestock and Fisheries, 27% Crop production and 24% Land Use.

While hunger is a global problem, exacerbated by the Covid pandemic, conflicts in different parts of the world and the climate crisis, lack of access to nutritious food is growing. According to the 2023 Lancet countdown report, around 127 million people in 122 countries were experiencing moderate to severe food insecurity due to frequent heatwaves and droughts in 2021 and this number is likely to grow.

Food insufficiency is one of the causes of malnutrition, however, nutritional deficiencies in food is also a contrib-

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utor, a large population around the world consumes low quality diet which leads to many macro and micro nutritional deficiencies. According to FAO, 74% Indians are not able to afford a healthy diet and this is true of many countries. Further, only 11% infants are getting adequate quantity and quality of complementary feeds in India. To address this complex problem, we need not only targeted nutritional interventions, but a holistic and multisectoral health centered approach. For the first time during COP28, health was brought into the center of international climate action.

Environmentally Responsible Food Production

Environmentally responsible and sustainable food production is needed. The current contribution of food production to Green House Gas (GHG) emissions is 26% i.e., one-quarter of the world's GHG emissions of which 18% is contributed by supply chains, 31% Livestock and Fisheries, 27% Crop production and 24% Land Use. Around 70% of water extracted from nature is for food systems and it causes around 60% of the biodiversity loss.

Climate change also increases some pest populations which causes increased pesticide usage and this in turn causes the pests to develop resistance. Apart from direct pesticide exposure of farmers, people living in the surroundings and those who eat the exposed food or drink contaminated water are also impacted. Exposure to pesticides for long periods has been associated with neurotoxicity, cancer, asthma, reproductive disorders, allergies and asthma, cardiac diseases, diabetes and even DNA damage leading to infertility in males. Nitrogen compounds in the pesticides have been reported to cause neurodegenerative disorders like Parkinson's disease.

The livestock industry uses antibiotics as feed additives to maintain animal health. Animal products such as meat, milk, eggs, fish and honey, etc., and crops produced using water contaminated due to inappropriate recycling processes which have antibiotic residues can predispose to anti-Microbial Resistance (AMR), a major public health threat. It is clear that increasing food production using current agricultural and industrial

Millets as Alternatives

Rice is the staple food in many Indian states and India is the largest exporter of rice. Approximately around 3,500 litres of water is needed to produce 1 Kilogram of rice and it accounts for 10% of global methane emissions. Whereas, millets such as Ragi, Sorghum, pearl millet require less than 30% of water required for rice cultivation. Therefore, millets were identified as climate smart nutri cereals under National Food Security Mission and the year 2018 was declared as National Year of Millets. Based on the proposal by Indian Government, United Nations declared 2023 as the International Year of Millets.

Sustainable agricultural practices and resilient food systems are the keys to reducing GHG emissions.

processes will further contribute to the climate change burden. Sustainable agricultural practices and resilient food systems are the keys to reducing GHG emissions.

One Health Strategy

Climate smart, nutrition sensitive food production needs political will and multisector collaboration. FAO recommends a One Health strategy as part of the transformation of the agri-food system for the health of people, animals, plants, and the environment. The One Health concept emphasizes interactions between people, animals, plants, and the environment, recognizing the interconnectedness of human, animal, and ecological health. This can only be accomplished by incorporating a broad range of stakeholders and focusing on sustainable agriculture, animal, plant, forest, and aquaculture health, food safety, AMR, food security, nutrition, and livelihood security.

Under the umbrella of One Health, agro-biodiversity which includes crop and horticultural, microbial, animal and forest bio-diversities are well preserved. This is an important component of food security and also acts as a sustainable solution for climate change.

Reducing Emissions – A Collective

Effort

Therefore, a major shift in the behaviors to rebalance the food consumption to reduce emissions is the need of the hour. Changing the world's eating habits using diverse crops, sustainable agriculture and food practices, encouraging the consumption of regionally available crops (millets, legumes, and cereals), fish, and animals to build a low carbon society should be emphasized. Usage of biodegradable products, increasing greenery, rational usage of energy resources in order to preserve the biodiversity should be promoted. These collective efforts by all stakeholders contribute to reduce the ill effects of climate change and to build the health of the society.

Inclusion of Women

Finally, we have to remember that the impact of climate change is not gender neutral. The climate crisis disproportionately impacts women, who have responsibilities of securing food and water for their families and for caregiving in the household. The climate crisis is creating new threats to the health, livelihoods and human rights of women, worsening existing gender vulnerabilities. We need more women at the table – at national and international convenings - and empowerment of women in communities so that they can implement local solutions for adaptation and resilience. Tackling interdisciplinary challenges spanning nutrition, agriculture and food security, air pollution, water and sanitation and the health consequences of displaced populations need diverse and transformative leadership – both men and women!

IMPACT OF CLIMATE CHANGE ON FISHERIES SECTOR

Global climate change is having notable impacts on the environment, which include increasing trends in temperature, rising sea levels, acidification of the ocean water, and modifications in ocean currents. The supporting evidences for these impacts are abundant and diverse, derived from experiments in laboratories, observations of natural systems, and computer modeling. While the specific consequences may differ based on location, species, and other variables, the evidence indicates that the impacts are substantial and widespread, posing implications for the well-being and sustainability of marine ecosystems. The widespread influence of temperature on the biology and ecology of organisms, along with changes in natural environmental cycles, leads to shifts across ecosystems, including alterations in the distribution of fish stocks and the overall structure of ecosystems. Ocean acidification, resulting from increased carbon dioxide absorption, threatens species with calcium carbonate structures. Altered rainfall patterns impact estuarine ecosystems, crucial for saltwater-freshwater balance. Increased storm

frequency poses direct threats, causing habitat destruction and affecting life cycles. Changes in phytoplankton composition disrupt the food web, impacting fish prey availability. Rising sea levels jeopardize coastal habitats and breeding grounds, intensifying vulnerabilities.

Increase in SST linked to a decline in Fish Catch

Climate change is having a profound impact on marine fisheries in India, affecting both the distribution of fish species and the traditional fishing practices of local communities. Over the past two decades, there has been a marginal increase in sea surface temperatures (SST) in the North Indian Ocean and Bay of Bengal basins, signaling a potential shift in climatic conditions. In the last 45 years, the SST along the Indian coasts has increased by 0.2°C to 0.3°C. There has been a reduction in fish catch associated with the occurrence of climatic disturbances and extremes, such as depressions and cyclonic storms. It is estimated that a one-degree increase in SST corresponds to a significant reduction in total fish catch by approximately nine percent and a 13 percent reduction in

pelagic fish catch. Studies on Indian mackerel reveal negative effects of temperature and salinity, emphasizing the complex interaction between environmental variables and fishery dynamics. Small-scale fisheries which are the economic backbone of coastal communities, face risks from abnormal weather events, impacting livelihoods.

Shift in Marine Species' Distribution and Behaviour

Studies in the northern Indian Ocean quantified the anticipated alterations in key climate variables. Incorporating climate change models, the study systematically examines long-term forecasts involving SST, pH, sea level, salinity, rainfall, and chlorophyll. These variables play a critical role in shaping the marine environment, affecting the distribution and behaviour of aquatic species. The study highlights the impacts on productivity, vulnerability of ecosystems like coral reefs, and broader social implications. Elevated SST disrupts ecological balance, influencing marine species' distribution and behaviour. There has been a northward movement of both oil sardine and Indian mackerel species

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Seaweed rafts integrated with cobia cage (IMTA)

towards higher latitudes. The distributional and spawning shift of Indian oil sardine on the southwest coast of India, changes in the vertical distribution of Indian Mackerel, shift in the breeding season of threadfin breams and increasing landing of juvenile fishes are strong records indicating the impacts of climate alternations.

It is predicted that by 2030, around 78% of the Earth's Exclusive Economic Zones (EEZs) will undergo shifts in the distribution patterns of at least one fish stock. Climate change found to affect directly the recruitment and abundance of marine fish populations. Fish in their early life stages are dependent on oceanographic variables, the physical dispersal of eggs and larvae and other planktonic forms of life are also influenced by oceanographic processes, which are susceptible to climate variability and change. Climate-driven changes in primary productivity are influenced by winds and upwelling, followed by phenological changes found to affect lower trophic level coupling and eventually the food web and recruitment success of marine fish.

A Positive Trend in Carbon Emissions

Despite the adverse effects of climatic variables on fisheries, the marine sector in India exhibits a positive trend concerning carbon emissions. The study revealed that greenhouse gas (GHG) emissions from Indian trawlers were 16.3% below the

It is estimated that a one-degree increase in SST corresponds to a significant reduction in total fish catch by approximately nine percent and a 13 percent reduction in pelagic fish catch.

global average. With the global increase in emissions, the latest data indicates a further reduction, reaching 17.7% below the global average. This implies a noteworthy enhancement in the environmental friendliness of Indian marine fisheries. Over 40 years, a shift in the diet composition with the dominance of phytoplankton instead of zooplankton and copepods was observed for Indian Mackerel. This is an indication of the resilient strategy of the fish being able to adapt to climate change.

Wetlands and Climate Change

The wetlands are evidenced by depth reduction, shrinkage, eutrophication and increased incidence of toxic algal blooms leading to fish kills. Impact on the hatching of Indian major carps was observed with progressively increased temperatures upto 32°C, at which 95% survival rate was attained but no hatching was observed beyond 34°C. Extreme climatic events further threaten brackishwater aquaculture, causing significant yield reductions.

Brackishwater aquaculture is found to be more vulnerable in coastal districts on the east coast compared to the west coast. It is moderately vulnerable to seasonal variations (20-40% loss) and highly vulnerable to extreme weather events (EWEs) like floods, heavy rains, and cyclones (50 to 100% loss). Significant impact have been witnessed in ovarian maturation, spawning, and nursery rearing of shrimp and fishes beyond 32°C water temperature.

Adaptation Strategies in Aquaculture

Adaptation strategies in aquaculture encompass a comprehensive range of initiatives aimed at fostering climate resilience and sustainability. This includes the development of a climate-resilient carbon-neutral seaweed integrated multi-trophic mariculture package of practice. Additionally, efforts have been focused on the production of thermo-resilient Indian candidate mariculture species, Silver pompano (*Trachinotus blochii*), capable of withstanding temperatures 2.8°C higher than the ambient seawater temperature. Sea cage farming along with standardized seed production of stress-tolerant species could be successfully demonstrated for the farming of climate-resilient species and seed production. The implementation of low-cost cage farming has been successfully replicated in 31 climate-smart coastal villages. Indigenous seaweed-based mariculture packages have been developed, which are tailored for shallow coastal waters, particularly in locations such as Lakshadweep and Tamil Nadu coast. These systems, aiming to sustain economic, ecological, and social benefits, rely on factors such as genetic diversity, low stress, and efficient resource utilization. The concept of 'Integrated Multi Trophic Aquaculture (IMTA) i.e. sea cage farming of cobia (*Rachycentron canadum*) along with the rafts of seaweed *Kappaphycus alvarezii* found to be an important climate-resilient farming model with advantage of additional production of fish and seaweed. These technologies can be looked upon as diversified livelihood opportunities for the stakeholders who are affected by the climate crisis.

COP28: Addressing The Challenges Within Our Food Systems

Unnikrishnan Divakaran Nair is the Head of Climate Change at the Commonwealth Secretariat, where he plays a pivotal role in steering the climate change program. Before joining the Commonwealth Secretariat, Mr. Nair served at the UNFCCC in Bonn, where he held a crucial role in managing Climate Finance and National Adaptation Plans for Small Island States and Least Developed Countries. In his conversation with Anjana Nair, Group Editor, Agriculture Today, he discusses the results of recently concluded COP28 and the need to integrate climate aspects in program planning and policy implementation.

Pursuant to COP 28, there is euphoria surrounding inclusion of agriculture and food systems into the declaration. How elated are you?

I find it incredibly encouraging that in the recent COPs, the presidencies have consistently demonstrated a robust commitment to addressing the challenges within our food systems. Numerous countries have not only increased their awareness but have also pledged investments, recognizing the tangible impact of climate extremes on food systems and subsequent reductions in food availability. The critical next step is to observe how these pledges will materialize into concrete, real-time commitments and how nations will seamlessly incorporate these initiatives into their food system governance. This integration presents a formidable challenge. On the global stage, discussions surrounding this theme are abundant. It is intriguing to witness how countries will weave these climate action elements into their policies, actions, and budgeting. The significance of this COP 28 lies not only in its focus on food systems but also in conducting the first-ever global stocktake of NDC commitments by member countries. This serves as a crucial baseline, underscoring the importance of agriculture and food-based systems. As we eagerly anticipate the upcoming global stocktake, we have the opportunity

The significance of this COP 28 lies not only in its focus on food systems but also in conducting the first-ever global stocktake of NDC commitments by member countries.



to gauge the progress made against the established baseline, fostering optimism for positive developments ahead.

The final agreement, however, focused on adaptation, rather than mitigation. How do you view it?

In the last decade of COPs, a prevalent critique was that they leaned heavily towards mitigation efforts. However, the narrative has notably shifted in the recent past, with a heightened emphasis on adaptation. This shift could stem from the acknowledgment that despite our current actions, inevitable extreme events are on the horizon. Especially for developing countries, least developed nations, and small islands, the urgency to prepare and adapt has become paramount. It's truly gratifying to witness the increased prominence of adaptation in these discussions. This transition seems not only logical but also imperative, allowing us to address the challenges posed by climate change without neglecting the critical focus on mitigation.

Agriculture is a significant emitter of GHGs and also at the receiving end of climate change. If we compare both sides, which side outweighs the other?

In many developing countries, agriculture holds paramount significance, serving as a crucial sector for food security, livelihoods, and economic stability. Understandably, the emission aspect of agriculture often takes a backseat in the priorities of governments compared to adaptation efforts. In densely populated states, the government faces the formidable task of safeguarding citizens and ensuring their basic rights to food, livelihood, and economic security. Striking a balance in agricultural development, while addressing mitigation challenges, is a complex undertaking. The Government of India has previously asserted a stance that views agriculture not merely through the lens of mitigation but primarily as a realm for adaptation. A closer examination of India's national action plans reveals a substantial emphasis on the adaptive dimensions of agriculture. Concurrently, commendable

tête-à-tête with Anjana



It is crucial for both states and the central government to systematically infuse climate considerations into every facet of program planning and policy implementation.

strides have been made in streamlining the mitigation aspects of agricultural production.

Are there any explicit examples of how mitigation has been

addressed?

Certainly. Take, for instance, the digitization of soil records in India—an explicit commitment to rationalize fertilizer use based on soil nutrient status, a major contributor to agricultural emissions. Various multilateral agencies are steering initiatives like Direct Sown Rice (DSR) and the adoption of alternate wetting and drying in rice cultivation, demonstrating potential reductions in methane emissions to name a few. Notably, considerable focused action is unfolding on the mitigation front. However, countries exhibit a strong inclination towards approaching agriculture primarily through the lens of adaptation, hesitating to make firm commitments on mitigation due to its intricate ties to livelihoods, economics, and food security. This reluctance is compounded by the intricate management of diverse agricultural aspects across numerous departments and ministries. While substantial progress is evident in mitigation



endeavours, it is imperative to underscore the pressing need for increased financing, technology deployment, and capacity building on the adaptation front.

Does India have any plans/projects solely dedicated to climate change? To what extent these plans percolate to the field?

An illustrative case of the percolation of climate action into practical implementation is exemplified by the National Adaptation Fund for Climate Change of Government of India. Its establishment marked the commencement of numerous projects, yet a substantial portion of the implementation phase awaits activation at the state level. This necessitates a proactive role from the states in aligning climate change considerations with both centrally sponsored schemes and state-level programs. Particularly critical is the imperative for states to spearhead the seamless integration of climate change elements into major centrally sponsored and state initiated programmes and schemes. These large-scale endeavours must be attuned to the evolving climate landscape to enhance their coherence and mitigate investment risks for both the state and the central government. Presently, there are gaps in enhancing the dedicated focus on incorporating climate aspects into the planning of these critical infrastructure projects.

Any state that you consider to have done a commendable job in this area?

In my perspective, states like Madhya Pradesh, Rajasthan and Odisha stands out as states that have made significant strides in the realm of climate action, both in terms of institutional development and implementation. Similarly, the North Eastern States have demonstrated commendable innovation with projects like springshed development, specifically targeting perennial springs in mountainous regions. Another noteworthy initiative is Punjab's inventive project focused on a climate-indexed livestock-based insurance mechanism, addressing the challenges faced by high-yielding breeds introduced in the



northern part of India, particularly concerning the thermal humidity index. When temperatures and humidity exceed a certain threshold, these breeds cease to yield. The project's ingenious design aims to compensate farmers facing production losses during such periods, akin to a weather index insurance, showcasing a forward-looking approach.

How can financial instruments help the farmers in transitioning towards sustainable food systems?

A prime illustration to consider is organic agriculture, which simultaneously contributes to both mitigation and adaptation efforts. However, the inherent risk of yield reduction poses a threat to farmers' income. In this context, financial institutions play a pivotal role, with a strategic infusion of funds in the initial three years mitigating the impact of reduced yields and sustaining farmers' interest. The corporate sector, through CSR initiatives, and private entities can also be instrumental in supporting farmers. The adoption of blended financial instruments, combining grants with loans, serves to de-risk investments and bolster farmers' capacities. Models such as the System of Rice Intensification and System of Sugarcane Intensification present effective ways to curtail emissions, yet farmer skepticism persists. Grant programs should be instituted to instil confidence and encourage widespread adoption of these techniques.

Unfortunately, the contingency funds currently in place lack flexibility and timeliness. It is imperative to enhance their adaptability. Similarly, insurance schemes need robust improvement, incorporating

advanced technologies to increase efficacy.

At policy level, what changes can be made?

In Agriculture sector, climate change driven water scarcity, soil quality issues, and biodiversity loss are persistently perceived as issues that may only manifest in the long term. The agricultural sector grapples with the significant challenge of subsidized agriculture, resulting in both overuse and underutilization. It is crucial for both states and the central government to systematically infuse climate considerations into every facet of program planning and policy implementation. With great progress, still-climate considerations do not often secure a prominent position in resource allocation, planning, and expenditure. Furthermore, there is a noticeable lack of communication between different departments, highlighting the pressing need for improved coordination to address issues as complex and dynamic as climate change.

How can the sense of climate urgency created in the next generation?

Agricultural universities must overhaul their curriculum to include comprehensive insights into climate change. Graduates should be well-versed in understanding how every facet of agriculture influences and is impacted by climate change. This holistic approach aims to empower graduates to contribute significantly to sustainable agricultural practices and innovate in adaptation methodologies, bringing in a monumental shift in their preparedness for the challenges posed by climate change.

COP28: A DECISIVE MOMENT FOR AGRICULTURE

The 28th Conference of the Parties (COP28) stands as a defining juncture in our global battle against climate change. In a world where the urgency to reduce greenhouse gas emissions, adapt to a shifting climate, and safeguard biodiversity is paramount, agriculture emerges as a critical arena under scrutiny. Not only does agriculture contribute significantly to greenhouse gas emissions, but it is also profoundly susceptible to the impacts of climate change. COP28 offers an unparalleled opportunity to confront these pressing challenges head-on and pave the way for sustainable solutions within the agricultural sector.

The Critical Intersection of Agriculture and Climate Change

Agriculture, a linchpin of human civilization, sustains billions of people worldwide by providing sustenance, livelihoods, and economic stability. Yet, it is simultaneously a primary driver of climate change, responsible for roughly a quarter of global greenhouse gas emissions, chiefly stemming from livestock, rice cultivation, and synthetic fertilizer usage. The ramifications of climate change have already begun to reverberate through agriculture. More frequent and severe weather events, shifting precipitation patterns, and rising temperatures are causing diminished crop yields, heightened pest and disease pressures, and decreased livestock productivity. These hardships imperil global food security and jeopardize the livelihoods of countless farmers.

The Pivotal Role of COP28 in Tackling Agricultural Predicaments

COP28 offered an unprecedented oppor-

COP28 offered an unprecedented opportunity for the international community to confront the formidable challenges that climate change poses to agriculture.

tunity for the international community to confront the formidable challenges that climate change poses to agriculture. Key areas on the agenda included:

- 1. Emission Reduction:** At the forefront of COP28's mission was the development of strategies to curb greenhouse gas emissions from agriculture. This involved promotion of sustainable farming practices, curtailing deforestation for agricultural expansion, and fostering the adoption of renewable energy sourc-



Deepak Pareek with HE Mariam Almheiri Minister of Climate Change and Environment of UAE at World Economic Forum

About the **AUTHOR**

Deepak Pareek is an agriculture economist, a serial entrepreneur, investor, and ecosystem builder in the agriculture technology domain. He has 25 years of diverse experience working across 34 countries on various projects. He is a well-decorated technocrat honoured by World Economic Forum, UNDP and various global organizations.

es on farms.

2. **Adaptation and Resilience:**

COP28 placed a significant emphasis on bolstering the resilience of agricultural systems in the face of climate change. This entails substantial investments in research and technology to cultivate crops and livestock breeds that can withstand extreme weather events, as well as enhancement of irrigation and water management practices.

3. **Biodiversity Conservation:**

The intricate relationship between agriculture and biodiversity took centre stage at COP28. The importance of preserving biodiversity within agricultural landscapes was underscored, with a strong focus on practices such as agroforestry and organic farming that benefit both the environment and food production.

4. **Global Cooperation:**

Given the inherent interconnection between agriculture and climate change, international cooperation is indispensable. COP28 encouraged nations to collaborate, share knowledge, technology, and resources to effectively address agricultural challenges.

The time for action is now. COP28

COP28 holds the promise of a brighter, more sustainable future for agriculture—a future where we not only mitigate the impacts of climate change but also build resilient, thriving agricultural systems that nourish the world while safeguarding the planet

holds the promise of a brighter, more sustainable future for agriculture—a future where we not only mitigate the impacts of climate change but also build resilient, thriving agricultural systems that nourish the world while safeguarding the planet.

Major Actions for Agriculture at COP28

COP28 made significant strides in ad-

dressing agriculture and food systems amid climate change challenges:

COP28 UAE Declaration: Backed by 159 nations, this declaration commits to enhancing resilience for farmers, fishers, and food producers, promoting food security and sustainable agriculture. It emphasizes integrating food systems into climate plans and reducing emissions while improving soil health.

Global Stocktake and Adaptation Goal:

Food became a focal point in the Global Stocktake, recognizing food security's vulnerability to climate change. It called for multi-sectoral solutions, including resilient food systems, in climate action plans.

Alliance of Champions for Food Systems Transformation (ACF):

Launched during COP28, ACF, led by nations like Norway and Brazil, aims to boost food system resilience and sustainability while improving livelihoods. It accelerates progress in food systems transformation.

FAO's Global Roadmap: The FAO introduced a roadmap aligning with the UN's Sustainable Development Goals. It focuses on sustainable crop and livestock yields, reduced agricultural emissions,



less food waste, and sustainable diets to limit global warming.

Non-State Actor Commitment: Over 200 non-state actors, including companies, cities, farmers, and Indigenous People, committed to action on food systems, recognizing their pivotal role in addressing climate change.

Financial Support: Governments and foundations pledged \$519 million for sustainable food systems. This funding backs research and emissions reduction efforts, crucial for advancing sustainable food practices.

Financing the Future of Agriculture

During COP28, significant financial support was pledged for sustainable food systems. Here are the key details:

Total Funding Committed: A total of \$519 million was pledged by various governments, foundations, and organizations. This funding is aimed at supporting the next phase of global agricultural research and investments in key areas.

Beneficiaries of the Funding: A portion of this funding is destined for CGIAR, a global agricultural research consortium based in Rome. CGIAR plays a crucial role in developing sustainable agricultural practices and technologies. A Part of the funding is allocated for initiatives aimed at reducing emissions from livestock. Livestock production is a significant source of greenhouse gas emissions, and reducing these emissions is essential for sustainable food systems. Investments will also be made in reducing food loss and waste. Addressing food waste is critical for improving the efficiency of food systems and reducing their environmental impact.

Contributors to the Fund: The fund includes contributions from the United Arab Emirates (UAE), the Bill and Melinda Gates Foundation, and the Bezos Earth Fund, among others. These contributions reflect a growing recognition from both governmental and non-governmental sectors of the importance of investing in sustainable food systems.

Technical Cooperation Collaborative



(TCC): Alongside these funding commitments, a Technical Cooperation Collaborative (TCC) involving key agencies like the FAO and the World Bank committed to coordinate their support in partner countries, including those that had signed the COP28 UAE Declaration. This collaborative effort is crucial for ensuring that the funds are utilized effectively and that the initiatives have a broader impact.

Purpose and Impact: The financial support is a significant signal that governments and the philanthropic sector are ready to back the food and climate agenda. It demonstrates an understanding of the need for substantial investment in sustainable agriculture and food systems as part of the global response to climate change.

These financial commitments at COP28 highlight the increasing focus on and investment in sustainable food systems as a critical component of climate action.

COP28 is a pivotal moment for ad-

dressing the complex relationship between agriculture and climate change. It marked a significant step forward in integrating agriculture and food systems into the global climate action agenda, recognizing their critical role in achieving climate goals and sustainable development. The agriculture sector must transform to reduce its emissions, adapt to a changing climate, and protect biodiversity.

By prioritizing emission reduction, adaptation, global cooperation, and the involvement of farmers, COP28 has paved the way for a more sustainable and resilient agricultural future. Success stories and best practices from around the world provide a roadmap for achieving these goals, ensuring that agriculture continues to feed the world while mitigating its impact on the environment. The decisions made at COP28 will shape the future of agriculture and our ability to combat climate change effectively.

CLIMATE FINANCE

BUILDING RESILIENT AND SUSTAINABLE AGRICULTURAL ECONOMY

The UN has estimated that world population would reach 9.7 billion by 2050. To feed this escalating population, global food demand is expected to increase from 35% to 56% by 2050, necessitating agricultural expansion while straining natural resources.

Climate Change and Agriculture

Climate change adds an additional layer of challenge as agriculture is highly dependent on weather and climatic conditions. Climate change shrank agricultural yield by 21% worldwide between 1961 and 2021. Further, rising global temperatures are expected to lead to a 10-40% loss in crop productivity by 2100. Lower agricultural yields would have cascading effects on farmers' incomes, food security and livelihoods, exposing them to unfamiliar and unprecedented extremities.

Simultaneously, agriculture exacerbates climate change through GHG

Measures towards innovative financing mechanisms to scale up on credit enhancements, guarantees and interest subvention schemes need to be encouraged at policy level.

emissions arising from production-linked on-farm activities, animal husbandry, crop cultivation, land use, land use change and forestry. The AFOLU sector represents 22% of global GHG emissions, with agriculture contributing to 45% of methane and 80% of nitrous oxide emissions.

Climate change and agriculture, therefore, are critically intertwined. Since developing economies rely significantly on this sector, climate-related impacts are bound to affect economic drivers through productivity losses, reduced yields, and heightened food, energy, and water insecurity.

Strained Climate Financing

India, with 45.5% of its population employed in agriculture, is highly vulnerable and Indian government had estimated an annual economic loss in agriculture worth USD 9-10 billion in 2018 due to climate change-related events. Field and simulation models

project a 20% reduction in rainfed rice yields by 2050 and 19.3% reduction in wheat yields by 2050, if adaptation measures are absent.

Urgent action, therefore, is required towards adaptation and resilience which include finance. Globally, nations need USD 680 billion annually to tackle climate change within agriculture by 2030. However, only 22% of global climate-related development finance was allocated to AFOLU. Agri-food systems witnessed a dismal contribution worth 4% of global climate finance. Asia witnessed a stark 44% drop in funding. Closing this gap to enable the sector's climate resilient transition would require multiple stakeholders coming together.

Financing the sector has its limitations and farmers continue to face challenges due to high actual and perceived risks by capital providers. Smallholder farmers particularly, need long-term capital to boost growth and its unavailability hinders this. Greater risks, combined with high transaction and monitoring costs, serve as a deterrent, which are further impacted by low profitability, and low margins for financiers. This leads to limited capital flows and high borrowing costs, especially for climate adaptation and mitigation.

Resultantly, unavailability of capital



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on account of low risk mitigating financial products, accessibility of finance for various types of farmers, and unaffordability due to excessive interest rates, lead to farmers depending on informal sources like moneylenders, who charge exorbitant rates, creating a vicious circle of indebtedness.

Government Support

Many governments are supporting with schemes that go beyond conventional farming. India's multiple schemes to tackle impact of climate change on agriculture is improving the sector's. For example, National Adaptation Fund for Climate Change provides funds towards adaptation costs for climate related vulnerable areas. Projects like National Innovations in Climate Resilient Agriculture have been working to identify areas of vulnerabilities to design coping mechanisms and IMD's recent update on providing panchayat-level weather forecast data for farmers is slated to improve planning and help cut-down on climate-related losses.

With rising recognition of adaptation in agriculture, specific policy interventions or strengthening of existing policies would delineate explicit financial mechanisms and enhance capital flows. Capacity building and guiding farmers through a robust sustainable financial landscape can influence sustainable practices and improve capital access.

Policy Interventions

To foster transition towards sustainable farming practices and reducing sector's impact on climate, approaches like Climate Smart Agriculture (CSA) need to be mainstreamed into national policies. CSA encourages sustainable farming practices such as adoption of climate-resilient crop varieties, conservation techniques, agroforestry, precision farming, water management strategies and improved livestock management. It helps maximize productivity, enhance resilience, and lower GHG emissions, while providing a holistic solution to food insecurity and achieving sustainable development.

Measures towards innovative financ-

Blended finance has emerged as an effective instrument that attracts commercial capital and offers larger pool of funds for financing longer term and risky investments in high-risk sectors such as agriculture.

ing mechanisms to scale up on credit enhancements, guarantees and interest subvention schemes need to be encouraged at policy level. This would provide risk-based mechanisms and access to long term capital to banks and NBFCs to lend onward to farmers and FPOs for adopting sustainable farming practices. Towards this, opening central / state subsidies or leveraging CSR funds to support guarantee programs and/or blended finance funds could be an added advantage, as this would accelerate capital flows.

Regulatory guidance on climate risks management techniques by capital providers to include climate scenario analysis and stress testing, would facilitate navigation of these complex topics and emerge with climate risk-based pricing and tenures, that are factored in traditional risk management systems.

Alternate Financial Resources

Including climate as a sub sector in RBI's priority sector lending (PSL), categorised as nature-based solutions, and climate-related technologies, would help build momentum within PSL, beyond renewable energy and increase its allocation towards climate focused interventions in the agriculture sector.

The quantum of institutional funding required for anticipatory adaptation and climate resilience is huge, especially since climate sensitive sectors such as agriculture and forestry, contribute significantly to India's GDP. Therefore, a particular focus on adaptation finance, to prepare for and manage climate-related risks, need to be deployed by FIs at local level for activities such as irrigation management, crop va-

riety development, precision farming and crop-sensing technology.

Blended finance has emerged as an effective instrument that attracts commercial capital and offers larger pool of funds for financing longer term and risky investments in high-risk sectors such as agriculture. Replication of successful models such as AGRI3 Fund that supports sustainable agriculture investments in Central and South America, East Africa, and South Asia, would accelerate capital flows and bring scalability to climate related agricultural projects.

Building Social Capital

Gender equality and social inclusion, integrating vulnerable and marginalized communities, through financing will help to build resiliency in the face of climate shocks. Replicating proven models such as Ukama Ustawifrom Eastern and Southern Africa that support women and youth through financial inclusion and governance frameworks by providing soft loans and linkages to financial services, are enablers to gender and social inclusion.

Improving efficiency of rural credit bureaus and partnering with fintechs to source alternative data, would help FIs overcome the hurdle of information asymmetry by providing access to up-to-date information on the present and past credit behaviour. This would enhance the evaluation of the credit worthiness of borrowers, significantly lowering monitoring and transaction costs for FIs, and speed of access to finance for farmers.

Awareness and capacity building programs for farmers, alongside existing schemes, can help advance towards sustainable farming and deepen adoption of technology for CSA transition.

Bolstering climate finance mechanisms, intensified by efforts from policy-makers, financial sector players and farmers, is vital for India to meet its Nationally Determined Contribution of reducing emission intensity by 45% and SDG goals by 2030. A partnership approach such as this would go a long way in unlocking climate smart financing solutions, whilst supporting a just transition.

FARMING FOR THE FUTURE

A FARMER'S FIGHT AGAINST CLIMATE CHANGE

In a world grappling with environmental challenges, the significance of sustainable agriculture has never been more evident. As we confront the consequences of climate change and endeavor towards a greener future, it becomes increasingly clear that sustainable practices are imperative. Ravichandran Vanchinathalyer, a farmer from Tamil Nadu, India, whose commitment to eco-friendly farming practices has earned him recognition within Corteva's esteemed Climate Positive Leaders Program.

Journey towards Sustainable Agriculture

Ravichandran, a graduate in Mathematics, defied conventional career paths in 1985 to embark on a transformative journey toward sustainable agriculture. His motivation stemmed from the belief that agriculture presented unique challenges and financial prospects, coupled with the opportunity to make a positive impact

on society. Recognizing the need for a paradigm shift from maximizing yields to considering the long-term well-being of the land and environment, Ravichandran initiated eco-friendly practices, focusing initially on rice cultivation.

This journey involved adopting drip irrigation, optimizing fertilizer use, implementing intercropping, and selecting rice varieties suited to local conditions. The result was not just increased crop yields but a profound reduction in water consumption, decreased methane emissions, and a significantly smaller carbon and water footprint.

In Tamil Nadu, where Ravichandran's farm is situated, environmental challenges such as water scarcity, methane emissions, and shrinking arable land due to urbanization are prevalent. Sustainable agriculture practices, including drip irrigation, improved fertilizer application, and strategic crop selection, have been pivotal in mitigating these challenges.

Drip irrigation emerged as a game-changer, allowing Ravichandran to use

water more efficiently. Through strategic fertilization methods and the selection of environmentally friendly rice varieties, he achieved a remarkable 50 percent reduction in water consumption, simultaneously reducing methane emissions and his carbon footprint.

Commitment beyond Cultivation Methods

Adopting a zero-plastic waste/zero pollution approach, composting, crop rotation, and forestry projects have further enhanced soil health and supported carbon sequestration. He strategically converts farm waste into wealth, exchanging straw for cow dung from cattle owners and transforming it into compost using microorganisms. By composting residues in the same field, he not only enriches the soil but also addresses the logistical challenge of transporting farm waste to compost pits.

Engaging and educating fellow farmers is central to Ravichandran's mission. Utilizing agriculture forums, social media, and farmer-to-farmer communication, he shares his experiences and insights, particularly focusing on eco-friendly rice cultivation and water conservation.

Micro meetings in fields, WhatsApp groups, and advocacy for modern farming technologies are some of the avenues through which he connects with farmers locally and globally, inspiring them to adopt sustainable practices. He has handpicked farmers in his region who are not only receptive to sustainable farming practices but also serve as ambassadors, spreading the message to more farmers.



Ravichandran's journey exemplifies how sustainable agriculture can be both economically viable and environmentally beneficial, paving the way for a greener and more sustainable future in agriculture.

Through strategic fertilization methods and the selection of environmentally friendly rice varieties, he achieved a remarkable 50 percent reduction in water consumption, simultaneously reducing methane emissions and his carbon footprint

between Environmental Benefits and Economic Viability

While embracing sustainable farming practices, Ravichandran stresses the need to strike a balance between environmental benefits and economic viability. In the pursuit of sustainability, if production and productivity are compromised, and farm produce becomes unaffordable for consumers, the entire system may struggle to sustain itself economically.

To ensure the adoption of sustainable farming practices by farmers, the focus should be on technologies that not only enhance production and productivity but are also environmentally friendly. Ravichandran has leveraged BT Cotton, the only genetically modified crop approved for cultivation in India, to its maximum potential. Not only does it demonstrate increased yield and cost reduction, but it also eliminates the need for insecticide spraying, showcasing the potential of technologies that benefit both farmers and the environment.

Corteva's Climate Positive Leaders Program: A Global Acknowledgment

Ravichandran's contributions have not gone unnoticed, as he has been acknowledged by Corteva's Climate Positive Leaders Program. While he appreciates the personal recognition, he views it as an opportunity to share his experiences globally. As a leader in the program, he has a platform to discuss climate-positive practices and engage in conversations with policymakers, government officials,

and fellow farmers.

The recognition provides him with a lifetime membership and training from the Global Farmer Network, enabling him to refine his sustainable farming practices. This opportunity allows him not only to continue evolving his methods but also to engage in broader conversations about the agriculture industry with stakeholders worldwide.

The Future of Sustainable Agriculture

Looking ahead, Ravichandran envisions a future of farming where innovation and technology play a crucial role in advancing sustainability. Embracing biotechnology, precision agriculture, data-driven farming practices, and sustainable farming methods will be key. He emphasizes the importance of science-based proven technologies that not only enhance farmers' income but also contribute to environmental preservation. Ravichandran's

journey exemplifies how sustainable agriculture can be both economically viable and environmentally beneficial, paving the way for a greener and more sustainable future in agriculture.

Ravichandran's story serves as an inspiration for farmers globally, proving that eco-friendly practices not only preserve the environment but also contribute to enhanced productivity and livelihoods. His commitment to sustainable agriculture has not only earned him recognition but has also positioned him as a torchbearer for a new era in farming. As we navigate the complex landscape of environmental challenges and technological advancements, his experiences offer valuable insights into the possibilities and potential pitfalls of sustainable farming.

The future of agriculture lies in the hands of visionaries like Ravichandran, who understand the delicate balance between nurturing the land and reaping its bounty. Through continuous education, advocacy, and the adoption of innovative technologies, farmers worldwide can join hands in cultivating a sustainable tomorrow, where the fields are not just a source of livelihood but a testament to our commitment to the planet.



NOURISHING THE PLANET WITH PLANT-BASED FOODS CHOICES

As we step into the year 2024, our world still finds itself grappling with the undeniable impacts of climate change. From unpredictable weather patterns to surprising changes in Himalayan snowfall, the signs of a warming planet surround us. At the heart of this crisis lies our food system, a major player in climate change and a leading cause of biodiversity loss.

Our current method of producing food, heavily reliant on animal agriculture, is causing significant problems. Besides the coal and petroleum-based energy sectors, including automobiles, one of the most important contributors to climate change is the meat and dairy industry. It contributes significantly to greenhouse gas emissions, deforestation, and land degradation. Livestock, especially animals like cattle, emit methane during digestion, a potent greenhouse gas that exacerbates the climate crisis.

Livestock and Climate Change

According to the Food and Agriculture Organization (FAO), the livestock sector is responsible for about 14.5% of global greenhouse gas emissions. Methane is approximately 28 times more potent than carbon dioxide in terms of its global warming potential over a 100-year period. Currently, India is the world's fourth-largest methane emitter.

Raising animals for meat is not a very

efficient process. Chickens and other animals need a lot of feed before they are ready for slaughter. In fact, it takes around 4 kcal of energy to produce just 1 kcal from them. This highlights that the current cruel animal-based food system may not be sustainable in the long run.

The Urgency of Change

With glob-

According to the Food and Agriculture Organization (FAO), the livestock sector is responsible for about 14.5% of global greenhouse gas emissions.



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al temperatures rising, action is crucial. If we want to limit the rise in temperature to 1.5 degrees or less, transforming our food systems is imperative. Without quick changes to reduce emissions, adapt to climate impacts, and produce food sustainably for our growing global population, we will face a daunting challenge. Shifting to plant-based diets is a key strategy to combat climate change.

The EAT-Lancet Commission report indicates that embracing plant-based diets can help us reach environmental sustainability goals, including reducing greenhouse gas emissions and protecting biodiversity. Dr. Tedros Adhanom Ghebreyesus, the Director-General of the World Health Organization, stressed the urgency of shifting to plant-based diets during COP28, emphasizing that it is not just about personal health but is "essential" for the well-being of both people and the planet.

Changing the Ecosystem

Shifting to plant-based foods can significantly reduce greenhouse gas emissions. By 2035, the switch to plant-based meat and eggs alone could prevent the emission of over 1 gigaton of CO₂, equivalent to making Japan entirely carbon-neutral for a year.

Additionally, embracing plant-based foods addresses the impending challenges of food security. With nearly 10 billion people expected on Earth by 2050, there is a considerable gap between current food production and the amount needed to feed everyone. Plant-based foods can provide a sustainable and efficient solution to meet the nutritional requirements of a growing population.

How Plant-Based Foods Contribute

Across the globe, innovative companies are utilizing ingredients such as mung beans, yellow peas, and rice to create plant-based alternatives that mimic the taste of meat and eggs. By providing a diverse array of plant proteins and promoting agricultural biodiversity, India can attract global corporations, fostering a sustainable shift in dietary choices.



By 2035, the switch to plant-based meat and eggs alone could prevent the emission of over 1 gigaton of CO₂, equivalent to making Japan entirely carbon-neutral for a year.

Plant-based foods, particularly those derived from pulses and millets, offer a climate-resilient alternative. These crops thrive in diverse and challenging environmental conditions, contributing to a more sustainable and resilient food system. Boosting agricultural productivity sustainably is a priority in the race to revamp food systems, allowing farmers to produce higher quality food, support growing populations, and enhance their livelihoods while mitigating the impact of agriculture on climate and natural resources.

Plant-based farming is generally more environmentally friendly compared to traditional animal farming. Crops like pulses naturally enrich the soil with nitrogen and trap carbon, aligning farming practices with sustainable development goals and supporting India's aim to achieve net-zero emissions by 2070.

Health Outcomes of Plant-Based Foods

In a world where more than 820 million people suffer from insufficient food, plant-based diets emerge as a beacon of hope. Despite global food production meeting caloric demands, a significant portion of the global population faces food insecurity and malnutrition, leading to various health issues, including obesity and diet-related non-communicable diseases.

The positive impact of plant-based diets on health is evident in studies supported by institutions like the American Heart Association and the American Institute for Cancer Research. Plant-based eating is associated with overall mortality reduction, lower ischemic heart disease mortality, reduced medication needs, sustainable weight management, and a lower incidence and severity of high-risk conditions such as obesity, hyperglycemia, hypertension, and hyperlipidemia. Remarkably, plant-based diets have shown potential in reversing advanced cardiovascular disease and type 2 diabetes.

As we navigate the challenges posed by climate change, our dietary choices become a powerful tool for positive change. Shifting towards plant-based diets is not just a personal decision but a collective commitment to a healthier planet. Let us embrace the nourishing power of plant-based foods, fostering both individual well-being and a sustainable future for generations to come.

From Ashes to Action

Addressing India's Crop Residue Burning Crisis

Burning of Kharif Crop Residue in India, 2022, derived from MODIS Data

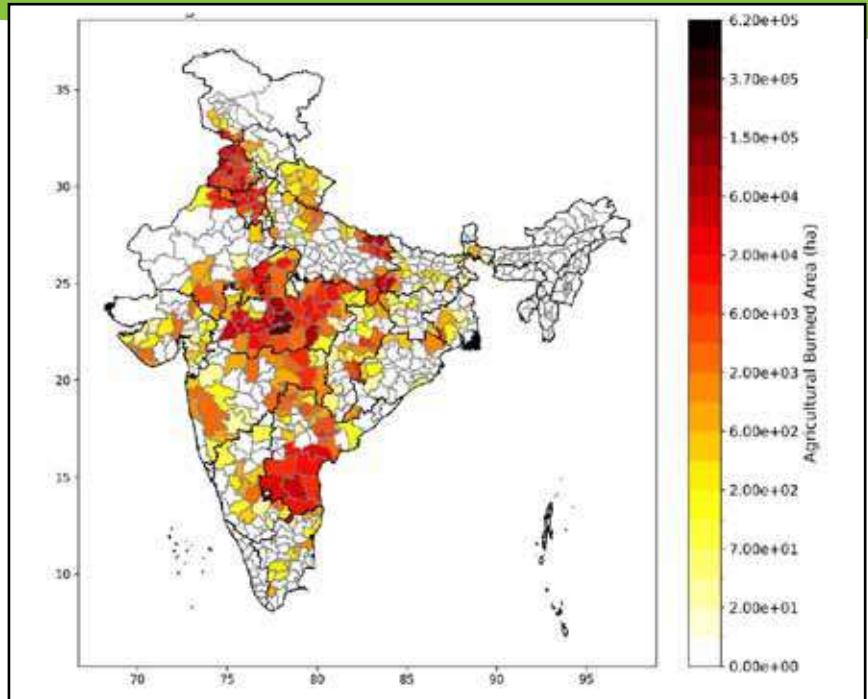
Crop residue burning, a common practice of agricultural biomass management, offers a cost-effective solution for residue clearance and pest/disease/weed control. However, its widespread adoption in India has escalated into a serious environmental and health concern. This practice significantly contributes to air pollution, particularly increasing particulate matter levels and poses severe risks to public health. Furthermore, the burning of crop residue releases greenhouse gases (GHGs), contributing to global warming. It also adversely impacts soil health. Exploring alternatives for sustainable crop residue usage and reducing the incidents of residue burning is crucial for India's commitment to climate change mitigation and for achieving broader sustainable development goals.

Why burn the residue?

Despite the severe health externalities associated with emissions, farmers continue to burn crop residue in India. Understanding the reasons behind this practice is essential to curb it.

- **Time and Cost Efficiency:** The government regulation (Punjab Preservation of Subsoil Water Act of 2009) that mandated delaying the transplanting of paddy to June 10 and beyond to conserve groundwater, ricefarmers are often left with a short window to prepare their fields for the rabi crop. Many farmers consider burning the residue as the quickest and cheapest way to clear the field.

- **Lack of Alternative Uses:** While mechanized harvesting and other agronomic technologies inadvertently increase the labour required for sustainable residue management, there are few economical options



for the use of agricultural residues. While residue can be used as fodder, in bioenergy production, or for making biochar, the lack of infrastructure and market demand in many parts of India limits these options. Although there are machines to incorporate

residue into soil (e.g., Happy Seeder), they have yet to gain popularity.

- **Lack of Awareness and Misconceptions:** Some farmers believe that burning residue returns nutrients to the soil, although this is a misconception. In reality,

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According to a recent study, published in the *Science of the Total Environment*, the annual crop burning emissions had increased by 1.3 tons of carbon dioxide equivalents (t CO₂e) per hectare during the 2011-2020 period, with over half of the emission events occurring in Northwest India. Punjab has emerged as the leading contributor. Interestingly, there has been a surge in crop burning outside the Indo-Gangetic Plains. Madhya Pradesh, traditionally not considered to be a major contributor, has now become the second largest emitter. Among the crops, rice and wheat were responsible for about 89% of the estimated emissions, with rice residue burning contributing the most emissions (55%), followed by wheat (34%).

burning destroys nutrients and can harm soil health in the long term. Farmers might not be fully aware of the environmental damage caused by burning stubble or of the alternative methods available. Also, farmers are afraid that keeping residue in the field increases rodent and termite infestation and enhances weed growth.

- **Absence of Strict Enforcement:** While there are laws and regulations against stubble burning in many states, enforcement is often lax. The absence of stringent penalties or their ineffective implementation allows the practice to continue.

How to reduce burning incidents?

There is an urgent need for policy interventions and innovative agricultural practices to address the challenges of residue burning. The existing approaches can be broadly categorized into technological innovations, policy interventions, and evolving market-based mechanisms.

Technological Innovations:

Biological or chemical treatment of rice straw to improve quality and digestibility could increase demand from the livestock sector. Certain emerging uses (e.g., biochar production) can also create demand and increase the market price of crop residues, disincentivizing farmers to burn them.

Going for short-duration rice varieties will provide farmers with a wider window to manage crop residue. Moving away from the conventional rice-wheat cropping system to crops with nutritionally more valuable residue can be a suitable alternative.

Technologies that increase the feasibility of residue retention on farms, such as those utilizing microbes for faster residue



PHOTO CREDIT: Abdullah Thaseem, CIMMYT

The carbon markets provide financial incentives for farmers to adopt regenerative residue management practices.

degradation and zero tillage are useful approaches. Zero tillage with residue retention is an important technological intervention that has been promoted by international agricultural R&D organizations in the Indo-Gangetic Plains.

Policies and Standards:

India has developed the National Policy for Management of Crop Residue (NPMCR) to control residue burning and promote in-situ crop residue management. Its effective implementation can curtail residue burning.

The provision of machinery, such as stover choppers and zero tillage drills, at subsidized rates and setting up demon-

stration plots can enhance the sustainable use of crop residue. In India, the agricultural R&D sector focuses on promoting technology-based solutions in a similar way, especially in Punjab.

Evolving Market-Based Mechanisms:

The Indian government's move to ask the National Thermal Power Corporation to use crop residue pellets mixed with coal for electricity generation is an example of promoting market-based mechanisms.

Participation in voluntary carbon markets and regenerative agricultural practices with residue retention can help increase soil organic carbon and reduce GHG emissions. The carbon markets provide financial incentives for farmers to adopt regenerative residue management practices. However, challenges exist in building an effective carbon market, such as designing monitoring platforms to support global initiatives to increase soil organic carbon. Also, carbon credit payments may not be feasible in areas where residue burning has already been banned (e.g., Punjab).

To conclude, the challenge of increasing crop residue burning in India calls for multifaceted and region-specific interventions. The effectiveness of these strategies depends on the regional context, the involvement of stakeholders, and the integration of these approaches into the agricultural systems. While technological innovations provide practical options for residue management and policy interventions and offer necessary regulatory frameworks, evolving market-based mechanisms could incentivize sustainable practices. It is crucial to balance these approaches with the realities of local farming practices, which requires collaboration among governments, farmers, scientists, and industry stakeholders. Ultimately, addressing the challenges of residue burning is not just about mitigating environmental impact but also about enhancing the sustainability and resilience of agricultural systems in India. The successful management of crop residues holds the key to achieving India's climate change mitigation goals and ensuring environmental health, both locally and globally.

GM MUSTARD — AN ABSOLUTE NECESSITY

GM crops have shown great promise in increasing crop yields since their cultivation started in 1996 with around 1.7 million hectares. Currently, GM crops are cultivated globally in around 200 million hectares. In India, Bt cotton is the only GM crop that is commercially grown since 2002 in about 11.5 million hectares. Rapid adoption of Bt cotton has resulted in substantial increase in cotton production from about 14 million bales in 2002-03 to 37 million bales in 2021 and reduction in pesticide usage by about 39%.

India heavily depends on imported edible oils, to the tune of around Rs. One lakh crore annually. For increasing productivity and production of oilseed crops, adoption of science-based technologies such as genetic engineering and genome editing as a supplement to conventional breeding methods, has become an absolute necessity.

As a step forward in this direction, India has recently environmentally released the GM Mustard hybrid and its two GM parental lines with the barnase/barstar gene system developed by CGMCP, University of Delhi. The bar gene confers resistance to herbicide, which is essentially required for hybrid seed production and to maintain high hybrid seed purity. The GM parental lines will provide an opportunity to transfer the two genes through conventional breeding into diverse parental lines for developing more high-yielding hybrids, and with added traits such as disease resistance and improved oil quality.

The three genes used in the Indian GM mustard have been earlier deployed in rapeseed, also called Canola, for hybrid seed production. Hybrids using this system have been growing in Canada, USA,

and Australia for the last 20 years.

A major emphasis is currently needed on accelerating the process of genetically improving crops grown in India for increasing food production and becoming self-reliant. We require superior crop varieties and hybrids that provide enhanced yields, possess wide adaptability across environments and climate resilience, and have high input-use efficiency of natural resources. Now that a versatile hybrid seed production system using the barnase/barstar genes has been deployed in mustard and the resultant hybrid DMH-11 gives an advantage of about 25 % more yield over the existing parental lines, it is expected that this would help reduce the country's dependency on import of edible oils.

GM food crops have been in cultivation around the world for many years and have proven beyond doubt to be safe for human consumption. Currently, more than 90% of oilseed crop in Canada are GM hybrids. Recently, in October 2022, Australia has released GM Indian mustard for cultivation.

The high yielding GM mustard in India has been developed using the same technology that has been deployed in rapeseed in Canada with some modifications. This technology has already been well-



tested, and used effectively to develop and commercialize GM mustard hybrids (Canola) on a large scale in Canada for a long time. It will be in India's interest to pursue this technology for increasing domestic oil production.



About the **AUTHOR**

Dr. KC Bansal has research interests in genome engineering and functional genomics, and is the Former Director, National Bureau of Plant Genetic Resources (ICAR) and Secretary, National Academy of Agricultural Sciences.

DO WE NEED GM MUSTARD AT ALL?



What is GM mustard, and why is its desirability the subject of debate among scientists and non-scientists alike? Its technical name is Dhara

Mustard Hybrid 11 or DM H11 and it is a genetically engineered crop (GM crop) which has used a technology using the Bar-Barnase-Barstar gene system to create a hybrid mustard plant. GM mustard is a herbicide tolerant (HT) crop because the Bar gene confers the Herbicide Tolerant (HT) trait.

The scientists who developed DMH 11 claim it to be higher yielding than existing mustard varieties. However, mustard scientists point out that the existing non GM hybrids NDDB-DMH 1, NDDB DMH 3 and NDDB DMH 4 have higher yields than the GM DMH 11. So why do we need the GM DMH 11?

However, for me the most worrying aspect is the fact that DMH 11 is a herbicide tolerant (HT) hybrid and thus against the interest of farmers. The HT technology controls weeds by spraying chemicals that kill all plants that do not carry the HT trait, essentially all the biodiversity near the fields. This biodiversity is considered to be weeds in monoculture farming but not in the Indian context.

These so called weeds like bathua and chaulai ka saag are useful plants providing the farm family food and nutrition at no cost. Plants that are not eaten by the farm family serve as fodder for

the livestock that rural families keep as additional food and income sources. In a fodder deficit country like India, destroying green fodder by spraying herbicides is foolish.

Cultivating HT crops with their partner herbicides would kill the surrounding vegetation and deprive rural communities of the medicinal plants which form the basis of indigenous healing traditions. This would deprive village communities of crucial health and veterinary care opportunities.

Apart from this, using HT crops would make it impossible to do intercropping and mixed farming which is done to provide additional food and increased farm incomes. Traditionally, farmers usually plant more than one crop in the field. Mixed cropping is widely practiced, with differing combinations of crops depending on the region. Often farmers will grow crops like yams, ginger or vegetables on the bunds surrounding rice fields. Thus two or three kinds of produce are available from the field in the same season. This advantage would be lost if the package of herbicide tolerant crop varieties and herbicide use would be implemented.

As can be seen, there are several reasons why the adoption of HT technology in Indian agriculture is detrimental to our interests. The Technical Expert Committee appointed by the Supreme Court to provide expert advice on the matter of GM crops had in fact recommended a ban on the adoption of Herbicide Tolerant technology. Any government wanting to improve the lot of farmers, let alone double their incomes, cannot possibly adopt HT technology in any crop.



About the AUTHOR

Dr Suman Sahai is a scientist trained in genetics and founder chairperson of the Gene Campaign

SOIL RESTORATION A CRITICAL FRONTIER IN CLIMATE CHANGE MITIGATION

As the global community grapples with the escalating challenges posed by climate change, a growing consensus is emerging that innovative and sustainable solutions must be sought across multiple fronts. Among the myriad strategies for mitigating climate change, soil restoration emerges as a critical frontier, offering not only carbon sequestration but also a host of other ecological and agricultural benefits. Soil restoration assumes importance in the fight against climate change and holds immense potential in facing unprecedented environmental challenges.

The Role of Soil in Climate Change Mitigation

Soil, often overlooked in the broader discourse on climate change, plays a crucial role in both carbon sequestration and the overall health of ecosystems. Healthy soil acts as a reservoir for carbon, storing substantial amounts of it in the form of organic matter. However, unsustainable land management practices, deforestation and industrial agriculture have led to soil degradation, compromis-

ing its ability to sequester carbon effectively.

Soil degradation not only contributes to the release of carbon dioxide into the atmosphere but also diminishes the soil's capacity to support plant life and retain water. This, in turn, exacerbates the effects of extreme weather events, such as droughts and floods, which are becoming increasingly common due to climate change.

Soil Restoration as a Carbon Sink

Implementing soil restoration

Soil degradation not only contributes to the release of carbon dioxide into the atmosphere but also diminishes the soil's capacity to support plant life and retain water

techniques can turn the tide by enhancing the soil's capacity to sequester carbon. Practices such as cover cropping, agroforestry, and regenerative agriculture promote the accumulation of organic matter in the soil, acting as a carbon sink. By restoring degraded soils, we not only sequester carbon but also mitigate the release of greenhouse gases into the atmosphere.

About the AUTHOR

Melind Deshpande, Founder and CEO of BhoomiSeva, HCF Tech Services Private Limited and distributor for Bhu-Vision (Krishi-RASTAA) which is an IOT based automated soil testing manufactured by HiMedia Labs and a agronomy advisory platform developed by KrishiTantra.



The Carbon-Negative Potential of Soil

Beyond mere carbon sequestration, certain soil restoration practices have the potential to achieve carbon negativity. Biochar, for example, involves converting organic waste into a stable form of carbon that can persist in the soil for centuries. This approach not only sequesters carbon but also enhances soil fertility and water retention, contributing to more resilient and productive ecosystems.

Biodiversity and Soil Health

Soil restoration goes beyond carbon sequestration, addressing the broader issue of biodiversity loss. Healthy soils support diverse microbial communities, which play a pivotal role in nutrient cycling, pest control, and overall ecosystem resilience. By restoring soil health, we promote biodiversity, creating ecosystems that are more resilient to climate change impacts.

Water Management and Soil Restoration

Soil restoration also plays a key role in sustainable water management. Healthy soils have better water retention capacity, reducing the risk of both drought and flood events. By restoring degraded soils, we contribute to the overall resilience of landscapes, protecting communities from the adverse effects of extreme weather events exacerbated by climate change.

Empowering Local Communities

Soil restoration is not only a global imperative

By restoring degraded soils, we not only sequester carbon but also mitigate the release of greenhouse gases into the atmosphere

but also an opportunity to empower local communities. Adopting sustainable agricultural practices and regenerative land management techniques can enhance food security, improve livelihoods, and promote community resilience in the face of climate change.

Case Studies in Soil Restoration

Numerous successful initiatives around the world demonstrate the potential of soil restoration in mitigating climate change. In China, the "Grain for Green" program has led to the reforestation of millions of hectares of degraded land, resulting in increased carbon sequestration and improved ecosystem services. In Africa, the push for sustainable land management practices, such as agroforestry and conservation agriculture, aims to restore soil health and enhance resilience to climate change.

The Importance of Policy Support

While grassroots initiatives are crucial, the widespread adoption of soil restoration prac-

tices requires supportive policies at local, national, and international levels. Governments, agricultural organizations, and global institutions must incentivize and promote regenerative practices through financial mechanisms, subsidies, and educational programs.

Soil Restoration – Critical Frontier

Cultivating hope in the face of climate change requires embracing innovative solutions that address the root causes of environmental degradation. Soil restoration stands out as a critical frontier in climate change mitigation, offering a multifaceted approach that goes beyond carbon sequestration. Agroecology, an approach that emphasises sustainable and biodiverse farming systems, is gaining traction as a means to restore and maintain soil health.

Practices such as crop rotation, intercropping and the use of organic fertilizers not only improve soil fertility but also contribute to the resilience of agricultural systems in the face of climate change. By prioritising the health of our soils, we not only contribute to the global effort to combat climate change but also build more resilient and sustainable ecosystems for generations to come. It is time to recognize the transformative potential of soil restoration and harness its power in cultivating a more hopeful and sustainable future.

Hyperspectral Technology

FOR EFFICIENT AND SUSTAINABLE AGRICULTURE

The hyperspectral sensors in agriculture possess the ability to discern subtle variations in the colour and reflectance of plants, thereby playing a pivotal role in the early identification of diseases, pest infestations and nutrient deficiencies

What is the scope of hyperspectral sensors in agriculture?

The hyperspectral sensors in agriculture possess the ability to discern subtle variations in the colour and reflectance of plants, thereby playing a pivotal role in the early identification of diseases, pest infestations and nutrient deficiencies. They facilitate precision agriculture with invaluable insights for optimizing crop management, resulting in higher yields and reduced resource wastage. The integration of hyperspectral technology has the potential to transform farming prac-

tices, making them more efficient and sustainable.

Moreover, hyperspectral sensors, when deployed with drones, are instrumental in capturing essential agricultural parameters such as plant height, plant canopy cover, panicle formation, flowering days, disease severity, water stress, and chlorophyll content, requiring minimal human intervention while minimising errors and biases. This technological synergy empowers farmers with precise and reliable data, further enhancing the efficiency and productivity of agriculture.

How practical is it in Indian agriculture?

Hyperspectral sensors possess the adaptability to monitor and analyze the specific requirements of a wide array of crops grown across diverse agro-climatic regions of India. This versatility renders them highly practical, regardless of the crop type or geographical location. Hyperspectral sensors excel in their ability to detect early signs of pest and disease threats, enabling timely and targeted interventions. Precision in nutrient application is pivotal for crop health and yield enhancement and hyperspectral sensors empower farmers to assess nutrient deficiencies accurately and make data-driven decisions regarding fertiliser application.

Amandeep Panwar
Director & Co-founder, Bharat Rohan

India's variable rainfall patterns necessitate efficient water management in agriculture. Hyperspectral sensors prove invaluable by identifying signs of water stress in plants. This technology, especially when integrated with drones for data collection, can be scalable even for small holder farmers. It can be adapted to suit the needs of small farms, by providing them with access to advanced agricultural practices. The Indian government's favourable policy environment aligns seamlessly with the practicality and potential of hyperspectral sensors to modernize and optimize farming practices.

Bharat Rohan has been working with Indian farmers in this area. How did you convince the farmers about the effectiveness of this technology?

Since 2016, Bharat Rohan has been at the forefront of working closely with farmers to empower them with real-time data collected through drones equipped with hyperspectral sensors.

Our success in convincing farmers about the effectiveness of hyperspectral technology can be attributed to our holistic approach, which included training sessions on advantages of precision agriculture, localised communication by trust-building, offering tailored solutions, and maintaining long-term engagement with the farmers.

We customized our services to suit the specific needs and challenges faced by smallholder farmers making the technology more relevant and practical to meet their requirements. We provided them with data about their crop and they experienced tangible benefits of increase in profits and reducing the cost of cultivation.

What are drone swarms? What is their relevance in agriculture?

Drone swarms are groups of multiple drones that work together in a coordinated manner to achieve specific objectives, often communicating with each other for efficient and collaborative operation.



Drone swarms offer a distinct advantage in agriculture by significantly enhancing efficiency and data collection.

Drone swarms offer a distinct advantage in agriculture by significantly enhancing efficiency and data collection. These coordinated groups of drones can cover extensive fields quickly, providing timely and comprehensive data on crop health, pest infestations, and field conditions. This real-time information empowers farmers to make informed decisions, optimize resource usage, and ultimately improve crop yields and sustainability.

How is the policy environment in India for drone startups?

The policy environment for drone startups in agriculture-related applications in India has improved over time. The government has recognized the potential of drones in agriculture and has introduced specific regulations and initiatives to support their use. These policies have streamlined the process for obtaining permissions to oper-

ate drones in agriculture, making it easier for startups to offer drone-based services to farmers. Additionally, the government's focus on promoting technology-driven agriculture aligns with the goals of drone startups in the agricultural sector, creating a conducive environment for innovation and growth in this field.

What are the advancements in Drone Technology?

Longer flight times due to battery technology improvements enable drones to cover larger agricultural fields efficiently. Miniaturization has resulted in more portable drones, enhancing their ease of use and deployment in agriculture. Advanced sensors, such as hyperspectral and LiDAR, enable precise data collection for agriculture applications like crop health monitoring and soil analysis. Obstacle detection and avoidance systems reduce the risk of accidents during drone flights, ensuring safe and reliable operations. Drones can now operate in coordinated swarms, enhancing their application in agriculture, where multiple drones can efficiently cover vast areas. Drones offer higher-resolution cameras and thermal imaging, improving performance in tasks like aerial photography, crop monitoring, and search and rescue.

HYDROPONICS

A NEW PARADIGM FOR CLIMATE RESILIENT AGRICULTURE

The foreseen scenario of escalating food demand, coupled with the desire to cultivate fresh vegetables while recognizing the significance of nutritious, pesticide-free, and health-promoting produce, has prompted a surge in individuals considering the cultivation of vegetables in their residential spaces, including backyards and rooftops. This trend has facilitated investments in advanced urban farming systems, with an emphasis on protected farming methodologies serving as a driving force. Hydroponics emerges as a promising avenue in advancing sustainable food production to meet the escalating demands of the expanding global population amid heightened climate stress.

Why hydroponics?

Cultivating a diverse array of horticultural crops utilizing various substrates encompassed within growbags, pots, conduits, pipelines, and trays defines the practice of "soil-less agriculture." In this method, plants are cultivated hydroponically, devoid of traditional soil, either in water or on alternative soilless mediums.

The adoption of hydroponic technology primarily seeks to alleviate the strain on arable land resources, given that the available cultivable land is not expanding.

Hydroponics emerges as a pivotal strategy for mitigating the impacts of climate change

Arable land per capita has exhibited a consistent decline worldwide, exceeding 20% in many instances since 1975. This trend underscores the imperative to address the excessive water consumption associated with conventional agriculture. Foreseen climatic changes are propelling the proliferation of protected agriculture. Nevertheless, even within protected cultivation, there exists a noteworthy concern: if such practices are less reliant on local climatic conditions, their internal climate, energy balance, and consequently economic models are profoundly influenced by external factors.

Land and Water Conservation

Presently, 38% of non-frozen land globally is dedicated to agricultural pursuits. This percentage is poised to escalate significantly, with projections indicating the necessity to convert 593 million hectares of land into agricultural landscapes by 2050 to meet the anticipated calorie requirements of the burgeoning global population—an expanse

approximately twice the size of India.

In the context of hydroponics, it is observed that a mere 140 liters of nutrient solution can sustain 50 lettuce plants to maturity, contrasting with conventional methods. When extrapolated to a hydroponic setup with an average yield of 25 grams for the green wave variety and 50 grams for fanfare, this equates to 140 liters of nutrient solution supporting the growth of 2.5 kg and 5 kg of lettuce, respectively. Alternatively, 56 liters of nutrient solution are requisite for green wave and 28 liters for fanfare to achieve 1 kg of lettuce. The global average water footprint for 1 kg of lettuce stands at 130 liters, significantly higher than the reduced water footprint associated with rooftop hydroponic methods, which is less than half of global estimates.

Hydroponics – A Climate Smart Cultivation Technique

Hydroponics emerges as a climate-smart cultivation technique, boasting water savings of up to 90%, a 75% reduction in spatial requirements, and the absence of traditional soil. This technology not only conserves valuable water, land, and labor resources, creating an efficient ecosystem, but also ensures 100% residue-free farming due to the controlled growing environment devoid of harmful chemicals.



About the AUTHORS

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In addition to reducing evapotranspiration, farmers are increasingly interested in water use efficiency (WUE), exemplified by a 15% and 20% increase in WUE observed in a shaded apple orchard and a pepper crop within a naturally ventilated greenhouse, respectively.

Year Round Production

Vegetables and cut flowers consistently experience substantial post-harvest losses, ranging from 20% to 30%. The implementation of protected agriculture technologies has the potential to significantly mitigate these losses and enhance productivity by 5–10%, especially when facilitating year-round cultivation. Protected agriculture, through judicious resource utilization, provides manifold advantages for the cultivation of high-quality horticultural crops and their planting materials. Notably, the cultivation of fruits, vegetables, and flowers often yields revenues that are 4 to 8 times greater than those derived from other crops. This financial margin can be further augmented by employing protected environments such as greenhouses, net houses, tunnels, among others. The integration of hydroponics into these systems not only reduces the time between harvest and consumption but also facilitates year-round production of vegetables, optimizing the overall efficiency of the cultivation process.

Opportunity for Future Entrepreneurs

Hydroponics emerges as a highly lucrative avenue for generating revenue and employment, with noteworthy potential in both rural and urban settings. Its inherent entrepreneurial value and emphasis on profit maxi-

Hydroponics emerges as a climate-smart cultivation technique, boasting water savings of up to 90%, a 75% reduction in spatial requirements, and the absence of traditional soil

mization contribute to local employment opportunities, fostering social empowerment, and enhancing the respectability of growers within the community. Furthermore, the adoption of environmentally friendly strategies, particularly through the utilization of Integrated Pest Management (IPM) techniques, mitigates hazards associated with high-value items. This technique not only bolsters productivity but also elevates the overall quality of horticultural produce. Hydroponics excels in nutrient utilization efficiency, ensuring that every gram of nutrient is precisely administered based on the crop's developmental stage.

Solution to Soil Borne Problems

Compared to soil-based approaches, hydroponics or soilless culture presents a superior alternative, fostering ideal conditions for plant growth and resulting in larger, higher-quality yields. Notably, protected agriculture grapples with two paramount challenges—nematodes and soil-borne illnesses—prompting farmers to resort to precarious chemical treatments, costly soil sanitation measures, and soil improvement practices to safeguard tangible income.

In this context, hydroponics emerges as a pragmatic and environmentally beneficial

choice for protected cultivation. This alternative approach not only offers a viable solution but also aligns with sustainable and eco-friendly practices, ensuring the resilience and prosperity of agricultural endeavors in protected environments.

Hydroponics and Climate Change

Hydroponics emerges as a pivotal strategy for mitigating the impacts of climate change. Since rooftop hydroponics enables on-site production and consumption of food, it minimizes or eliminates carbon emissions associated with food miles.

Beyond the direct impact on food production, rooftop hydroponics offers additional carbon reduction benefits. Specifically, every 96 square meters of rooftop vegetation contributes to a reduction of 62.59 kg of carbon through enhanced building cooling and decreased reliance on air conditioning. However, it's imperative to acknowledge that the electricity demand of vertical farms, a key component of hydroponics, can influence greenhouse gas (GHG) emissions. To achieve environmental sustainability, a transition from fossil-based energy sources to nuclear or renewable energy (wind, water, solar) is indispensable for vertical farming. This shift is crucial for aligning vertical farming practices with ecological imperatives and fostering a more sustainable and climate-resilient agricultural system.

Hydroponic Farming: Future of Indian Agriculture

The agricultural landscape in India grapples with numerous challenges, including the erratic nature of the monsoon, inadequate infrastructure, a shortage of skilled labor, subpar soil and crop quality, and a limited adoption of modern farming technologies. Approximately 58% of the country's population, predominantly comprised of farmers, finds itself contending with these obstacles, struggling to sustain their livelihoods. A notable shift towards sustainable and protected farming practices, driven by the growing demand for such alternatives, has given impetus to the adoption of hydroponics in India. Hydroponics is gaining global momentum in the agriculture sector owing to its capacity for higher yields.

14TH AGRICULTURE LEADERSHIP CONCLAVE 2023 & AWARDS



The 14th Agriculture Leadership Conclave 2023 & Awards conducted on 20-21 December 2023, saw an impactful participation of key functionaries of Indian and global agriculture system. The event organised with the objective of discussing the challenge of climate change, and its potential long-term impact on food and nutrition security situation; and to deliberate upon mitigation strategies for climate resilient agriculture through policies, research and development, government programmes and interventions realised its goal of developing a roadmap to sustainability and food security.

20/12/23 Inaugural Ceremony

The inauguration of the first day of the leadership conclave began with the ceremonial lighting of the lamp by the dignitaries - Justice P Sathasivam, Former Chief Justice of India; H.E. Manoj Nardeosingh, Secretary General, African Asian Rural Development Organization; Dr. Tarun Shridhar, Member, CAT and Former Secretary, AHD&F; Mr Shantanu Pendse, CGM, NABARD; Ms Anjana Nair, Group Editor, Agriculture Today Group and Dr MJ Khan, Chairman, Indian Chamber of Food & Agriculture ,

Dr. M J Khan welcomed the dignitaries

and elaborated on the genesis of the Agriculture Leadership Awards. He took a trip down the memory lane and informed that Agriculture Today pioneered the tradition of Agriculture Today Awards and that many important personalities of the agriculture sector were awarded. Somnath Chatterjee, the then Speaker was first chief guest who had graced the first Agriculture Leadership Summit in 2008. While addressing the topic of the conclave, "Sustainable Agrisystems for a Food Secure planet", he called for 4 Is – Innovation, Investment, Information and Integrated approach. He also pointed out the potential of Africa in realising the objective of Food Security.

Shri Shanthanu Pendse believed that we are at the cusp of agricultural innovation. He laid out three problem statements. He noted that the farmers took the entire risk. He observed that so far farmers have not been accommodated in the supply chain. He was of the view to make producers processors and to make best use of the assets.

Dr. Tarun Shridhar observed that today agriculture is viewed as a profession which was a paradigm shift of how the vocation was perceived earlier. He spoke about how Indian agriculture was flourishing and catering to the global food needs. He suggested that we need to capitalise on this aspect. He was of the view that we should stop viewing agriculture as merely a source of livelihood to a scenario where agriculture is the pillar of economic growth.

Justice P Sathasivam talked about the ground realities in agriculture. He recounted his own experiences as a farmer. He noted that farmers were not getting remunerative prices. Although there were a lot of impactful schemes by the Central Government, he was of the view that they were not reaching the farmers. He considered language barrier to be the primary reason for this, as the details of these schemes were either in Hindi and English. He suggested that the government can print and release small booklets containing the information on these schemes in all Indian languages for the benefit of the millions of farmers. He also noted that labour has emerged as a big problem with the introduction of MNREGA.

H.E. Manoj Nardeosingh cautioned against an impending food shortage on account of the burgeoning global population. He accorded a lot of importance at the Agriculture Leadership Conclave as it saw a confluence of visionaries, experts and change agents. He said that any changes in the agriculture scenario needed political will and better placement of farmers in the value chain. He also indicated that Africa was a united continent and presented a lot of potential in agriculture. Their inclusion will bring about resolution and solution for many of the problems.

SESSION 1 : POLICY INITIATIVES: UNLOCKING POTENTIAL OF AGRICULTURE

Mr. JP Meena, Secretary General, Indian Beverage Association and former Secretary, MOFPI was the moderator for the session. The session panellists were **Dr. SN Jha, DDG (Eng), ICAR; Dr Praveen Malik, CEO, Agrinnovate India Limited; Dr. Vijay Sardana, Advocate, Supreme Court of India, Arbitrator and Techno-legal Expert for Food and Agriculture; Mr. Alekh Sanghera, Co Founder, Farmart; Dr. MJ Saxena, Advisor, Dabur Foundation and Mr. Chirag Jain, Partner and Solution Leader for Agriculture and Food Processing, Grant Thornton.**

Mr. JP Meena said that a good policy should have a vision, clarity of goal, objectives and should be sustainable in use and be flexible and adaptable to the changing environment. He noted that Indian agriculture policies are unpredictable and consumer driven.

Dr. S N Jha was also observant of the inequities in Indian agricultural policies. He

suggested that agriculture in India required directorial change and suggested that the country worked on a policy of post-harvest. He noted that although mechanization has the potential to increase yields by 20%, India has only achieved 47%. Custom hiring centres in many states have helped to improve mechanisation and there are many government schemes to popularise mechanisation. However, he emphasized on post-harvest mechanisation.

Dr. Praveen Malik encouraged to think about value chain of production while formulating policies. He said that we have come a long way in agriculture from drafting policies for availability of food nutritional and safe food. He also said that we have to open up from the government side for public private partnership. He called for resource sharing and risk sharing. He was also of the view that technology was not reaching farmers and feedback from the farmer is required. Dr Malik noted that scientists are not looking at the benefit cost ratio while developing new research products and technology.

Dr. Vijay Sardana observed that policies were made by politicians. According to him policies are to ensure food security at least cost and this principle did not favour farmers. He alluded that 90% of exports of agriculture commodities from India is happening because they were cheaper when compared to the rest of the world. He said that the unit cost realisation is very less and we have not understood the market. He commented that short term objectives can be achieved by programs and long term objectives can only be achieved by through well thought out policies.





Mr Alekh Sanghera suggested to link farmers to buyers. He has observed that by doing so 33% reduction in carbon emissions can be achieved. He also noted that it will increase the cost efficiency. Headvocate for policies that will help in achieving this and said that this will help to reduce post harvest losses.

MJ Saxena remarked that today agriculture is at crossroads. He pointed out that there was a hidden cost of agriculture such as soil damage and reduction in water quality. He was of the view that short term policies were not good for agriculture and that agriculture should be viewed in totality.

Mr.Chirag Jain noted the 11% is growth that India had achieved in food processing. He was of the view that enabling policies can help private sector investment and agriculture growth. Mr Jain suggested integrated value chain program and also noted that regional disparity should be addressed.

SESSION 2 : TRANSFORMING AGRICULTURE THROUGH INDUSTRY – ACADEMIA PARTNERSHIP

Dr KML Pathak, Former DDG (AS), ICAR was the moderator of the session. **Dr. Nutan Kaushik**, DG Agriculture, Amity Foundation; **Dr.Yasheshwar**, Associate Professor, ANDC, DU; **Dr. Chandrashek-**

har Biradar, Country Director – India, CIFOR-ICRAF; **Mr. Varun Khurana**, Co Founder, Otipy; **Mr. Saurabh Pandey**, Director, Imperial School of Agri- Business (ISAB) and **Dr. Neha Pareek**, Founder & CEO, Attmans were the panellists of the session.

Dr. Nutan Kaushik referred to Agriculture 4.0 which heavily relied on technology. She suggested that the industry should inform their problems in terms of technology to the academia which will help the academia to direct their research towards it.

Dr.Yasheshwar called for quality education in agriculture and the impact it will have on industry. He talked from his experience of conducting research and

commented how it can benefit the industry.

Dr.Chandrashekhar Biradar suggested regular interactions between industry and academia and exhorted for a change in the landscape of thinking

Dr. Varun Khurana lightened the panel about the challenges faced by a company involved in marketing of agricultural produce. He was of the view that the academia, through their research and development, can help in quantifying the quality parameters of the agricultural produce which will help them in getting better price for the farmers.

Dr. Keshavulu discussed about India's seed sector. He noted that the Indian Seed Sector was placed at 5th place globally.



However, when it comes to global trade, we made up to only 2%. He also observed that many countries refrain from seed trade with India due to quality concerns. With good academia and industries' linkage, Industries can leverage the expertise of the researchers.

Mr. Saurabh Pandey talked about retention of candidates by the company. He was of the view that candidates should be trained by the educational institutions according to the industry demands so that after they graduate from the respective organisation they will be industry fit.

MS SWAMINATHAN GLOBAL DIALOGUE ON CLIMATE CHANGE & FOOD SECURITY

The 2nd MS Swaminathan Global Dialogue on Climate Change & Food Security organized by Agriculture Today Group on 20th Dec 2023 session saw the participation of **Dr Soumya Swaminathan, Chairperson, MSSRF; Dr Purvi Mehta, Deputy Director, Agriculture - Asia, Bill & Melinda Gates Foundation; Ambassador Kenneth M. Quinn, President Emeritus, The World Food Prize Foundation; Dr RB Singh, Former Chancellor, Central Agricultural University, Imphal; Prof MS Reddy, Founder & Chairman, Asian PGPR Society of Sustainable Agriculture and Dr. William Dar, former DG, ICRISAT and Secretary of Agriculture, Philippines.**

Dr. RB Singh remarked that green revolution was important for India back then when our food supplies were not able to meet our demand. He said that MS Swaminathan wanted to transform green revolution into evergreen revolution which ensured perpetuity of agro ecological situation along with production and productivity.

Dr. Soumya Swaminathan stressed on the relevance of nutritional security. She urged to include the element of nutritional security along with the food development programmes.. Majority of the Indians do not have healthy diets and she quoted her father, Dr. MS Swaminathan who always said that nutritional maladies have agriculture remedies. She lamented that public health does not play any role in formulation



of agriculture policies.

Dr. Purvi Mehta analysed the meaning of MS Swaminathan's 'Evergreen Revolution' and inferred that it meant thrust on diversification, increasing productivity and increase in farmers' income. She pointed out at the interconnectedness between livestock and crop production which was very high in India. She informed that 86 % of milk production in India came from farmers who are crop farmers and the rest came from livestock farmers.

Mr Rajeev Varshney's address focussed on climate resilience and nutritious food which are profitable to farmers. He discussed the significance of genetic improvement in increasing agriculture productivity. Rapid Discovery and Rapid delivery should be pursued. Once the scientist identify the beneficial genes, efforts should be made to deliver those genes to target crops either by traditional or modern genetic tools. Delivering the right variety at the right time is important.

Ambassador Kenneth Quinn said that Government leaders were not giving enough emphasis on creating policies to address change in climate and their effect on food production. He then talked about 3Cs that is pertinent today- Climate Change, Corona and Crop production that have managed to influence agriculture production.

Dr. MS Reddy primarily talked about Plant Growth Promoting Rhizobacteria

(PGPR) and its potential in increasing agricultural production. He talked about the deteriorating soil and how the inclusion of PGPR has helped to restore the balance in soil. He was particularly concerned about the reduction of soil organic carbon and elaborated on the efforts of Asian PGPR society to popularise and propagate PGPRs and their use in agriculture.

Dr. William Dar talked about the collaborative and multilateral efforts which should transcend boundaries to fight climate change. He discussed about scaling up technology to promote food security through social platforms. He urged to support workers in agriculture, strengthen water management and adopt complementary measures. Dr Dar asked to have a critical focus on conserving and protecting environment and to work on water optimisation through drip irrigation.

Dr. Keshavulu talked about the relevance of diversity in seed crops and seed systems. He talked about the importance of good irrigation facilities and the effect of climate change and encouraged to make diverse seeds available to the farmers. He called for inclusive policies and effective seed policies to mitigate climate change.

The session ended with the dignitaries presenting the MS Swaminathan Global Leadership Award 2023 to Ambassador Kenneth Quinn. During his acceptance speech he reminisced about his association with MS Swaminathan and how they

shared the vision of food security.

SILVER JUBILEE CELEBRATIONS OF AGRICULTURE TODAY

Inviting all to the silver jubilee celebrations, **Dr MJ Khan, President, Agriculture Today Group** remembered the initial years of Agriculture Today. He said that while universities and ICAR system started technical journals, there was the need for a comprehensive publication, reporting from field to policy makers, and from industries to markets, and from technology institutions to trade and global developments. He said that within a year of its launch, Agriculture Today hosted the first ever Round Table on Farmers Issues and Agriculture Policies, participated by 25 plus Members of Parliament, and chaired by Sh. Sompalji himself, now as Member, Planning Commission. He talked vividly how the first state special issue on Andhra Pradesh was launched and also how the Agriculture leadership awards in agriculture evolved to become an important recognition for the stakeholders in agriculture.

Sh. Pratap Narayan, former DG, Fertilizer Association of India, who was part of the magazine's launch program, joined in the silver jubilee celebrations and he expressed his profound gratitude. **Doctor KL Chadda, President, Indian Academy of Horticulture Sciences** and father of India's golden revolution recollected his association with Agriculture Today Group and gave his blessings for all future endeavours. **Dr RB Singh, Former Chancellor, Central Agricultural University, Imphal** also talked about Agriculture Today and how it has emerged to become an important player in agriculture sector. **Shri Ashok Bajpai, former MP and Agriculture Minister, UP** was impressed at the devotion of Dr MJ Khan towards agriculture sector and also hailed the important role played by Agriculture Today magazine in addressing issues related to the agriculture sector.

Personalities associated with Agriculture Today were honoured through special recognition awards. It was followed by unveiling of the special issue of Agriculture Today.

Distinguished Panel on Farmers' Agenda

Dr. RG Agarwal, Chairman, Dhanuka Agritech noted that farmers were not getting new technology after the green revolution era. He believed that there was reduction in technology generation and a collapse in external extension. He said that farmers were not getting prices and they should be able to sell their produce wherever they wanted. He also enlightened the audience about the menace of spurious pesticides which was creating problems.

A host of farmer leaders also joined the panel who poured some interesting insights into the farmers' problems. Padmashree Chauhan Singh was conversant about the challenges associated with Farmer Producer Organisations. Pushpendra Singh, President, Kisan Sangh was disturbed at the last preference given to the farmers and said that they have become mere spectators. Raju Narasimhan, Farmer, Chennai talked about his farm and how new technology can increase production and productivity of the farms. Naresh Sirohi, Founder, Advisor DD Kisan channel called for improved participation of farmers in agriculture conclaves. He also urged policy makers to consider including farmers in committee for policy making, especially in those policies which had a direct bearing on them. Shri V M Singh, National convener, BKMS suggested 10% reservation to farmers in the Parliament and he called for respectful partnership with the farmers. He also vehemently argued for the implementation of the MSP formula as suggested by MS Swaminathan Commission.



21/12/2023 INAUGURAL CEREMONY

The inauguration of the second day of the leadership conclave began with the ceremonial lighting of the lamp by the dignitaries **Mr. Vijay Paul Sharma, Chairman, Commission for Agricultural Costs & Prices; Dr. JK Jena, Deputy Director General, Indian Council of Agriculture Research; Mr. Baldev Prakash, CMD, J&K Bank; H.E. Ms RONALDA HORATIO EDWARD, Hon'ble High Commissioner, High Commission of Guyana; Dr MJ Khan, Chairman, Indian Chamber of Food & Agriculture and Ms. Vinita Singh, Agriculture Today Group.**

Dr MJ Khan welcomed the audience and talked about the journey of Agriculture Today. He traced the journey of agriculture today and noted that the magazine has evolved into a composite platform for diverse stakeholders.

Dr J.K Jena talked about the inter-sectoral competition of resources existing in the agriculture sector. For instance, Fisheries and animal husbandry sector competed for maize and soyabean. He urged

to work towards alternate resources. He also noted that Agriculture Today has an important role to play in the dissemination of information.

Dr. Maharaj Muthoo focussed on global food systems. He believed in bottom up approach and said that political will is required for long reaching impacts. He advocated structural transformation for affordable and healthy diets. Dr. Muthoo averred that SDGs cannot be achieved without agriculture. He called for holistic approach and urged for the inclusion of agriculturally diverse and climate resilient crops.

H.E. Ms RONALDA HORATIO EDWARD touched upon pandemic, conflict, climate change, value chain etc. She talked about the global crisis that has gripped us, especially with increase in prices of the food. She urged to make food system climate resilient. She cited Guyana's vision in agriculture and how the country was collaborating with regional counterparts. She stressed upon the need for interaction and collaboration in knowledge exchange.

Mr. Baldev Prakash talked about how agriculture was transforming in J&K. He



talked about subsidized plantation credit facilities and also on the spiralling interest for organic farming in Jammu and Kashmir. He was conversant about improving market access and linkages. He noted the impressive minimum import price for apple that was implemented by the central government in J&K. He particularly mentioned KCC saturation drive by J&K bank.

Mr. Vijay Paul Sharma said that agriculture was important from the socio economic perspective and noted that there has been a Paradigm shift in policies. He observed that agriculture now is not just production centric and the focus has been shifted to farmers' income and welfare. He viewed the increased agriculture exports as an offshoot of trade liberalization. He commented that technology disruption in the form of artificial intelligence and machine learning will shape agriculture in coming years. Mr Sharma pointed out that limited resources will lead to stiff competition and to prevent food wastage, he exhorted the agriculture community to invest in post harvest Technology. He suggested the four pillars of agriculture growth as technology, state of the art infrastructure, strengthening institutions and incentive to the producer in line with the market demand.

SESSION 1 : ACHIEVING GLOBAL NUTRITION SECURITY THROUGH MILLETS

Mr Deepak Pareek, Co-founder, Agrifi.

AI was the moderator of the session. **Ms Annapoorna, Head Agriculture, Invest India; Tara Satyavati, Director, ICAR-IIMR; Mr Vijay Nadmiti, CEO & Director, AgHub; Mr. Sathyanarayana Raman, CEO, Millet Mart and Dr. Udita Ghosh Sarkar, Associate Director, Grameen Foundation** were the panellists.

Ms Annapoorna averred that there was a minor increase in yield of millets. She stressed for more research in the area which could increase the area under production.

Dr. Tara Satyavati called for integrated development in millets. She observed that there is a demand for only a small segment of millets such as ragi. Smaller millets are still not in demand. She brought the attention to Orissa where millet development is happening in mission mode. She said that

the millets had immense business opportunity as they are gluten free . Millets are not only good for humans but also planets.

Mr.Sathyanarayana Raman discussed about the palatability of the millets. He asked to ensure a uniform quality process for millets as they are in high demand in other countries. He also suggested altering the taste of millets through recipe to make it acceptable.

Dr. Udita Ghosh Sarkar discussed in length about the good qualities of millets. She said that cultivating millets in partnership mode will be beneficial.

Mr.Vijay Nadmiti talked about the 12 million dollar market in the global food processing ecosystem. He also asked for funding for startups and the need to produce many ready to cook culinary items.



SESSION 2 : CLIMATE CHANGE AND AGRICULTURE SUSTAINABILITY

Dr Kailash Bansal, Secretary, NAAS moderated the session and the panellists were **Mr. Anuja Kadian, Director Government Relations & Corporate Affairs – South Asia, Corteva**; **Dr KC Ravi, Sustainability Head, Syngenta**; **Mr Kaushal Bisht, Head – Strategic Partnerships, Varaha** and **Mr. Pradipta Sahoo, Business Head, Safal and International Business, Mother Dairy Fruit and Vegetable Pvt Ltd.**

Mr. Anuja Kadian informed that all the Corteva products will soon be satisfying the sustainability criteria. They have set a task force of the entire millet value chain. She informed that they have a mustard variety which has high oil content and hence will give good income to the farmers. She talked about how the improved varieties and products can help in climate sustainability of agriculture.

Dr K C Ravi, talked about the relevance of small holder farmers in climate sustainability. He was of the view that right inputs at the right time should be used. He reminded the audience of the immense responsibilities of controlling GHGs, working towards water conservation and feeding the global population. He called for Swachh



agriculture Abhiyan and Carbon Neutral technologies.

Mr. Pradipta Sahoo was conversant about the complexity of value chains. He suggested crop planning to fall in line with climate sustainability. He pointed out that consumers demanded for certain off season crops which in turn resulted in the transportation to far away locations. He suggested using processed products such as onion flakes and tomato puree to tide over price rises.

Mr Kaushal Bisht talked about Varaha's commitment towards climate change and elaborated how Varaha's Carbon Credit programme was helping farmers monetize their agriculture.

SESSION 3 : CREDIT AND INSURANCE FOR POWERING AGRICULTURE GROWTH

Mr Mashar, MD, Agriculture Finance Corporation Ltd. was the moderator of the session. **Mr. Rakesh Magotra, DGM, J&K Bank**; **Mr Rajesh Srivastava, Chairman, Prowess Advisors**; **Mr Neelam Gupta, Head Agriculture, JB Boda Group**; **Mr Rajeev Ratna Srivastava, DGM, SBI** and **Mr Arun Raste, MD, NCDEX** were the panellists

Mr. Rajesh Srivastava said that credit is the critical input in agriculture and the sector is credit hungry. He suggested new credit products for food processing. He suggested more products in the insur-



ance segment.

Mr. Rakesh Magotra talked about the various initiatives of J&K bank in the sphere of agriculture and how credit had improved the agriculture scenario. He mentioned the various products of J&K Bank which were helping apple farmers of the state in retaining their products in Controlled Atmosphere and in the process fetching better prices for them.

Mr. Neelam Gupta talked about the relevance of creating awareness among the farmers regarding various credit products. He was sure with appropriate credit and insurance products, financial inclusivity can be increased.

Mr. Rajeev Ratna Srivastava talked about the various initiatives of SBI in farming. He talked about Kisan Credit Cards and their Pilot in Karnataka where agri digitisation was helping them to give farmers hassle free loans and credit products.

Mr. Arun Raste talked about his experiences in commodity marketing and what are the products that can help farmers.

SESSION 4 : PRECISION AGRICULTURE FOR PROFITABLE FARMING AND CEOs PANEL ON FUTURE AGRICULTURE

Mr Kalyan Goswami, DG, ACFI was the moderator of the session for which Ms Rina Soni, ED, Heifer International; Mr Debabrata Sarkar, Vice President, Algaenergy; Mr AK Tyagi, Executive Director, Haldirams; Mr. Raju Kapoor, Director, FMC India Limited Presentation; Mr Utsav Mishra, Director Agriculture, Ernst & Young; Mr Gaurav Sharma, Vice President, Head of Global Agribusiness Research, Accenture; Dr. Dinesh Chauhan, VP, Dehaat; Mr. T B S Rajput; Dr. Prafull Gadge, Founder and CEO Biome technologies and Dr. Samresh Dwivedi,

Mr Debabrata Sarkar talked about future of agriculture, which depended on soil health and food security. He advocated sustainable agriculture and suggested using bio fertilizer and optimization in agriculture.

Mr. T B S Rajput talked about precision agriculture. He focussed on water compo-



nent in precision agriculture especially microirrigation and how it was revolutionising agriculture.

Ms Rina Soni said that future of agriculture was small holder farmers. She suggested keeping the small holder farmers at the centre.

Mr AK Tyagi explained about Haldiram's procurement system and the entire value chain.

Dr. Pragul Gadge talked about optimization of inputs. He also talked about the importance of decision support system and suggested that precision farming should be in accordance with Indian conditions.

Mr Utsav Mishra remarked that right now we are at Agriculture 4.0 which used more of sensors and has made precision agriculture cheaper. He also discussed about agristack which was helping in creating a database and helping farmers.

Dr. Dinesh Chauhan observed that cost of technology is still high vis a vis small and marginal holder farmers. He also was concerned about data security. Adoption of technology is another challenge.

Dr. Samresh Dwivedi talked about the benefits of precision farming.

Mr. Raju Kapoor was of the view that policies should be inclusive of private sector. And regulator should be renamed as facilitator. He called for a harmony between the centre and the state for the success of agriculture development. He talked about stewardship of technology, breaking the barriers and asked us to leverage

our geographical position.

PRESENTATION OF 14TH AGRICULTURE LEADERSHIP AWARDS

The 14th Agriculture Leadership Conclave, the AT Group's annual flagship event, culminated on 21st December 2023, with the presentation of 14th Agriculture Leadership Awards. Union Minister for Agriculture and Tribal Affairs, Shri Arjun Munda presented the award in the presence of Justice P Sathasivam; Shri Saurabh Bahuguna, the Minister of Animal Husbandry, Dairy and Fisheries, Uttarakhand; Shri Tarun Sridhar, Member, CAT and Former Secretary, AHD&F Government and Dr. M J Khan, Chairman, ICFA.

Union Minister for Agriculture and Tribal Affairs, Sri Arjun Munda called for a reduction of imports and augmented exports of agricultural products while addressing the 14th Agriculture Leadership Conclave in New Delhi. He also called for enhancing the soil productivity by organic means and to increase awareness about organic products. In his address, Shri Arjun Munda averred the importance of agriculture in India. He said that today India is number one in many agricultural commodities and under the leadership of Prime Minister, Narendra Modi, several schemes for agriculture development have been implemented. He exhorted all the stakeholders in agriculture to work in harmony to realize the intended target of prosperity in agriculture.



LIST OF AWARDEES

	CATEGORY	PROPOSED AWARDEES
1	Policy Leadership Award 2023	The state of Tamil Nadu- Parasuraman
2	Development Leadership Award 2023	NIRD J & K Bank
3	Industry Leadership Award 2023	Godrej Agrovert Ltd Dr KC Ravi, Head- Sustainability
4	Research Leadership Award 2023	NDRI, Karnal
5	Farming Leadership Award 2023	Apurva Tripathi
6	CSR Leadership 2023	DCM Sriram Group REC Limited
7	Academic Leadership 2023	GB Pant University of agriculture & Technology
8	Startup Leadership Award 2023	Waycool
9	Entrepreneur Agriculture Award 2023	Azad Agro
10	International Agriculture Award 2023	KRBL
11	Corporate Leadership Award 2023	Cargill
12	Woman in Agriculture Award 2023	Dr Vibha Dhawan, DG, TheEnergy & Resources Institute(TERI)
13	Innovation Leadership Award 2023	Carnot Technologies Pvt. Ltd.
14	Best State in Agriculture Award 2023	Orissa
15	Food rocesing Leadership Award 2023	BL Agro
16	Best State in Horticulture 2023	Himachal Pradesh Maharashtra
17	Best State in Animal Husbandry 2023	Uttarakhand
18	Program Leadership Award 2023	Mr JP Meena, Secretary General, Indian Beverage Association
19	CEO of the Year 2023	Mr Ankur Agarwal,MD, Crystal Group Protection Ltd.
20	Lifetime Achievement Award 2023	RG Agarwal
21	Young Scientist Award 2023	Dr. Roaf Ahmed Parray
22	Special Achievement Award 2023	OP Dhankar

RECOMMENDATIONS

- Translation of the government schemes to all India languages
- Tapping the potential of Africa in meeting food security
- Develop a policy on post-harvest agriculture
- Policies of better Public Private Partnerships
- Resource sharing and Risk Sharing among private and public sector
- Enhanced Investments in Post-harvest machines
- integrated value chain program
- Addressing Regional Disparity
- Role of public health in formulation of agricultural policies.
- Policies for Nutritional Security
- Scaling up technology to promote food security through social platforms
- Support workers in agriculture
- Strengthen water management and adopt complementary measures
- Water optimisation through drip irrigation
- Adoption of alternate wetting and drying method in rice cultivation
- Promotion of PGPRs
- Swachh Agriculture Abhiyan
- Carbon Credit Programme
- Creating awareness among consumers to use season specific fruits and vegetables
- Maintaining harmony between the centre and the state for the success of agriculture development
- Introduction of new credit products in the insurance segment and food processing segment
- Introduction of healthy ready-to-cook Millet products
- Altering the taste of millets through recipe to make it acceptable
- Integrated development in millets
- Global interaction and collaboration in knowledge exchange.
- Implementation of the MSP formula as suggested by MS Swaminathan Commission
- 10% reservation to farmers in the Parliament
- Including farmers in committee for policy making
- Effective seed policies to mitigate climate change.
- Rapid Discovery and Rapid delivery should be pursued. Delivering the right variety at the right time is important.
- Thrust on diversification, increasing productivity and increase in farmers' income
- Regular interactions between industry and academia



RALLIS INDIA: SMART SOLUTIONS FOR SUSTAINABLE FOOD SECURITY AND RESILIENCE

Indian agriculture faces several challenges that impact its productivity and sustainability. These include limited knowledge and insufficient infrastructure, especially in rural areas, limited access to credit and finance, water scarcity and irrigation, soil degradation and land erosion, coupled with food security, and lack of proper food storage.

To address these challenges, India needs to raise agricultural productivity per unit of land, promote new technologies, reform agricultural research and extension and diversify to higher value crops. Companies like Rallis India, in their 75th year of operations in India are testament to the fact that science has been serving as catalysts in increasing agriculture production and productivity.

Sustainable and Green Practices

With rampant concerns about sustainability and resilience, companies are increasingly being evaluated on environmental and social metrics, as well as their corpo-



Rallis India has focussed on reducing its environmental impact in manufacturing with use of renewable energy.

rate governance.

Rallis India has focussed on reducing its environmental impact in manufacturing with use of renewable energy. Agrochemical formulations are being developed with high efficacy, and R&D teams are working on green chemistry principles to make manu-

facturing more sustainable. The manufacturing teams are focused on the principles of recycle, reuse, and reduce.

All of these developments have helped Rallis India bag awards like the FICCI Chemicals and Petrochemicals Award for "Sustainability – Best Green Process," recognizing Rallis's model approach to promoting sustainable and green practices.

Rallis has evolved its innovation strategy to 'Serve Farmers through Science'. Accordingly, it develops innovative solutions to enable farmers to improve their productivity. Through extensive R&D, Rallis has initiated several introductions in crop care and seeds business that are sustainable and cost-effective, which will be the key business driving factors in the coming years.

Rallis Innovation Chemistry Hub (RICH)

Most of their new formulations contain water and other environmentally-friendly solvents as a medium, and other safe ingredients that lead to sustainable products. RICH also works closely with strategic alliance partners and customer groups to develop innovative products. In the past, it has developed a few innovative solutions based on Focused Group Discussions (FGD) with farmer groups and collectives.

With a rich research capital, Rallis India has been focusing on being more resilient in agriculture using technology. To serve this purpose, the company has been working on several projects. Digital preparedness has been at the forefront of Rallis India's future-ready strategy, and it continues to focus on leveraging digital tools such as Artificial Intelligence, Big Data Analytics, Internet of Things (IoT), Smart Manufacturing, etc., to fuel future growth and deliver benefits to the farming community.



Rallis India bears the name from Ralli Brothers, after the Greek merchants who dealt in agricultural commodities. Rallis was reborn in India in 1948 and the manufacture of fertilisers and pesticides marked the beginning of the company's foray into agrochemicals. The company went public in 1951, and by 1962, Fisons and Tatas became the chief shareholders of Rallis India. By 1962-63, fertilisers and pesticides became a full-fledged division. In the 1990s, Rallis India directed its sole focus on agrochem. Through the decade and the next, the company enhanced its position in the agricultural space and enhanced its international footprint. Around this time, Rallis divested its pharma business to consolidate its pesticide and fertiliser businesses. The company's acquisition of Metahelix Life Sciences has given it a prominent position in the seeds market. Today, Rallis stands tall with a robust suite of research, technical knowledge, germplasm, hybrids and seed production. Rallis continues its journey of "Serving Farmers Through Science", with over 75 years of experience providing the most extensive range of products and solutions for Indian farmers in rural markets, it has become one of the top agro sciences companies in India. Today, Rallis stands tall with a robust suite of research, technical knowledge, germplasm, hybrids and seed production.

Technology to Transform Agriculture as We Know It

The demand for digitization in Indian agriculture is well understood and acknowledged to improve crop yield and enhance sustainability. In September 2021, the Union Minister of Agriculture & Farmers Welfare, Mr. Narendra Singh Tomar, announced the initiation of the 'Digital Agriculture Mission 2021–2025'. Rallis India's state-of-the-art decision intelligence and crop monitoring system, DRISHTI, essentially harnesses the power of Spaceborne Remote Sensing (SRS) and Artificial Intelligence (AI). Its predictive analytics helps the Hybrid Seeds Production (HSP) function to spot future risks and opportunities and helps make informed decisions to optimize production cost and improve yield.

Following its implementation, Rallis India has witnessed a four-fold increase in farm scanning and grading frequency. The high spatiotemporal resolution of the DRISHTI farm scan and yield monitoring process allows the seed team to have near real-time monitoring of the scattered and distant production farms. This allows to take timely intervention for yield protection and enhancement and help in improving yield compared to manual surveillance. DRISHTI has also received several accolades from the industry, including the prestigious CII Digital Transformation Award.

Apart from these, Rallis India has developed the following apps: E-Bandhan, a distributor app; E-Sparsh, a salesforce app; Samadhan, an app for farmers to access crop info; SeedSure, an app to enable



Rallis India's state-of-the-art decision intelligence and crop monitoring system, DRISHTI, essentially harnesses the power of Spaceborne Remote Sensing (SRS) and Artificial Intelligence (AI).

hybrid seed production activities; Sampark, a crop advisor app.

With a rich history of over 150 years and a strong focus on serving farmers through science, Rallis India has been at the forefront of developing innovative solutions to enable farmers to improve their crop yields. They have consistently promoted smart farming practices, enhance food security, and build resilience in the face of evolving challenges.

STRENGTHENING AGRICULTURE EDUCATION THROUGH COLLABORATIVE APPROACH



India's agricultural sector- the backbone of the nation's economy, is poised for a transformative journey under the New Education Policy (NEP) 2020. In the heart of India's bustling agricultural landscape lies an imminent need to revamp the education system that caters to this important sector. The NEP 2020 has emerged as a beacon of hope, paving the way for a momentous shift in agriculture education. To fully harness the potential of this policy, fostering strong and powerful collaborations between the Indian Council of Agriculture Research (ICAR), State Agriculture Universities (SAUs), Agri-Industry, farmers, and students is very critical.

Key Areas of Improvement

To align agriculture education with the goals and objectives of new education policy, several key areas of

improvements needs immediate attention for realising the fruitful results. Some of the critical areas for improvement in agriculture education can be envisaged as below.

- **Curriculum Modernization:** The current curriculum often lags behind the rapid advancements in agricultural technologies and practices, as the changes in technology are very rapid. A modernized curriculum, incorporating emerging fields like precision agriculture, climate-smart practices, digital interventions and agripreneurship is very much essential.

- **Practical Exposure:** Theoretical knowledge alone is insufficient. Practical exposure through internships, field visits, and hands-on training is crucial to bridge the gap between theory and real-world applications. All the agriculture colleges and Universities must insist on internship exposure to students. National Institute of Agricultural Extension Management (MANAGE), Hyderabad is offering opportunities

A modernized curriculum, incorporating emerging fields like precision agriculture, climate-smart practices, digital interventions and agripreneurship is very much essential.

About the **AUTHOR**

P Chandra Shekara, Director General and Mahantesh Shirur
National Institute of Agricultural Extension Management (MANAGE), Hyderabad

to students to hone their skills during the internship to make themselves ready for professional responsibilities in the field of teaching, research and extension.

- **Interdisciplinary Approach:** Agriculture is intricately linked to various disciplines such as social system, economics, environmental science, and life sciences. An interdisciplinary approach will equip students with a holistic understanding of the agriculture sector.

- **Digital Literacy:** In today's technology-driven world, digital literacy is indispensable for farmers and agriculture professionals. Integrating digital tools, e-learning platforms, and data analytics into the curriculum is imperative.

- **Entrepreneurship Development:** Agriculture offers a wealth of entrepreneurial opportunities. Fostering an entrepreneurial spirit among students, through workshops, mentorship programs, and access to funding, can drive innovation and job creation.

Partnership in Agriculture Education

Having seen agriculture education mostly delivered through public institutions for so long, and now the private sector is driving the technology development and dissemination, we see a scope for partnership in agriculture education to be effective. Hence, building a collaborative ecosystem involving multiple stakeholders is very much required. Such collaborative efforts can be envisaged through following.

- **ICAR-SAU Partnership:** Indian Council of Agriculture Research (ICAR), as the apex body for agricultural research, can collaborate with State Agriculture Universities (SAUs) to develop cutting-edge curricula, train faculty on regular basis, and establish research centres.

- **Agri-Industry Engagement:** Agri-industries can provide internships, sponsor research projects, and offer career guidance to students, ensuring they are equipped with industry-relevant skills.

- **Farmer-Student Interaction:** Farmers possess invaluable knowledge and experience. Regular interactions between farmers and students can foster a deeper understanding of agricultural practices and



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challenges.

- **FPO Promotion:** Farmer Producer Organizations (FPOs) play a pivotal role in empowering farmers by leveraging the advantages of scale of economy and collectivisation of individual farmers' efforts. Collaborative efforts of the Government can promote FPO formation, training, and market linkages.

Facilitating Agripreneurship and Nurturing Agri Startups

In recent times, the solutions to problems and challenges of agriculture as avocation are addressed effectively by facilitating Agripreneurship and nurturing Agri Startups by incentivising their efforts. The policy support and creating congenial ecosystem for agribusiness to thrive in agriculture sector is very essential. The modern education in agriculture must accommodate the following to achieve the potentiality of agriculture sector.

- **Agripreneurship Incubation Centers:** Establish incubation centers within universities and agricultural institutions to provide budding agripreneurs with mentorship, infrastructure, and funding support.

- **Agri-Startups Network:** Create a network connecting agri-startups with investors, industry partners, and potential cus-

tomers, facilitating their growth and success.

- **Agripreneurship Bootcamps:** Organize bootcamps to equip students with entrepreneurial skills, market analysis techniques, and business plan development.

- **Agri-Startup Competitions:** Host competitions to showcase innovative agri-startups, attracting potential investors and partners.

- **Agri-Startup Success Stories:** Highlight the achievements of successful agri-startups who have addressed the burning problems in agriculture (like scarcity of labour, stubble burning, value addition and processing opportunities, market information, etc.) to inspire and motivate aspiring agripreneurs.

Revamping agriculture education in India demands a collaborative approach that brings together ICAR, SAUs, Agri-Industry, farmers, and students. By addressing key areas for improvement, nurturing agripreneurship, and fostering strong partnerships, we can empower the next generation of agricultural leaders to drive India's agricultural revolution. Together, we can transform agriculture into a sector that not only sustains the nation but also fuels innovation, entrepreneurship, and prosperity for coming generation.

PROMOTE ATMANIRBHAR WITH INDIGENOUS MANUFACTURING

What are your views on the Agri-mechanization scene in India? Have we become an important market for farm machines?

Compared to industrialised economies, where farm mechanisation has exceeded 90%, India's farm mechanisation level is still between 40% and 45%. Although there is wide scope for farming process mechanisation in the country, unreasonably high focus on 'tractorisation' has led to tractors being the most common sight on Indian farms, at the expense of specialist machines such as combine harvesters, balers, forage harvesters, paddy transplanters, etc. India's farm equipment market is 7% of the global market, with more than 80% of the value contribution coming from tractors. Globally the tractor industry sales is annually worth \$60 billion, whereas the corresponding sales of farm machinery is around \$100 billion. It is the other way around in India where tractor industry annual sales is \$7-8 billion compared to hardly \$1.2 billion from farm equipment.

In India farm machinery exports are driven by the tractors, and farm machinery imports are driven by non-tractor farm machinery imports., the direction of trade is lopsided where 53% of non-tractor farm machinery imports are coming from China without any restrictions. In India, the central and state governments subsidise farmers' purchases of farm machinery via Direct Benefit Transfers. Since there is no requirement for local value-add, dealers sell Chinese farm machinery on India's DBT portals. Thus, Chinese farm machinery manufacturers get support from both China and India, leaving the Indian ones at a huge disadvantage.

We observe a huge disparity in the level of adoption of farm technology in the country. Some states like Punjab, Haryana, Andhra Pradesh, Telangana, Tamil Nadu, Karnataka etc. have led the way in usage of combine harvesters. In the East, Odisha and West Bengal are catching up quickly.

The Indian combine harvester market size is estimated at USD 231.8 million in 2023 and is expected to reach USD 306.2 million by 2028, registering a CAGR of 5.7% during the forecast period (2023-2028).

However, even a big producer state like Rajasthan is still lagging in adoption of mechanised harvesting for crops like pulses, mustard, cluster beans etc. The size and pattern of landholding are both crucial considerations while mechanising farms, the smaller the land area, the more challenging to mechanise such farms. The exceedingly small size of landholdings and low purchasing power in the northeastern parts of the country makes successful mechanisation quite difficult.

How was 2023 in general for the industry?

The Indian combine harvester market size is estimated at USD 231.8 million in 2023 and is expected to reach USD 306.2 million by 2028, registering a CAGR of 5.7% during the forecast period (2023-2028). The industry performance was good with



Mr. Sriram Kannan,
Chief Executive Officer &
Managing Director,
CLAAS India

production of roughly 7K+ units - 4000+ units of wheeled combine harvesters and remaining market for track combine harvesters. In the total market of 7K+ units, 60% was dominated again by lower cost imports which goes against Make in India initiative of the GoI.

What keeps CLAAS products a class apart?

CLAAS in India is one of the pioneers of harvesting mechanisation and the undisputed technological leader in agricultural machinery space. Our machines like the CROP TIGER series of combine harvesters, JAGUAR forage harvesters, QUADRANT and ROLLANT straw balers, PADDY PANTHER rice transplanters, etc. have established CLAAS as a household brand among the Indian farming community. In a continuous effort in this direction, our aim for the upcoming years is to capture additional markets and enhance the brand image.

The CLAAS Academy has all the necessary capacities to provide customers & operators of CLAAS products with the appropriate in-depth technical training. The CLAAS Harvest Centre is a meeting place for farmers and the private sector to exchange ideas about the best harvesting techniques. CLAAS Rental is an easy-to-use app that allows CLAAS Combine Harvester owner (contractor) to post details about his fleet of equipment. On the Farmers login & interface, it provides access to locate. CLAAS Trackmaster enables the CLAAS customer to track the location of the harvester, working hours and threshing hours, harvester periodical maintenance requirements, cautionary alerts via sms alerts & enables recovery in case the harvester is stolen.

How has CLAAS emerged as a trendsetter in providing solutions to different segments?

Over the last few years, CLAAS has been playing a leading role in the mechanisation of silage production for cattle feed. Though India is the world leader in milk production, productivity of our cattle is very low. One of the main reasons for this is the high cost,

Promote Atmanirbhar concept by encouraging local manufacturing of agri machines and discouraging imports when local substitutes are readily available.

and poor availability, of good quality feed. The tractor drawn CLAAS JAGUAR 25 forage harvester is ideally suited for small dairy farmers for their own use or for renting it out to other farms in the vicinity for maize foraging.

Another instance is straw management using large sized Balers from CLAAS. Burning of paddy stubble is a major reason for worsening air quality in the North, particularly in NCR. The Government is working on several initiatives to create demand for paddy straw – co-gen plants by public power utilities, production of Ethanol and Compressed Bio-Gas are a few of the major steps. This demand generation will gradually create a value for paddy straw and discourage farmers from burning.

Maize is a good example of a future growth market. Use of combine harvesters in maize is today very low at about 10% or less. The area under maize is increasing and the Government recognizes the need for better harvesting solutions to increase farmer productivity. CLAAS has specially designed maize harvesting solutions for Indian farms.

Do the policies and subsidies program in India favour farm mechanization?

Among the enabling policy initiatives, the Government of India (GoI) has executed various schemes and policies supporting greater mechanisation of Indian agriculture, in the light of its commitment to transform the agriculture sector and double farmers' income. The Sub Mission on Agricultural Mechanization (SMAM) is a significant initiative by GoI in this direction. The government has introduced the concept of

Custom Hiring Centre's (CHCs), opened in public-private partnership mode to make technology adoption affordable.

Talking about what is disabling the industry, the Government is allowing import of low quality Combine Harvesters from China and Thailand which reduces the capacity utilization of domestic manufacturers to upto 60% and this conflicts with the government's Atmanirbhar Bharat slogan.

What are your recommendations on improving the farm mechanization scenario in India?

- Promote Atmanirbhar concept by encouraging local manufacturing of agri machines and discouraging imports when local substitutes are readily available.
- Given the unfair competition that Indian manufacturers face, it should be mandated that farm machinery that is sold under government subsidy on government DBT portals (both Central and State) follow the revised public procurement norms with regard to preference to 'Make in India' goods.
- Regulate price of raw materials inputs in agri machinery industry such as metals
- Expand PLI (Performance Linked Incentive) scheme to cover components, parts, aggregates and finished products of agri machinery industry.
- Availability of finance for machines other than tractors is still to improve. Bankers need to be sensitised to farmers, the various farm mechanisation schemes and CHCs.
- Eligibility criteria for machine subsidy programmes requiring a farmer to have at least 1 acre of land (or any type of land ceiling or any other criteria) should be removed.
- There is a growing demand-supply mismatch in skilled manpower where Private sector also needs to play a more active role.

COMMITTED TO SUSTAINABILITY

LDC, a global merchandiser of agri Commodities and processors, have been in existence for more than 170 years. Founded in France by Leopard Louis Dryfus, LDC today operates in more than 100 countries. With more than 17000 Employees across different sectors and different parts of the world, the company has various businesses and platforms, and is present across edible oil and seeds, cereals such as wheat, rice and barley, sugar, coffee, cotton and feed solutions. "We believe in a four pillar strategy. Of which one and two are trading and assets related to our core business, third pillar is more about downstream activities that includes B2B Sector, offering more solution to our customers and fourth pillar is more about technology and innovation," says

in an interview with Agriculture Today.

What are your activities in India?

We started operations in India 26 years ago in 1997. We have offices in around 10 locations in India, with two main offices - Gurgaon is the head office, and Bangalore the other strong office, where the research and data science team is based.

We have two assets in India; one is the oil refinery in Kandla (Gujarat), where we refine and process soyabean and palm oil. Secondly, we have a coffee processing unit in Karnataka, where we sort, grade, and process green beans of coffee. We have sales of around 7-10k tonnes per month. In grains, we carry out operations in wheat, corn, barley, millets and pulses. We work closely with farmers at one end, and the consumers at other end. So, we are supply chain managers. In cotton our operation are in merchandising and supply chain management of cotton. In cotton, we also work closely with farmers on sustainable program. Project Jagruti is one such

program that was launched in 2022.

Tell us more about Jagruti.

Project Jagruti was launched in 2022 to support local cotton farmers in adopting sustainable practices, further to the Pink Bollworm (PBW) outbreak that led to yield losses from limited pink bollworm management knowledge. Project Jagruti workshops aim to minimize yield losses from pest outbreaks, increasing cotton production and farmers' incomes. The workshops emphasize on scientific PBW pest management, supplying pheromone traps and educational materials. Farmers receive technical advice and field demonstrations, including pheromone trap installation and pest scouting. Project Jagruti's success in 2022-23 helped over 7500 Indian farmers to reduce cotton yield loss from PBW. They saw higher yields in 2022/23 (an additional 1-2 quintals per acre), translating to higher earnings (roughly INR 15000

Regenerative agriculture can help to address some of the biggest challenges facing the world today, including climate change, soil degradation and biodiversity loss.



per acre). It was well received by farmers and prompted LDC to intensify efforts in 2023-24, focusing on training farmers in sustainable cotton cultivation and related practices. In 2023-24, LDC plans to educate over 22,000 farmers through educational workshops held in 70 locations across India. More than 22,000 farmers have been trained and equipped with over 120,000 pheromone traps across India in the 2023/24 crop season.

As you know lot of emphasis today is placed on adoption on adaptation strategies and how to cope with climate changes. Is LDC working in that area?

LDC is committed to supporting the adoption of regenerative agriculture practices throughout its supply chain. Regenerative agriculture can help to address some of the biggest challenges facing the world today, including climate change, soil degradation and biodiversity loss. We are educating over 4,000 farmers in Maharashtra on regenerative agriculture practices. This project is expected to produce 20,000 regenerative agriculture certified cotton bales, which will help farmers to sell at a premium price in the market. AFPRO will be implementing this project on the ground, and experts from Peterson will provide training on regenerative agriculture. Until now 30 villages have been mapped for regenerative agriculture certification, including over 4,000 farmers and 300 soil samples have been submitted to NBSS and KVK for testing.

Demo farmers have been identified for drip irrigation, and discussions are in progress with government departments for subsidies. Discussions are ongoing with Indian Meteorological Department scientific data to calculate reductions in carbon emissions. By the end of the season we are expecting a marked reduction in GHG/carbon emissions and increase in soil organic carbon. Improved irrigation structures, financial literacy and access to financial services, with a focus on using farmer group structures to improve access to credit are some of the other expected outcomes.



In 2022, LDC rolled out its Responsible Sourcing Program to certify and verify over 300 farmers in India – representing 4,000 MT of coffee, based on the ethics and sustainability standards, principles and provisions enshrined in LDC's Global Code of Conduct for Coffee Suppliers

LDC also runs a Coffee Sustainability Initiative. Please elaborate.

In 2022, LDC rolled out its Responsible Sourcing Program to certify and verify over 300 farmers in India – representing 4,000 MT of coffee, based on the ethics and sustainability standards, principles and provisions enshrined in LDC's Global Code of Conduct for Coffee Suppliers. LDC is also supporting more than 1,500 farmers to improve their soil fertility. As part of this initiative, LDC organized the distribution of first aid kits to provide emergency primary treatment in case of accidents in farms and install boards to prevent accidents. Full sets of Personal Protective Equipment were

also distributed free to farmers and farm workers, to safely handle agro-chemicals such as fertilizers, herbicides or pesticides.

Are there any women centric programmes for LDC?

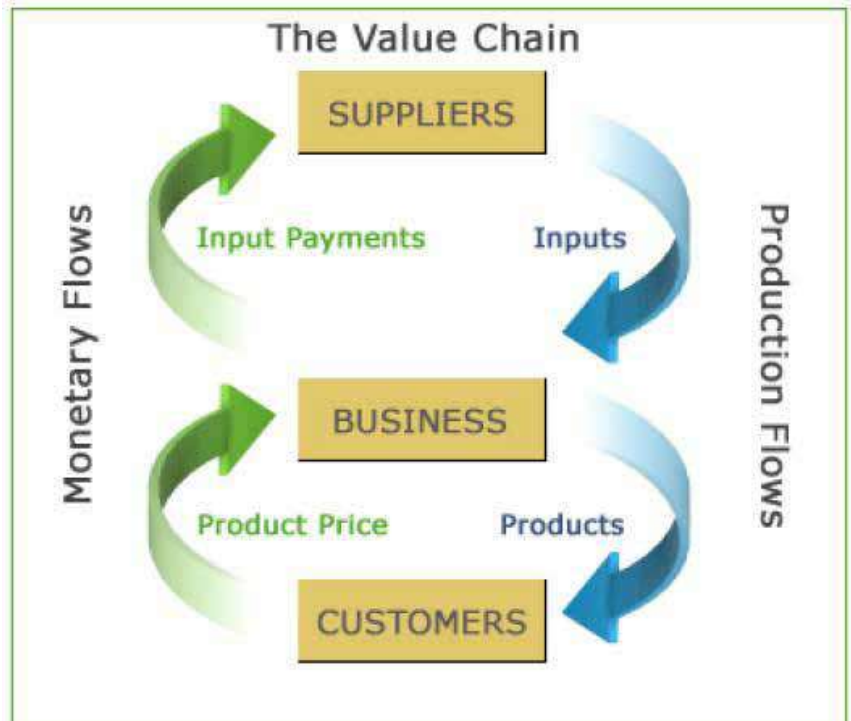
Yes. In 2020, LDC embarked on a two-year project with the Louis Dreyfus Foundation and the Centre for microfinance, to enhance the food security and cash incomes of women smallholder farmers in the district of Tonk. This project supported the creation of women Self-Help Groups (SHGs) of 10 to 20 women per group, who received training in finance literacy to facilitate access to credit for group members. The project also worked to improve agricultural knowledge and production skills among women smallholders, with a focus on low-cost, organic farming methods, water harvesting and crop diversification. Since its beginnings in 2020, the project has trained over 4,232 women farmers.

In addition to increased productivity, project participants saw an average 41% improvement in their incomes, as better food production practices allowed participating women farmers to generate a food surplus that covered their household food requirements for months. Due to its success, the program has been extended until 2024 and aims to empower 6,000 women farmers in 100 villages across the region, through crop diversification, improved livestock production and efficient water use. 450 farmer groups will also be trained in financial literacy to apply for government funding.

FINANCING AGRICULTURE VALUE CHAINS IN INDIA

Financing agriculture value chains (FAVC) is the provision and management of financial services that cater to the specific needs and characteristics of the AVCs, such as short-term working capital, medium-term investment, and long-term asset building. FAVC can help overcome the constraints and challenges faced by the traditional sources of agricultural finance, such as informal moneylenders, cooperatives, and banks, which often fail to meet the demand and diversity of the farm sector.

However, FAVC in India is still at a nascent stage, and faces several challenges, such as lack of awareness, information asymmetry, high transaction costs, collateral requirements, and regulatory barriers. These challenges limit the access and affordability of FAVC for millions of small and marginal farmers, who constitute about 86% of the total farm holdings in India and hinder their participation and integration in the AVCs.



Agriculture Value Chain Finance Models

Producer-Driven Value Chain Model: This model empowers producers, such as farmers or cooperatives, to influence various value chain activities, from production to marketing. The Amul cooperative model in Gujarat is a classic example where dairy farmers have significant control over producing, processing, and marketing milk and milk products under a common brand.

Buyer-Driven Value Chain Model: Buyers, such as processors or retailers, have a strong influence over value chain activities, including sourcing, distribution, and branding. The ITC e-Choupal initiative in Madhya Pradesh leverages information technology to connect farmers with markets, providing quality inputs and services, thereby enhancing productivity

and incomes.

Community-Based Value Chain Model: In this model, communities work together to create, deliver, and capture value in the agricultural chain. The SRI (System of Rice Intensification) approach in states like Andhra Pradesh involves communities adopting innovative rice cultivation techniques collectively, leading to increased yields and income.

Horticulture Value Chain Model:



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FAVC can help overcome the constraints and challenges faced by the traditional sources of agricultural finance, such as informal moneylenders, cooperatives, and banks, which often fail to meet the demand and diversity of the farm sector.

Figure 3
The typical agricultural value chain



Source: A.T. Kearney analysis

Focused on fruits and vegetables, this model emphasizes efficient post-harvest handling, processing, and marketing to minimize losses. Safal, a venture by Mother Dairy, operates in several states and facilitates the aggregation, processing, and retailing of fresh fruits and vegetables.

Precision Farming Value Chain

Model: This model integrates technology for precision farming practices, including data-driven decision-making and resource optimization. Companies like RML AgTech offer precision agriculture solutions in Maharashtra, helping farmers with data-driven insights to optimize crop production.

Organic Farming Value Chain Model:

Focused on organic produce, this model includes certification, processing, and marketing of organic products. The Sikkim Organic Mission in Sikkim supports farmers in transitioning to organic farming, ensuring a complete value chain for organic produce.

Poultry Value Chain Model:

This model covers the entire poultry production cycle, including feed, farming, and processing. Venky's in Tamil Nadu is a vertically integrated poultry company with operations ranging from feed production to processing and retail.

Aquaculture Value Chain Model:

Focused on fisheries and aquaculture, this model includes hatcheries, farming, and processing. The Vannamei shrimp farming value chain in Andhra Pradesh integrates hatcheries, farms, and processing units to meet global demand for shrimp.

Agricultural Value Chain Finance Instruments

Product financing is a type of financing that is based on the value of the agricultural product itself, rather than the creditworthiness of the borrower. Trader credit is provided by traders or middlemen to farmers or agribusinesses, usually in the form of inputs, cash, or deferred payments. Input supplier credit is provided by input suppliers, such as seed, fertilizer, or pesticide companies, to farmers or agribusinesses, usually in the form of inputs on credit or discounts.

Marketing company credit is pro-

vided by marketing companies, usually in the form of advance payments, contracts, or guarantees. Lead firm financing is provided by a lead firm to its suppliers or distributors, usually in the form of inputs, technical assistance, or market access. Receivables financing is based on the value of the receivables, or the money owed by the buyers, rather than the creditworthiness of the seller. The lender provides funds to the farmer or agribusiness by purchasing or discounting the receivables, or by using them as collateral.

Physical asset collateralization is based on the value of the physical assets and the lender provides funds to the farmer or agribusiness by using the assets as collateral or by leasing them. Warehouse receipts are documents that certify the ownership, quantity, and quality of a stored agricultural product and can be used as collateral for loans, as evidence for contracts, or as instruments for trading.

Challenges

- Lack of access to formal credit and insurance for small and marginal farmers, who often depend on informal sources of finance.
- High transaction costs and risks involved in linking farmers to markets, especially for perishable and quality-sensitive products.
- Inadequate infrastructure and logistics for storage, processing, transportation and marketing of agricultural produce.
- Fragmented and unregulated markets that limit the bargaining power and price discovery for farmers and consumers.

- Weak institutional and policy support for promoting value chain development and innovation, such as farmer producer organizations, contract farming, e-markets, etc.

Opportunities

- Leveraging digital technologies and platforms to improve information flow, traceability, quality assurance and financial inclusion along the value chain.
- Developing and scaling up successful models of value chain financing that involve multiple stakeholders.
- Enhancing the infrastructure and logistics for storage, processing, transportation and marketing of agricultural produce, especially for perishable and quality-sensitive products.
- Strengthening the institutional and policy support for promoting value chain development and innovation, such as creating a national agricultural market, easing regulatory constraints, and providing incentives for value addition.

In conclusion, financing agricultural value chains (FAVC) in India is pivotal for advancing the farm sector's efficiency and farmers' income. The diversity of agriculture value chain finance models, such as producer-driven and buyer-driven approaches, coupled with a range of financial instruments and digital innovations, provides a nuanced strategy to address the challenges. The convergence of effective value chain financing and comprehensive support systems will be crucial in unlocking the sector's full potential and fostering sustainable growth.

FARMER FIELD SCHOOLS

Learning by Doing

Most farmers in Northern India have a good awareness of agriculture practices and mechanization; though not in equal terms throughout the region they at least have exposure to the developing trends in the agrarian sector. Since the early Green Revolution, Punjab has been at the core of boosting agricultural productivity and meeting the food security of the nation, with more focus on cereal crops and pulses. Over time, landholding size was reduced and the next two generations had to survive on the portion of land they received in lineage as per the applicability of the law. Currently about 54 percent of the population is dependent upon agriculture directly or indirectly. However, there is a meager 20.3 percent of the total GDP contribution from the sector.

Agriculture has the scope to evolve and produce much more diversified and quality products to capture a better portion of the GDP. Perishable items such as vegetables and flowers have enormous potential but, due to climate change and erratic patterns of rain and wind, these can also incur huge losses. Thus, farmer's motivation and willingness to continue farming as an informed livelihood option is a must.

Farmer Field Schools

In order to address issues such as monocropping, flood irrigation, and traditional methods of farming, Sehgal Foundation formulated the concept of "Farmer Field Schools" in 2020 and tested the model in different districts in the states of Haryana and Uttar Pradesh, which paved way for a positive response garnering appreciation from the farming community along with positive results. This model has been a promising intervention, aligning with crop

Perishable items such as vegetables and flowers have enormous potential but, due to climate change and erratic patterns of rain and wind, these can also incur huge losses.

VDCs are social institutions that lead holistic development activities and help select appropriate beneficiaries for project-related interventions. The committee also governs the project activities during and beyond the project period.



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diversification, catering to market demand, changing climatic patterns, and availability of forward and backward linkages throughout the year. Learnings from the area were broad-based for replication within the semi-arid areas of Haryana. Furthermore, it was planned to convene farmer meetings at different Village Development Committee (VDC) levels to increase awareness about the field schools. Farmer Field Schools thus integrate modern and climate-resilient agriculture techniques for assured crop productivity and diversity, focusing on climate-suitable off-season vegetables.

Farmer Field School in Nuh, Haryana

With advice from thematic experts, and collaboration of farmers, a Farmer Field School was established at the field of Md. Akhlak, Hamzapur village, under the HDFC Parivartan Project being implemented by Sehgal Foundation.

Akhlak and his father, Iqbal, are hard-working and progressive, despite a small landholding of three acres collectively. Both showed keen interest in new practices like on-farm seed trials and crop diversity. However, they did not succeed. When the VDC proposed them for Farmer Field School intervention, they were sceptical, largely about the practices involved, such as staking in tomato, but their inherent willingness to do something new prompted them to move forward.

Built at a total cost of ₹3,80,000/-, the beneficiary farmer contributed 25 percent of the total project cost. As the engagement of both the farmer and the field specialists intensified, the Farmers Field School reads itself as an income-generating model along with climate-resilient techniques. The field schools will be studied as a cropping cycle is completed. The crop basket was considered to include tomatoes as the major crop in the field, and ridge gourd and bottle gourd as border crops. Subsequently, with healthy saplings raised in-house, they were transplanted in January 2023, following all customized practices along with the judicious doses of micronutrients and timely bamboo staking of the tomatoes for enhanced plant growth and prevention of soilborne diseases.



Profit Maximisation and Better Soils

It was observed further that as the plants remained healthier throughout the flowering and fruiting stages with more than 1.5 times the yield of regular crop production in tomatoes. Furthermore, the intervention led to improvement in the colour, shape, size, and quality of the produce. The area that was averse to crop diversification, and the notion that vegetable farming would incur losses was broken by the intervention; and about 314 farmers from the nearby villages visited Akhlaq's farm to understand the practices. Over a dozen farmers also

#	Technique/Component	Purpose	Life span
1	Poly House	Protection from pests, rain, and direct sunlight, controlled environment	Structure: 10 Y Sheet: 4 Y
2	Soilless nursery (seed trays, vermiculite, perlite and cocoapeat)	Prevent soilborne disease at the sapling stage, equal nutrients to all saplings, leading to healthy growth.	Cyclic
3	Fencing (chain link)	Prevent predation and wild grazing, and assist in border cropping, which protects against excessive heat during summer.	5 Years
4	Mulching (black/silver coated)	Prevent weed growth and reduce the loss of water.	1-2 Cycles
5	Drip irrigation	Optimum use of irrigation and equal water application	3 Years
6	Solar spray pump	Pest control and nutrient management, renewable source.	Panel: 10 Years
7	Staking (bamboo & wire based)	Support to creeper/climber plants	1-2 Cycles
7	Yellow stickers	Pest control	Cyclic
8	Seed & micronutrients	Plant Growth & Nutrient Management	Cyclic

Farmer Field Schools are well suited to the trans-Gangetic plains, which come under agro-climatic zone VI, with a semi-arid climate and higher temperature during summers. It features technology, implements, and farming practices that can be adopted throughout the crop cultivation cycle. These practices include a poly house, soilless nursery, fencing, solar spray pumps, mulching and drip, and other agriculture equipment such as light traps and yellow stickers. All these work for the benefit of the farmer and also as a demonstration for other farmers, providing continuous assistance.

Farmer Field Schools thus integrate modern and climate-resilient agriculture techniques for assured crop productivity and diversity, focusing on climate-suitable off-season vegetables.

introduced some of the practices such as mulching, fencing, and staking into their fields. On the contrary to conventional farming, farmers followed integrated nutrient management and integrated pest man-

agement across the season and harvested bumper produce.

Akhlaq and his father have used the increased income to fund education and repaid loans against their mortgaged 0.5 acres of land. Out of the gross income of ₹1,62,000, they reinvested about ₹30,000 for the next cycle of strawberries and tomatoes from September onward. As the count (yield) spread to 19.75 tonnes, fetching more income, it can further continue in the coming years if the production is maintained. The farmer observed that not only is there increased income from the new practices, but the intervention has allowed for soil health management by crop rotation and enabling regeneration of soil microbial activity along with nutrient management.

AGRICULTURE ROADMAP

A Multi-sectoral and Holistic approach

The state government stressing for 'Rainbow Revolution' has laid its focus on increasing the production of pulses, vegetables, fruits, milk, fish, and animal husbandry, alongside cereals. Attending to this requirement, a holistic strategy was chalked out by the state government for the first time in 2008 called "Agriculture Roadmap" aimed towards enhancing the income and promoting the welfare of agricultural producers. Thus far, the government has launched three Agriculture Roadmaps, each with a set vision and brought together 12 departments that are linked to the agriculture sector. The implementation of Agriculture Roadmaps led to multifarious positive effects on the agriculture and allied sector in Bihar. To begin with, the state of Bihar was accorded with prestigious "Krishi Karman Award" five times between 2011-2018. More importantly, there has been qualitative increase in production and productivity of major crops as a result of implementation of Agriculture Roadmaps. Further, over the period the state has also been able to leave a footprint in the global agricultural scenario by receiving Geographical indications (GI) tag for Katarni Rice, Jardalu Mango, Shahi Lithi, Magahi Paan, Mithila Makhana and



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27,77,925 agricultural machines have been provided to the farmers at subsidized rates, as a result of which the farm power availability in the state has increased from 1.23 kW to 3.21 kW.

Marcha Dhan.

Increase in crop production and productivity

There has been qualitative increase in production and productivity of major crops as a result of implementation of Agriculture Roadmaps.

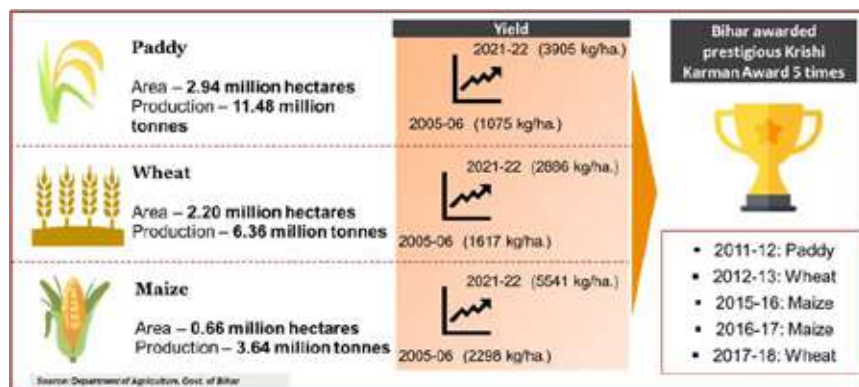
- **Rice:** The productivity of rice in the year 2007-08 was 12.37 quintals per hectare which increased to 24.96 quintals per hectare in the year 2021-22. As a result of the implementation of the agricultural roadmap, the average productivity of rice has doubled. The average production of rice increased from 42.66 lakh metric tonnes to 71.31 lakh metric tonnes during the same period.

- **Wheat:** During the period preceding Agriculture Roadmap i.e., 2003-04 to 2007-08, the average productivity of wheat was 18.29 quintals per hectare which increased to 28.89 quintals per hectare during 2017-18 to 2021-22. Moreover, the average production of wheat increased from 37.97 lakh metric tonnes to 62.82 lakh metric tonnes during the same period.

- **Maize:** During 2003-04 to 2007-08, the average productivity of maize was 25.04 quintals per hectare which increased to 50.26 quintals per hectare during 2017-18 to 2021-22. The average production of maize increased from 15.97 lakh metric tonnes to 33.72 lakh metric tonnes during the same period.

- **Fruits & vegetables:** The production of fruits in the pre-agriculture roadmap period was 32.2 lakh metric tonnes, which has increased to 45.36 lakh metric tonnes. Additionally, vegetable production increased from 101.03 lakh metric tonnes to 169.25 lakh metric tonnes during the same period.

- **Mushroom:** In the year 2021-22,



Tissue culture brings huge increase in banana production

Banana is grown vastly in Bihar especially in the two distinct growing regions viz. old Vaishali region and new North-Eastern (Kosi) region, both regions are endowed with congenial climatic conditions favorable for growth and development of banana. It is an important source of income for small as well as large farmers who produce it either on small or large areas. Recently, the demand for banana is increasing and area under the crop in the state has undergone large expansion in last 20 years. Though banana was introduced in this region during late seventies, the pace of adoption was very fast during eighties and today the Kosi belt produces nearly two-third of total banana in the state.

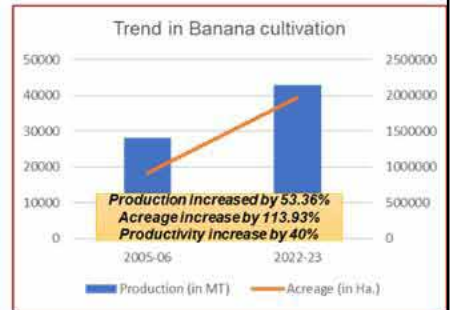
And with TC banana the production has increased in the State from 9,20,044 MT in 2005-06 to 19,68,211 MT in 2022-23, with an increase of 40% in the productivity. **Shri. Ajay Kumar Yadav** is one such farmer in the Katihar region of Bihar who was growing banana since last 10-15 years. He was informed by the local Horticulture officials about Tissue culture technique for propagation of Banana which not only heightened his interest in the method, but he also decided to take up tissue culture of Banana in 1 acre of land. Further, Shri. Ajay also received support for installation of drip irrigation in the plantation area. This step has facilitated him in saving expenditure on irrigation, application of fertilizer and labour cost as well. He stated that good return of the investment is there in banana cultivation and plans to continue the production.



Centre of Excellence, Desari, Vaishali



Banana production



the state has achieved the highest position with a total mushroom production of 28,000 MT, which is 10.82 percent of the total mushroom production produced in the country.

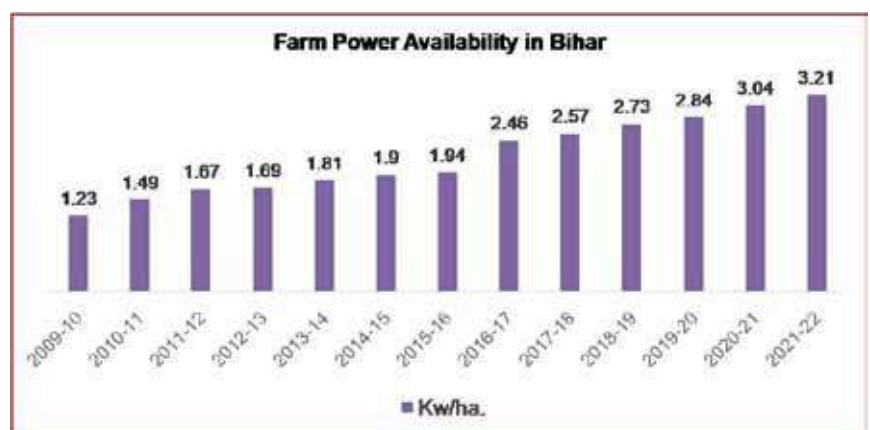
• **Honey:** In Bihar, Muzaffarpur (9000 MT), East Champaran and Begusarai (2500 MT) and Vaishali (1305 MT) are ranked first, second and third respectively in honey production. The total production of honey in the year 2021-22 is 20477.64 metric tonnes, which marks Bihar at an important place at the national level in the field of honey production.

Digital agriculture

By embracing technological advancements for facilitating enhanced reach of scheme benefits to farmers, arrangements were made by the Agriculture Department for Aadhaar-based registration of farmers. Under this, a total of 1.90 crore farmers have been registered, out of which 72 per cent belong to the category of small farmers and 20 per cent are marginal farmers. The digitization has eased out the process of benefit transfer of various schemes to the farmers and the database is being used by other departments.

Promotion of modern agricultural machinery

Prior to the implementation of agricultural



In the fourth Agriculture Roadmap, a strong action plan has been devised for sensor-based technology

roadmap, a total of 48,956 agricultural machines were made available to the farmers. Thus far, 27,77,925 agricultural machines have been provided to the farmers at subsidized rates, as a result of which the farm power availability in the state has increased from 1.23 kW to 3.21 kW.

Fourth Agriculture Roadmap

The fourth Krishi Roadmap 2023-28 for Bihar was launched by the Hon'ble Presi-

dent of India, Smt. Droupadi Murmu on 18th October 2023. In the fourth Agriculture Roadmap, a strong action plan has been devised for sensor-based technology. Further, Improved varieties of pulses, oilseeds, and millets, which have been neglected till now, will be developed soon. Efforts will be made to increase the pace of research and development by incorporating the latest technology in these crops. To give impetus to necessary research and technology development, an incentive based innovative experiment is envisaged that will provide continuity to research and technology development and pave the way for creation of technology as per requirement. Along with this, the provision of 'Flexi Fund' to each universities every year will provide strength to such essential



Hon'ble President of India, Smt. Droupadi Murmu launching the fourth Krishi Roadmap 2023-28 for Bihar

research. By making good use of the new technology and with the continuous efforts, all the land records of the state will be corrected by 2024 and the door to consolidation will open. Undoubtedly, this will give a new dimension to agriculture and will be counted among the greatest land reform

works ever done.

Working on the principle of 'Save and Develop' in Agriculture, Bihar is moving towards 'real agriculture' by integrating so-called primary agriculture and secondary agriculture. Therefore, efforts are being made to develop a production-con-

sumption system which is sustainable & profitable in nature and is evolving based on the need and demand of the consumers. To cater to the farmers' need for technology dissemination, "Gyan Vahan, Vikas Vahan", equipped with more than a thousand technologies, will bring the light of agricultural knowledge and science to every village and will provide full support in achieving the goal of Rainbow Revolution.

The agriculture roadmaps are state's response to the need for a holistic system-based futuristic plan which can simultaneously enhance the productivity, profitability, equity and environmental sustainability through integrating crop, cash crop, horticulture, livestock, fisheries, agroforestry, watershed-based soil and water management, social capital formation, agro-processing, and marketing in an end-to-end mode. The above-mentioned initiatives and programs under the gamut of Agriculture Roadmap are proof that steps have been taken by the state government in the right direction and the past growth process of the state's economy is not a short-term phenomenon, but the beginning of a long-term stable growth process.



Enhancing women farmer awareness and participation – Soil Health Card distribution in Sheohar district of Bihar

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