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CEEW Policy Brief

Promoting Neo-traditional Agriculture to Achieve Food and Livelihood Security, and Climate Change Adaptation

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A policy brief on 'Promoting Neo-traditional Agriculture to Achieve Food and Livelihood Security, and Climate Change Adaptation'.

The Council on Energy, Environment and Water (CEEW) is one of South Asia's leading policy research institutions. CEEW addresses pressing global challenges through an integrated and internationally focused approach. In 2016, CEEW was ranked the best in South Asia in two categories three years running (Global Go To Think Tank Index); among the top 100 out of 6846 think-tanks in nine categories. In 2016, CEEW was also ranked 2nd in India, 4th outside Europe and North America, and 20th globally out of 240 think tanks as per the ICCG Climate Think Tank's standardised rankings.

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In little over five years of operations, CEEW has engaged in more than 100 research projects, published well over 50 peer-reviewed books, policy reports and papers, advised governments around the world over 160 times, engaged with industry to encourage investments in clean technologies and improve efficiency in resource use, promoted bilateral and multilateral initiatives between governments on more than 40 occasions, helped state governments with water and irrigation reforms, and organised more than 125 seminars and conferences.

CEEW's major projects on energy policy include India's largest energy access survey (ACCESS); the first independent assessment of India's solar mission; the Clean Energy Access Network (CLEAN) of hundreds of decentralised clean energy firms; India's green industrial policy; the $125 million India-U.S. Joint Clean Energy R&D Centers; developing the strategy for and supporting activities related to the International Solar Alliance; modelling long-term energy scenarios; energy subsidies reform; decentralised energy in India; energy storage technologies; India's 2030 renewable energy roadmap; solar roadmap for Indian Railways; clean energy subsidies (for the Rio+20 Summit); and renewable energy jobs, finance and skills.

CEEW's major projects on climate, environment and resource security include advising and contributing to climate negotiations (COP-21) in Paris; assessing global climate risks; assessing India's adaptation gap; low-carbon rural development; environmental clearances; modelling HFC emissions; business case for phasing down HFCs; assessing India's critical mineral resources; geoengineering governance; climate finance; nuclear power and low-carbon pathways; electric rail transport; monitoring air quality; business case for energy efficiency and emissions reductions; India's first report on global governance, submitted to the National Security Adviser; foreign policy implications for resource security; India's power sector reforms; resource nexus, and strategic industries and technologies for India's National Security Advisory Board; Maharashtra-Guangdong partnership on sustainability; and building Sustainable Cities.

CEEW's major projects on water governance and security include the 584-page National Water Resources Framework Study for India's 12th Five Year Plan; irrigation reform for Bihar; Swachh Bharat; supporting India's National Water Mission; collective action for water security; mapping India's traditional water bodies; modelling water-energy nexus; circular economy of water; and multi-stakeholder initiatives for urban water management.

About the Authors

RUDRESH K SUGAM

Rudresh Kumar Sugam is a Senior Programme Lead at the Council on Energy, Environment and Water (CEEW), India. He has around six years of working experience in the water sector. He has done several projects involving extensive primary and secondary research. Recently, he completed a project focussing on developing circular economic pathway for the wastewater sector in India. Recently executed and on-going research work includes, a project on identification of drivers of Collective Action for Water Security and Sustainability; a project on analysing the status of traditional water bodies in Meerut district, using on ground GPS mapping, GIS application and water quality assessment; a project on developing framework for creating smart cities; a project on Low carbon rural development; research paper on building water secured cities by adopting multi-dimension approach; impact of continuous water supply on overall livelihood of people etc. In the past, he has done a project on urban water management in India, which involved a series of multi-stakeholder round table discussions for identifying challenges and opportunities in the urban water sector in India. He also conducted an evidence-based research for the Minor Water Resources Department, Government of Bihar exploring institutional reforms that are required in minor irrigation to achieve agricultural growth targets set by the State.

He has worked as Project Executive in Asian Consulting Engineers Pvt. Ltd., Delhi, where he has executed several projects of "Source Vulnerability Assessment and Source Water Protection Plan" for the coca cola bottling plants located in different states of India. His interest areas include food-water-energy nexus, land use planning, impact of climate change on water resources, integrated watershed management, wastewater management and sustainable cities. His educational qualifications include a Post Graduate degree in Water Resources Management (gold medalist) from The Energy and Resources Institute (TERI) University, Delhi and a B.Sc. in Botany from Kirori Mal College, University of Delhi. His post-graduate dissertation was on estimating storm water pond nitrogen and phosphate removal efficiency with the Yale School of Forestry and Environment Studies, Yale University, United States.

He has done trainings on Hydrological Modelling and SWAT modelling in National Water Academy, Pune and IIT-Delhi, respectively. He has done a Post Graduate Diploma in Urban Environmental Management & Law from WWF and NLU, Delhi. He has also participated in an Indo-Bangladesh IUCN sponsored two weeks programme *Water Futures II: A Dialogue for Young Scholars and Professionals* to understand and debate on trans-boundary water management concerns.

POULAMI CHOUDHURY

Poulami Choudhury worked as a Programme Officer with the Council on Energy, Environment and Water (CEEW). She has done extensive work on decentralised renewable energy projects which includes formulating a roadmap for scaling off-grid energy in India; documenting applications of renewable energy beyond electricity (with the WWF) and drafting recommendations for DERC's Net Metering Guidelines. She has also worked on assessing green industrial policies for grid connected solar and wind power in India.

She is a post graduate in Natural Resources Management from The Energy and Resources Institute (TERI) and has done her graduation in Microbiology from the Institute of Home Economics, Delhi University. Following post-graduation, she had a short stint at J.M. EnviroNet Pvt. Ltd. where she worked as a consultant for Environment Impact Assessment (EIA) projects. She went on to work for C40, in partnership with the Clinton Climate Initiative (C40-CCI) as a Program Analyst for two years. During her tenure with C40-CCI, she was involved in developing models for calculating greenhouse gas emission reductions resulting from various waste management projects, developing questionnaires, ward monitoring plans and Request for Proposals and Concession Agreements for the East Delhi Municipal Corporation. She has also worked extensively on developing material for C40-CCI's Knowledge Platform on solid waste management, wherein she assembled a comprehensive database and generated profiles for global cities (C40 cities) to better characterize their solid waste management systems that would facilitate city-to-city solid waste networks and help identify opportunities to improve municipal waste management in various cities. In addition to these Waste projects, Poulami also conducted other work for the Solar team of the Clinton Climate Initiative, such as preparing papers and reports related to Rajasthan solar park and technical specifications for CSP projects planned under National Solar Mission. She has co-authored a research paper entitled, "Optimization Studies for hybrid and storage designs for parabolic solar trough systems with the System Advisor Model" which was published in the journal of Environmental Progress and Sustainable Energy in 2011.

JENNIFER HARTL

Jennifer Hartl is currently enrolled in the Erasmus Mundus Master of Science in Rural Development (IMRD) at Ghent University (Belgium). As part of the program she has completed each semester in a different part of the world. The program was kicked off in Ghent University. For her second semester she has moved to India where she has deepened her profile in Natural Resource Economics and Agronomy at University of Agriculture (India). During her semester break she has completed an internship at the Council on Energy, Environment and Water in New Delhi (India) where she has extensively reviewed concepts and models on vulnerability assessments. Jennifer Hartl then became an affiliated researcher at the Mekong Delta Research Institute (Vietnam) where she has investigated the impact of climate change and urbanization on agricultural transformation in the in regards to developing countries. Jennifer Hartl is going to write her Master Thesis at the Resource Economics Department at Humboldt University (Germany). Her work is related to Natural Resource use, the role of traditions and the legitimacy and efficiency of rural and environmental policies.

Abstract

Persistence of subsistence agriculture based on small landholdings (78 per cent), dominance of rain-fed agriculture (60 per cent of net cropped area), inadequate market linkages, and poor coping capacity, among other factors, make the Indian agricultural system highly vulnerable to climate-change impacts. Even a single extreme-weather event such as flood, drought, or cyclone leads to huge losses due to the unpreparedness of farmers and lack of sufficient storage facilities. Similarly, mono-cropping, or the cultivation of a single variety of a crop, undertaken because of the encouraging market prices of only a few crops or varieties, makes the entire agricultural system less resilient to climate-change impacts or pest attacks. For example, in the 1960s, India was estimated to have over 70,000 rice landraces. Two decades later, in the 1980s, more than 75 per cent of India's rice production came from less than 10 varieties because of an aggressive push for modern, input-intensive hybrids by scientists and policymakers. As a result of all these factors (non-affordability due to escalation in market prices, unavailability of varied crops), the impact on nutritional security has been serious, especially among women and children. It is now widely recognized by researchers and policymakers that adapting agriculture to climate-change impacts is a priority for ensuring food and nutritional security. While modern technologies and scientific research will continue to play an important role in promoting the sustainability of agricultural production, there is a need to harness traditional knowledge and agricultural heritage, which are gradually declining. This policy document examines the reasons for diminishing traditional agricultural knowledge and the ways of protecting it. The document is based on extensive secondary research and discussions with experts.

Contents

1. Introduction

Climate change is real, whether induced by humans or natural, and its impact on the environment and humans is yet to be completely understood or measured. Nevertheless, the finding of the Fifth Assessment Report (AR5) of the United Nations Intergovernmental Panel on Climate Change (IPCC), 2014, that human influence has been the dominant cause of the observed warming since the mid-twentieth century, is alarming. The report also found that the Asia region as a whole experienced the most weather and climate related disasters in the world between 2000 and 2008, and suffered the second highest proportion (almost 30 per cent) of total global economic losses. Changes in monsoon patterns have huge implications for water resources and associated systems such as agriculture. This makes India even more vulnerable, as nearly 70 per cent of the country's population (a large proportion of small and marginal farmers) relies on agriculture for its livelihood (World Bank) and nearly two-thirds of the cultivated land is rain-fed (Water Statistics, CWC).[1], [2] Cases of crop failures, farmer suicides, and reduced productivity are increasingly being observed in several states in India, which illustrate the negative consequences of climate change for the overall agricultural system.

Realising the importance of traditional agricultural knowledge and indigenous crop varieties, IPCC has suggested their examination as a tool for climate-change adaptation. The UN University Institute for the Advanced Study of Sustainability (UNU-IAS), based in Tokyo, Japan, recently identified more than 400 examples of the roles of indigenous peoples in climate-change monitoring, adaptation, and mitigation.[3] Traditional farming practices, especially those of marginal farmers, are in many cases climate resilient. These farmers utilise locally available resources and choose specific varieties that can survive under adverse climatic conditions. They cannot afford losses, and thus have evolved farming practices in the best possible way by utilising local resources most efficiently. Traditionally, farmers are also well versed with the varieties available and make informed choices for cross-breeding. These varieties constitute an irreplaceable gene bank; several locally available species have been protected and propagated over the centuries. In addition to the cultivation of the major cereals, local communities often also grow secondary crops and forest products to supplement their diet and to build food stocks in case of primary crop failure, thus maintaining their nutritional and food-security needs.[4]

Traditional agricultural systems have evolved over centuries through trial and error in the field, and have proven their effectiveness, adaptability, and strength. Hence, they should not be ignored or dismissed. Since the documentation of these practices is really poor, and has long been neglected, we might have already lost numerous useful traditional practices appropriate for local conditions. Having said that, it should also be acknowledged that several traditional practices, such as flood irrigation and tilling, are not always resource efficient, and hence need to be modified according to the changing conditions. The shift from traditional to modern systems has to be gradual; this has not been the case so far.

Modern agricultural practices such as the use of chemical fertilisers and pesticides, tractors and combine harvesters, and high-yielding varieties (HYVs) and hybrid seeds evolved as solutions to the problems of

1 Ranuzzi, Anna, and Richa Srivastava (2012) "Impact of climate change on agriculture and food security," ICRIER Policy Series No. 16, available at http://icrier.org/pdf/Policy_Series_No_16.pdf; accessed 14 May 2015.

2 Sugam, Rudresh Kumar (2015) "Managing Water and Climate Change Risks: An Alarming Challenge Facing India's Water Security," *SARCist*, Centre for Policy Research's (CPR) Newsletter, available at http://thesarcist.org/Opinion/124; accessed 29 October 2015.

3 Galloway McLean, Kirsty (2010) *Advance Guard: Climate Change Impacts, Adaptation, Mitigation and Indigenous Peoples: A Compendium of Case Studies*. UNU-IAS. United Nations University, Traditional Knowledge Initiative. Darwin, Australia.

4 Swiderska, Krystyna, Yiching Song, Jingsong Li, Hannah Reid, and Doris Mutta (2011) *Adapting agriculture with traditional knowledge,* Briefing, International Institute for Environment and Development (IIED), October 2011.

low productivity and increased food demand. Undoubtedly, these interventions increased production levels dramatically, allowing India to become self-sustainable in the major food crops. However, this shift had negative consequences as well. The promotion of such input-intensive farming practices without considering the role of local or traditional resources has led to several problems such as reduction in soil fertility, increased concentration of fertilisers and pesticides in food products, mono-cropping, and loss of wild crop and seed varieties. All these have further led to loss of nutritional security and to increased vulnerability to climate change, as traditionally grown crops, which were suited to local conditions and which were chosen on the basis of the availability of local resources, are no longer cultivated. For example, we can clearly see the negative consequences of extensive rice cultivation in Punjab, which is naturally not suited for growing rice. Punjab, after reaching a peak in productivity levels, thanks to the adoption of modern agricultural practices and the extensive use of chemical fertilisers and pesticides, is now struggling to sustain the current levels of productivity.[5]

Therefore, by integrating the complementary systems of both traditional and modern agricultural practices, a much larger range of new ideas and innovative practices could be generated. Although a handful of government institutions and NGOs are working towards documenting traditional farming knowledge and conserving traditional varieties of seeds (through the setting up of seed banks), it is yet to be seen if farmers will have access to government repositories of traditional seed varieties. It is important to note that documented traditional wisdom when disseminated to communities could help build adaptive capacities in response to climate change. Furthermore, traditional agricultural knowledge has yet to gain prominence in central government policies and programmes on food security and climate change.

CEEW, with the support of UNESCO India, organised a deliberation by experts on 8 October 2015 in New Delhi with the objective of garnering their inputs on the (i) role of traditional agricultural knowledge in enhancing food and nutritional security, securing the livelihood of farmers, and increasing adaptation to climate change; (ii) existing efforts (by government and grassroots organisations) aimed at promoting traditional farming systems and the lessons learned as a result; (iii) drivers for the loss of traditional farming knowledge; (iv) interventions to promote the blending of traditional agricultural practices with modern methods; and (v) ways of promoting collaboration between relevant agencies working towards the same goals.

The experts were of the opinion that only a few states such as Punjab and Haryana have been the focal point of agricultural innovation, which is why Indian agriculture in general suffers if these states do not perform well. This situation has led to two problems: first, excessive exploitation of natural resources and degradation of soil fertility in these states; and second, loss of interest in agriculture in other states due to low productivity levels.

As local conditions are different in different places, climate-change impacts would also be different. Assessing the vulnerability of Indian agriculture to climate change is an issue of great concern. The vulnerabilities are usually not assessed properly, and to strengthen agriculture, the backbone of India's economy, it is essential to define context-specific vulnerabilities.

5 Singh, Joginder, and R. S. Sidhu (2006) "Accounting for impact of environmental degradation in agriculture of Indian Punjab," *Agricultural Economics Research Review* 19 (Conference No.) 2006: 37–48. http://ageconsearch.umn.edu/bitstream/57776/2/DrJoginder-singh.pdf

2. Framework for Assessing Agricultural Vulnerability

The IPCC Fourth Assessment Report: Climate Change (2007) defines ***vulnerability*** in the context of climate change as "the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity."[6]

In the context of climate change, ***exposure*** relates to "the nature and degree to which a system is exposed to significant climatic variations."[7] ***Sensitivity*** reflects the responsiveness of a system to climatic influences and the degree to which changes in climate might affect the system in its current form.

Exposure and sensitivity indicators point to the potential impact of climate change on a system. **Thus, the impact on the agricultural system is shown by a combination of indicators relating to 'exposure' and 'sensitivity' (Figure 2)**.

In addition, there is a third category, **adaptive capacity,** which, according to the IPCC (2007), is the ability (or potential) of a system to adjust successfully to climate change (including climate variability and extremes).

After reviewing around 50 environmental, livelihood, and vulnerability assessments on agriculture, CEEW has listed the following indicators as crucial for assessing agricultural vulnerability, shown in **Figure 1**. **Exposure** has been classified as an external stressor as there is no human control over it. **Sensitivity** and **adaptive capacity** have been classified as internal stressors because they will change in response to changes in agriculture practices and social, economic, and political conditions. The interrelationship between these factors is included in the analysis to some extent, since we know that an increase in exposure and sensitivity leads to negative impacts or increasing vulnerability, and an increase in adaptive capacity leads to positive impacts or decreasing vulnerability.

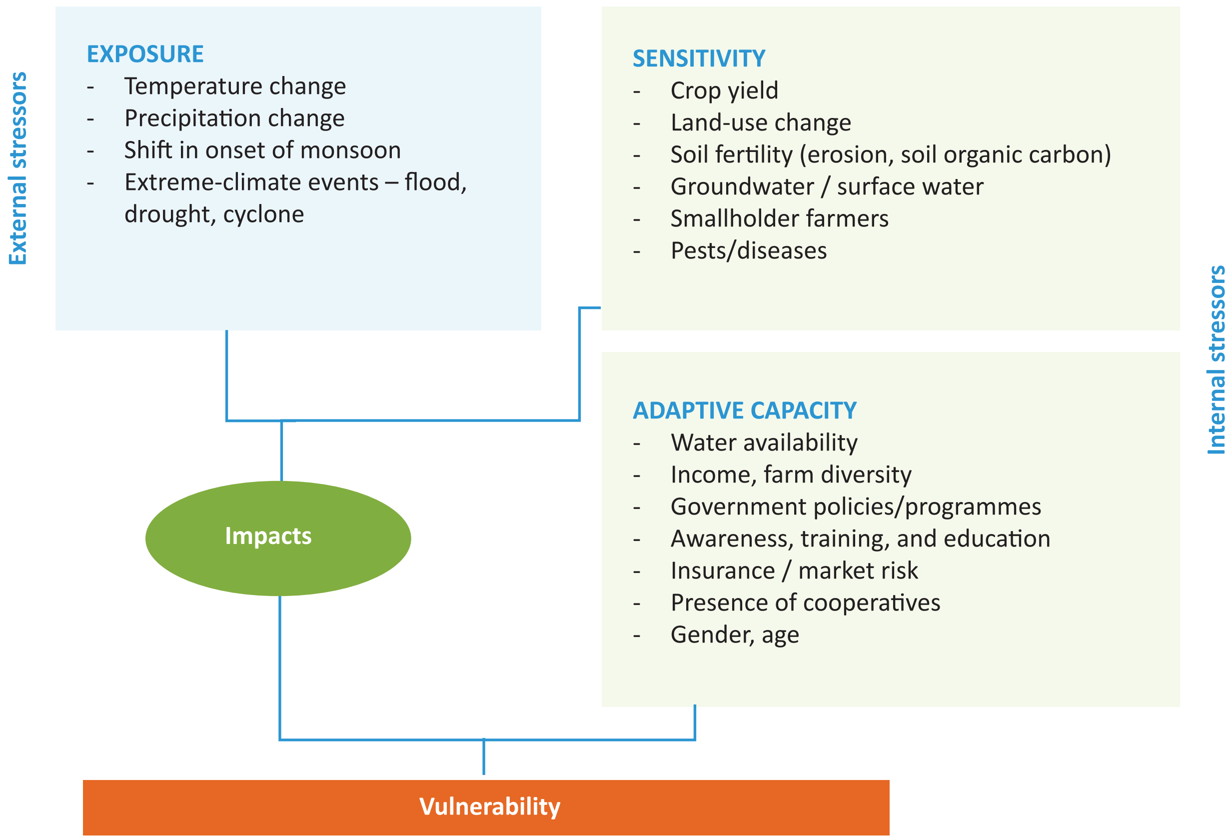
The framework reveals the important categories of indicators that are indispensable for the assessment of any agricultural vulnerability. Regardless of the financial or social assets of farmers, spatial and/or temporal variation in temperature and precipitation is the fundamental information required for analysing climate variability. Most studies evaluate the vulnerability of crops, but do not address the vulnerability of farmers. The absence of an analysis of the latter aspect means that the assessment is incomplete. Thus, for assessing the vulnerability of farmers, and indeed of the entire agricultural system, since India's production is largely dependent on smallholder farmers and on the rainfall received during the south-west monsoon, the framework consists of indicators such as farm diversity, water sensitivity, and access to information. We have adopted a simpler approach in order to help decision makers in assessing the vulnerability of Indian agriculture more quickly. However, there are some other factors, such as location (remoteness of a village), nature of farming

6 IPCC (2007), *Fourth Assessment Report: Climate Change 2007*, *Definitions of key terms*, available at https://www.ipcc.ch/publications_and_data/ar4/wg2/en/spmsspm-e.html; accessed 15 November 2015.

7 IPCC (2001), *Third Assessment Report, Working Group II: Impacts, Adaptation and Vulnerability, Annex B: Glossary of Terms*, available at http://www.ipcc.ch/ipccreports/tar/wg2/index.php?idp=689; accessed 15 November 2015.

terrain (whether coastal or hilly), and use of pesticides (whether natural or chemical), that differ from one site to another. Thus, a detailed analysis of the local situation is needed in each case.

Figure 1: Agricultural vulnerability indicators (examples)

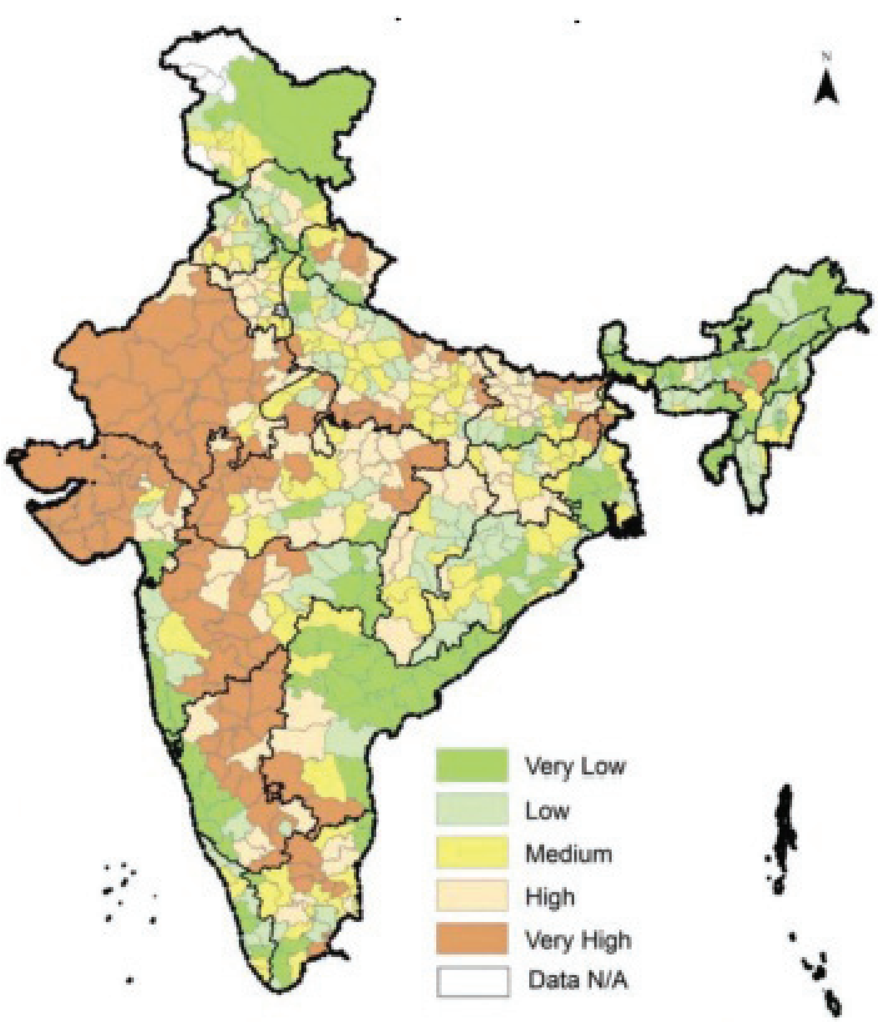


Source: CEEW analysis

3. Climate Change-Related Vulnerabilities of Indian Agriculture

The Agricultural Vulnerability Atlas for India (Figure 2), developed by the Indian Council of Agricultural Research, indicates that farmers in the states of *Rajasthan and Gujarat, along with parts of Karnataka, Maharashtra, Madhya Pradesh, Bihar, and Jharkhand,* are most vulnerable to climate-change impacts.

Figure 2: Agricultural Vulnerability Atlas for India



Source: www.nicra-icar.in

Climate change would have a negative impact on the major crops of India, that is, wheat and rice, and fluctuations in temperature and moisture conditions would lead to increased pest attacks. **Table 1** shows some of the probable impacts on, or the vulnerability of, different crops in India.

Table 1: Predicted climate-change impacts on Indian agriculture

Crops/livestock/ fisheries	Impacts
Rice	○ An increase of 2–4ºC in temperature is predicted to result in reductions in yields. ○ The eastern regions are predicted to be the most affected.
Wheat	○ Increase in temperature (by about 2ºC) will result in reduced potential grain yields in most places. ○ Reductions in yields as a result of climate change are predicted to be more pronounced for rain-fed crops (as opposed to irrigated crops).
Mustard	○ 60% reduction is projected.
Maize	○ 18% reduction at the regional level in irrigated kharif maize by 2050 due to warming is predicted; this can be partly offset by increased rain.
Sorghum	○ 2–14% reduction in kharif sorghum is predicted.
Milk production / livestock	○ An annual loss (production) of 1.8 MT by 2020 is predicted. ○ Northern India is likely to experience more negative impacts of climate change on milk production. ○ Decline in milk production will be higher in crossbred cattle (0.63%) than indigenous cattle (0.4%). ○ The frequency and incidence of diseases affecting crossbred cows and other high-milk-producing animals may increase due to an increase in the number of stressful days.
Fisheries	○ Tamil Nadu, Andhra Pradesh, Kerala, and Maharashtra are the most vulnerable states.

Source: Alok K. Sikka (2015), "Climate change: Production variability and diversity," Presentation made at the 7th Agricultural Summit, AGRI@8% Challenges & Way Out, 15 January 2015, organised by Assocham, available at http://assocham.org/recenteventdetail.php?id=1074; accessed 10 November 2015.

Variation in temperature or spatial and temporal fluctuations in precipitation are not new phenomena. Indian farmers have been dealing with these hazards for centuries by adopting innovative practices, as highlighted in Section IV.

4. Case Studies: Traditional Knowledge and Practices for Combating Climate-Related Challenges

Case study 1: Dhala village, Udaipur district, Rajasthan[8]

CC vulnerability: Erratic rainfall, drought, land degradation, low water availability

Adaptation measures: Blend of traditional and 'improved' practices

- Intercropping or mixed cropping: Growing maize and legumes
- Green manuring: Growing sunn hemp
- Mulching
- Improved seeds: Drought resistant and early maturity

Case study 2: Munda village, Rayagada district, Odisha[9]

CC vulnerability: Irregular rainfall, growth in population resulting in competition for scarce forest resources, HYVs (paddy) and chemicals distributed for free by government

Adaptation measures: Resorting to traditional agriculture

- Mixed cropping: Combination of niger (an oilseed), sorghum, millet varieties (like finger, foxtail, pearl, pigeon pea), and horse gram along with creeper beans
- Local seeds: Withstand monsoon unpredictability and are more suited to dry conditions

Case study 3: Jeypore tract, Koraput district, Odisha

The Jeypore tract (undivided Koraput district), the southernmost district of Odisha, is famous for conserving the genetic diversity of Asian cultivated rice, managed by tribal farmers over centuries. Between 60 and 80 per cent of these farmers practise mixed cropping for their subsistence and only sell the surplus.[10]

- Crops of different lengths are selected to ensure maximum exposure to sunlight.
- The diverse topography has resulted in a range of ecosystems: upland (unbunded as well as bunded), medium land (irrigated and rain-fed), and lowland.
- Plants are chosen based on morphological characteristics or cultural practices (aromatic and non-aromatic).[11]

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8 Shah, Ronak and Niranjan Ameta (2008) "Adapting to Change with a Blend of Traditional and Improved Practices," available at http://www.agriculturesnetwork.org/magazines/global/dealing-with-climate-change/adapting-to-change-with-a-blend-of-traditional-and; accessed 8 September 2015.

9 Jena, Manipadma (2012) "Tribal Farming Beats Climate Change," available at http://www.ipsnews.net/2012/04/tribal-farming-beats-climate-change/; accessed 8 September 2015.

The notion of 'scared grove' or 'sacred woods' is an effective way of preserving the genetic resources of local varieties of trees, plants, and crops. This helps in promoting the protection of forest patches as well as in ensuring biological diversity.[12]

The Food and Agriculture Organization (FAO) of the United Nations has recently recognised this traditional agricultural practice under the Globally Important Agricultural Heritage Systems (GIAHS). In addition, the M.S. Swaminathan Research Foundation has also taken up the documentation and conservation of traditional knowledge through community biodiversity registers.[13]

Case study 4: Tribal regions, Ranchi, Gumla, and Hazaribagh districts, Jharkhand[14]

CC vulnerability: Increase in average monthly maximum temperature and increase in rainfall pattern

Adaptation: A holistic approach

Land preparation, manuring, and soil treatment: Primary tillage
Cropping systems: Legume-based mixed and intercropping practices, for example, pigeon pea + rice; gram + linseed; gram + wheat
Crop rotation: rice–gram, rice–pea, groundnut–wheat

Input management
Preparation of organic manure/composting: Manure from household waste and dung and mahua cakes
Herbicides, pesticides, and their inputs: Application of neem and karanj cakes — conditioning the light-textured acidic soil of Jharkhand and safeguarding vegetables of the Solanaceae (nightshade) family like tomato and brinjal;

Water resource management

- Crop-residue mulching
- Plot-to-plot bunding (field dykes)
- Stone bunding; stone-cum-earthen bunding; stone-cum-vegetative bunding
- Management of water from rivulets
- Low-cost structures to address soil and water erosion: grassed waterways; spur structures (temporary barriers)

In-situ moisture conservation: Linseed/gram seed is broadcasted in standing rice crop just before harvesting

10 Mishra, Smita, S. S. Chaudhury, S. Swain, and T. Ray (2009) "Multiple cropping system for conservation and sustainable use in Jeypore tract of Orissa, India," Asian Agri-History 13(1): 39–51.
11 Mishra, Smita, S. S. Chaudhury, S. Swain, and T. Ray (2009) "Multiple cropping system for conservation and sustainable use in Jeypore tract of Orissa, India," Asian Agri-History 13(1): 39–51.
12 Ramoo (2012) "FAO Recognition of Traditional Farming Should Keep GM Away," available at http://agrariancrisis.in/2012/02/01/fao-recognition-of-traditional-farming-should-keep-gm-away/; accessed 04 November 2015.
13 Sood, Jyotika (2012) "UN Heritage Status for Odisha's Koraput Farming System," available at http://www.downtoearth.org.in/news/un-heritage-status-for-odishas-koraput-farming-system--35627; accessed 04 November 2015.
14 Lakra, Valeria, M. K. Singh, R. Sinha and N. Kudada (2010) "Indigenous technology of tribal farmers in Jharkhand," *Indian Journal of Traditional Knowledge* 9(2): 261–263.

Case study 5: Parangipettai (Porto Novo), Cuddalore district, Tamil Nadu[15]

The coastal agro-ecosystem of Parangipettai (Porto Novo), a gram panchayat in Cuddalore district in the north-eastern coastal region of Tamil Nadu, is a typical agri-silvicultural zone whose people follow effective practices based on traditional farming knowledge.

A wider range of indigenous methods like rainwater harvesting and soil and water conservation are followed to cultivate annual and perennial crops. These methods are eco-friendly and cost-effective. They employ traditional knowledge to conserve the local environment, to enhance the use of locally available inputs, and to provide economic security to rural people.

Crop production depends on the input of locally available organic manure derived through penning and crop residues. Management of traditional water resources is also important in the conservation and utilisation of natural resources. The following are the traditional practices adopted:

- Soil conservation through crop-residue mulching and summer ploughing, followed by leaf-litter mulching, vegetative barriers, crop rotation, and relay cropping
- Growing trees on field bunds
- Green manuring
- Animal penning
- Farm ponds
- Water management practices

Case study 6: Apatani plateau, Lower Subansiri district, Arunachal Pradesh[16]

- The plateau is located at an altitude of about 1,525 m above mean sea level. It has a humid tropical climate.
- Farmers here practise wet rice cultivation integrated with aquaculture in terraces, and grow finger millet on risers or terrace bunds.
- Varieties of long-duration rice (190–278 days) are grown.
- Risers or terrace bunds are used for growing finger millet.
- Finger millets bind the soil and also suppress the growth of weeds in the bunds.
- Millets are used by local breweries.
- The cost of maintenance is zero because the fish feed on naturally available organisms such as phytoplankton and other microorganisms.
- Puddling and levelling of terraces is done manually with the help of indigenous wooden tools.
- Pig and poultry droppings, rice husks, kitchen waste, ash, and weeds removed during weeding are also recycled in the fields every year.

Source: CEEW compilation

15 Immanuel, R. Rex., V. Imayavaramban, Murugan G., Kannan T. and Lyla Elizabeth L. (2010) "Traditional farming knowledge on agroecosystem conservation in northeast coastal Tamil Nadu," Indian Journal of Traditional Knowledge 9(2): 366–374. http://nopr.niscair.res.in/bitstream/123456789/8163/1/IJTK%209%282%29%20366-374.pdf

16 Pulamte, Lalsiemlien (2008) "Indigenous agricultural systems of Northeast India," India, Science and Technology, S&T for Rural India and Inclusive Growth, available at http://www.nistads.res.in/indiasnt2008/t6rural/t6rur18.htm; accessed 21 December 2015.

Sustainable modern agricultural practices such as the system of crop intensification (SCI) recently have been readily accepted by farmers in a few places. In Nalanda district of Bihar, a farmer, Sumant Kumar, reported a harvest of 22.4 tons per hectare using the technique of crop intensification, which is a world record.[17] Similarly, in Punjab, a total of 1,848 tensiometers were installed at farmers' fields, which resulted in water savings of 14–15 per cent in rice cultivation with a corresponding savings of power of 101 kwh/acre in 2012 and of 70 kwh/acre in 2013.[18] Use of sprinklers and drip irrigation systems is also becoming more common, especially in water-scarce areas. Thus, there is room for both traditional and advanced agricultural practices to be accepted, followed, and sustained together. However, the incentive structure, existing market conditions, and current policies are not sufficient to promote the rational blending of traditional and neo-traditional practices.

17 Piras, Nicola (2011) "New Record in Bihar Thanks to SRI," available at http://www.agriculturesnetwork.org/resources/extra/bihar-sri; accessed 13 January 2012.

18 Vatta, Kamal, R. S. Sidhu and Baljinder Kaur (2014) "Towards Sustainable Water and Energy Use in Agriculture: The Case of Tensiometers in Rice Cultivation, Introduction," pp. 1–12, available at https://www.researchgate.net/publication/264309638_Towards_Sustainable_Water_and_Energy_Use_in_Agriculture_The_Case_of_Tensiometers_in_Rice_Cultivation_Introduction; accessed 10 November 2015. DOI: 10.13140/2.1.1891.1368

5. Drivers for Loss of Traditional Agriculture Knowledge

A study by the International Institute for Environment and Development (IIED), London, analysed the traditional agricultural systems of the Karst Mountains in southwest China, the Andes Mountains in Bolivia, and the coastal region in Kenya. It found that there are multiple drivers for the loss of traditional knowledge and genetic diversity, which are often interlinked and mutually reinforcing. The drivers for the loss of traditional agricultural practices are:[19]

Pro-modern agricultural policies

Agricultural policies in India, especially after the success of the Green Revolution in the country, have been advocating modern agricultural practices through various means, for example, supply of HYV seeds through seed distribution agencies and huge subsidies for chemical fertilisers and power. Also, institutional structures such as Krishi Vigyan Kendras (KVKs) were established in every district to promote advanced agricultural practices. These policies and measures have led not only to the loss of traditional knowledge but have also resulted in the overexploitation of natural resources in several regions. Recently, a few initiatives have been undertaken to compensate for the damage done, such as subsidies for vermicomposting, solar pumps, and drip irrigation systems, as well as crop insurance for SRI (system of rice intensification) cultivation. However, more support on the ground is required for ensuring maximum benefits of these initiatives.

Productivity and marketability

Traditionally grown varieties usually do not have very high grain productivity. In addition, their appearance may not be very appealing to consumers. Thus, the marketability of these products is difficult. Another factor that affects productivity and marketability is non-availability of land, which forces farmers to choose high-producing varieties. All these factors together govern the choice or selection made by farmers.

Poor documentation

At present, there is no government policy or initiative that directly supports the documentation of distinctive traditional practices. For example, hilly regions are distinctive in their topography, and these areas do not offer much support for agriculture (that is, a favourable natural environment for agriculture) in terms of terrain, topography, water availability, soil, climate, etc. Nevertheless, local communities have been able to discover resilient varieties and to adopt diverse traditional agricultural practices to support the local

19 Adapted from Swiderska, Krystyna, Yiching Song, Jingsong Li, Hannah Reid and Doris Mutta (2011) “Adapting agriculture with traditional knowledge,” Briefing, International Institute for Environment and Development (IIED), October 2011, http://pubs.iied.org/pdfs/17111IIED.pdf?; accessed 21 December 2015; and from the technical discussion during the CEEW–UNESCO roundtable on “Promoting Neo-traditional Agriculture to Achieve Food and Livelihood Security and Climate Change Adaptation,” 08 October 2015, New Delhi.

population. However, these local traditional practices are being lost because of two reasons: first, these practices are not high-yielding, so locals are opting for better-paying opportunities, with most of the migration happening towards the service sector; and second, there are not enough government incentives to support traditional agriculture. Due to poor documentation of these practices, after one or two generations many of these innovative practices will no longer be known to anyone.

Research focus

Most of the research undertaken by government agencies and research institutes has been aimed at making modern agricultural systems more efficient, and very few studies have been directed towards identifying the positive impacts of existing practices.

View of farmers as always being receivers, not givers

There is a common notion that traditional agriculture is unscientific as it is not based on experimentation. However, many experts do not understand that these traditional practices evolved over centuries and after extensive experimentation, and through trial and error, by farmers in the field. Thus, most government initiatives are aimed at farmers as prescriptions, and not as matters to be discussed mutually and deliberated upon collectively. Initially, due to promising technologies and practices, the measures advocated by the government resulted in high levels of productivity, but also led to depletion in soil fertility. It has now become almost impossible to achieve the same productivity levels without the use of chemical fertilisers. Unfortunately, this has done more damage, and farmers are now becoming increasingly reluctant to listen to new directions and initiatives emanating from the government, because they have already faced the negative consequences of following government guidelines and recommendations.

Non-availability of farmers' intellectual property rights (IPRs)

New hybrid varieties that are being produced in laboratories through experimentation have associated IPRs. However, there is no such system to protect farmers' rights over traditional varieties, which means that farmers have no incentive to sustain or conserve traditional varieties.

Lack of location-specific policies

Most agricultural policies are centre- or state-level policies, which are overarching in nature and are not customised to suit local conditions. There is either not enough capacity at the local level or there is no incentive to design a location-specific policy. Hence, these umbrella policies—which do not deal with location-specific conditions—lead to the adoption of the most common advanced practices, resulting in the neglect of locally developed practices and context-specific traditional knowledge.

6. Policies Recognising the Role of Traditional Agriculture in Food Security and Climate Change Adaptation

International Agreements and Declarations

The Food and Agriculture Organization's (FAO) International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA), 2004: This treaty, also known as the International Seed Treaty, deals with the conservation and sustainable use of plant genetic resources for sustainable agriculture and food security.

The Convention on Biological Diversity (CBD), 1993: This convention is very similar in nature to the ITPGRFA, as its objectives are the conservation of biological diversity, the sustainable use of its components, and the fair and equitable sharing of the benefits arising out of the utilisation of genetic resources.[20] Both the above-mentioned conventions talk about the importance of the conservation of seed varieties, but they do not lay much stress on the need for the documentation and conservation of traditional agricultural practices.

IPCC Fourth Assessment Report (AR4), 2007: The IPCC (Intergovernmental Panel on Climate Change) AR4 considers indigenous knowledge as extremely important for adapting against climate change. It highlights the crucial and indispensable role of indigenous knowledge in developing climate adaptation and natural resource management strategies in response to environmental and other forms of ecological change. Also, it emphasizes the fact that local knowledge is essential for understanding the effects of climate change on indigenous communities.[21], [22] and how, for example, some communities have absorbed the effects of change through flexibility in traditional hunting, fishing, and gathering practices. Reiterating this point, the 32nd Session of the IPCC in 2010 states: "Indigenous or traditional knowledge may prove useful for understanding the potential of certain adaptation strategies that are cost-effective, participatory and sustainable."[23], [24]

20 The Convention on Biological Diversity, 1993, *Article. 1 Objectives*, available at https://www.cbd.int/convention/articles/default.shtml?a=cbd-01; accessed 12 November 2015.

21 Riedlinger, Dyanna, and Fikret Berkes (2001) "Contributions of traditional knowledge to understanding climate change in the Canadian Arctic," *Polar Record* 37(203): 315–328.

22 Krupnik, Igor, and Dyanna Jolly (eds) (2002) *The Earth is Faster Now: Indigenous Observations of Arctic Environmental Change*. Fairbanks, Alaska: Arctic Research Consortium of the United States (ARCUS).

23 IPCC (2007), Fourth Assessment Report: Climate Change 2007, Definitions of key terms, available at https://www.ipcc.ch/publications_and_data/ar4/wg2/en/spmsspm-e.html; accessed 15 November 2015.

24 Raygorodetsky, Gleb (2011), "Why Traditional Knowledge Holds the Key to Climate Change," available at http://unu.edu/publications/articles/why-traditional-knowledge-holds-the-key-to-climate-change.html; accessed 15 November 2015.

Indian Legislation

The Protection of Plant Varieties and Farmers' Rights Act, 2001 and the Biological Diversity Act, 2002: These Acts establish the rights of farmers to register their innovations and to be rewarded for protecting extant (existing) varieties.[25]

However, the legislative provisions laid down by the government of India have not led to action due to lack of specific stipulations for identifying the beneficiaries (individual farmers and communities).

25 Dey, P., and A. K. Sarkar (2011) "Revisiting indigenous farming knowledge of Jharkhand (India) for conservation of natural resources and combating climate change," *Indian Journal of Traditional Knowledge* 10(1): 71–79.

7. Essential Policy Reforms

Documentation of traditional practices

The first and most important initiative to preserve traditional knowledge is the documentation of traditional agricultural practices. Educational institutions and government agencies whose networks and roots extend to the farthest and remotest parts of the country should be engaged and encouraged to start working on this project immediately. This step would allow the creation of an incredibly rich library or depository of innovative agricultural practices that could be referred to as and when required. The government should provide research grants to young scholars as an incentive to undertake extensive research on traditional agricultural practices. This research would complement the ongoing parallel research on modern agricultural practices. Also, it would be helpful in documenting the biodiversity of secondary crops that exist in remote areas. This research would also be helpful in exploring the ways in which communities were able to meet their nutritional and food requirements.

Adoption of participatory decision making

As discussed above, it is essential to acknowledge and recognise the knowledge and contribution of indigenous farmers that has made the preservation of several varieties of crops over the centuries possible. New agricultural policies and plans should be prepared and implemented in consultation with farmers and representatives of agricultural associations. It is essential to understand the reasons why a certain crop or a certain variety of a particular crop is chosen by farmers before suggesting any changes. The case study of Koraput, Odisha clearly demonstrates that the choice of a certain crop or a certain variety of a particular crop depends on the preferences of the community. In Koraput, innumerable rice varieties are grown depending on the preferences of local farmers for morphological characteristics such as height of plants, pigmentation of plant parts, and shapes of grain; or agricultural practices such as broadcasting and transplanting; or methods of food preparation such as cooked rice, popped rice, and puffed rice; or palatability such as the preference for aromatic and non-aromatic varieties. 26 Involvement of farmers in decision making could happen at different levels and in direct or indirect ways. For example, representatives of institutes such as KVKs and officials of district-level agriculture or irrigation departments could hold such discussions one year prior to the year when the new five-year plan or agriculture policy is supposed to be presented. At the state level, elected representatives as well as department officials could interact with representatives of NGOs and research institutes working in the agricultural sector to further refine and prioritise the concerns identified and the suggestions made by the farmers. These could then be merged with the recommendations made by the experts. That being said, it is essential to further share the draft plans and policies with farmers and their representatives to ensure that their concerns have been addressed and also to ensure that they agree with the recommendations made. This step would also act as a check to see if anything essential is missing. It is important that the policy and programme designs be given sufficient time and enough resources to produce the desired results, and the participation of all stakeholders also needs to be ensured.

26 Mishra, Smita, S. S. Chaudhury, S. Swain, and T. Ray (2009) "Multiple cropping system for conservation and sustainable use in Jeypore tract of Orissa, India," *Asian Agri-History* 13(1): 39–51.

Capacity development of local communities

An educated and informed community can utilise government incentives, natural resources, and technologies in the best possible way for developing a climate-resilient agricultural system. Generally, the current capacity-development programmes focus on providing training for only one or two days, which in no way meets the purpose. Initiatives such as setting up farmer field schools and showing films and dramas in vernacular languages on climate-change impacts on agriculture should be held at more frequent intervals rather than being organised as yearly events.

Promotion of agriculture as a sustainable livelihood option

The burden of Indian agriculture rests almost exclusively on the shoulders of poor and uneducated farmers who generally lack support from various quarters. Now the precariousness of Indian agriculture is likely to increase as it becomes even more vulnerable to climate-change impacts. To address this issue, the education system in India should introduce agriculture as a subject at the school level, especially in rural schools. This would not only expose children to available technologies and incentives, but would also help them in developing customised solutions to address local challenges and to meet local needs.

Support to traditionally grown products

Experts have clearly expressed their concern over decreasing crop varieties, as this leads to increased vulnerability of the agriculture landscape. Traditional agricultural practices and systems of knowledge need to be conserved, as these diverse crops are important not only from the diversity point of view but also because they increase the resilience of farmers in dealing with instances of extreme-climate events or pest attacks. To encourage diverse cropping, it is essential to create larger and more lucrative markets for such crops and to provide incentives to farmers. The media can definitely play an important role in publicising such products, for instance, stressing the benefits of organically grown products or their unique nutritional value.

Development of, and reward for, local gene banks

In India, the IPR scheme and the incentives for protecting wild varieties of crops are not sufficiently developed at present. Farmers who have been the custodians of thousands of wild varieties of crops should be incentivised and rewarded for their role, contribution, and knowledge. Also, the links between farmers and the research agencies engaged in protecting and preserving genetic varieties need to be strengthened.

Targeting of hitherto neglected states

Agriculture in India has made a great deal of progress in the last few decades, especially after the Green Revolution. Associated initiatives helped in increasing food production and in making India food secure. However, this growth has been spatially skewed. Only states such as Punjab and Haryana that have plain and fertile land were targeted as the centres of growth. This is substantiated by many studies that show that government agencies and researchers have largely focused on these states only. This kind of lopsided growth has resulted in two major adverse effects. First, it has led to the overexploitation of natural resources, resulting in decreasing soil fertility in these states. Second, agriculture in other states did not develop as it did in Punjab and Haryana because of a lack of official attention. States with hilly and/or coastal terrain and rain-fed agriculture, which are more vulnerable to climate change, have suffered the most. Thus, it is essential to prioritise agricultural development in these states, as productivity in the previously targeted states (such as Punjab and Haryana) may decline or may not be able to meet the food and nutritional requirements of Indians. India cannot depend on just two or three states to produce the food supply for the entire country. This kind of skewed set-up itself poses a serious challenge to the food security of India.

Adoption of informed policy decisions

Even policy makers who understand the local situation pretty well and have a good grasp of the complexity of the situation nevertheless have to be updated and informed about advancements in scientific research in the agricultural sector. Five-year goals or departmental targets should be set realistically and should be aimed at encouraging farmers to grow traditional varieties. The policy-making process should definitely involve farmers, department and ministry officials, and research institute representatives.

Encouragement of mixed cropping and farming practices

The traditional practices of growing multiple varieties of crops, agro-forestry, and agro-fisheries should be encouraged. These practices should be studied further to enhance the productivity and income of farmers. Such initiatives would strengthen and support indigenous traditions and would also prevent farmers from shifting to mono-cropping. In addition to the existing traditional practices, new options should be explored and adopted, as farmers in many states grow crops in one season only due to agro-climatic limitations.

Integration of water, agriculture, and climate-change risks

It is important to shift to a resource-based planning and development strategy from a crop-based planning and development strategy, that is, there should be an understanding about the kinds of resources available in a region. This underlines the necessity of various departments and agencies working together in pursuit of common goals and targets.

Shift from maximising yields to minimising risks

Policies till date have been targeting interventions that could maximise agricultural yield, which was necessary for supporting farmers and for ensuring food security for the country. However, the situation has now changed dramatically and hence new goals need to be set. Forecasts of climate change and predictions of climate-change impacts, which are already being experienced with devastating effect all over the world, necessitate that all planned and imminent policies should be directed towards minimising risks. This means that farmers will have to move towards crop varieties and farming practices that are resilient to climate change-related risks. Thus, policy making should be used indirectly to support the push towards climate-resilient agriculture.

Phasing out of chemical farming and shift to organic farming

The move towards traditionally used fertilisers and pesticides should be done in a phased manner for two reasons: (i) Currently, the supply of organic fertilisers and pesticides is not available as per requirement; (ii) Many traditionally used fertilisers and pesticides will have to be checked for efficiency and efficacy, and their manufacture will have to be standardised based on the findings of reliable laboratory tests. Also, there is a possibility of decreased production because of a decline in soil fertility in several places due to extensive use of chemical fertilisers. Therefore, the first priority should be to decrease the use of chemical fertilisers, and the second priority in the longer term should be to completely replace the former with non-damaging natural fertilisers.

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