

Community based Adaptation to Climate Change through Agro Ecological Reforms in India

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Abstract:- Climate change has been a burgeoning issue that threatens the existence of the human race in the future. Although the global community have risen up to the problem and is aspiring to mitigate its effect, the solutions are long term and numerous problems seem to be irreversible. The world is already facing economic slowdown, social injustices along with severe environmental crisis. Besides this, emerging planetary problems have opened up a new chapter that has to be addressed quickly for a better tomorrow. Since mitigations have longer gestation period before they can show positive results, it should be suitably complemented with stronger adaptation measures. A country like India with higher population concentration, which also needs a generous investment in people centric activities is likely to be affected by greenhouse gas emissions and its consequences for decent number of years. Some of the regions are likely to face a greater threat due to its geomorphology, climatic characteristics and ill planned development process. Water deficit in the region owing to climatic uncertainties are often followed by economic turmoil. Agricultural sufficiency may be hampered due to a cocktail of issues including degenerative methods of landscape destruction and misuse of valuable resources like soil and water. Being primarily an agriculture-based economy, the country should focus on agro ecological reforms that can ensure long term sustainability and building a climate resilient society. This paper attempts to visualise the impending problems in vast stretches of the country that are at risk from lowering agricultural productivity. The researchers lay emphasis on regenerative methods of agricultural production as a community-based learning tool for adapting to climate change.

Keywords:- Climate Change, Adaptation, Regenerative Agriculture, Resilience.

I. INTRODUCTION

Adaptation has been a part of human evolution. Since the time human life evolved, they have been subject to many ecological stimuli against which social responses, both physiologically and culturally have been a tremendous achievement for humankind. With every new set of challenge, cultural adaptations have also been much stronger. In this process, human species considered to be most adaptable have also impacted the physical or the natural world. They have not only disturbed the natural balance but have also created vulnerabilities for their own

community. Resilience for some have transformed into vulnerabilities for others, especially for those who are poor and marginal.

The developed world with their high ecological footprint has dominated the world economies for a long time. Many countries like India have been culturally and economically exploited by colonial powers. With independence, new set of challenges emerged in front of the country which was devastated and plundered by invaders over a long time. Among them providing food security was one of the highest priorities for the policy makers. This needed rapid growth, urbanization, industrialization and a neo agricultural revolution. Population continued to rise and so did the exploitative human responses to provide for food, fuel and fodder. Although our economies have always been sustainable in theory and practice, yet the globalized and inter connected world had inevitable influences on the people. Along this difficult trajectory, agricultural patterns also changed phenomenally that had severe repercussions on the environment. This was realized at a later stage once the damage was widespread.

Climate Change has created a global shock that has instilled fear in minds of people world over. It is emerging as a critical local problem in the Indian territory alike. In order to fulfil the aspirations of its demanding populace, many developmental models although flawed, still continues in the country. The government is spearheading many policy changes in the recent times yet the obstacles in the path towards reduction of carbon footprint are too many. With a better understanding of the future risk, mitigation methods are being introduced. As we all understand the limitations of mitigations in such a short period, adaptations measures can be significant in this rapidly changing world.

All regions of the country are already and is likely to be affected by climatic variabilities, yet the areas with rainfall deficit may suffer more with respect to intense heat, lower precipitation and lack of water availability. It will additionally disturb their agricultural patterns. Energy needs will also increase to combat these problems and to make life comfortable at the cost of the environment.

This paper addresses the need for adaptation in India amidst this climatic crisis. It further focusses on the strategies which can be possibly introduced to the community for creating climate resilience in the future. The communities themselves have to be deeply involved to speed up the process of building their capacity and to

upsurge their adaptability. Multiple adaptation approaches are required with a multisectoral framework. However, in this paper, one of the main areas of concerns in the water stressed regions includes mitigating the impact on the agricultural economy and associated food insecurity.

The adaptation method focusses on *Regenerative Agriculture* using various tools like suitable water conservation methods, preserving the soil health, use of energy efficient technologies and overall improvement of the environment. This will further help in designing an *Ecological Friendly Human Habitat* for the entire region.

II. NEED FOR ADAPTATION

Climatic extremes are going to affect individuals and societies in the near future. Although risk cannot be fully eliminated yet they can be averted if early interpositions towards mitigation and adaptation become a part of the government policy and way of living. Along with suitable mitigation strategies that the country is initiating, adaptation can complement the process of Risk Reduction. Each and every mitigation activity may take several years to reduce the root causes related to climatic variabilities. In the long term, they may transform into a climatic change that would be irreversible. Before the mitigation measures actually show results, there would be less scope left for building resilience. Besides climatic factors, non-climatic social and economic parameters will continue to increase the vulnerabilities of places and people.

Adaptation is a social change and an evolutionary process for communities that may face extreme risk. Community members are affected differently because of differential exposures. Also, they have different adaptive capacities based on their understanding of the ground realities, perception related to risk and ability to bounce back.

India in the recent past, has been facing many challenges due to climatic variability. It is not the lack of adaptability to extreme weather conditions but also the large population whose livelihood may be affected. Sectors like agriculture and forestry can be very sensitive to climate change in the future. Many regions are already facing huge risk due to uncertainties arising out of these changes.

India has both climatic as well as geomorphological diversity which further influences the cultural diversity. Climatologically, both the extremes in temperature and rainfall are intrinsic characteristic of this biome dominated by monsoon type of climate. Between the highly humid to highly arid topology, there is a substantial area of semi-arid conditions too. These are highly water stressed regions with relatively a significant per centage of people who are dependent on rainfall and groundwater for their various needs.

In these areas many farmlands suffer from degradation of different kinds. Conventional agriculture which involves continuous tilling exposes the soil to oxidation and thus

CO₂ is released in huge quantity. Besides, erosion further adds to the land degradation and fallowing. Many farmers are unable to make that land productive and leave farming forever. Over the years many places have been completely devoid of the soil cover and the soil moisture balance also can't be maintained. Many have lost their household incomes and are in desperate need for livelihood protection. In some areas farmers have also committed suicide due to lack of hope, support and resource base. In such a situation regenerative farming which is ecologically way sounder can reverse the process.

Climate change poses significant challenges to agriculture in India, including increased temperatures, changing precipitation patterns, and more frequent extreme weather events. To adapt to these challenges, various strategies and practices can be implemented to make Indian agriculture more resilient. Here are some climate change adaptation strategies for agriculture in India:

➤ *Diversification of Crops:*

Farmers can diversify their crop selections to reduce reliance on a single crop. Growing a variety of crops can help mitigate the risk of crop failures due to changing climate conditions.

➤ *Crop Rotation:*

Implementing crop rotation practices can improve soil health and reduce the risk of pests and diseases. Different crops have varying water and nutrient requirements, which can help in adapting to changing conditions.

➤ *Use of Climate-Resilient Crop Varieties:*

Developing and using crop varieties that are more tolerant of heat, drought, and changing weather conditions is crucial. Research and breeding programs can play a significant role in this regard.

➤ *Improved Irrigation Practices:*

Efficient water management is critical. Investing in water-saving technologies like drip irrigation and rainwater harvesting can help reduce water wastage and ensure that the crops receive the right amount of moisture.

➤ *Agroforestry:*

Introducing trees and shrubs into agricultural systems can improve resilience by providing shade, reducing soil erosion, and improving overall microclimates.

➤ *Soil Health Management:*

Implementing sustainable soil management practices, such as no-till farming, cover cropping, and organic matter incorporation, can enhance soil fertility and water retention.

➤ *Weather Forecasting and Information:*

Access to timely and accurate weather information can help farmers make informed decisions regarding planting, harvesting, and other agricultural practices.

➤ *Farm Infrastructure Improvement:*

Developing infrastructure like better storage facilities and post-harvest management systems can reduce food losses and improve overall farm resilience.

➤ *Insurance and Risk Management:*

Promoting crop insurance and risk management mechanisms can provide financial support to farmers in the event of crop failures due to extreme weather events.

➤ *Capacity Building and Training:*

Training farmers in climate-resilient agricultural practices and technologies can enhance their ability to adapt to changing conditions.

➤ *Promotion of Sustainable Livestock Farming:*

Livestock management practices can also be adapted to changing climate conditions. This includes improving animal shelter and nutrition and ensuring access to clean water.

➤ *Community-Based Adaptation:*

Encourage community participation and local adaptation strategies that consider unique solution to unique challenges faced by different regions in India.

➤ *Government Policies and Support:*

The government can play a crucial role by formulating and implementing policies that promote sustainable agriculture, provide financial incentives, and support research and development efforts.

➤ *Promotion of Climate-Smart Agriculture:*

Climate-smart agriculture combines adaptation and mitigation strategies. It involves sustainable practices that adapt to climate change while reducing greenhouse gas emissions.

It's essential to integrate these strategies into a comprehensive approach to climate change adaptation for Indian agriculture. This should involve cooperation between government agencies, research institutions, farmers, and NGOs to ensure the success of these initiatives and enhance the resilience of India's agricultural sector in the face of climate change.

III. REGENERATIVE AGRICULTURE FOR THE COMMON GOOD OF THE SOCIETY

On the basis of *literature review, discussions with experts and farming community*, it was interpreted that the agricultural system has to undergo radical change. The present system is highly unsustainable and will be unproductive in future. The future climate along with the environmental destruction of the habitat will be a heart wrencher for both rich and poor. It will also compound the social injustices and enhance gaps between them. There is no dearth of information related to this yet awareness is abysmally low.

Green Revolution during the sixties was a response to food scarcity and dependence on foodgrains exported from outside. It did help in increasing productivity, come out of famines and helped the Agro based economy to grow. However ecologically, it proved to be fatal destroying soil and water, developing heavy reliance on chemical fertilizers and pesticides. Now we need a second revolution that will balance production and ecological wellbeing.

Indian agricultural system traditionally was mostly subsistence in nature and worked on barter economy. The principle of Sanatan Economics as described by certain experts is also based on complementing nature and not competing with it. Sometimes small farmlands of the oriental kind are much better than large landholding model of the west, as it reduces cost, energy and water consumption. Collective farms can also help in creating a support system for the entire community during periods of stress. At the same time diversification of commodities becomes much easier even though individual plot size may be smaller. Though many new models of agriculture have emerged recently, it is actually a reorganization of traditional practices with some systematic input and design principles. Most farmers in the country are not aware of these possible reforms.

There is a great degree of loss of trust and receptivity to this innovative style as information is meagre. They also fear that their produce will decrease and hence a reduction in their farm income. While educated and new age farmers who have turned towards organic and natural methods are profiting highly from such change, the conventional farmers are still very apprehensive. Since competition is low, these new farmers are selling their produce to a niche population at a premium cost.

This system maintains diverse life forms, improves soil quality as well as improve food nutrition. Since this practice reduces use of heavy machinery, ploughing and continuous grazing, land degradation can be minimized. It will thus assist in reducing carbon emissions and impact of flooding on the deeply eroded land that once had cropland. It will ensure efficient use of water and induce higher biodiversity. Instead of a falling yield it can actually feed the world population and provide a pathway for sustainable living.

Many describe this as regenerative agriculture that is designed to farm along with soil stabilization and environmental protection. Rodale (1983) defined regenerative agriculture as an integrative system of producing more food using as few resources as possible at the same time revitalizing the productive capacity of the soil and sequestering carbon. Soil is always kept covered with crop residues or mulch which maintain the right temperature and protects it from erosion. Through this process, soil disturbance can be minimised too. Also, diversification of crops can mineralize the nutrients because of their variable capacities to do so. Livestock rearing is again not commercial in nature but provides for sustainable food management and improves the nutrient cycling. All this can benefit the environment without compromising on food

quality and quantity. Despite many poor farmers being dependent on rainfed agriculture, it can still help them getting their returns from the field by careful planning and applying ecological principles to bring overall stability to this system.

IV. SUSTAINABLE PATHWAYS THROUGH INDIAN AGRICULTURAL REFORMS

There can be a quick guide to such a transformation that will not only help in coping up but also stabilize the food supply chains. These are very doable and less capital intensive and can be well experimented in smaller patches along with the earlier practices. Once it starts to give results, more such areas can be brought into the ambit of Agro-ecological design. It may sound very dramatic but it is actually possible to maintain all ecosystem services at one place. It is like a one stop solution for multiple problems. Most of our lives we engage in solving our problems in silos without realizing, every set of complex problem needs integrated solutions without doubt.

The genesis of the land degradation and loss of soil productivity emerged from the need to increase the calorific yield which was desirable at that time to secure food supply. However, the society kept on moving unilaterally in this direction without reviewing the consequences. Continued

reliance on carbohydrate increase led to abundance of food at the cost of nutritional quality, biodiversity loss, dipping soil water balance and ultimately destruction of the farming system. With this, age-old wisdom to cope up with environmental and psychological stresses were also lost.

Agriculture is the largest economic activity at the global level. In India it has always been the backbone of our culture and economy. It is also understood to be the contributor of greenhouse gas emissions right from farm to plate. The industrial crops have further enhanced this system. Yet the tables can turn with regenerative agriculture which is ecologically sound.

Robert Rodale, son of American organic pioneer J.I. Rodale, defined Regenerative Agriculture as, “...takes advantage of the natural tendencies of ecosystems to regenerate when disturbed. In that primary sense it is distinguished from other types of agriculture that either oppose or ignore the value of those natural tendencies.”

With this transformation, all basic reforms related to agro-economy is possible. If done in the right manner, it will cover all the aspects of a sustainable economy thus fulfilling the economic, social as well as ecological goals. There might be small tradeoffs without compromising on permanent damages to landscape.

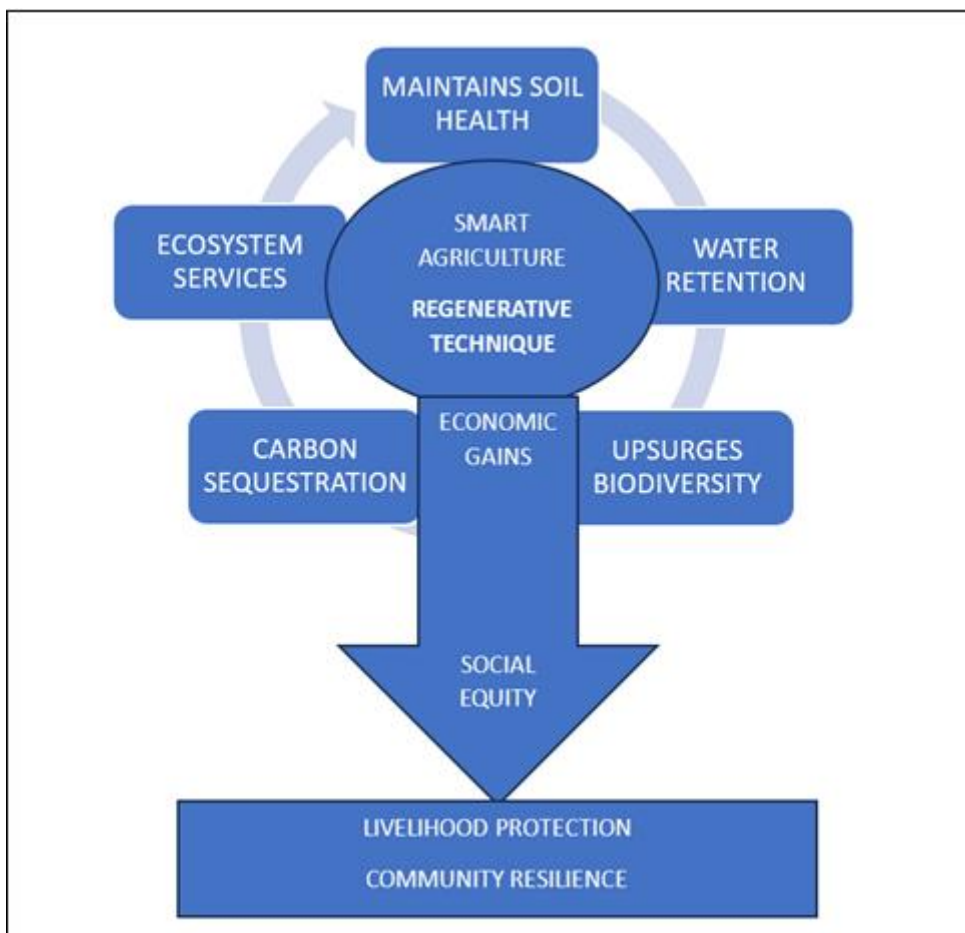


Fig 1: Holistic Benefits of Regenerative Agriculture
Source: Designed by the Researchers

The farming model referred above is not represented as a 'Business as Usual' but follow the concept of spaceship unity. It will benefit everyone if all community members in a region participate equally in the process. Unsustainable farms support tillage, grazing and wrong choice of crops that may have degrading effect in future due to compaction, poor water retention, acidification and erosion. Under stress they deteriorate further and eventually are left fallow. They soon lose their productivity and lie barren for ages and are bereft of all regulatory ecosystem services.

➤ *A Stepwise Adaptation Process along with a Mitigation Strategy can Evolve through the following Processes:*

- *Improving the Soil-*

First and foremost work would be to improve the soil by protecting it by mulch and cover crops. It is about bio compost and using all biodegradable waste to the farm. Although it is a continuous process, yet in the beginning it may need additional work. More organic matter in soil means more soil carbon which is both useful for plant growth as well as for stabilizing the carbon release. It further holds more water and prevents erosion. This soil is a no till zone that maintains the soil structure efficiently.

- *Water Channelization-*

One has to carefully design the earthwork for the waterflow and creation of a network of several water recharge zones. Rainwater-harvesting have to be implemented along with conserving every drop of water. The maintenance of terrestrial ecosystem will further help the aquatic ecosystem as most chemical discharges from the agricultural field reach the water bodies through run off or leaching. Even in arid regions rain water harvesting has been an age-old process. The Intergovernmental Panel on Climate Change (IPCC) rates rainwater harvesting as having a medium global mitigation potential, with moderate ease of farmer adoption and 5 to 10 years required for wide implementation.

- *Crop Diversification-*

This system of agriculture should be based on crop diversification and rotation along with emphasis on agroforestry and small-scale livestock rearing which is beneficial. Silvo-arable systems have both trees and annual crops. It has been discovered that methane production actually comes down in this form of agriculture. Crops have to be organically raised by choosing the guild cropping system where different crops benefit from each other. At the

same time crops should be chosen as per the climatic characteristics and carbon solution model. Water guzzling varieties have to be replaced by more healthier options like millets. Sometimes it is beneficial to go for tree crops instead of seasonal crops or commercial grain farming as they have multiple perennial benefit especially during crop failures. Similarly, silvopastures are also proven techniques for managing livestock by integrating trees and forage areas together.

Today health costs have significantly increased due to wrong eating habits as well as low nutritional quality of food. All this can be enriched by sowing and harvesting in sync with the environmental system. Diversity also means food variety that can reach the tables of the consumers giving them wider choices and fulfils nutritional demands. These products are nutrient dense and has the ability to heal.

- *Strong Documentation of Agricultural Reforms-*

A detailed analysis and documentation of all the reforms is equally important. This will ensure keeping a tab on the outcomes and create a diary of good practices. Each and every farmer should be given a record keeping book with diverse details. It has to be aimed towards livelihood protection and greater gender parity.

Pilot projects should be initiated where complete reform is not possible. In course of time, it can be replicated in larger spaces. Children should also be shown the importance of land-based activities and encouraged not to abandon their farms. Each school and institutions can be mapped for creating a database of future ready and resilient communities.

- *Mapping Ecological Services-*

The final goal of every community should be to wholesomely benefit from this process that will ensure a rise in the quality-of-life index. Not only their businesses should improve but their living environment should also become a mini biosphere. Climate resilience will automatically set in and become part of their habit rather than a fight against vulnerability.

Awareness and sensitization have to be done by community leaders and grass root workers. The farmers may need help and support from the entire community. In this way their vulnerabilities can also be addressed with much ease and they will reduce the ecological footprint from their land. In a way it mimics a natural ecosystem.

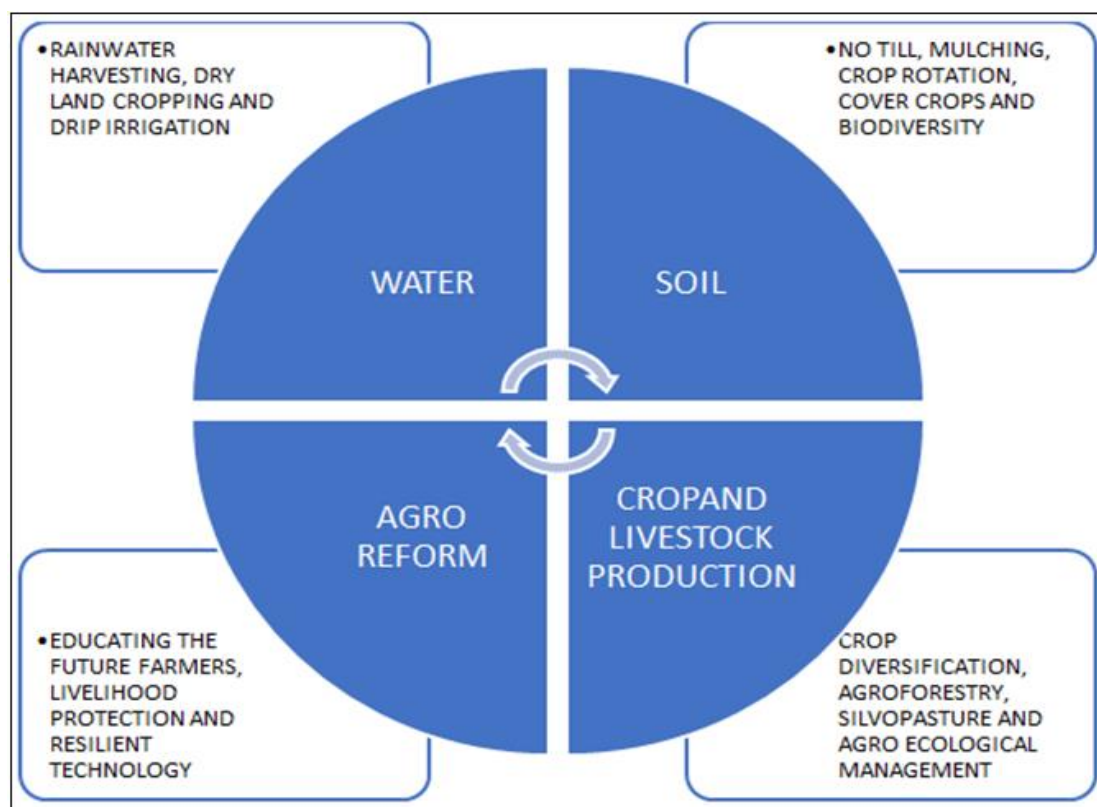


Fig 2: Strategies for Climate Change Adaptation
Source: Designed by the Researchers

• *Strategic Outcome- Celebration of Yield and Ecology-*

The general narrative is, in order to protect the ecology one has to compromise on the yield. Often farmers believe that crop yield will decrease if one goes for such a technique. Also there have been criticism about the possibility of increasing yield without using chemical fertilizers and tillage. This process on the contrary, can result in greater yield, lower input costs, and also help the end consumers in availing healthy food. In a well-designed plot of land, yield will be healthy and abundant. Every specie which is healthy will survive and also overcome disturbances posed by nature. They try to retain the steady state conditions. They also get immune to the external influences very easily.

Now, one has to debunk the theory of food shortage. It can be taken care off by complementing with reduction in food wastage. It is only people with vested interest who can spread misinformation. Farmers can go for direct selling and meet the local demands rather than focusing on long distance supply. Those farmers who have larger landholdings and want to go for more commercial ventures can also supply their products to the processing industry without negotiating on the ecological principles. Even small farmers can get together and fulfil the industrial demand. Monoculture is to be strictly avoided and soil disturbance should be minimal.

During disasters and other crop failure years, farmers are often forced to sell of their land in order to support their families. This distress selling have to be avoided and mechanism for preventing such practice should be there.

They have to be counselled against such steps and helped monetarily. Otherwise, they will be left with no access to precious land forever. It has been found in several places that either farmers are forced to sell their land or they simply lose interest in retaining their land due to heavy investment on unproductive plots.

These small farmers are ready to work in the nearby urban areas as small-time labourers or become vendors in informal sectors who are always at the receiving end. They are never treated at par with other retail businesses in urban setups, often harassed and exploited by some agencies minting money over their desperation to survive. In towns and cities, they are not able to live in a dignified manner as they become labourer for life losing out on their self esteem and pride. They also become more malnourished as their access to food is limited to their low purchasing power. In their own farms at least they had access to food.

Maintaining agricultural sustainability can be tough but benefits are much enriching. It can be concluded through a varied field-based study conducted by the researchers. They also strongly feel that Indian system can sustain many challenges in the future as their coping capacities have been an outcome of long civilizational response. Indian farmers and consumers have always celebrated the harvesting with festivities and they knew the value of traditional practices that their forefathers believed in. As conservationist, the policies as well as the community should aim towards greater trust on the wisdom of their ancestors and question the western model of chemical and industrial cropping. Tim Searchinger and Janet Ranganathan comment "...In short,

produce, protect and prosper are the most important opportunities for agriculture."

Like the concept of Atma Nirbharta which has become a fad now, one should follow the principle of food sovereignty that clearly highlights the need for achieving self-reliance in this sector too.

Food sovereignty is "the right of each nation or region to maintain and develop their capacity to produce basic food crops with the corresponding productive and cultural diversity . . . [It] emphasizes farmers' access to land, seeds, and water while focusing on local autonomy, local markets, local production-consumption cycles, energy and technological sovereignty, and farmer-to-farmer networks."

V. CONCLUSION

Climate change adaptation is not a choice but a necessity for India. It is essential for ensuring food security, water resources, public health, infrastructure resilience, biodiversity conservation, and sustainable livelihoods. While mitigation efforts are crucial to reduce the future impacts of climate change, adaptation is important to address the changes that are already happening. It requires a collaborative effort from governments, communities, NGOs, and the private sector to develop and implement climate-resilient strategies that safeguard India's future.

Regenerative Agriculture may sound quite ambitious nevertheless it is possible to bring down the carbon emissions from agricultural sources. Due to variety of crops and other lifeforms which help the plant to thrive, there will be greater diversity and thus assist in soil carbon sequestration even below the ground. Many countries today are adopting climate smart agriculture which will make them resilient in future.

The fight is not about climate activist versus industry. When people suffer, nation never thrives, it is a total collapse of the system. So there has to be a conscious choice between wealth and real prosperity. Education and awareness should rise above politics and thus community members have to build an alliance of like-minded people and help each other. Civil society can be powerful if they maintain integrity and work for common and shared interest. In simple words regenerative is just a new word in old clothes that already existed in the past.

In the words of Bruno Oberle, Director General, International Union for Conservation of Nature and Natural Resources (IUCN)-

"We now have tangible evidence of the value of investing in landscape restoration interventions to address land degradation...brings to light the multitude of benefits of regenerative agriculture, undeniably linked to improved ecosystem services such as pollination, better water quality or soil fertility while offering alternative and additional revenues to local communities."

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