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CONTENTS

Articles

Introducing New Books

Introducing New Book

Memoirs of a Psychiatrist

Novum Nilavum (Mal) (Anguish and Moonlight) ***Memoirs of a Psychiatrist,***
Chintha Publishers, Thiruvananthapuram, 2024, 312 pages, Rs. 420/-

N.Shanmughom Pillai

This is an illustrious memoir of Dr.K.A Kumar, who has made his indelible imprint in the realm of mental healthcare as a leading psychiatrist, teacher, researcher, writer and organiser. It is not a mere life sketch of a doctor in the challenging mental health sector. The book is introduced with an attractive foreword by the prolific writer Zachariah. The book spans across 12 chapters of which 8 chapters are devoted to tracing the trajectory of mental health care in Kerala which is intertwined with his own life story.

The book begins with a narration about his grandparents, parents, child hood and education up to MBBS. He began his career as a Tutor in the Mental Health Centre (MHC) Thiruvananthapuram. The mode of treatment for mental disorder was distressingly primitive and unscientific until 1950. Caging the patients in cells similar to those in the police stations and beating up the hapless victims were the order of the day. Insulin Coma Treatment and Electric Shock Treatment (ECT) were the new methods.

The physical conditions in the hospitals were very pathetic in both male and female wards. Efforts by Dr.Kumar and his colleagues to improve patient diet, supply of clothes etc. were met with unpleasant resistance. The patient's diet served was what was left after removing egg, meat and fish for the staff. It was taken for granted that the staff had a right over the diet of the patients. Another initiative of Dr.Kumar was to provide dhoti and half sleeve shirts to male patients who were moving around full naked. The condition of women patients was still worse. There was collection of bribe money in the name of doctor's fee for admitting even poor patients. Those who had no money had to mobilise money by pledging what little gold ornaments were left with them. The long staying patients were susceptible of *poverty of thinking, affective blunting, social withdrawal, amotivation* etc. Studies and research in the West about these symptoms revealed that these changes were not the direct result of the disease but were attributable to the communication defect and hierarchy changes prevalent in the hospital ambience. It was a kind of institutional neurosis.

On return from NIMHANS (Bangalore), Dr.Kumar introduced Lythium treatment for affective disturbance or mood disorders (Mania) in 1976. Introduction of Lythium was a stellar chapter in the treatment of mental disorders. In May 1977 he was transferred to Medical College, Kottayam. Around that time Mother Teresa made a surprise visit to MHC Thiruvananthapuram. As many as 20 patients were tranquilised and kept away in order to hide them from the Mother. Her visit triggered several changes in the working of the hospital. NGOs like Abhaya under the leadership of K.V.Surendranath, renowned communist leader and public activist, and Smt.Sugatha Kumari, poetess and environmental activist came forward to help the patients and the working of the hospital. This was followed by a Public Interest Litigation (PIL) based on which a special Bench in the High Court of Kerala and a Monitoring Committee under the District Judge were setup. In 1984 Mental Health Centers were delinked from Medical Colleges and put under the Director of Health services.

By the end of 1985 Dr. Kumar came back to Medical College, Thiruvananthapuram as Professor. He organised a two day Annual Conference of Trans Cultural Psychiatry Association at Thiruvananthapuram, which was attended by 40 foreign delegates. The conference went on very well. But what followed was not

that well. Dr.Kumar was summoned by the Enforcement Directorate for interrogation followed by an inquiry by the State Vigilance Department. But it was all a kind of much ado about nothing.

Dr.Kumar was responsible for several initiatives in the hospital like introduction of Mental health OP, anti-suicide clinic, childrens clinic, De-addiction clinic, Psycho somatic clinic and Gynopsychiatry clinic in the SAT Hospital. He used to meet the Monitoring Committee of the District Judge and Justice Narendran Commission appointed by the Kerala High Court with his proposals for improvement in Mental Health Care. He organised a five day training workshop for judges in Juvenile Justice Act, which was the first of its kind in India. PG Diploma in Clinical Psychology and Psychiatric Social Work were started in the Medical College, Thiruvananthapuram at his instance. As part of intervention in suicide trend he submitted a project - Kerala Integrated Scheme for Intervention In Suicide (KRISIS). The project took off in April 2003, and the same month he also retired. For want of proper follow up the project suffered a natural death. He had served as a Visiting Faculty in the renowned Duke University (USA) during 1987. He is a recipient of DLM Murthy Rao Oration Award (2005).

His dream project of a Mental Health Institute on NIMHANS Model at Thiruvananthapuram submitted to Government still remains a dream due to cold response from the authorities. In Anguish he recalls the name of C.Achutha Menon, the visionary Chief Minister and Institution Builder of Kerala.

The last chapter discusses his acquaintance with politicians and social activists like K.V. Surendranath, K.Damodaran, A.K.Gopalan and others. Throughout his book he acknowledges the late K.V.Surendra Nath as his mentor. At the end of the book the dedicated psychiatrist perturbed and anguished by the road blocks in his professional journey tries to find some solace in the serenity of moon light. It is a fine and neatly structured record of the chequered journey of mental health care in Kerala. It has turned out to be a neat handbook for teachers, doctors, researchers, policy makers and students. It is a must read for the stakeholders in the Mental Health Sector.

US-China Competition in Biotechnology during the Pandemic Times: A Retrospect

Adithya S.

Biotechnology plays a crucial role in addressing some of the most pressing issues faced by nations today, including pandemic threats, food security and climate change. The COVID-19 pandemic renewed attention on biotechnology, highlighting its importance with the development of vaccines at unprecedented speeds. This has led to increased interest and investment in the sector.As a result, biotechnology is acknowledged as a strategic technology by people all over the world. This study delves in to various realms of technological competition between the US and China, the realm of Biotechnology particularly in the context of COVID-19 to explore its various dimensions. The study attempts to do so with the help of a framework provided by Charles Kindleberger's hegemonic stability theory to analyse the actions of both US and China during the pandemic period.

Keywords : U.S. Bioeconomy, COMIRNATY, operation warp speed, vaccine nationalism, civil - military fusion strategy, sinovac vaccination.

1. Introduction

The battlegrounds of power have traversed across different spheres to reach the realms of technology finally. Today the fiercest battles over power are fought in the tech arenas - chips, nanotech, AI, biotech etc. In fact, technology in different forms had considerable influence on relations between states in the international sphere. From the industrial revolution in Britain to the space wars during the cold war era to the information revolution of today, it has always played a role in determining power relations. However, in recent decades, scholars have begun to actively consider it as a leading factor in shaping power structures superseding military or economic spheres. The presence, absence or access to the latest technology has come to determine a nation-state's position in the hierarchy of societies. After periods of global affairs dominated by steam engines, nuclear weapons and computers, as per many scholars, Biology will be the dominant field of study in the 21st century. Biotechnology plays a crucial role in addressing some of the most pressing issues faced by nations today, including pandemic threats, food security and climate change. The COVID-19 pandemic renewed attention on biotechnology, highlighting its importance with the development of vaccines at unprecedented speeds. This has led to increased interest and investment in the sector.As a result, biotechnology is acknowledged as a strategic technology by people all over the world.

Biotechnology's origins trace back millennia, encompassing practices like selective breeding of plants and animals and utilizing microbes for beer, wine, cheese, and bread production. US Government publications define biotechnology as "techniques that use organisms or their cellular, subcellular, or molecular components to make products or modify plants, animals, and micro-organisms to carry desired traits" (Paugh and Lafrance, 1997). Biotech companies engage in research and production of various commercial products, including enzymes, polymers, alcohol and biofuels. In the medical field, biotechnology aims to find and develop techniques to identify and treat life-threatening illnesses. The wide scope and utility of biotechnology make it a vital component of strength for any country.

This study thus chooses among the various realms of technological competition between the US and China, the realm of Biotechnology particularly in the context of COVID-19 to explore its various dimensions.

The study attempts to do so with the help of a framework provided by Charles Kindleberger's hegemonic stability theory to analyse the actions of both US and China during the pandemic period.

2. The US Biotech Sector

The arena of present-day biotechnology is regarded to have mainly originated on June 16, 1980, when the Supreme Court of the United States said in Diamond v. Chakrabarty that a genetically modified microbe might be patented (Diamond vs Chakraborty, 1980). This decision resulted in a flood of novel biotechnology enterprises and the first boom of investment in the industry. Another major event in the development of the US biotech sector was the passing of the Bayh-Dole Act in 1985. Instead of leaving intellectual property rights with the government, the Bayh-Dole Act permitted universities and their faculty members to claim patents on innovations created via research funded by federal agencies including the National Institute of Health (Athanasia, 2022). More generally, it has been calculated that the U.S. bioeconomy - which includes "infrastructure, innovation, products, technology, and data derived from biologically-related processes and science" - makes up around 5% of the country's GDP, or more than $950 billion (Gallo, 2022). As a large number of advancements that enable the progress of the economy were developed in the US, it has enjoyed the position of a leader in the development applying biotechnology for commercial purposes (Dileo, et.al, 2022). Today, US companies lead the world in global patent production. US companies produced 5,812 biotechnology patents in 2021, significantly overtaking other leading economies like Japan (1,578) or China (1,539) (Huggett & Paisner, 2022). The US appears to be considerably ahead of others in the amounts private sector capital assigned in the name of biotechnology. As of May 2022, Biotechgate, a database comprising more than 60,000 biotech companies, mentions the US as possessing the world's highest number of biotech companies (12,064). In the US, there exists huge global networks of Public Research Organisations and life sciences corporations, as well as a very active labour force of scientists and engineers traversing between academia and industry (Owen-Smith & Powell, 2004). The American state possesses high personnel mobility and policies that support interregional cooperation, all of which contributes to constructing sizeable interregional networks (Niosi, 2011).

The COVID pandemic severely affected the United States. It resulted in the loss of human lives, devastated existing healthcare systems, ravaged the economy and brought about huge social and financial costs. With such devastating impacts, the focus of the nation turned towards the biotech sector in the lookout for vaccines as they were considered as the only refuge to put an end to the crisis and provide relief to the people. Several initiatives were taken by the American government in the aftermath of the calamity. The CARES Act (Coronavirus Aid, Relief and Economic Security Act) 2020 was one such measure that contained several provisions concerning the pharmaceutical industry. The Act provided regulatory flexibility to expedite the approval process for certain medical products and devices related to COVID-19. This allowed pharmaceutical companies to navigate regulatory requirements more efficiently, accelerating the development and deployment of critical medical interventions. The Donald Trump government also launched "Operation Warp Speed", targeted towards creating an effective vaccine and manufacturing enough dosages for the entire American population. The operation offered billions of dollars to pharmaceutical companies that provided promising vaccine candidates to ensure that financial barriers did not impede the progress of potential candidates. In a PCAST (President's Council of Advisors on Science and Technology) Report to the president titled "Recommendations for strengthening American leadership in Industries of the future", they say that the COVID-19 pandemic has exposed both dismaying challenges and valuable opportunities within the field of biotechnology. Thus, it is a prerequisite to maintain and extend the nation's biological and biomedical R&D to enhance US' ability to mitigate and cure contagious diseases.

The significant push given by the government to the sector in the aftermath of the pandemic was a boon to the private biotech companies engaged in the field, particularly in pharmaceuticals. They suddenly saw an exponential rise in investment, resources, attention as well as the overall significance attached to the sector. Being an investment-intensive sector requiring a continuous flow of large amounts of resources, the

renewed attention provided a vigorous lift to its overall functioning and efficiency (Fedasuik, 2022). The increased focus on biotech during the pandemic also created market opportunities for companies to commercialize their products and technologies. In 2021, the industry's revenues were 55% higher than in 2016;market capitalization for biotech was 84% higher; levels of financing were 116% higher, with large surges in VC investment and the biotech IPO market; and yearly drug approvals were 80% higher than in 2016 (Ural, 2022). For instance, Pfizer's (producer of the covid vaccine, now called COMIRNATY) quarterly growth had been 10% before the pandemic, but by the second quarter of 2021, it became 86%, largely owing to COVID-19 vaccines. Similarly, Moderna Inc.'s revenue increased from $ 803 million in 2020 to $ 17 675 in 2021.

Figure 2.1 Showing the Revenue of Moderna Inc.

Characteristic	Revenue in million U.S. dollars
2021	17,675
2020	803
2019	60
2018	135
2017	206
2016	108

Showing entries 1 to 6 (6 entries in total)

(Source: Statista, 2023)

The preceding discussion dealt mostly with the internal aspects of the US biotech sector following the pandemic, the various policies undertaken and the broader new-found circumstances. However, it is necessary to understand the impact of these changes on US power projections across the world. As technology had already become the battlefield of power, and biotech was one among them, the pandemic added fresh dimensions to it. The US, despite being the most powerful country in the world equipped with far more scientific and technological resources than arguably any other state, suffered from the highest number of loss of lives. This significantly affected the popular image of the USA as a strong and reliable power questioning its scientific superiority. Also, several erroneous steps taken by the Donald Trump administration did little to help fix the deteriorating crisis. His disregard of the experts dismayed people both at home and abroad and disheartened the scientific community. Also, by demonizing international associations such as the WHO, Trump debilitated America's ability to respond to global crises and cut off the country's science from the rest of the world. Even though the WHO tried to urge the countries of the globe to decide on a shared initiative to create a covid vaccine, the US did not take part in this struggle, whereas it chose to develop its own vaccines in the anxieties of a vaccine war. Also, when countries across the world fought with the first wave of the pandemic, under immense pressure to obtain medical supplies and expert know-how, the American state adopted an astonishingly nationalistic approach. Reliability is one of the most crucial features of an international leader and is significantly connected to how long-lasting its leadership is considered to be. Even in the later stages of the pandemic, the American government showed reluctance to join the COVAX initiative and was not willing to express commitment to provide vaccine aid to allies. Thus, despite having a robust biotech sector, the US was largely unsuccessful in projecting its strength outwards because of its increasingly nationalistic policies and several miscalculated steps. This created an image of a superpower equipped with resources but unwilling to help others and, at the same time, unable to even protect their own citizens. According to data pertaining to 2021, a majority of the intellectual property related to COVID-19 vaccines is owned by pharmaceutical giants in the US and EU, and they have reaped tens of billions of dollars from an exponential spike in sales. However, many countries in the rest of the world were still struggling to access immunisations. Even with regard to India's vaccine development, the US temporarily restricted the export of critical raw materials necessary for COVID vaccine when the US president invoked an embargo affecting India's vaccine production. When biotechnology and vaccine development had become crucial areas of competition, the US must have actually used its vaccines to promote its foreign policy objectives through diplomacy while it disappointingly adopted a strategy of narrow-

mindedness. Thus, a policy of "vaccine nationalism" followed by the US almost dispelled the technological edge that the country had in developing vaccines because of its failure to accompany it with appropriate and tactical measures to combine its prowess with responsible and reliable leadership. A hegemon, after all, requires not only the capabilities but also the willingness to maintain the existing international order, as Kindleberger argued long ago. According to many policy experts and scientists, the damage done by these measures to scientific integrity, public trust and US stature could persist well beyond the pandemic.

3. The Chinese Biotech Sector

Most experts believe China's rise as a global superpower will continue economically, diplomatically and militarily in the years ahead. As battles of power shifted into the realms of technology, China is catching up in their attempts to refashion its tech policies with the aim of absolute technological supremacy. The biotech sector is no different, it is necessary to understand the reasons behind China's exponential growth in the biotech sector in a short period of time.

3.1 Large Investments and State Support

The Chinese government have been investing large sums of money into the sector than ever before. Between 2016 and 2020, Chinese biopharmaceutical companies experienced an exponential rise in market capitalization, soaring from $1 billion to $2 billion (Han, et.al, 2021). Consequently, from 2007 to 2017, China's biotech related publications rose by the rate of 20% each year, ranking second only to the United States (Schmid & Ziong, 2021). China has also been at the forefront of using the CRISPR, a gene editing tool, for healthcare purposes. China is second only to the US in the number of CRISPR patents owned (Cohen & Desai, 2019).

3.2 A Policy of Domination

The marked change in the Chinese administration's policy is that earlier, the focus was much on international exchange and cooperation in the field, mainly because they needed foreign assistance and technology to help their domestic biotech industry. However, the current policy focuses on developing globally competitive companies and advanced indigenous biotech institutes. This is reminiscent of a more significant shift from China as the "world's factory" producing cheap goods to a "smart manufacturer" of high-end products (Moore, 2020). President Xi Jinping is on the record saying, "[we] must boldly research and innovate, dominate the high points of GMO techniques and cannot let foreign companies dominate the GMO market." (Levin, 2021).

3.3 Biotech in Military

There are also fears of China employing its biotechnological prowess to support the military in what is called the "civil-military fusion strategy" (Bitzinger, 2021). Major General He Fuchu has been a prominent advocate for the militarization of biotechnology. These kinds of military encounters aim to obstruct and distort the opponent's cognition using various methods such as technical, physiological or psychological techniques. The cognitive domain conflicts seek to weaken the enemy's determination and strength by impairing their perception and command abilities, manipulating their decision-making process and undermining their fighting spirit (Kania, 2019). Biotechnology is both a national development and a security issue in China.

3.4 Intellectual Theft and Data Transfer

There are specific other ways in which China possesses an advantage in developing its biotech industry. Biotech is a sector that requires large amounts of data for conducting intensive research processes and arriving at the most accurate results. To boost its biotech industry, China places a high value on genetic and other health-related data. Internally, China created national and provincial big data centres for health and medicine. China could hold and obtain a data benefit in genomics and biomedical technologies based on the sizeable quantities of genomic and medical data that already exists and are about to be collected (Kania, 2019). Externally, investment and cooperation in the US biotech arena provide Chinese corporations with contact to vast amounts of US medical and genetic data, but no reciprocal access is provided to US enterprises. These

impediments include drug regulatory clearance delays, drug pricing restrictions, reimbursement limits, and Intellectual Property theft. For instance, the Chinese Food and Drug Administration withheld authorization for Pfizer and Moderna's vaccines having 95% efficacy (Martin & Leonard, 2023). Several US biotech startups try to raise money through Chinese and Asian investors with the aim of bringing US medicines to China. However, the government of China's goal of technological leadership at any cost means these foreign firms often become victims of theft of intellectual property or forced technology transfer obligations to gain entry to the Chinese markets. The Chinese administration is also accused of using dishonest methods, including industrial espionage, to obtain US data, which has both commercial value and are essential to national security.

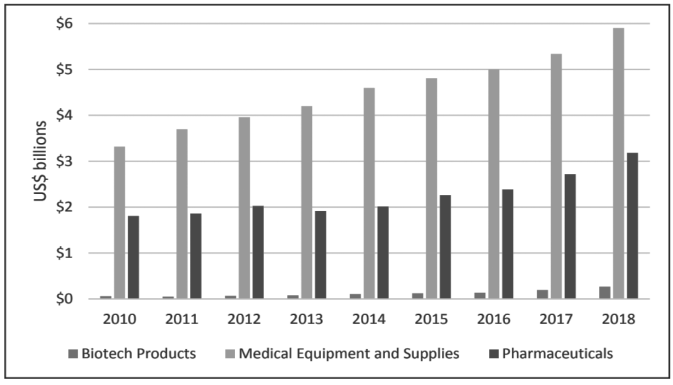
3.5 Regulatory Freedom

China also has lesser regulatory requirements binding its biotech sector compared to the Western countries. China still conducts primate research despite ethical questions and expenses involved, that too with the support of the state. China's drug approval process has undergone significant reforms to expedite the review and approval of innovative drugs (Gupta, 2021). Also, it cannot be forgotten that the world's first-ever human application of the CRISPR technology happened in China by a scientist named He Jiankui, resulting in the birth of "gene-edited babies", leading to an uproar from the global scientific community (Cohen, 2020). Although he was condemned and punished, the simple reality that it did happen in China raises serious concerns regarding the regulatory frameworks they have in place.

3.6 American Dependence

China is also the world's biggest manufacturer of Active Pharmaceutical Ingredients (APIs), a primary raw material in medicine production. Millions of US consumers, including the US military, rely on drugs or APIs procured from China. Also, as mentioned before, there exists severe shortcomings in health and safety requirements in China's pharmaceuticals sector and inconstant and ineffectual regulation by Chinese government. This lets chemical and pharmaceutical producers to distribute harmful, controlled, and uncontrolled substances. For instance, in 2018, a medicine for blood pressure made in China was adulterated with a cancer-causing chemical, sparking withdrawals in the US and worldwide (US-China Economic and Security Review Commission, 2019). Thus, this American dependence on China not only gives an edge to the latter's biotech industry but also creates serious health and safety concerns for the former as well.

Figure 3.1 Shows US Import of health products from China (2010-2018)



(Source: US Census Bureau, USA Trade Online, June 17, 2019)

3.8 The External Projection of China's Biotech Prowess

China has leveraged its biotech capabilities in global health diplomacy, especially during the COVID-19 pandemic. By providing vaccines and medical supplies to numerous countries, China has bolstered its geopolitical influence. These actions are strategically aligned with China's broader foreign policy goals, including garnering support for its Belt and Road Initiative. The pandemic highlighted the effectiveness of China's state-driven approach compared to the market-driven strategies of Western countries, reinforcing debates on the efficacy of authoritarian versus liberal governance models.

The Chinese administration vigorously encouraged biotech firms to export freely to different nations in an attempt to tide over supply deficits of COVID-19 vaccines. In July 2020, Brazil became the first country to accept a Chinese vaccine for emergency use in South America. Several of the agreements made by China's enterprises consisted of a clause which said that if a local pharmaceutical firm had hosted the clinical trial, the nation themselves would be declared as a partner in producing and distributing vaccines for use within the nation including even for exports. Chinese business magnate Jack Ma's Alibaba Foundation delivered various countries with masks, surgical gowns, and diagnostic test kits. However, these "benevolent acts" were coupled with important foreign policy outcomes in true Chinese fashion (Lee, 2021). In Algeria, for example, the Sinovac vaccination arrived as the Algerian government committed not to condemn Beijing's human rights violations in Hong Kong; in Brazil, China provided the Sinovac vaccine about the same time. Brasilia unexpectedly authorized Chinese telecommunications giant Huawei to participate in the construction of the 5G wireless network, reversing its earlier policy of prohibiting it. Despite the fact that Huawei is the world's largest supplier of 5G apparatus, the US intelligence agency believes the company is tied to the Chinese government and has charged it of espionage and effectively banned its products.

Shortly after Trump's announcement of a possible withdrawal from the WHO, Xi committed over $2 billion to the organisation and vowed to distribute any coronavirus vaccine developed by China worldwide. When the US left the WHO citing inefficiency and alleged Chinese favour, China legally entered COVAX, the WHO-supported international COVID-19 vaccine programme, giving rise to the idea that China's vaccine diplomacy will significantly advance the global public good and strengthen China's position as the international establisher of order.

The Trump administration's fragmented international engagement, coupled with an absence of scientific leadership, made the USA face a large number of COVID deaths reflecting a failure to protect their own citizens. The slowness of both the reaction and its execution, as well as existing imbalances in access to medical care, all contributed to exacerbating the harm inflicted by the public bad, having left the domestic underpinnings of US domination in question. The country committed several mistakes, such as downplaying the danger and sidelining experts, slow and flawed testing and inadequate isolation and quarantine. On the other hand, China, after initial hiccups, not only effectively handled the spread of the disease but also recovered from the challenges of an economic slump while providing help to other countries in this regard. As an authoritarian country, China could impose commanding quantitative measures using strict surveillance methods. While the US and many Western countries utilised advanced purchase agreements in their market-driven approach, China opted for a state-driven model that combined political mobilisation with economic instruments. Therefore, the COVID-19 crisis revived a debate long considered settled between authoritarianism and liberalism. Thus, the pandemic period presented an opportunity before China to display its economic, administrative and biotechnological prowess before the entire globe, abandoning its long-practised low-profile foreign policy.

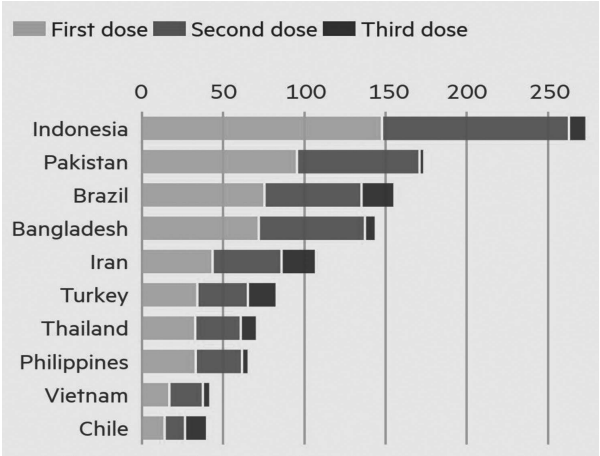
4.Countering China's Vaccine Diplomacy

The creation and preservation of the post-World War II global order and the advancement of globalization were important in establishing US worldwide leadership. Similarly, China's position in the world has shifted from a radical power with active engagement to emergent power trying to restructure the global order to serve its needs. China has traditionally approached the world order that the US created on a case-by-case basis in its international endeavours. For instance, by participating actively in international organisations, particularly the United Nations (UN), carrying out multiparty cooperation and non-violent conflict resolution, and providing international peacekeeping to war-torn nations, China has shown its commitment to world peace. The vaccine diplomacy based on the capacities of its biotechnology sector, pursued by China was also another such strategy aimed at displaying the nation's capabilities and willingness to aid the world in times of crises. These achievements have allowed China to influence global politics and the economy more and more. In part, the development of China is seen in western discourse as a major threat to the US-led international

order because of China's exceptional economic growth and aggressive diplomacy. Therefore, the US must step up in employing its capabilities robustly to maintain an international order that it so skilfully created. In order to guide its future medical diplomacy policy, the US must take a hard, realistic look at its early shortcomings and China's later failings during COVID-19.

However, first of all it has to be made clear that despite China's large-scale efforts at vaccine diplomacy, its effects remain limited or at least, rather questionable. A plethora of factors seriously impeded China's attempts, the most important being vaccine efficacy. China has failed to dispel widespread doubts about the reliability and effectiveness of its vaccines. Clinical research show that the inactivated vaccines from China are effective between 50% and 80% of the time. However, their effectiveness is lower as compared to mRNA vaccinations, and concerns regarding their efficacy to counter the extremely contagious delta variant are doubtful. Also, although many developing nations relied on China for their scarce vaccination supplies, China was not their exclusive source. China's vaccine was merely an alternative for some developing nations while they waited for the arrival of vaccines from the United States or Europe. Thailand fits in as a perfect example. The country struggled to get vaccines as cases increased and Southeast Asia became the pandemic's new epicentre. Sinovac was the only one to deliver on time. The 70 million nation's vaccination effort could have started sooner thanks to the shots, but Thailand soon ran into problems when questions of efficacy began to seriously emerge. As a consequence, the government of Thailand became the initial country to provide those who had already gotten one or even two Sinovac injections an AstraZeneca shot. Thai research revealed that Pfizer's dose of the viral vector vaccine from the Cambridge, UK-based firm, which is not an mRNA, is effective as a booster to the Chinese shot. However, a large number of Thais immediately voiced a strong preference for Western vaccine, going so far as to demonstrate in support of them, and the opposition of the nation started criticizing the state for its dependence on Chinese vaccine. Thailand stopped ordering Sinovac vaccines and started purchasing more Western vaccination. China also struggled to meet its obligations to other countries while still undertaking an extensive vaccination programme at home. Officials in Turkey and Brazil also voiced concerns about flight delays. Due to capacity issues, many Chinese gifts have been small in scale and can amount to little more than a publicity stunt. Furthermore, there are many questions about whether China's vaccine diplomacy would actually result in the geopolitical victory that would demonstrate its generosity and scientific skill. The political and geopolitical motivations underlying China's liberal offer of their vaccine are still being questioned by the western media. The COVID-19 vaccination does, in the grand scheme of things, give China a chance to "fill some vacuums by proposing Chinese vision for the world order and launching Beijing-led multilateral institutions to advance Beijing's priorities and values" (Zhang, 2021). China's vaccination programmes, though, fell short of their anticipated worldwide goal of enhancing China's geopolitical influence and international standing. These flaws presented an opening for the United States to demonstrate its leadership in global health once again.

Figure 4.1 Decline in the use of Chinese vaccine



(Source: Airfinity, 2022)

Following a period of vaccine nationalism and a regime change, US changed its external trajectory albeit late. The developed countries' strategy as a whole started to change in late 2021. As per UNICEF, by 2022 they delivered over 1.1 billion dosages of the COVID-19 vaccine to 144 partner nations with the aid of COVAX. According to UNICEF, more than 45% of the donated doses were sent to the African continent, while over 95% were sent to low-income countries. In contrast to the Trump government with its "America-first" stance, US pledged to donate more than a billion dosages to developing nations. The World Health Organization (WHO) and COVAX, both received renewed commitments from the Biden administration, which promised to donate four billion dollars to each. In 2021 and 2022, the Biden administration sponsored the Global COVID-19 meeting. China flatly declined to join the conference out of worry that her presence may strengthen US dominance in vaccine diplomacy on a global scale.

As according to many experts, the world is only poised for many such, more sever pandemics in future, COVID should teach US important lessons on leadership. Future global events will need the US to be among the first to give relief, re-evaluate how it conveys cargo, and come up with new political or economic accompaniments to strengthen its position. Renewed, consistent and sustained US commitment, including foreign assistance and information exchange, would benefit everyone in better preparing for the next pandemic, as well as other issues with sustainable growth that are made worse by pandemic-like shocks. In addition, the United States will need to continue to take the lead in the global partnerships and institutions dedicated to international well-being, especially the ones which has the capacity to aid in early detection and warning structures for an impending pandemic. The most important factors are timing and consistency. The case of Latin American countries is a case in point. While these countries benefited from support from both the US and China early in the pandemic, Chinese vaccinations came earlier. China gained favour with regional leaders by distributing vaccines prior to the US, and the residents questioned the timeliness of US gifts as a result. Vaccine shipments followed China's COVID-19 PPE help while US bilateral vaccine support arrived months later. Publicity is also another important component. Chinese aid to LAC was frequently accompanied by headline-grabbing high-level and subnational diplomacy. During the outbreak, the former president Trump had little interactions with LAC, while Biden's interactions were mainly limited to international contexts and Xi's interactions were bilateral. In order to avoid the mistake of coming out as distant, egotistical, and uncaring to others, the US must better balance global vs. direct bilateral humanitarian aid agreements. It cannot allow nationalist or isolationist ideas to seep into its humanitarian aid strategy in areas where China aspires to advance diplomatically.

5. Conclusion

For many decades, USA has served as an international pioneer in the field of science and technology (S&T). This exceptional R&D basis, which explains the country's safety, wellness, financial stability, and inventiveness, dates back to the immediate postwar period, and was fuelled in a significant way by Vannevar Bush's revolutionary work, *"Science: The Endless Frontier"*. These along with other acts ushered America's First Bold Era of Science and Technology. Sustaining scientific and technological leadership is critical to the nation's future as it approaches the Second Bold Era of Science and Technology. The moment is marked by significant challenge as nations around the world grow quickly, but it is also marked by enormous potential.

The US biotech sector faces a challenge from growing Chinese competition. There are several aspects to it, however the most important among them is the flourishing Chinese biotech sector itself. However, what signifies analysis is China's utilisation of its growing biotech strength to craft for itself an image of a benevolent leader. This was witnessed during the COVID 19 pandemic when China initially took a lead in distributing vaccines at a low cost to developing and under developed countries. China jumped on the opportunity to behave like a responsible world leader by allowing access to its vaccines at a low cost and giving away token loads of vaccine as donations. However, China nevertheless continued this policy while following brutally suppressive policies to contain the pandemic at home. These acts were often coupled with significant strategic foreign policy objectives, but nevertheless portrayed China as of lending a helping hand to the world during

a time of crisis, and most significantly at a time when the US was absent to do the same. However, this was short lived, as with a reduction in vaccine nationalism tendencies of the developed world including the US and the increasing apprehensions regarding the efficacy of Chinese vaccines, it was revealed that most countries only considered Chinese vaccine as an alternative until a better US or European vaccine was available. Thus, even though it is true that China did gain a few geopolitical benefits and earned momentary spotlight, US continued to be the most trusted source with enough capabilities to provide vaccine support for the world.

Putting this within the framework of hegemonic stability theory, a country which had the necessary capabilities of managing the crisis - the US - failed to step up to show willingness and withdrew itself. However, US later in the aftermath of a regime change and successfully vaccinating their own populations, committed itself to vaccine diplomacy as well and became one of the leading suppliers and donors of the COVID vaccine.

The US was able to do this because of its superior biotech industry which has been made possible as a result of various factors such as effective state engagement, a robust innovation system, significant public private partnerships and an empowered skill force. The country has vast private and public resources to aid emerging countries in purchasing machinery and educating workers. The network dynamics of the US biotech sector also immensely contributed to US superiority in the arena. Thus, in conclusion, the COVID 19 pandemic helped considerably to strengthen the US biotech sector internally as a result of increased governmental engagements and other factors. Hence, the COVID pandemic influenced US leadership in the biotech sector in a positive way by contributing to internal strengthening and providing an opportunity to utilise its biotech prowess to manage a crisis albeit late, for the world.

On the other hand, a country which was willing to show leadership - China - failed to possess and showcase enough capabilities required to manage the crisis. Thus, despite its booming biotech sector, it does not possess sufficient capacities to replace the US in this field any time soon. China will have to enable far more research and development programmes and a number of effective innovation support initiatives to be able to do that.

In a post-covid era,as both countries aims towards decoupling in the biotech sector to reduce dependence on each other, it remains to be seen what implications will it bring to both sides. With the scramble to lead intensifying, caution must be exercised to ensure the scientific and industrial community is well-equipped to deal with its aftermath and essential functions are not affected as crucial applications of biotech are necessary to sustain life.

References

Athanasia, G. (2022, January 12). The Legacy of Bayh-Dole's Success on Global US Competitiveness Today. Retrieved from CSIS: www.csis.org

Bitzinger, R. A. (2021). China's Shift from Civil-Military Integration to Military-Civil Fusion. *Asia Policy*, *16*(1), 5–24. https://www.jstor.org/stable/27023952.

Bold Goals for US Biotechnology and Biomanufacturing: Harnessing Research and Development to Further Societal Goals. (2023). The White House Office of Science and Technology Policy.

Cohen, J. (2020, November 25). China's Vaccine Gambit. Retrieved from Science: www.science.org.

Diamondv. Chakrabarty, 447 U.S. 303 (1980). https://supreme.justia.com/cases/federal/us/447/303/.

Dileo, et.al. (2022, April 29). Maintaining US Leadership in Advanced Biotechnology& Growing the Bioeconomy. Retrieved from MITRE: https://www.mitre.org/news-insights/publication/maintaining-us-leadership-advanced-biotechnology-growing-bioeconomy.

Fedasuik, R. (2022). Measuring Success in US Biotechnology Development, Regenerate: Biotechnology and US Industrial Policy, Centre for a New American Security.https://www.jstor.org/stable/resrep42465.9.

Gallo, M.E. (2022). *The Bioeconomy: A Primer.* Congressional Research Service. https://crsreports.congress.gov.in.R46881

Gupta, G. (2021). As Washington ties pharma's hands, China is leaping ahead, https://www.barrons.com.

Huggett, B., Paisner, K. Biotech patenting 2021. (2022). *Nature Biotechnology* 40, 813–814. https://doi.org/10.1038/s41587-022-01338-7

John Cohen, N.D. (2019, August 2). *With its CRISPR revolution, China becomes a world leader in genome editing*. Retrieved from Science:https://www.science.org/content/article/its-crispr-revolution-china-becomes-world-leader-genome-editing

Han, Kiki, et.al. (2021, October 29). The dawn of China biopharma innovation. Retrieved from McKinsey & Company: https://www.mckinsey.com/industries/life-sciences/our-insights/the-dawn-of-china-biopharma-innovation.

Kania, E. B. (2019). Chinese Military Innovation in the AI Revolution. *The RUSI Journal*, *164*(5–6), 26–34. https://doi.org/10.1080/03071847.2019.1693803

Kindelberger, C. (1973). The World in Depression:1929-39, University of California Press.

Lee, S. T. (2021, July 6). Vaccine diplomacy: Nation branding and China's COVID-19 soft power play. Retrieved from National Library of Medicine: https://ncbi.nlm.nih.gov.

Levin, Jeremy. (2021, August 5). Biotechnology leadership is too valuable to throw away. Retrieved from Rapport: https://rapport.bio/all-stories/biotech-leadership-too-important-throw-away.

Moore, S. (2020) China's role in the global biotechnology sector and implications for US Policy, https://www.brookings.edu.

Niosi, Jorge. (2011). Building innovation systems: An introduction to the special section. Industrial and Corporate Change. 20. 10.1093/icc/dtr064.

Owen-Smith, J., & Powell, W. W. (2004). Knowledge Networks as Channels and Conduits: The Effects of Spillovers in the Boston Biotechnology Community. *Organization Science*, *15*(1), 5–21. http://www.jstor.org/stable/30034707.

Paugh, J., Lafrance, J., & United States Department of Commerce Assistant Secretary for Technology Policy (1977). *Meeting the Challenge: US Industry faces the 21st Century: the US Biotechnology Industry.* U.S. Department of Commerce, Office of Technology Policy.

Peter Martin, J. L. (2023, January 7). The US keeps offering China its COVID vaccines. China keeps saying No. Retrieved from Bloomberg: https://www.bloomberg.

Schmid RD, Ziong X. (2021) Biotech in China 2021, at the beginning of the 14th five-year period. *Applied Microbiology and Biotechnology*.Doi: 10.1007/s00253-021-11317-8.

The President's Council of Advisors on Science & Technology (PCAST). (2020). Recommendations for Strengthening American Leadership in Industries of the Future: A Report to the President of the United States of America.

Ural, A. (2022, August 30). Biotech in 2016-2011 & Looking Ahead. Retrieved from Bioprocess Online: https://www.bioprocessonline.com/doc/biotech-in-looking-ahead-0001.

Zhang, A. B. (2021, September 27). China's "Weaponized" Vaccine: Intertwining Between International and Domestic Politics. Springer Nature, 279-296. doi: https://doi.org/10.1007/s12140-021-09382-x.

Lies on Labels: Uncovering Food Tampering Practices in India

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Recent mislabeling and tampering of food products in India have raised concerns among consumers.The instances include the detection of a carcinogenic toxin, ethylene oxide, in two prominent Indian Masala brands, leading to their ban. In developing countries, tampering, and mislabeling are also common in food products targeting children, such as instant cereal mixes with added sugar. Protein supplements in India have also been found to contain less protein than advertised, with some brands containing harmful ingredients such as green tea extract, turmeric, and ashwagandha. A popular chocolate malt drink in India, advertised as a health drink for children, contains high levels of added sugar. Repeated occurrences of fraud include lack of regulations, low pricing points, and aggressive marketing, which can be prevented through the proper training of consumers, reforming laws, and standardizing labels.

Keywords : Food fraud, mislabeling, tampering, diabetes, carcinogenic, food safety

Introduction

Labelling and proper representation of food items are essential for ensuring consumer safety. Mislabeling and tampering fall under the category of food fraud because manufacturers intentionally deceive people to consume their products (Tsimidou et al., 2015). In the past few months, new reports have been published on the mislabeling and tampering of food products and the presence of toxic substances in food items in India. The effects of food fraud may not be evident in the short run, further increasing the incentive for manufacturers to continue with their malpractices. This is a perspective article that discusses recent instances of mislabeling and tampering of food items in India, the reasons for their repeated occurrences, and potential solutions for tackling them.

Recent Instances of Mislabeling and Tampering in India.

The latest mislabeling and tampering incidents in India were reported in the last week of April, as Singapore and Hong Kong have banned the masalas of two prominent Indian brands because of the detection of a carcinogenic toxin, ethylene oxide (present in pesticides) (Anand, 2024). The treatment of this toxin may vary from country to country, as the United States Food and Drug Administration (FDA) concluded that the level of ethylene oxide is low in these masalas and is deemed safe for consumption (Anand, 2024). This revelation sparked discussions in India, prompting people to check for toxins in their favorite food brands.

Tampering and mislabeling are more common in food products targeting children. A recent investigation by the Public Eye and International Baby Food Action Network (IBFAN) revealed that the instant cereal mix of a popular multinational brand uses more sugar in its products in developing countries than in developed ones (Gaberell et al., 2024). Instant cereal mixes are specifically designed for infants and children; 94% of the products have added sugar in developing countries, whereas the same is sold in high-income countries with no added sugar. In India, the added sugar content is 2.2 g-2.7g per serving, which is alarmingly high for baby products. In other countries, such as Vietnam and the Philippines, where the sugar content is higher

than that in India, the added sugar content is not labelled in the packaging. This is not the case for India, as it is clearly labelled in the packaging that the product has added sugar. The disclosure was likely made by the company because of the FSSAI provision that sucrose/fructose can be added as a carbohydrate source if their sum does not exceed 20% of the total carbohydrates (refer to page 3, Food Safety and Standards (Foods for Infant Nutrition) Regulations, 2019 or watch the video essay by Mohak Mangal) (Food Safety and Standards (Foods for Infant Nutrition) Regulations, 2019, 2019; Mangal, 2024).

Philips et al. (2024) published on the protein supplements available in India, where seventy per cent of the brands have less protein than advertised, with some brands having 20% or less protein than what they labelled in their product. Some supplements had a higher protein content than what was labelled on their products, indicating the presence of amino spiking (the presence of cheap amino acids to boost protein content). Protein supplements in India are far inferior to international brands, with a higher chance of the presence of green tea extract, turmeric, and ashwagandha, which are considered hepatotoxic (harmful to the liver). Some protein supplements contain grade-one carcinogenic toxins, such as pesticide residuals, fungal aflatoxins, industrial solvents, and volatile organic compounds.All products used in this study were approved by the FSSAI and were openly sold in the market, revealing a lack of regulation and widespread mislabeling in the country (Philips et al., 2024).

Revant Himatsingka, a youtuber popularly known as Foodpharmer in a series on his YouTube channel, exposed a popular chocolate malt beverage in India advertised as a healthy drink to appeal to children. According to the product label, it contained 32 g of sugar per 100 g, and a single serving contained more than 7.5 g of added sugar. Despite the higher sugar content, it was advertised as a healthy drink that would help children develop their immune system. The increased sugar content in the drink was confirmed by the Nutrition Advocacy in Public Interest (NAPi) and the company themselves, forcing the latter to reduce sugar content. The Indian Ministry of Commerce advised the company to remove its health drink labelling (Singh, 2023). It exposed a popular chocolate malt beverage in India that was advertised as a healthy drink to appeal to children. Foodpharmer recently created videos exposing tomato ketchups and ready-made tomato soups to contain more sugar than tomatoes, and using inferior ingredients in the production of food by multinationals in India when compared to the same products in developed countries (Foodpharmer, n.d.).

Other Instances of Food Fraud in India

Food tampering is not a new phenomenon in India, as there were several reported instances of food tampering in the country. Solomon (2015) in their article on food adulteration in urban India elaborates on the common food tampering practices in India. The milk provided to the people are often mixed with water, and the milk industry is plagued by “rackets.” General food adulteration tactics like use of mashed potatoes to whiten ghee, adding stones on rice to increase weight, and chalks are used for whitening salts and sugars (Solomon, 2015). In India, there is a wider market for dairy products, which often results in frequent instances of adulteration. An investigation from Montgomery et al. (2020) found that some milk tankers in India were tested positive for toxins like maltodextrin, and ammonium sulphate. In some places fake milk was being sold, made using skimmed milk powder, and sweet oil. Paneer, a popular ingredient in Indian diet were found to have been bleached by synthetic colors (Montgomery et al., 2020). Jurica et al. (2021) reported that a prominent protein powder in India mislabeled itself as approved in USA, and European Union. Later the authorities found that it contained banned steroids. There are many reported incidence of altering expiry dates, and false declarations in India, making life harder for Indians (Jurica et al., 2021).

The adverse effects of these food tampering practices have come to light in the country. In 1998, 60 people died due to dropsy caused by the mixing of argemone with mustard oil. In a 2013 incident, 20 children died in Bihar after eating pesticide contaminated food from national mid-day meal scheme. The deaths from alcohol adulteration happens at least once a year in the country. The consequences of food fraud mentioned above are immediate effects of food tampering, and less fatal instances of food fraud occurs regularly like

diarrhea, and vomiting, which often goes unreported. The chronic effects of food fraud will only be apparent in the long run, which often results in deadly diseases like cancer, or kidney failure (Jurica et al., 2021; Montgomery et al., 2020; Solomon, 2015)

Causes of Repeated Instances of Mislabeling and Tampering

There were several studies conducted in India about tampering and mislabeling similar to the ones mentioned above, pointing towards the inefficiency of India's present food safety system.The major reasons cited by these studies are as follows.

1. Lack of regulations and oversight: This was frequently suggested as the major reason for repeated food fraud occurrences, and companies have used the loopholes in FSSAI regulations to add more sugar and toxin, without getting caught (Gaberell et al., 2024; Philips et al., 2024; Tsimidou et al., 2015).

2. Low Pricing Point: Another reason that can be inferred is the low prices of food products and supplements, owing to the low purchasing levels of the country.This motivates companies to use inferior quality ingredients in their products to maximize profits and justify their low pricing points (Philips et al., 2024; Tsimidou et al., 2015).

3. Aggressive Marketing: Along with the low price, the companies misleadingly design their front label, as they present their product as "essential" and "healthy," prompting customers to buy products before looking through their ingredients list (Gaberell et al., 2024).

4. Lack of Label Standardization: Even if they look at the backside of the label, the lack of standardization of food labelling would make it difficult for the consumer to identify the presence of excessive sugar and toxins. The same ingredient can named in several ways (for example, sugar is often written as, "sucrose," "fructose," "corn syrup" in the label) confusing the consumer, and getting away from the radars of regulations (Philips et al., 2024; Tsimidou et al., 2015).

Potential Health Effects on Consumers.

The Food and Agricultural Organization (FAO) mentions diseases such as allergic reactions, indigestion due to acute poisoning, and illness as potential short-term effects of food fraud (Tsimidou et al., 2015). While the short-term effects could be fatal, they can be detected at the start itself, as the symptoms will appear quickly and can be cured with relative ease. However, the same does not apply to long-term effects, as the symptoms are likely to appear after the disease becomes fatal.In the recent events mentioned earlier, the elements detected in the products were toxins used in pesticides such as ethylene oxide, which are considered to be carcinogenic; that is, the likelihood of developing cancer will increase by consuming it (Philips et al., 2024).The use of added sugar in food products for infants and children can lead to type-2 diabetes and childhood obesity, and sugar is a highly addictive agent that causes children to consume increasing amounts of it (Tsimidou et al., 2015).

Conclusion and Recommendations

Recent revelations that popular Indian brands have been a part of the mislabeling and tampering of food products have raised concerns from people all over the country. The greatest concern was the presence of added sugar and toxins in products targeted to infants and children. The elements detected in these supplements are considered sources of cancer and diabetes. The low pricing point, aggressive marketing, lack of regulation, and label standardization are highlighted as reasons for repeated instances of mislabeling and tampering. Some of the recommendations to prevent further incidents of food fraud are as follows.

- Reforming the present rules and regulations for food safety in the country and promoting active research in food science (Gaberell et al., 2024; Philips et al., 2024; Tsimidou et al., 2015).
- To create the habit of label reading among the people, formulate programmes and policies promoting consumer awareness on health and food (Gaberell et al., 2024; Tsimidou et al., 2015).

- Standardizing product labeling would help consumers easily identify the ingredients used in their products (Philips et al., 2024).

References

Anand, A. (2024). US says treatment of spices with ethylene oxide is “safe” as Hong Kong, Singapore ban some MDH, Everest products. *Mint*. https://www.livemint.com/news/world/us-spice-body-says-treatment-of-spices-with-ethylene-oxide-is-safe-as-hong-kong-singapore-bans-mdh-everest-11715338554069.html

Foodpharmer. (n.d.). YouTube. Retrieved May 12, 2024, from https://www.youtube.com/@Foodpharmer

Food Safety and Standards (Foods for Infant Nutrition) Regulations, 2019, 1 (2019).

Gaberell, L., Abebe, M., & Patti, R. (2024). How Nestlé gets children hooked on sugar in lower-income countries. *Public Action*, 1–32. https://stories.publiceye.ch/nestle-babies/

Jurica, K., Brèiæ Karaèonji, I., Lasiæ, D., Bursaæ Kovaèeviæ, D., & Putnik, P. (2021). Unauthorized food manipulation as a criminal offense: Food authenticity, legal frameworks, analytical tools and cases. *Foods*, *10*(11), 1–37. https://doi.org/10.3390/foods10112570

Mangal, M. (2024). *Dark Reality of MDH and Nestle - YouTube*. YouTube. https://www.youtube.com/watch?v=OeAv7lv74iU&ab_channel=MohakMangal

Montgomery, H., Haughey, S. A., & Elliott, C. T. (2020). Recent food safety and fraud issues within the dairy supply chain (2015–2019). *Global Food Security*, *26*(July). https://doi.org/10.1016/j.gfs.2020.100447

Philips, C. A., Theruvath, A. H., Ravindran, R., & Chopra, P. (2024). Citizens protein project: A self-funded, transparent, and concerning report on analysis of popular protein supplements sold in the Indian market. *Medicine (United States)*, *103*(14), E37724. https://doi.org/10.1097/MD.0000000000037724

Singh, R. (2023). Bournvita Reduces Added Sugar By 14.4% After Criticism, Influencer Calls It “‘Big Win.’” *NDTV*, 1. https://www.ndtv.com/feature/watch-bournvita-reduces-added-sugar-by-14-4-after-criticism-influencer-calls-it-big-win-4733774

Solomon, H. (2015). Unreliable eating: Patterns of food adulteration in urban India. *BioSocieties*, *10*(2), 177–193. https://doi.org/10.1057/biosoc.2015.10

Tsimidou, M. Z., Ordoudi, S. A., Nenadis, N., & Mourtzinos, I. (2015). Food Fraud. In *Encyclopedia of Food and Health*. https://doi.org/10.1016/B978-0-12-384947-2.00010-6

Videogame Addiction, Aggression and Life Satisfaction Among Young Adults

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Young adults are more fond of playing video games. The instant gratification and pleasure of playing games lead to an addiction. Video game addiction among young adults has become an increasingly prevalent concern in recent years. This study aims to find out the role of video game addiction on aggression and life satisfaction among young adults. The sample consists of 150 participants (55 males and 95 females) of age ranging between 18 and 25 from Thiruvananthapuram district of Kerala. The participants were assessed using Game Addiction Scale, Aggression Questionnaire (AQ) and Life Satisfaction Questionnaire (LSQ-11). The statistical analysis used was Pearson's correlational analysis. A positive correlation was found between video game addiction and aggression ($r = 0.430^{**}$, $p < 0.01$). A significant negative correlation was found between life satisfaction and video game addiction ($r = 0.235^{**}$, $p < 0.01$). Video game addiction was also found to be closely linked to both physical and verbal aggression, anger, and hostility. Furthermore, findings highlight how excessive gaming can impact overall well-being, potentially causing individuals to neglect other fulfilling aspects of their lives.

Keywords : Videogame addiction, aggression and life satisfaction among young adults

Introduction

Nowadays addiction to video games has grown significantly among young people. As technology develops daily the number of players is also increasing, which might lead to compulsive gaming behaviour (Hawi & Samaha, 2023 & Moroianu et al., 2023). Game addiction is also connected with psychological and social problems, like heightened aggression, stress, anxiety and poor interpersonal relationships (Pan et al., 2024, Limone et al., 2023 & Nurmagandi & Hamid, 2020). Young adulthood is a critical and vulnerable stage between the transition of youth and adulthood, which involves social interactions, academic stress and career preparations (Lepièce et al., 2019 & Ramos et al., 2024).

Research shows evidence that game addiction results in lower general well-being and depression (Jeong et al., 2020 & Nurmagandi& Hamid, 2020). Research indicates that both aggression and video game addiction are complex, exposure to violent and competitive games has the potential to generate aggressive thoughts and actions (Sharma et al., 2020). In short, the obsession with gaming can reduce life satisfaction by taking away accomplishments in real life, relationships with others, and personal fulfilment, which lowers life pleasure.

According to ICD 11 the term "video game addiction," which is also used to refer to "gaming addiction" or "gaming disorder," is characterised by a compulsive engagement in video games that disrupts daily life and leads to negative consequences across various domains of relationships, education, career, mental or physical health, or other aspects of one's life. Any gaming that has a negative impact on one's life or creates suffering could indicate a dysfunctional gaming connection.

Among the most addictive technological uses, playing digital games has a major role (Zhang et al.,

2022). In recent years, the increased use of technology has resulted in a rise in addiction and problematic gaming (Bickham, 2021; Rosendo-Rios et al., 2022). Mental health and medical professionals are concerned about the rising prevalence of juvenile gaming addiction due to the ease of access and greater exposure (Johnson & Edwards, 2020; Lee et al., 2018). Although studies have repeatedly demonstrated that a small percentage of computer or video game players spend excessive amounts of time playing these games and exhibit various symptoms of pathological behaviour including preoccupation, withdrawal, loss of control, interpersonal or intrapersonal conflicts, pathological use of these games is not officially recognised as a clinical disorder (Charlton & Danforth 2007; Gentile 2009; Grüsser et al. 2007).

Young adults frequently do not consider their addiction to be problematic or are reluctant to make changes. Seeking treatment and advice from a video game addiction specialist may be important in severe cases. Video game addiction is characterised by obsessive behavioural engagement, loss of interest in other activities, interactions mostly with other addicts, and withdrawal symptoms both physically and mentally while trying to cease the habit (Soper & Miller, 1983). The DSM-5 uses the following standards to define video game addiction: Salience, Euphoria/Mood, Modification, Tolerance, Withdrawal, Conflict and Relapse.

The General Aggression Model (Anderson & Bushman, 2002) states that playing violent video games can reinforce aggressive attitudes, perceptual schemata, aggressive scripts, and aggression desensitisation. Players gain automated aggressive knowledge structures and emotional desensitisation to violent stimuli by being continuously rewarded for violent actions. These violent behaviours have a stronger effect on hostile moods and aggressive thought processes the more they are practised (Carnagey & Anderson, 2005). As a result, engaging in violent video games in particular in a pathological way, may begin acting more aggressively because their excessive use of these games has taught them that using force to settle disputes is appropriate (Möller & Krahé, 2009).

The relationship between video game addiction and life satisfaction among young adults is complex. Research suggests that gaming provides social benefits like improved social bonds, social awareness, teamwork and emotional connection (Bargavi &Kabrabam, 2024; Bowman et al., 2022), but excessive use often leads to negative outcomes like lower life satisfaction, increased loneliness, anxiety and depression (Sarda et al., 2016). Even though mindful and moderate gaming contribute positive aspects, empirical evidence suggests the importance of balancing gaming habits to avoid the associated risks. Addiction to video games has an impact on families, communities, and educational settings, among other places (Yue, 2024).

This study explores the relationship between ‘aggression and life satisfaction and video game addiction’ among young adults. This research could contribute to the creation of therapies at several levels, ranging from family counselling and educational counselling to public health campaigns and policy formation, by examining the relationships among addiction, aggression, and life satisfaction. The knowledge acquired can also help to create healthier digital spaces, encourage well-being, and lessen the likelihood of addiction. The importance of this study is that it explores the dualistic character of gaming in contemporary society, which may be both enjoyable and harmful. This study can help create balanced gaming habits, encourage responsible usage, and promote mental health and well-being by identifying the elements that lead to undesirable effects like hostility and lower life satisfaction.

Objectives

- To assess the role of video game addiction on aggression among young adults.
- To assess the role of video game addiction on life satisfaction among young adults.

Hypotheses

- There will be a significant relationship between video game addiction and aggression among young adults.

- There will be a significant relationship between video game addiction and life satisfaction among young adults.

Method

Participants

The sample consists of participants (N=150; Females=95, Males=55) pursuing graduation and postgraduation, from various colleges in Thiruvananthapuram, aged between 18- 25.

Sampling Method

The sampling method used is convenient sampling.

Research Design

The research design used here is descriptive research design.

Measures

- **Sociodemographic data Sheet.**

  The details of the participants (age, gender, education qualification) were collected using the socio-demographic data sheet developed by the researcher.

- **Game Addiction Scale (Lemmens et al., 2015)**

  Game Addiction Scale (GAS) is a seven-item five-point Likert scale is an assessment tool for Video Game Addiction developed by Lemmens, Valkenburg and Gentile (2015), involves sub-dimensions: preoccupation, loss of control, and conflict. The confirmatory factor analysis demonstrated the structural validity, which was satisfactory and the scale showed a good criterion-related validity. GAS has a Cronbach alpha of 0.82 to 0.87 which shows high internal consistency.

- **Aggression Questionnaire (AQ) (Buss & Perry,1992)**

  The Aggression Questionnaire by Buss and Perry (1992) assesses aggression across four dimensions: physical aggression, verbal aggression, anger, and hostility. It shows high internal consistency (Cronbach's alpha > 0.70) and reliable test-retest scores, indicating stability over time. A good divergent validity was found for the Aggression Questionnaire.

- **Life Satisfaction Questionnaire (LSQ-11) (Melin et al., 2003)**

  The Life Satisfaction Questionnaire (LSQ-11), was developed by Fugl-Meyer and Melin (2002). It is an 11-item scale assesses life satisfaction across key domains such as physical health, psychological well-being, social relationships, and daily functioning. It has strong internal consistency (Cronbach's alpha > 0.80) and high test-retest reliability. The LSQ-11 demonstrates good construct and criterion validity.

Procedure

Initially, five colleges were randomly selected from '218' arts and science colleges in Thiruvananthapuram, from which 150 participants gave consent for the study. These participants were screened using Game Addiction Scale (Lemmens et al.,2015) from which '45' scored '21' or more indicating problematic video game addiction were selected. The selected participants were administered Aggression questionnaire and Life satisfaction questionnaire to assess the aggression and life satisfaction. The data collected was then recorded, scored and tabulated.

Statistical Techniques

The data obtained from the participants were statistically analysed using SPSS and the statistical technique used was Karl Pearson's Product Moment Correlation.

Results and Discussion

Table 1

Distribution of participants screened for Game Addiction

Total no of Participants (N= 150)	Game Addiction	Non Addiction
	45 (30%)	105 (70%)

Table 2

Relationship between video game addiction and aggression (and its sub-dimensions) among young adults.

		Aggression	Physical aggression	Verbal aggression	Anger	Hostility
Video Game Addiction	Pearson Correlation	**.430****	**.444****	**.242****	**.362****	**.394****
	Sig. (2-tailed)	<.001	<.001	.003	<.001	<.001
	N	45	45	45	45	45

***. Correlation is significant at the 0.01 level (2-tailed).*

From Table 2, it can be observed that there exists a positive correlation between video game addiction and aggression, with r value 0.430**significant at the level of 0.01. It shows that when video game addiction increases, aggression also increases. It may be due to the fact that violence in video games severely impacts the thoughts and reinforces the aggressive instincts of the individuals. Video games can give a sense of pleasure in winning initially and then the player expects to attain the pleasure repeatedly which is being reinforced by the smaller approximations of winning. When a video game is played among adolescents, the pleasure area in the brain 'nucleus accumbens' is more active and stimulative during young adolescent and adult age and this region if stimulated repeatedly may lead the person to be addicted (Galvan et al., 2006). The present study is supported by the findings of Anderson and Dill (2000), which revealed that violent video games increase aggressive thoughts and behaviours. The findings of Bushman and Anderson (2002) are also in line with the present findings. Also analyzing the relationship between video game addiction and the sub-dimensions of aggression. It can be observed that there exists a positive correlation between video game addiction and physical aggression, with r value 0.444** significant at the level of 0.01. This implies that prolonged and excessive gaming might heighten aggressive responses, impulsivity due to increased exposure to violent content, frustration tolerance, or behavioural reinforcement within the gaming environment. In terms of game addiction and physical aggression, the results are consistent with the findings of Althnaibat et al. (2022) that game addiction is a predictor of aggression and a positive correlation between game addiction and physical aggression.

The subsequent sub-dimension of aggression, verbal aggression, also evidences a statistically significant positive correlation between video game addiction and verbal aggression among young adults, with an r-value of 0.242** significant at the level of 0.01 (Table 2). This implies that excessive engagement with video games, particularly those with competitive or violent content, may contribute to an increased propensity for verbal aggression. It suggests that the immersive and often intense nature of video games might influence players' communication styles, potentially leading them to express anger or frustration through verbal aggression more frequently. The results of this study also support Lemmens, Valkenburg, and Peter's (2011) findings, which linked pathological gaming to increased verbal aggression. Adolescents addicted to video games exhibited more aggressive behaviours, including verbal outbursts, particularly when frustrated or experiencing withdrawal. Anderson and Dill (2000) demonstrated that violent video games prime aggressive thoughts and verbal expressions, leading to hostile communication which supports the present findings. The

findings of Teng et al. (2024) are in line with the present findings that game addiction can lead to increased verbal aggression, particularly through risk-biased decision-making processes.

Anger and video game addiction among young adults were found to be significantly correlated with r value .362** significant at the level of 0.01. It indicates that as individuals become more addicted to video games, their levels of anger tend to increase. This can imply that video game addiction could contribute to heightened emotional volatility, making individuals more prone to anger and possibly impacting their social interactions and mental well-being. Similar findings were found in the study of Lemmens, Valkenburg, and Peter (2011) where pathological gaming exacerbated anger and frustration in adolescents, particularly when access to games was restricted. This study also aligns with Rooij, Ferguson, Colder Carras, and Kardefelt-Winther's (2018) research, which showed that problematic gaming habits increase anger and irritability, suggesting that anger is a common response to gaming-related frustration or withdrawal.

Video game addiction and hostility among young adults were found to be significantly correlated with an r-value of 0.394** significant at the level of 0.01. It indicates that excessive gaming can increase feelings of irritability and antagonism, potentially due to exposure to competitive or violent games. This may harm social relationships by inculcating revenge, and negative emotions towards others than positive reinforcement. Lemmens, Valkenburg, and Peter (2011) also found that addictive gaming in adolescents was linked to increased hostility, driven by frustration and emotional imbalance from excessive gaming. The results of the present study are also consistent with the findings of Kim, N., Hwang, S.S., Lee, Y.C., & Lee, K.J. (2008), which focused on adolescents in South Korea and found a significant relationship between online game addiction and hostile behaviour. The more addicted participants were to online games, the more they exhibited hostility, both in their interactions with others and in their gaming behaviour, especially when confronted with losing or competitive scenarios. Conversely, the findings of Shabbir et al. (2020) showed no significant correlation between game addiction and hostility suggesting different dynamics between the variables.

Table 3

Correlation of video game addiction and life satisfaction

		Life satisfaction
Video game addiction	Pearson Correlation	**-.235****
	Sig. (2-tailed)	.004
	N	45

***. Correlation is significant at the 0.01 level (2-tailed).*

Analysing Table 3, we can see that there exists a statistically significant negative correlation between video game addiction and life satisfaction among young adults, withan r-valueof 0.235** significant at the level of 0.01. It indicates that higher levels of video game addiction result in lower levels of life satisfaction among young adults. This shows that as individuals become more addicted to video games, their overall satisfaction with life tends to diminish. It implies that excessive gaming may adversely affect one's quality of life, potentially by impacting personal relationships, work or academic performance, and emotional well-being. The present research study is also in support of earlier findings, such as ones conducted by Király, O., Griffiths, M. D., & Demetrovics, Z. (2015), this review highlights that individuals with internet gaming disorder often experience lower life satisfaction. Excessive gaming is associated with reduced well-being and diminished quality of life, suggesting that problematic gaming behaviours can negatively impact overall life satisfaction. The results of the present study are also consistent with the findings of Lemmens, J. S., Valkenburg, P. M., & Peter, J. (2011), that adolescents with pathological gaming behaviours reported lower levels of life satisfaction. The negative impact of gaming addiction on life satisfaction was attributed to its interference with social relationships and daily activities.

Conclusion and Implications of the Study

The present study highlights how excessive gaming can impact the overall psychological well-being of young adults, thus affecting the productivity of the young human resource. Therefore, prevention of game addiction among young adults should be addressed further.

Limitations of the Study

The study is limited to a specific age group and geographical location due to which it is not generalizable.

Suggestions for Further Research

Prevention techniques can be further planned for young adults from game addiction.

References

Althnaibat, H. A., Al-Kubaisy, W., &Alsaraireh, F. (2022). Study of the physical aggressive behaviors due to violent video games among early adolescents in Al-Mazar Al-Janobe District in the south of Jordan. *International Journal of Health Sciences*, 11124–11137. https://doi.org/10.53730/ijhs.v6ns2.7773

Anderson, C. A., & Bushman, B. J. (2002). Human Aggression. *Annual Review of Psychology, 53*(1), 27–51.https://doi.org/10.1146/annurev.psych.53.100901.135231

Anderson, C. A., & Dill, K. E. (2000). Video games and aggressive thoughts, feelings, and behavior in the laboratory and in life. *Journal of Personality and Social Psychology*, *78*(4), 772–790. https://doi.org/10.1037/0022-3514.78.4.772

Bargavi, D., & Kabrabam, R. (2024). The Potential of Video Gaming in Addressing Global Issues. *International Research Journal of Computer Science*, *11*(01), 73–79. https://doi.org/10.26562/irjcs.2024.v1101.12

Bickham D. S. (2021). Current Research and Viewpoints on Internet Addiction in Adolescents. *Current pediatrics reports*, *9*(1), 1–10. https://doi.org/10.1007/s40124-020-00236-3

Bowman, N. D., Rieger, D., & Lin, J. T. (2022). Social video gaming and well-being. *Current Opinion in Psychology*, *45*, 101316.https://doi.org/10.1016/j.copsyc.2022.101316

Buss, A. H. & Perry, M. P. (1992). The Aggression Questionnaire. Journal of Personality and Social Psychology, 63, 452-459.

Carnagey, N. L., & Anderson, C. A. (2005). The Effects of Reward and Punishment in Violent Video Games on Aggressive Affect, Cognition, and Behavior. *Psychological Science*, *16*(11), 882–889. https://doi.org/10.1111/j.1467-9280.2005.01632.x

Galvan, A., Hare, T. A., Parra, C. E., Penn, J., Voss, H., Glover, G., & Casey, B. J. (2006). Earlier Development of the Accumbens Relative to Orbitofrontal Cortex Might Underlie Risk-Taking Behavior in Adolescents. *Journal of Neuroscience*, *26*(25), 6885–6892. https://doi.org/10.1523/jneurosci.1062-06.2006

Gentile, D. (2009). Pathological Video-Game Use Among Youth Ages 8 to 18. *Psychological Science*, *20*(5), 594–602.https://doi.org/10.1111/j.1467-9280.2009.02340.x

Grüsser, S., Thalemann, R., & Griffiths, M. (2007). Excessive Computer Game Playing: Evidence for Addiction and Aggression? *Cyber Psychology & Behavior*, *10*(2), 290–292. https://doi.org/10.1089/cpb.2006.9956

Hawi, N., & Samaha, M. (2023). The Relationship Between Obsessive-Compulsive Disorder and Gaming Disorder. *International Journal of Cyber Behavior Psychology and Learning*, *13*(1), 1–15.https://doi.org/10.4018/ijcbpl.330133

Johnson, J. L., & Edwards, P. M. (2019). Youth Gaming Addiction: Implications for School Nurses. *NASN School Nurse*, *35*(5), 284–289. https://doi.org/10.1177/1942602x19888615

Kim, E., Namkoong, K., Ku, T., & Kim, S. (2008). The Relationship Between Online Game Addiction and Aggression, Self-Control and Narcissistic Personality Traits. European Psychiatry, 23, 212 - 218.https://doi.org/10.1016/j.eurpsy.2007.10.010.

Király, O., Griffiths, M. D., & Demetrovics, Z. (2015). Internet gaming disorder and the DSM- 5: Conceptualization, debates, and controversies. *Current Addiction Reports, 2*, 254-262.

Lee, S., Lee, H. K., Bang, S., Jeong, H., Yim, H. W., & Kweon, Y. (2018). Aggression and Harm-Avoidant Trait Impede Recovery From Internet Gaming Disorder. *Frontiers in Psychiatry, 9*.https://doi.org/10.3389/fpsyt.2018.00263

Lemmens JS, Valkenburg PM, Gentile DA. (2015). The internet gaming scale. *Psychol. Assessment* 2015; 27: 567–582.

Lemmens, J. S., Valkenburg, P. M., & Peter, J. (2011). Psychosocial causes and consequences of pathological gaming. *Computers in human behavior*, *27*(1), 144-152.

Lepièce, B., Zdanowicz, N., de Becker, E., de Timary, P., & Lorant, V. (2019). Adolescents in transition to young adulthood: evolution of mental halth status and risk factors associated with depressive and anxiety disorder. Psychiatria Danubina, 31(Suppl 3), 371-375.

Limone, P., Ragni, B., & Toto, G. A. (2023). The epidemiology and effects of video game addiction: A systematic review and meta-analysis. *Acta Psychologica, 241*, 104047. https://doi.org/10.1016/j.actpsy.2023.104047

Melin, R., Fugl-Meyer, K. S., & Fugl-Meyer, A. R. (2003). Life Satisfaction In 18- To 64-Year-Old Swedes: In Relation To Education, Employment Situation, Health And Physical Activity. *Journal of Rehabilitation Medicine*, *35*(2), 84–90. https://doi.org/10.1080/16501970306119

Möller, I., &Krahé, B. (2008). Exposure to violent video games and aggression in German adolescents: a longitudinal analysis. *Aggressive Behavior*, *35*(1), 75–89. https://doi.org/10.1002/ab.20290

Moroianu, L., Moroianu, M., Curis, C., Ardeleanu, I., Sargu, G. D., & Ardeleanu, V. (2023). Virtual Addiction to Video Games: Debut of Obsessive-Compulsive Disorder- Case Report and Short Review of the Literature. *Ars Medica Tomitana*, *29*(4), 232–238. https://doi.org/10.2478/arsm-2023-0034

Nurmagandi, B., & Hamid, A. Y. S. (2020b). Predisposing factors associated with online gaming addiction/ : a systematic review. *JurnalProfesi Medika JurnalKedokteran Dan Kesehatan*, *14*(1). https://doi.org/10.33533/jpm.v14i1.1654

Pan, Yifei., Saeid, Motevalli. (2023). 4. Exploring the Correlations Between Game Addiction, Aggression, Narcissism, and Self-Control among Adolescents: A Comprehensive Literature Review. International Journal of Academic Research in Progressive Education and Development,https://doi.org/10.6007/ijarped/v12-i3/17869

Ramos, P.A., Almeida, P.M., & Sánchez, M.B. (2024). The Transition to Adulthood from the Perspective of Former Foster Youth: A Socio-Educational Approach. Societies, 14(8), 147. https://doi.org/10.3390/soc14080147

Rosendo-Rios, V., Trott, S., & Shukla, P. (2022). Systematic literature review online gaming addiction among children and young adults: A framework and research agenda. *Addictive Behaviors*, *129*, 107238. https://doi.org/10.1016/j.addbeh.2022.107238

Sarda, E., Bègue, L., Bry, C., & Gentile, D. (2016). Internet Gaming Disorder and Well-Being: A Scale Validation. *Cyberpsychology Behavior and Social Networking*, *19*(11), 674–679. https://doi.org/10.1089/cyber.2016.0286

Shabbir, S., Saleem, M., Mahmood, S., & Perveen, S. (2020). Gaming Addiction and Aggression in Pakistani Young Adults: Through the Lens of Excitation Transfer Theory. *Journal of Professional & Applied Psychology*, *1*(1), 10–21. https://doi.org/10.52053/jpap.v1i1.4

Sharma, M., Palanichamy, T., Sahu, M., & Kanchana, D. (2020). Influence of Esports on stress: A systematic review. *Industrial Psychiatry Journal*, *29*(2), 191. https://doi.org/10.4103/ipj.ipj_195_20

Soper, W. B., & Miller, M. J. (1983). Junk-time junkies: An emerging addiction among students. *The School Counselor*, *31*(1), 40-43.

Teng, H., Zhu, L., Zhang, X., & Qiu, B. (2024). When Games Influence Words: Gaming Addiction among College Students Increases Verbal Aggression through Risk-Biased Drifting in Decision-Making. *Behavioral Sciences*, *14*(8), 699. https://doi.org/10.3390/bs14080699

Van Rooij, A. J., Ferguson, C. J., Carras, M. C., Kardefelt-Winther, D., Shi, J., Aarseth, E., Bean, A. M., Bergmark, K. H., Brus, A., Coulson, M., Deleuze, J., Dullur, P., Dunkels, E., Edman, J., Elson, M., Etchells, P. J., Fiskaali, A., Granic, I., Jansz, J., . . .Przybylski, A. K. (2018). A weak scientific basis for gaming disorder: Let us err on the side of caution. *Journal of Behavioral Addictions*, *7*(1), 1–9. https://doi.org/10.1556/2006.7.2018.19

Yue, Y. (2024). Effects of Video Game Addiction on Mental Health. *Lecture Notes in Education Psychology and Public Media*, *33*(1), 137–144. https://doi.org/10.54254/2753-7048/33/20231573

Zhang, Y., Hou, Z., Wu, S., Li, X., Hao, M., & Wu, X. (2022). The relationship between internet addiction and aggressive behavior among adolescents during the COVID-19 pandemic: Anxiety as a mediator. *Acta psychologica*, *227*, 103612.

Sustainable Coastal Management and Coastal Governance in Kerala in the Context of Climate Change*

Biju Kumar A.

Kerala's coastline, spanning approximately 590 km, is a dynamic and ecologically significant region that supports diverse marine ecosystems, livelihoods, and economic activities. Despite occupying only 15% of the state's total land area, the coastal zone is home to 30% of Kerala's population and 77% of its fisher community. The region is highly vulnerable to natural and anthropogenic threats, including habitat degradation, overexploitation of resources, and climate change impacts such as sea-level rise, coastal erosion, saltwater intrusion, and extreme weather events. The state's coastline, shaped by oceanic currents, winds, and geomorphological factors, faces increasing pressure due to human interventions like industrialization, tourism, and the construction of artificial coastal defense structures. With 45% of the coastline experiencing erosion, the need for sustainable coastal management is urgent. This paper emphasizes the importance of adaptive coastal management strategies, nature-based solutions, and intersectoral coordination to mitigate the impacts of climate change. A comprehensive approach integrating scientific research, local governance, and policy implementation is necessary to ensure the long-term resilience of Kerala's coastal ecosystem and communities.

Keywords : Coastal zones, marine transgressions, storm surges, integrated coastal management, blue economy, blue growth.

The uniqueness of Kerala coast

Coastal zones, the transitional areas between the sea and the land, are highly dynamic and provide a wide range of ecosystem services. These regions are crucial for environmental, social, and economic sustainability. Kerala, situated in the southwestern part of India (long. 74.87 to 72.37 E.; lat. 8.30 to 12.80 N.), is a narrow strip of land varying in width from approximately 35 to 120 km. It is flanked by the Arabian Sea to the west and the Western Ghats to the east, giving it a distinct coastal and landscape environment compared to other Indian states. Kerala's coastal formation is believed to have originated due to faulting during the late Pliocene, around three million years ago. Over geological time, the coastline has experienced oscillations due to marine transgressions. The region's humid tropical conditions have influenced its environmental dynamics for thousands of years, resulting in diverse geomorphological features such as backwaters, bays, lagoons, salt marshes, sand dunes, and sandy shores. The state's coastline stretches approximately 590 km, accounting for about 10% of India's total coastline. This coastal region is marked by an asymmetrical topography with undulating subdued hills and steep slopes, with altitudes ranging from below mean sea level (MSL) to 2,694 meters above MSL (Jagtap et al., 2004).

The coastal districts of Kerala include Thiruvananthapuram, Kollam, Alappuzha, Ernakulam, Thrissur, Malappuram, Kozhikode, Kannur, and Kasaragod. Despite covering only 15% of Kerala's total land area, the seashore is home to 77% of the state's fisher population and about 30% of the overall population. These

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* Revised version of C. AchuthaMenon Memorial Lecture delivered on 16th August, 2024 at Thiruvananthapuram.

coastal districts collectively have a population of 25.4 million. While the state's average population density is 859 individuals per square kilometer, the coastal lowlands have a significantly higher density, averaging 1,111 per square kilometer. The abundance of coastal and marine resources, coupled with favourable physical conditions, has driven habitation in these areas. The region also supports industries, small and large ports, and a thriving tourism sector.

Kerala's coastline is influenced by ocean currents and winds that bring cold, nutrient-rich upwelling waters, making the seashore highly productive and supporting substantial fish biomass. The state has a continental shelf area of 38,700 square kilometers and an Exclusive Economic Zone (EEZ) of 218,536 square kilometers, which sustain a robust marine fisheries sector. This sector provides livelihood for approximately 800,000 people residing in 222 coastal fishing villages. Additionally, Kerala's coastal ecosystems play a crucial role in supporting the state's tourism industry, serving as a backbone for economic growth and employment in the region.

Drivers of coastal change

The direct and indirect drivers of coastal change in Kerala coast can be broadly classified as direct and indirect drivers, and the drivers of coastal change include habitat loss/conversion, habitat degradation, overexploitation and climate change (Table 1).

Table 1. Drivers of Change in Coastal Ecosystems of Kerala

Direct Drivers	Indirect Drivers
Habitat Loss/Conversion	
Coastal development (ports, tourism-related developments, coastal cities)	High population density, poor spatial planning, greater demand for land for tourism and other developmental activities; violations of coastal regulation zone (CRZ) norms.
Over capacity of fishing crafts (especially trawlers) industries, increasing	Demand for domestic and international markets, animal feed competition in lightof diminishing resources; open access to sea
Mangrove deforestation, loss of coastal wetlands, other coastal vegetation and sand dunes	Poor policies, ignorance about the values of ecosystems and species; demand of land for various purposes including aquaculture.
Sand mining, dredging perceptions	Lack of alternative materials, global commons
Civil engineering works (hard armouring structures including sea wall)	Public demands to prevent coastal erosion, lack of knowledge about impacts and their costs
Habitat Degradation	
Pollution: Sewage discharge, eutrophication due to leaching of fertilizers from farms; marine debris	Urbanization; lack of sanitation in coastal regions; unregulated use of fertilizers in agricultural farms; loss of wetlands and other natural controls
Pollution: dumping and dredge spoils	Lack of alternative disposal methods; belief in unlimited assimilative capacities of oceans
Salinization of estuaries and saltwater intrusion into rivers due to decreased freshwater inflow.	Increasing demand for water for various purposes; dams and diversions
Alien species invasions	Lack of regulations; increased aquaculture-related escapes

Overexploitation	
Exploitation of high-value and low-value species at volumes exceeding sustainable levels	Pressure of markets and neoliberal policies; high demand, including those from international markets; exploitation of juveniles; improved fish-detection methods; illegal methods such as light fishing; poor enforcement mechanism and monitoring; breakdown of traditional regulation systems; subsidies for mechanised fishing
Incidental catch or bycatch	No regulations on bycatch reduction; high market demand from the animal feed and fish manure manufacturing industries
Climate Change and sea level rise	
Climate change	Insufficient controls on emissions (both global and local); unsustainable developmental practices; lack of resilience power of coastal ecosystems
Increase in storm surges, cyclones etc	Insufficient funds at the grass roots for adaptation
Sea level rise	Insufficient funds at the grass roots for adaptation; ; lack of resilience power of coastal ecosystems
Coastal erosion	Loss of natural defence systems; increase in hard armouring structures for coastal defence, including sea wall, groynes, breakwaters; increased interests in sea wall construction as a quick fix solution; lack of awareness on cheaper nature based solutions and apathy

Coastal Vulnerabilities and Climate Change

Kerala is multi hazard-prone and according to the Department of Revenue and Disaster Management in Kerala, the state is prone to 17 natural hazards and 22 anthropogenic hazards that have disaster potential. The natural hazards associated with the coastal regions include coastal hazards (high waves, storm surges (‘kallakadal), Tsunami, salt water intrusion, coastal erosion, winds (cyclone, gustnados, gusty winds), heat wave/sunburn/sunstroke, natural background radiation and epidemics, while the possible anthropogenic ones are industrial accidents, oil spill, boat capsizing, accidental drowning, and occupational and recreational area related hazards (GoK, 2022).

The inherently vulnerable coastal ecosystems of Kerala are exposed to the forces of seas and the cascading impacts of anthropogenic habitat changes in the terrestrial systems due to unsustainable land use and pollution. The climate change and its multi-dimensional complexities on the natural and human sub-systems of the state include increase in storms and cyclones, high waves and tides, coastal erosion and flooding, saltwater intrusion, increase in sea surface temperature, and decline in availability of few commercially valuable bioresources. The coastal communities have, at present, little adaptive capacity to minimise the impacts of climate change, and hence vulnerable to climate change. This is compounded as human population density and infrastructure development are relatively high in the coastal regions, thereby increasing socio-economic vulnerability. Of late, human activities, including waste disposal, eutrophication, habitation, harbours, industries, overexploitation of resources, tourism and recreational activities, have exerted additional pressure on natural coastal ecosystems which threaten their resistance and resilience. Given the existence of these hazards, it is imperative to build internal resilience to withstand the impact of climate change in the coastal zone.

Coasts are dynamic systems, undergoing adjustments of morphodynamics at time and space in response to geomorphological and oceanographical factors (Cowell et al., 2003a,b). Human activities exert further pressures over natural process, as in the case of rampant coastal erosion happening in the state. More than

half of the Kerala coast currently hosts artificial structures such as ripraps, groins, seawall, ports and fishing harbours. These 'hard' armouring structures for coastal and developmental activities have significantly altered the shoreline, and the sea level rise and rough coastal seas triggered by the climate change further exert pressure on the existing shoreline. The overall shoreline change status of Kerala coast indicates that 45% of the coast is eroding and 34% of the coast is in stable condition; while the shoreline stability is offered by the dynamic equilibrium of natural erosion and accretion processes, the current rate of accretion is only 21%, thereby impacting the stability of the coast (NCSCM, SICOM, and MoEF, 2011; Noujas and Thomas, 2018; Selvan et al., 2020).Noujas and Thomas (2015) have reported 30 erosion hotspots along Kerala coast. The primary cause for the erosion process is the wind-generated surface gravity waves originating from multiple regions of the Indian Ocean. The coastal erosion process has resulted in heavy damage on properties, particulary the dwelling spaces of fishers, loss of life and impacted the tourism and other developmental activities in the coastal zone.

The current trends in marine heatwaves over the tropical Indian Ocean indicates its impact on the Indian summer monsoon (Saranya et al., 2022) and such vagaries in monsoon patterns and intensification of cyclones and storm surges over the Arabian Sea further exert pressure on the coastal ecosytems, socio-economic systems and human capital in the state. Further, changes in primary productivity (Roxy et al., 2016; Shafeeque et al., 2021), development of oxygen minimum zones and sea surface temperature increase resulted in the decline in the availability of oil sardine, one the most dominant marine fisheries of Kerala coast. In general, increasing Sea Surface Temperature (SST), variability in Sea Surface Height (SSH), chlorophyll-a, salinity, pH, rainfall and other oceanic conditions are believed to be the potential consequences of global warming and extreme climatic events that could impact marine ecosystems in general and fisheries in particular (Roxy et al., 2016; Akash et al., 2021).

Salt water intrusion during the summer season due to rampant ground water exploitation and tidal effects also affect the coastal community, besides impacting coastal agriculture along the coast. Coastal cities in Kerala are vulnerable to water logging and flooding due to increased water inflow as well as sea-level rise and the current rate of sea-level rise along Kerala coast is 1.75 mm per year while the projected sea-level rise (SLR) is expected to be about 100 mm–200 mm by 2200 (Kerala-PDNA, 2018). Areas below mean sea level such as Kuttanad in Alappuzha district and the network of estuaries and backwaters along Ernakulam district are the regions projected to be severely impacted by the sea-level rise(Kerala-PDNA, 2018). Mangrove forests are keystone coastal ecosystems that provide numerous ecosystem services and offer critical ecosystem services. While the mangrove cover in the country based on 2021 assessment by the Forest Survey of India is 4,992 sq. km., in Kerala there is no very dense mangrove cover, and the mangrove stretch is limited to nine sq. km. (5 sq. k. moderately dense and 4 sq. km open) (FSI, 2021).

Table 2. Stakeholder Departments, their Role and Responsibilities
(with concerned institutes and organisations)

Sl.No.	Departments and institutions	Roles and responsibilities
1	Agriculture Development & Farmers Welfare (International Research and Training Centre for Below Sea level Farming, Kuttanad; Kerala Land Development Corporation: Kerala Corporation: Kerala University; College of Climate Change and Environmental Science (CCCES); Kerala Veterinary and Animal Sciences University (KVASU)	Meet the challenges in food production and food security, germplasm collection, including that of coastal and salt-tolerant species; the centre specifically look at farming in coastal areas below the sea level, especially under changing climate; initiating climate smart agriculture.
2	Coastal Shipping & Inland Navigation (KSINC-Kerala Shipping & Inland Navigation Corporation Ltd)	Transportation in coastal areas

3	Environment (Kerala Coastal Zone Management Authority; Kerala Centre for Integrated Coastal Zone Management; State Environment Impact Assessment Authority; Kerala State Wetland Management Authority; Institute for Climate Change Studies-ICCS)	Implementing programmes and policies related to coastal environment, coastal zone management, environmental impact assessment and climate change; management of climate change knowledge cell; planning and implementing climate change adaptation and mitigation; reseach, education and extension.
4	Fisheries and Ports (Kerala State Cooperative Federation for Fisheries Development Ltd.-Matsyafed; Agency for Development of Aquaculture, Kerala-ADAK; Kerala Fishermen's Welfare Fund=KFWEB); Fish Farmers Development Agency -FFDA; Kerala State Coastal Area Development Corporation - KSCADC); Society for Assistance to fisherwomen- SAF; Kerala Aquaventures international limited- KAVIL; Harbour Engineering Department; Kerala University of Fisheries and Ocean Studies)	Adaptation and mitigation activities in the coastal fisheries sector and alternate livelihoods and compensation for the victims of coastal hazards and sea erosion; rehabilitation of fishers; research, education, and extension.
5	Forest & Wildlife	Establishing bio-shield along the coastline of Kerala; mangrove afforestation; conservation of coastal species; climate adaptation.
6	Education (General Education and Higher Education; All universities in India under the department; State Higher Education Council)	Reseach, education and awareness on climate change; carbon neutral educational institutions and campuses
7	Health & Family Welfare (Kerala State Pollution Control Board; Kerala University of Health Sciences)	Monitoring and prevention of pollution and epidemics in coastal regions; health care under climate change
8	Irrigation	Mandate also include coastal protection
9	Law (The National University of Advanced Legal Studies-NUALS)	Advise on legal matters related to coastal zone management and climate change adaptation and mitigation
10	Local Self Government (Kerala State Planning Board; Harithakeralam mission, Mahatma Gandhi National Rural Employment Scheme-State Mission Office; Information Kerala Mission; Suchitwa Mission; Kudumbashree–the State Poverty Eradication Mission and women empowerment programme; Kerala Institute of Local Administration-KILA)	Decentralise climate adaptation, mitigation and training programmes; local interventions for climate adaptation; waste management in coastal areas; community based eco-restoration programmes in coastal areas; training and climate awarenss
10	Power (Agency for Non-conventional Energy and Rural Technology- ANERT; Energy Management Centre (EMC)	Popularisation of alternate energy sources to mitigate climate change; popularisation of electric vehicles and energy saving practices; education, reseach and extension.
11	Public Works Department	Constructions, including coastal armouring structures in coastal belt.
12	Revenue	Green/carbon tax

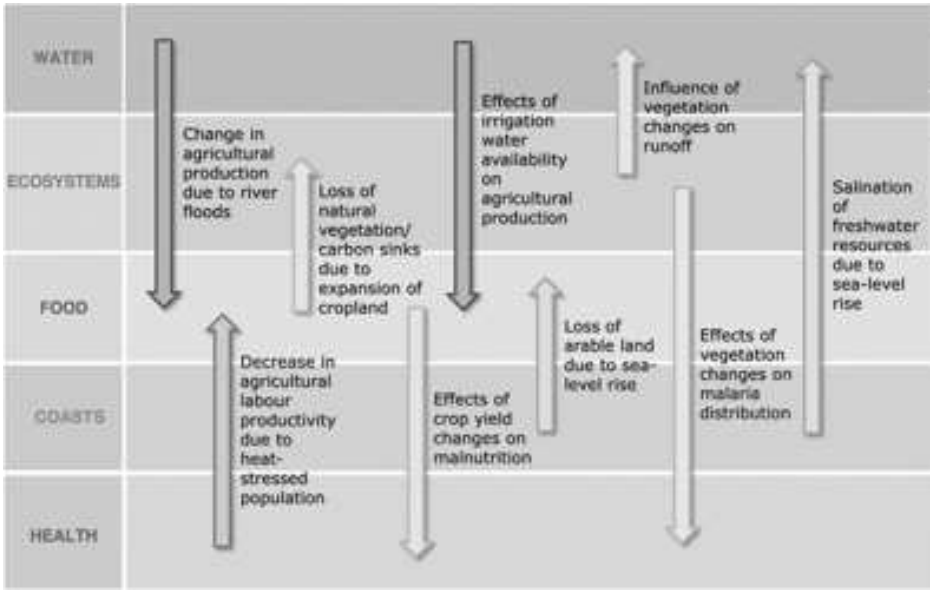
13	Science and Technology (Kerala State Council for Science, Technology and Environment -KSCSTE; Kerala Forest research Institute KFRI; Jawaharlal Nehru Tropical Botanic Garden & Research Institute – JNTBGRI; Srinivasa Ramanujan Institute For Basic Sciences- SRIBS; Malabar Botanical Garden & Institute for Plant Sciences -MBGIPS; National Transportation Planning & Research Centre – NATPAC; Centre for Water Resources Development & Management – CWRDM)	Education, reseach and extension related to climate change science, adaptation and mitigation; policy development in various sectors, including afforestation, energy, transportation, water conservation, pollution, climate change, etc.
14	Tourism	Promoting responsible coastal tourism and carbon foot prints of tourists
15	Transport	Climate change mitigation and clean transpiration; electric vehicles
16	Water Resources	Education, reseach and extension.

The autonomous institutions in Kerala such as the State Disaster Management Authority, and national institutions like National Centre for Earth Science Studies (NCESS), Central Institute of Fisheries Technology (CIFT), Central Marine Fisheries Research Institute (CMFRI), Centre for Marine Living Resources & Ecology (CMLRE), Indian Institute of Space Science & Technology (IISSR), National Institute of Oceanography (NIO) regional centre, and Vikram Sarabhai Space Centre (VSSC) can also play a key role in providing inputs towards coastal governance in Kerala.

Establishing inter-linkages and inter-sectoral coordination

The issues related to climate change in a highly populous state like Kerala is highly challenging, not to speak of the cascading effects of climate change across the sectors (Fig. 1.).

Fig. 1. Climate-risk cascades across sectors (Courtesy: Huber et al 2014).



In multi-hazard prone state like Kerala coastal governance is challenging since it remain integrated with multiple sectors of governance. Further, the increasing instances of coastal erosion all along the coastline of Kerala also offer greater challenges, especially in future, in the context of projected climate change impacts over the region. However, considering the high sensitivity of highly populous coastal zones to natural disasters

and other impacts of climate change, coupled with increasing needs for adaptation efforts, coastal governance demands better intersectoral linkages and coordination.

Integrated Coastal Management (ICM) is increasingly recognized as a key policy response to address the multiple challenges facing coastal zones, including climate change (Hurlimann et al., 2014; Wong et al., 2014). ICM is an adaptive management practice that takes into account various drivers that impact the coastal ecosystems and the life and livelihood of coastal populace, search for opportunities in the coastal areas towards sustainable development, bring together various stakeholders and opt for grassroot level solutions (Hurlimann et al., 2014). By utilizing adaptive management, and best available knowledge to inform decisions, ICM departs from conventional approaches whereby problems were addressed within specific sectors without considering linkages with, and implications for, other sectors. ICM facilitates adaptation because of its use of adaptive management and best available knowledge to inform decision-making; increasing participation and inclusion of the public in adaptation; improve coordination between actors and institutions at multiple levels of government; prevent fragmentation of laws and overlapping roles between institutions (Tobey et al., 2010). Therefore, in the context of increasing pressures from climate change and to ensure sustainable ecosystem services from the sector, the state has to implement effective Integrated Coastal Zone Management (ICZM), with a stronger focus on managing climate change-related vulnerabilities and risks. This approach has a holistic perception of addressing risks, planning and management, besides addressing the issues related with resilience building, ecosystem approach for management and ensuring nature-based solutions for sustaining the livelihood of people (such as conservation of mangroves to protect the coastline, provide habitat for coastal biodiversity and serves as a good sink for carbon).

Effective local governance is fundamental to addressing climate change challenges in coastal zones. This governance involves a diverse array of actors, including the state, civil society, and private sectors (Lemosand Agrawal, 2006). Since the impacts of climate change are much more effervescent locally, the local actors (including the local self-governments) are best suited to address the coastal issues and climate change impacts in the coastal zones. By facilitating a structured approach to addressing coastal issues, from identifying and prioritizing issues to preparing, implementing, and evaluation of response strategies, ICZM can create an enabling governance environment for effective climate action at the local level (Tobey et al., 2010). The state climate action plan can also be suitably modified for a bottom-up approach, wherein the climate adaptation plans are facilitated by the local governments. Furthermore, the provision of public services and infrastructure and the planning of spatial planning contribute to the reduction of risk and building of resilience. With the establishment of an Integrated Coastal Zone Management Authority (ICZMA), ensuring the participation of all stakeholder departments in climate action, and mainstreaming the disaster management, climate adaption and mitigation in various programmes of the local self-governments, a better model of coastal governance can be envisaged. Further, the line departments, particularly the departments of environment, revenue, local self-government, forests, agriculture, irrigation and science and technology, need to share the roles and responsibility, with the lead role played by the ICZMA in coordinating the activities through the local bodies.

Role of LSGs in coastal governance

Local government is the main actor for the implementation of climate action plan of the state government. An integrated coastal management plan by mainstreaming climate action would provide important insights into the challenges faced by local government action in climate change. The LSGs in Kerala, with a long experience in implementing grassroot level reformative actions in governance, can serve as the means of implementing coastal zone protection, adaptation to climate change and ecosystem restoration, besides playing a critical role in acting as a link between state, civil society and private sector.

The primary challenges in coastal governance in Kerala would be linked with the key issues such as coastal zone management (sustainable coastal developmental practices, mitigation of disasters including coastal

erosion, waste management), ensuring sustainable livelihoods of coastal communities who are the 'ecosystem people' in the area, adaptation including coastal afforestation measures such as conservation of remaining mangrove vegetation, and conservation of coastal wetlands. Further, the coastal tourism, fisheries and aquaculture activities receive high impetus under 'blue economy', there is a growing need to integrate the new paradigm of 'blue growth' into the whole process of coastal governance.

However, there are challenges and gaps in governance, and one of the primary challenges is to strengthen the discussion and knowledge base on integrating coastal zone management and climate change adaptation strategies with coastal governance of local bodies. This may lead to an official **community plan for local governments** to strengthen their ICZMP and activities therein. This plan may evolve and redefined based on the local scenarios in respective coastal panchayaths or other bodies involved. Though the local governments have limited resources available for climate change governance, pooling the central resources and mainstreaming climate change and coastal zone management in coastal governance would be the pioneering efforts in this transition.

There are still challenges to address the gaps in governance between the LSGs and various stakeholder departments, in particular in coordination, IEC (Information, Education and Communication), and capacity building. While Kerala Coastal Zone Management Authority (KCZMA) is responsible for the protection and conservation of the coastal environment and climate change adaptation activities are governed by the Department of Environment (which also houses KCZMA) through the Directorate of Environment and Climate Change (DoECC), the integration of activities with the LSGs need to be streamlined. The district level functioning of the office at District panchayats, and coastal monitoring committee at LSGs at panchayath levels would offer better choices of coastal governance. A state like Kerala, with plenty of grassroot level organisations, including civil societies, haritha karma sena, local stakeholder communities, self-help groups, etc. would serve as a support system for implementing the coastal climate action plans. Further, the disaster management system also should function in tandem with coastal environmental management system.

Recommendations and way forward

For the implementation of coastal zone management, sustainable management of coastal resources, ensuring the sustainability of coastal ecosystem services, Disaster Risk Reduction (DRR) basics and Climate Change Adaptation (CCA), inter-linkages, inter-sectoral coordination and sharing of roles and responsibilities between different stakeholder departments need to be ensured. The ongoing coastal management and climate adaptation measures need to be revisited, with the specific Local Government Coastal Management and Climate Action Plans, implemented through the LSGs, involving local communities. The local governments should drive for more green infrastructure options working with nature, in combination with traditional 'grey' adaptation approaches. In coastal resources management and climate change adaptation, the local communities and citizen scientist can play a major role.

The impact of extreme climate events in Kerala has its repercussions in coastal Kerala, and considering the projected climate change implications, there is an urgency to strengthen coastal governance in the state. The failures in coastal governance in the state stem from the lack of integration of activities, especially in coastal zone management, coastal erosion prevention, coastal biodiversity management, climate adaptation and disaster management. An integrated coastal zone management programme ensured through the coordination of all stakeholder departments, and implemented through the LSGs would help coastal governance in the initial phase. In the meantime there is also a need for strengthening the knowledge base for framing better policies for coastal governance and develop ICT tools for climate literacy. A concerted effort is required to make all the stakeholders aware of the implications of climate change in the coastal ecosystem, people, livelihood and economy. Mainstreaming climate change adaptation, disaster risk reduction and sustainable development into government policies and planning cutting across various stakeholder departments require consistent efforts and political will.

Parallelly, in a highly literate and politically conscious state like Kerala, coastal conservation requires the support of the local communities, citizen scientists, and civil societies. For example, the management of critically threatened mangrove ecosytems in Kerala, is possible only with the involvement of communities, specifically as community reserves. As major part of the mangrove ecosystems are privately owned, the areas should be taken over by the government as protected areas, with sufficient compensation for the owners. These areas can become the ideal sites for climate education. The implementation of ICZMP should invariably demand marine spatial planning, which would form an integral tool for coastal governance. Further, there is also a need for delineation and mapping of ecologically sensitive areas and critical vulnerable coastal areas along the Kerala coast.

The plan for developing green belts/infrastructure along coastal zones for both climate adaptation and coastal protection could become sustainable, when it is couple with ecosystem restoration activities initiated as part of the MNREG programme and other coastal afforestation programmes. The possibility of community-based mangrove management could be integrated with responsible tourism initiatives of the government. While promoting tourism, fishing tourism and using fishers as tourist guides would help to support the blue economy initiatives and to diversify the economy and income of fishing communities. The nature-based solutions in the coastal zone also include various strategies for protecting the sand dunes along Kerala coast.

There is also a need to strengthen the knowledge base on the impact of climate change on various coastal habitats and strengthening need-based research towards indigenous solutions for planning and designing coastal protection. The concept of carbon neutral villages is gaining popularity in Kerala, and this would become a reality only with a stronger knowledge capital.

References

Akash, S., Shah, P., Shafeeque, M., Pooja, A.S., Zacharia, P.U., Ajith, J.K., Bharti, V.,Sathianandan, T.V., George, G., (2021). Observed links between coastal oceanprocesses and Indian Oil Sardine (*Sardinella longiceps*) fishery along thesouthwest coast of India. Reg. Stud. Mar. Sci. 46 (101850), 1–13. http://dx.doi.org/10.1016/j.rsma.2021.101850.

Census of India. (2011). Population distribution, percentage decadal growth rate, sex ratio and population density of Kerala, 2011. Census Directorate, Thiruvananthapuram, Kerala.https://censusindia.gov.in/2011census/PCA/PCA_Highlights/pca_highlights_file/kerala/Exeutive_Summary.pdf

FSI (2021). India State of Forests Report. Forestry Survey of India, Dehradun, India, https://www.fsi.nic.in/forest-report-2021

GoK (2022). Formulation of Fourteenth Five Year Plan (2022-2027). Report of the working group on disaster management. State Planning Board, Government of Kerala.

Huber V et al. (2014). Climate impact research: beyond patchwork *Earth Syst. Dyn*. 5 399

Hurlimann, A., Barnett, J., Fincher, R., Osbaldiston, N., Mortreux, C., & Graham, S. 2014. Urban planning and sustainable adaptation to sea-level rise. Landscape and Urban Planning, 126, 84– 93. https://doi.org/10.1016/j.*landurbplan*.2013.12.013

INCOIS. http://www.incois.gov.in/Incois/cvi/pdfs/Kerala/58BSW.pdf

Jagtap, T.G., Ansari, Z.A., Coutinho, F.B., Charulata, S., Gaidhane, D.M. (2004).Impact of climate change on mangrove forests along the south west coast: acase study from Kasaragod, Kerala, India. In: Ravindranath, N.H., Sharma, S.K.,Garg, A., Bhattacharya, S., Murthy, I.K. (Eds.), Proceedings of the Workshop onVulnerability Assessment and Adaptation Due to Climate Change on IndianAgriculture, Forestry and Natural Ecosystem. *Ministry of Environment andForests, Government of India.* pp. 136–149.

Kerala-Post Disaster Needs Assessment (PDNA) Floods and Landslides. (2018). Government of Kerala. www.undp.org>library>PDNA>PDNA_Kerala_India.

Lemos, M.C., Kirchhoff, C. J. & Ramprasad, V. (2012). Narrowing the climate information usability gap. Nature Climate Change, 2(11), 789– 794. https://doi.org/10.1038/nclimate1614

NCSCM, SICOM, and MoEF, (2011). National Assessment of Shoreline Change - Kerala Shoreline

Change Fact sheet: National Centre for Sustainable Coastal Management (NCSCM), Society of Integrated Coastal Management (SICOM) and Ministry of Environment and Forests (MoEF), Govt. of India.

Noujas, V. and Thomas K.V. (2015). Erosion hotspot along southwest coast of India. Aquat Procedia 4:548–555

Noujas, V. and Thomas K.V.(2018). Estimation of longshore sediment transport direction from varying coastal morphodynamics due to shore structures. *Environ Earth Sci.* https ://doi.org/10.1007/s12665-018-7853-0

Roxy, M.K., Modi, A., Murtugudde, R., Valsala, V., Panickal, S., Prasanna Kumar, S.,Ravichandran, M., Vichi, M. and Levy, M. (2016). A reduction in marine primaryproductivity driven by rapid warming over the tropical Indian Ocean.Geophys. *Res. Lett*. 43 (2), 826–833. http://dx.doi.org/10.1002/2015GL066979.

Saranya, J. S., Roxy, M. K., Dasgupta, P., & Anand, A. (2022). Genesis and trends in marine heatwaves over the tropical Indian Ocean and their interaction with the Indian summer monsoon. Journal of Geophysical Research: *Oceans, 127, e2021JC017427*

Selvan, S.C., Kankara, R.S., Prabhu, K. and Rajan, B. (2020). Shoreline change along Kerala, south west coast of India, using geo spatial techniques and field measurement. *Natural Hazards* (2020) 100:17–38; https://doi.org/10.1007/s11069-019-03790-21 3

Shafeeque, M., George, G., Akash, S., Smitha, B.R.. Shah, P. and Balchand, A.N. (2021). Interannual variability of chlorophyll-a and impact of extreme climatic events in the South eastern Arabian Sea. *Regional Studies in Marine Science* 48 (2021) 101986; https://doi.org/10.1016/j.rsma.2021.101986

Sreelekshmi S., Bijeesh, K.V., Bijoy Nandan, S. and Harikrishnan, M. (2021). Mangrove forests along the coastline of Kerala, southern India: Current status and future prospects. *Regional Studies in Marine Scienc*e 41, 101573, https://doi.org/10.1016/j.rsma.2020.101573,

Tobey, J., Rubinoff, P., Robadue, D., Ricci, G., Volk, R., Furlow, J., and Anderson, G. (2010). Practicing coastal adaptation to climate change: Lessons from integrated coastal management. *Coastal Management.* 38(3): 317– 335. https://doi.org/10.1080/08920753.2010.483169

Wong, P. P., Losada, I. J., Gattuso, J.-P., Hinkel, J., Khattabi, A., McInnes, K. L., Saito, Y. And Sallenger, A. (2014). In R. J. Nicholls (Ed.), Coastal systems and low-lying areas. *Intergovermental Panel for Climate Change*.http://ro.uow.edu.au/scipapers/167.

Introducing New Book

Towards a Joyful Life

Vedabhyas Kundu and Munazah Shah,
The Joyful Talisman: Conversations on Human Values for a Joyful World,
Naamak Publications, New Delhi, 2024, xviii + 166 pages, Rs. 349/-

Saurav Kumar Rai

Long ago Mahatma Gandhi, the father of our nation, gave a talisman to overcome doubts or when the self becomes too much powerful. He says that in such a condition, 'Recall the face of the poorest and the weakest man whom you may have seen, and ask yourself, if the step you contemplate is going to be of any use to him. Will he gain anything by it? Will it restore him to control over his own life and destiny? In other words, will it lead to swaraj for the hungry and spiritually starving millions? Then you will find your doubt and your self melting away.'

Inspired by Gandhiji's iconic talisman, Vedabhyas Kundu and Munzah Shah provide a guide for personal and spiritual growth through rekindling ethical and moral values and positivity. Written in the form of conversation between the authors Vedabhyas Kundu and Munazah Shah it delves into various day-to-day situations we often face at home, office, neighbourhood, etc. and the ways to come over them. It sets the tone to have a positive mindset and resilience to face the negativity that has loomed large around us. The authors in conversation perfectly blend the philosophical insights of Mahatma Gandhi along with other great men and theorists to guide the readers to embark upon a journey of achieving balance, resilience, inner peace, and above all a joyful life.

Some of the conversations included in this book deal with developing deep reverence for life and treating others as 'human'; learning the path towards peaceful co-existence through the Gandhian way, practicing compassion for a joyful world; adopting simplicity and minimalism for a happy life; small acts of kindness; self-introspection; cultivating moral excellence in everyday life; tolerance and encouraging dialogues for peace; non-violent communication; using humour and laughter in dispute resolution and coming out of difficult conversations which looks gloomy; among many others.

An important concept flagged by the authors in their conversation is regarding 'solidarity footprints'in continuation to the much-acclaimed idea of nonviolent footprints. The main pillars of the framework of solidarity footprints, as envisaged by the authors, are: mutuality, deep respect for each other including nature and other living beings, empathy, kindness, compassion, ability to use the strategy of nonviolent communication for deeper connections, ability to do common good, encouragement and promotion of altruism in the society, human dignity and equality (p. 71). Furthermore, the authors also argue that in order to make the solidarity canvas bigger, and in the backdrop of serious conflicts that we are witnessing, we should think of 'Global Solidarity Index'. Nations can be ranked in terms of the 'Global Solidarity Index' on the basis of how a nation as a whole promotes the elements of solidarity internally as well as internationally (p. 72).

Similarly, yet another significant concept introduced by the authors in their conversation is about 'gratitude network' to promote harmony in neighbourhood as well as workplace. In this network, individuals are encouraged to thank each other for the smallest of things any one does for them (p. 75). It enhances the social capital inspiring greater trust and reciprocity amongst people.

This book is absolutely a delightful read with life-changing ethos.Incidentally, the authors have dedicated this book to the girl child. All royalties that will accrue to this book will go for the education of the poor girl child.

Deciphering the Contrasting Verdicts of the Palakkad and Chelakkara By-Elections

Josukutty C.A.,
Deepak Krishnakumar
& Mahi R.

The by-election outcomes in Palakkad and Chelakkara, two neighbouring constituencies, reflected a striking contrast in electoral verdicts. In Palakkad, widespread anti-incumbency sentiment against both the BJP and the LDF, combined with various other factors, created a favourable environment for the UDF, enabling it to secure victory by effectively channelling voter dissatisfaction with its rivals. Meanwhile, Chelakkara witnessed a more nuanced dynamics, where anti-incumbency sentiment was counterbalanced by the strength and appeal of the LDF candidate, ultimately leading to their success. This study, employing a convergent mixed methods approach, examines the dynamics of these elections through an analysis of survey data and in-depth interviews. We argue that simultaneous anti-incumbency against the LDF and BJP, along with the appeal of the UDF candidate in Palakkad, and the organisational strength and appeal of the LDF candidate in Chelakkara, were central to the divergent verdicts in these constituencies.

Keywords : Demographic dynamics, logistical challenges, quantitative findings, qualitative component, anti-incumbency, local dynamics

Introduction

The by-elections in Palakkad and Chelakkara were necessitated by the resignations of MLAs Shafi Parambil and K. Radhakrishnan, respectively, following their victories in the 2024 Lok Sabha general elections. Shafi Parambil now represents the Vadakara Lok Sabha constituency, while K. Radhakrishnan serves as the MP for Alathur.

In Palakkad, United Democratic Front (UDF) candidate Rahul Mamkootathil secured a decisive victory with 58,389 votes (42.27%), winning by a margin of 18,840 votes. Meanwhile, in Chelakkara, Left Democratic Front (LDF) candidate U. R. Pradeep emerged victorious with 64,827 votes (41.44%), securing a margin of 12,201 votes (Election Commission of India - ECI, 2024a, 2024b).

Key factors that influenced the results included perceptions of the Second Pinarayi Government's performance, allegations of corruption, candidate appeal, and perceived inefficiencies in delivering government benefits. Additionally, voter sentiments were shaped by concerns such as inflation, unemployment, and the diverse interests of different demographic groups. Table 1 presents a breakdown of the percentage of votes secured by each candidate, offering valuable insights into voter preferences and the distribution of support among contestants.

Table 1: Percentage of Votes Secured by Major Parties in the Palakkad and Chelakkara By-Elections (2024)

Constituency	Party	% of Votes
Palakkad	LDF	27
Palakkad	UDF	42.27
Palakkad	BJP	28.63
Chelakkara	LDF	41.44
Chelakkara	UDF	33.64
Chelakkara	BJP	21.49

Source: (ECI, 2024a,2024b)

This article identifies and examines the key factors that influenced and shaped the final by-election outcomes. It is divided into four sections. The first section details the methodology, the second section explores the factors that influenced the by-election results, highlighting the role of governance, economic anxieties, demographic dynamics, and candidate appeal,the third section analyses the interplay of these factors and assesses the impact of controversies, campaign strategies, and voter priorities and the final section concludes with key insights and implications for future elections.

Methodology

The study employed a convergent mixed methods approach, integrating both quantitative and qualitative data collection and analysis simultaneously. The quantitative component involved administering a closed-ended questionnaire to respondents selected using systematic random sampling.In both Palakkad and Chelakkara, the study aimed to survey a total of 1,200 respondents, targeting 30 individuals from each of the 40 randomly selected booths. However, the final sample comprised 612 respondents from Palakkad and 620 respondents from Chelakkara, covering 40 booths across panchayats and municipalities. Practical constraints, such as non-responsiveness, unavailability of individuals during the data collection period, and logistical challenges in accessing certain areas, explained the shortfall in achieving the intended sample size.

Data collection was conducted through direct interviews by trained investigators to ensure reliability and consistency in responses. Participants provided informed consent, and data confidentiality was ensured throughout the study. The survey data were systematically analysed using Microsoft Excel, utilising descriptive statistics such as percentages and cross-tabulations to identify voting patterns and voter concerns.

To complement the quantitative findings, the study incorporated a qualitative component through in-depth interviews with key stakeholders, such as community influencers, media personnel, politicians, civil society representatives, NGOs, and informed voters. The qualitative data were analysed using thematic analysis, employing manual coding to identify key themes. Predefined categories were used to structure the coding process, ensuring consistency in theme identification. Responses were coded based on recurring themes, and patterns were analysed to identify dominant narratives in voter behaviour. This approach helped uncover underlying socio-political and economic factors shaping voter behaviour, including perceptions of governance, campaign strategies, economic concerns, and demographic influences.

The integration of quantitative and qualitative methods allowed the study to cross-validate trends by comparing measurable voter preferences with insights from stakeholder interviews. This parallel integration of methods ensured a holistic and nuanced understanding of electoral behaviour in Palakkad and Chelakkara constituencies.

Electoral History of Palakkad and Chelakkara

The electoral history of Palakkad and Chelakkara constituencies provides valuable insights into Kerala's evolving political landscape, highlighting the shifting voter preferences and party dynamics in these regions. Palakkad has experienced significant fluctuations in voter behaviour, reflecting a dynamic contest between the UDF and the LDF. Historically, the constituency has alternated between these two alliances, with independent candidates making notable inroads in the 1990s. However, in recent years, the UDF has solidified its dominance, securing consecutive victories in 2011, 2016, 2021, and 2024 (ECI, 2018a–2018o, 2021, 2024b).

Although the UDF has consistently won in Palakkad, the runner-up party has changed over time. In 2011, the LDF secured second place, but in 2016, 2021, and 2024, the Bharatiya Janata Party (BJP) emerged as the primary challenger, underscoring its expanding influence in the region. The UDF's winning margin peaked at 12.69% in 2016, but by 2021, it had dropped to just 2.72%, indicating rising competition and voter shifts. However, in 2024, the UDF expanded its lead again, securing a 13.64% margin of victory, suggesting a recovery in support and possible voter realignments. Meanwhile, the BJP has steadily expanded its influence, consistently securing second place since 2016 (ECI, 2018a, 2018o, 2021, 2024b). The party's control of the Palakkad municipality since 2015, despite a thin majority, signifies growing local acceptance. In the 2020 municipal elections, the BJP further strengthened its foothold, winning 28 out of 52 seats, an increase from 24 seats in 2015 (The Hindu, 2020).

In contrast, Chelakkara, a reserved Scheduled Caste (SC) constituency, has remained a stronghold of the LDF for over two decades. Since 1996, the LDF has consistently secured victories, underscoring its deep grassroots connections and strong voter support. While the UDF had notable successes in earlier decades, Chelakkara's electoral trends over the last 20 years reinforce its status as a leftist bastion (ECI, 2018a, 2018d–2018o, 2021, 2024a). The LDF maintained a decisive lead in 2011, 2016, and 2021, though its margin fluctuated - dropping to 6.74% in 2016 before surging to 25.7% in 2021 - suggesting a consolidation of leftist support over time. However, in 2024, the margin dropped significantly to 7.8%, indicating a notable shift in voter alignment and a potential resurgence in UDF support (ECI, 2018a, 2018o, 2021, 2024a).

These trends highlight two distinct electoral narratives: Palakkad remains a highly competitive battleground, with the BJP having emerged as a key challenger to the UDF and the LDF, whereas Chelakkara continues to favour the LDF, with its support base fluctuating in recent years. Table 2 presents a detailed overview of the previous three election results in Palakkad and Chelakkara, offering valuable insights into the shifting voter preferences and electoral dynamics in these constituencies.

Table 2: Electoral history of Palakkad and Chelakkara since 2011

Category	Palakkad (2011)	Palakkad (2016)	Palakkad (2021)	Palakkad (2024)	Chelakkara (2011)	Chelakkara (2016)	Chelakkara (2021)	Chelakkara (2024)
Winner	UDF	UDF	UDF	UDF	LDF	LDF	LDF	LDF
Runner -Up	LDF	BJP	BJP	BJP	UDF	UDF	UDF	UDF
Winning Margin(%)	6.59	12.69	2.72	13.64	18.56	6.74	25.7	7.8

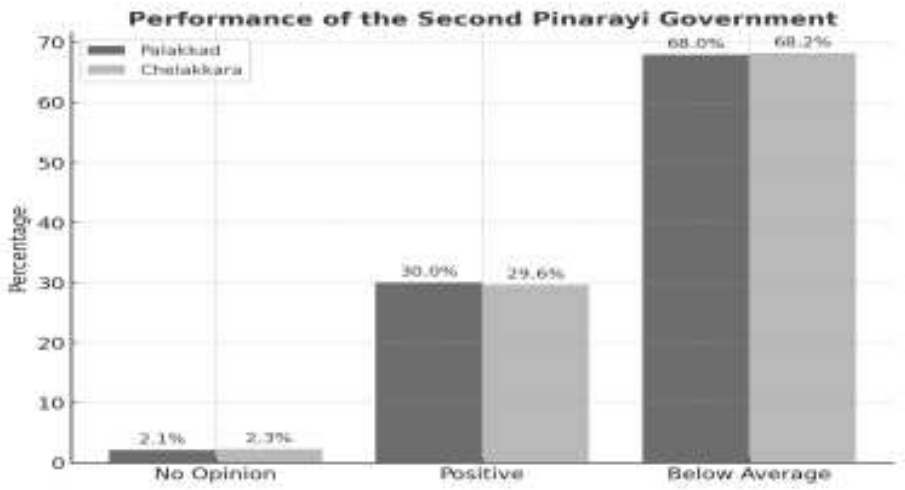
Source: (ECI, 2018a,2018o,2021,2024a,2024b)

Key Factors and Voting Patterns in Palakkad and Chelakkara

Various factors shaped the outcomes of the by-elections in Palakkad and Chelakkara. This section examines how governance, economic and livelihood anxieties, the political traditions of the constituencies, local dynamics, and perceptions of candidates' merit collectively influenced voter behaviour. It also evaluates the impact of key controversies and political developments, such as the trolley bag controversy, the midnight

raid in Palakkad, Sarin's defection from the UDF and subsequent candidacy for the LDF, and G. Sandeep Varier - a BJP spokesperson and state committee member - switching allegiance to the UDF (Anand, 2024; Philip, 2024a, 2024b).

Figure 1: Performance of the Second Pinarayi Government



Source: (Survey Research Centre- SRC, 2024a,2024b)

The perception of the people regarding the government's performance has always been a key factor in by-election verdicts. Figure 1 presents a comparative analysis of public sentiment towards the Second Pinarayi Government's performance in Palakkad and Chelakkara, revealing pronounced dissatisfaction. In both regions, the majority of respondents - 68% in Palakkad and 68.2% in Chelakkara - expressed a critical view of the government's performance, indicating a consistent trend of discontent. These findings highlight widespread dissatisfaction, which has contributed to anti-incumbency sentiment against the LDF government in both constituencies.

Table 3: Performance of the Former MLA

Category	Palakkad (%)	Chelakkara (%)
Satisfied	47.95	45.23
Not Satisfied	24.71	25.20
Somewhat Satisfied	27.33	29.56

Source: (SRC,2024a,2024b)

The track record of the outgoing representative has always impacted by-election political dynamics. Table 3 presents public opinion on the performance of the former MLA in Palakkad and Chelakkara, revealing significant levels of satisfaction in both constituencies. In Palakkad, 47.95% of respondents expressed satisfaction with the former MLA's performance, while 27.33% were somewhat satisfied. Similarly, in Chelakkara, 45.23% of respondents were satisfied, with 29.56% somewhat satisfied.

The strong levels of satisfaction, coupled with a substantial share of respondents being somewhat satisfied, contributed to building a broad support base and goodwill, ultimately aiding the UDF's victory in Palakkad and the LDF's victory in Chelakkara. This demonstrates how public approval of the former MLA's performance plays a key role in shaping electoral outcomes.

Table 4: Key Issues in the By-Election

Issue	Palakkad (%)	Chelakkara (%)
Corruption	22.59	21.49
Unemployment	27.33	24.72
Inflation	37.15	46.37
Others	12.93	7.43

Source: (SRC,2024a,2024b)

Every election is influenced by multiple factors, particularly those related to the everyday lives of people. Table 4 compares the key election issues in Palakkad and Chelakkara based on voter priorities. Inflation emerged as the most significant concern in both regions, with 37.15% of respondents in Palakkad and an even higher 46.37% in Chelakkara identifying it as their primary issue. Unemployment ranked second, with 27.33% of voters in Palakkad and 24.72% in Chelakkara citing it as a major concern. Corruption was the third most important issue, affecting 22.59% of respondents in Palakkad and 21.49% in Chelakkara.

The data reveals that inflation, unemployment, and corruption were the primary voter concerns in both regions, albeit with slight variations in emphasis. In general, voters hold the ruling front responsible for these issues, inevitably linking them to electoral dynamics.

Table 5: Responsibility for Livelihood Issues

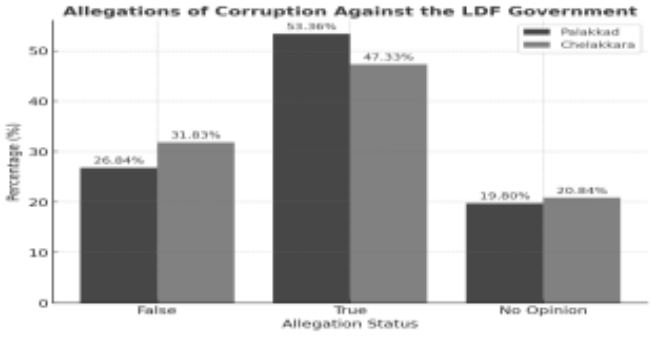
Responsibility	Palakkad (%)	Chelakkara (%)
State	32.90	21.16
Centre	16.86	21.81
Both	42.72	49.92
Others	7.53	7.11

Source: (SRC,2024a,2024b)

Livelihood issues, or those that the public considers important in their daily lives, play a crucial role in all elections. Table 5 highlights the perceived responsibility of governments for addressing election issues in Palakkad and Chelakkara. In Palakkad, 32.90% of respondents believed the state government was primarily responsible, while only 21.16% in Chelakkara shared this view. Conversely, 21.81% of respondents in Chelakkara attributed responsibility to the central government, compared to 16.86% in Palakkad.

A significant portion of respondents in both regions viewed responsibility as shared between the centre and the state, with 49.92% in Chelakkara and 42.72% in Palakkad supporting this perspective. Overall, the data reveals widespread dissatisfaction with both the central and state governments, which contributed to anti-incumbency sentiment against the LDF and BJP.

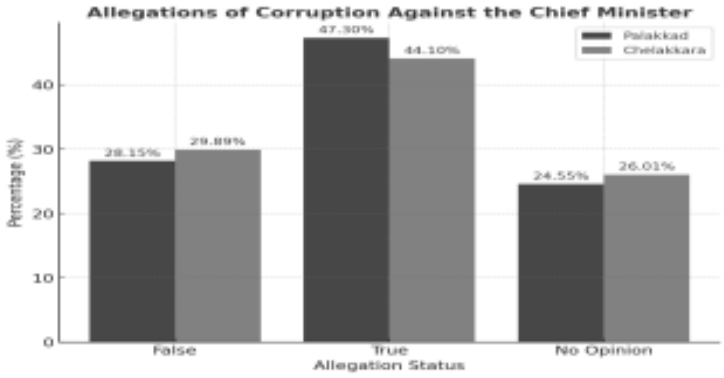
Figure 2: Allegations of Corruption Against the LDF Government



Source: (SRC, 2024a,2024b)

Allegations of corruption and public perceptions have always played a role in electoral dynamics. In both constituencies, a majority of respondents - 53.36% in Palakkad and 47.33% in Chelakkara - believed the corruption allegations to be true. However, a greater proportion of respondents in Chelakkara (31.83%) considered the allegations false, compared to 26.84% in Palakkad, indicating slightly higher scepticism in Chelakkara.

Figure 3: Allegations of Corruption Against the Chief Minister



Source: (SRC, 2024a,2024b)

As the head of the government, the Chief Minister plays a pivotal role in electoral politics. The Chief Minister, along with Cochin Minerals and Rutile Limited (CMRL) and others, faced allegations of accepting unlawful benefits for permitting the extraction of atomic mineral sand from Thottappally Spillway. Additionally, CMRL was under investigation for a payment of ₹1.72 crore to an IT firm owned by the Chief Minister's daughter, for allegedly unprovided services (Sudhi, 2023).

Figure 3 presents public perceptions of these allegations in Palakkad and Chelakkara. In Palakkad, 47.30% of respondents believed the allegations to be true, slightly higher than the 44.10% in Chelakkara. Meanwhile, 29.89% of respondents in Chelakkara considered the allegations false, compared to 28.15% in Palakkad. The data suggest that while a significant portion of the electorate in both constituencies considered the allegations credible, voters in Chelakkara were more dismissive, likely reflecting the LDF's strong presence in the constituency.

Table 6: Delivery of Government Benefits

Delivery Status	Palakkad (%)	Chelakkara (%)
Not Delivered on Time	63.50	68.50
Delivered on Time	36.50	31.50

Source: (SRC,2024a,2024b)

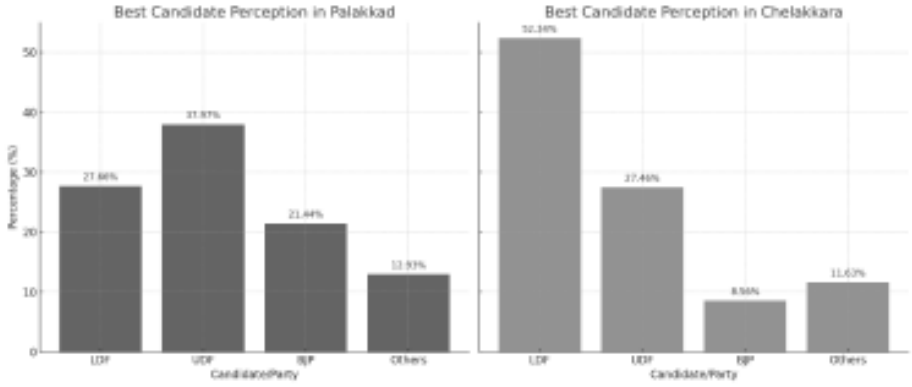
A key indicator of government performance and voter satisfaction is its track record in delivering welfare measures and benefits to the public. Table 6 presents public perceptions of government benefit distribution in Palakkad and Chelakkara. A significant majority in both regions believed that government benefits were not delivered on time, with 63.50% of respondents in Palakkad and an even higher 68.50% in Chelakkara expressing this concern.

Conversely, a smaller proportion of respondents felt that benefits were delivered on time, with 36.50% in Palakkad and 31.50% in Chelakkara holding this view. Overall, there was widespread dissatisfaction with delays in the timely distribution of benefits, with Chelakkara showing slightly greater discontent compared to Palakkad.

Performance of Palakkad Municipality

Palakkad Municipality marked a significant milestone for the BJP as it became the first local body in Kerala where the party gained power (The Economic Times, 2015). However, through interviews, it was found that residents of Palakkad increasingly voiced concerns over the BJP-led administration, particularly regarding issues such as inadequate waste management, poor infrastructure development, and inefficiencies in service delivery. A voter from Palakkad remarked: "The performance of the BJP-run municipality is below expectations" (Palakkad, Nov. 2024). The performance of Palakkad Municipality was perceived negatively by 65.95% of respondents, reflecting widespread discontent among the local population. This dissatisfaction led to anti-incumbency against the BJP in Palakkad (SRC, 2024b). Additionally, the BJP's governance in Palakkad was often marred by internal factionalism (Shyam, 2024), further diminishing administrative efficiency and eroding public trust.

Figure 4: Best Candidate

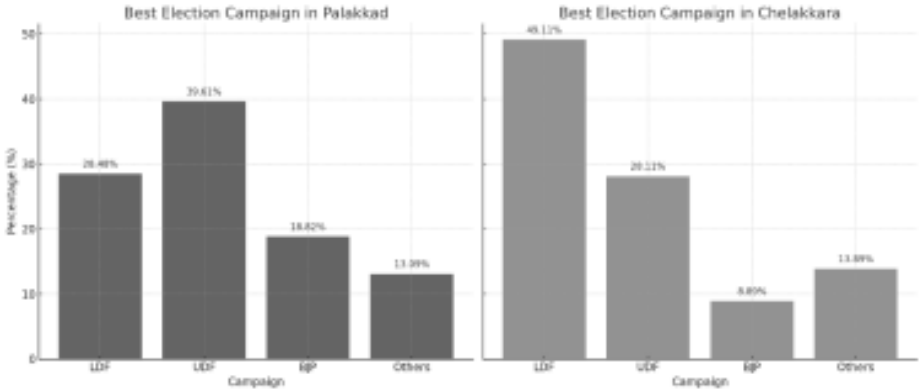


Source: (SRC, 2024a,2024b)

Apart from political affiliation, the most important factor in any election is public perception of the merit and appeal of the contesting candidates. In these by-elections, candidate merit played a critical role in determining the electoral verdicts.

Figure 4 compares public perceptions of the best candidate across three political groups - LDF, UDF, and BJP - in Palakkad and Chelakkara. In Palakkad, the UDF emerged as the preferred choice, securing 37.97% of the support, followed by the LDF at 27.66% and the BJP at 21.44%. In contrast, Chelakkara demonstrated a strong preference for the LDF, which led with 52.34% support, while the UDF garnered 27.46%. The BJP received significantly lower backing in Chelakkara, with only 8.56%. These results highlight the UDF candidate's greater appeal in Palakkad and the LDF candidate's dominance in Chelakkara, reinforcing the importance of candidate merit as a key factor shaping voter preferences.

Figure 5: Best Campaign



Source: (SRC, 2024a,2024b)

Campaigns conducted to woo voters are always vital in electoral politics. By-elections in Kerala are particularly noted for their high-voltage campaigns, which play a key role in shaping the electoral prospects of political parties and candidates.

Figure 5 illustrates public perceptions of the best election campaigns in Palakkad and Chelakkara. In Palakkad, the UDF conducted the most effective campaign, garnering 39.61% support, followed by the LDF with 28.48% and the BJP with 18.82%. In contrast, Chelakkara reflected a strong preference for the LDF, which led with 49.11% support, while the UDF followed with 28.11% and the BJP secured only 8.89%. The data highlight notable regional differences, with the UDF dominating in Palakkad and the LDF maintaining a clear advantage in Chelakkara, reinforcing the varying effectiveness of campaign strategies in shaping voter perceptions across the two constituencies.

Voter Preferences in the By-elections

The survey aimed to capture voting behaviour by asking respondents whom they would vote for in the upcoming election. Voter preferences in the by-elections revealed distinct political dynamics in Palakkad and Chelakkara.

In Chelakkara, the LDF led with 39.90% support, whereas in Palakkad, it lagged behind at 25.86%. Conversely, the UDF was the frontrunner in Palakkad with 32.57% but trailed in Chelakkara at 24.72%. The BJP held a stronger position in Palakkad (18.66%) compared to Chelakkara (8.08%). A small percentage of voters (3.07%–3.11%) supported other candidates, while a significant portion remained undecided or expressed no opinion, with 19.80% in Palakkad and 24.23% in Chelakkara (SRC, 2024a, 2024b).

These figures underscore regional variations in electoral support, highlighting voter sentiment and the influence of campaign strategies in shaping election outcomes. A key factor in this analysis was that a substantial section of voters was unwilling to disclose their preferences, leading to variations in vote share projections. However, the survey successfully captured the general electoral trends.

Socio-economic and Demographic dynamics

The unique composition and strength of different religious and caste groups play a significant role in elections. Political parties and candidates strategically shape their outreach efforts to engage various demographic segments, adapting their campaigns to the specific socio-political landscape of each constituency.

An analysis of voter demographics in the Palakkad and Chelakkara assembly constituencies highlight distinct patterns based on Census 2011 data and voter list analysis. In Palakkad, 48.73% of voters were male, while 51.27% were female (Thukral & Rahman, 2024b). Scheduled Caste (SC) voters constituted 10.91%, whereas Scheduled Tribe (ST) voters accounted for only 0.14%. The Muslim electorate represented 22.5%, Christian voters made up 3.2%, and Hindus formed the majority at 74.3% (Chanakyya, 2021b). Chelakkara exhibited a slightly different composition, with 48.43% of voters being male and 51.57% female (Thukral & Rahman, 2024a). SC voters represented 15.71%, while ST voters remained a small fraction at 0.24%. The Muslim voting population stood at 24.7%, Christian voters comprised 5.3%, and Hindus continued to be the dominant group at 70% of the electorate (Chanakyya, 2021a).

These socio-religious factors directly influenced voting behaviour and political preferences in both constituencies. In Palakkad, the UDF emerged as the most preferred party across genders, securing 40.20% support from female voters and 35.66% from male voters. The LDF followed, with 27.01% support among females and 28.33% among males. The BJP exhibited a significant gender gap, garnering 17.68% support from females and 25.34% from males. By religious affiliation, the UDF held a strong lead among Christians (57.88%) and Muslims (70.08%), while the LDF commanded the majority among Hindus (28.61%). The BJP received no Muslim support. Caste-wise, the UDF dominated among Ezhava, Nair, OBC/OEC, and other General groups, whereas the LDF had greater support among SC/ST communities (SRC, 2024b).

In Chelakkara, the LDF dominated across genders, securing 56.13% of female support and 48.13% of male support. The UDF ranked second, followed by the BJP. By religious preference, the LDF led among Hindus (53.38%) and Muslims (53.30%), while the UDF was favoured by Christians (38.90%). Caste-wise, the LDF remained the top choice across all groups, particularly among the Ezhava (61.98%) and SC/ST communities (67.41%) (SRC, 2024a). These trends highlight the intersection of gender, religion, and caste in shaping electoral choices, reinforcing the importance of demographic considerations in political strategy.

Analysis

The comprehensive analysis of voting patterns and public perceptions in Palakkad and Chelakkara revealed distinct political dynamics shaped by voter sentiment, government performance, candidate appeal, socio-economic priorities, and demographic preferences. In Palakkad, the data highlighted significant voter dissatisfaction with the performance of the Second Pinarayi Government, with 68% of respondents expressing dissatisfaction. The perception of inefficiencies in government benefits delivery, where 63.50% of respondents in Palakkad stated that benefits were not delivered on time, further deepened discontent. In Chelakkara, similar anti-incumbency sentiment against the Second Pinarayi Government and dissatisfaction with government benefits delivery were prevalent, with 68.17% dissatisfied with the government's performance and 68.50% dissatisfied with benefits delivery.

This dissatisfaction was compounded by widespread allegations of corruption against the Kerala government and the Chief Minister, which had eroded public trust and amplified voter discontent. Interviews with voters revealed that many voters viewed these allegations as evidence of systemic governance failures. One voter noted: *"The corruption allegations became the central narrative during campaigns, especially among urban voters who were already frustrated with inefficiencies"* (Palakkad, Nov. 2024). Similarly, a community influencer observed: *"People felt that the Chief Minister's office was directly responsible for mismanagement, and this perception spread quickly during the election"* (Palakkad, Nov. 2024).

Additionally, issues such as inflation, unemployment, and corruption emerged as major concerns, with a significant portion of respondents attributing shared responsibility for these challenges to both the state government (LDF) and the central government (BJP). A voter from Chelakkara stated: *"It doesn't matter who's in power—state or centre—when prices keep rising, people hold everyone accountable"* (Chelakkara, Nov. 2024). Another respondent from Palakkad remarked: *"Unemployment has hit every family I know, and neither the central nor the state government has done anything meaningful to address it"* (Palakkad, Nov. 2024).

Interestingly, political controversies such as the trolley bag controversy, the midnight raid in Palakkad, LDF candidate Sarin's defection from the UDF, and BJP leader Sandeep's defection from the BJP did not seem to have influenced the election outcomes. Interviews with voters and stakeholders indicated that these controversies were largely perceived as distractions from core issues such as governance, inflation, and unemployment. One voter in Chelakkara commented: *"These controversies come and go, but what matters to us is whether our basic needs are being met"* (Chelakkara, Nov. 2024).

The merit of the candidates and the demographic composition of their support bases played a pivotal role in shaping voter preferences. In Palakkad, the UDF received strong support from Christians (57.88%), Muslims (70.08%), and OBC/OEC communities (47.37%). This broad-based backing helped the UDF consolidate its position and secure a significant lead in the constituency. Additionally, the UDF was viewed as having conducted the most effective campaign in Palakkad, garnering 39.61% support for its strategic outreach and targeted messaging.

In contrast, Chelakkara demonstrated a strong preference for the LDF, which secured support from Hindus (53.38%), Muslims (53.30%), SC/ST communities (67.41%), and Ezhavas (61.98%). The LDF's ability to maintain a strong connection with these key demographics, coupled with the credibility of its candidate and a well-organized grassroots campaign, allowed it to overcome anti-incumbency sentiment. Furthermore,

the LDF's campaign in Chelakkara was perceived as highly effective, with 49.11% of respondents identifying it as the best campaign, which solidified its dominance in the constituency.

These qualitative and quantitative insights underline how voter dissatisfaction, candidate merit, campaign effectiveness, and demographic preferences collectively shaped the electoral dynamics in Palakkad and Chelakkara. While the UDF capitalised on anti-incumbency sentiment and garnered substantial support from minority and OBC communities in Palakkad, the LDF's strong grassroots presence and demographic appeal enabled it to retain its hold in Chelakkara.

Conclusion

The contrasting electoral outcomes in Palakkad and Chelakkara underscore the significance of local dynamics, voter sentiments on various issues, candidate appeal, perceptions of government performance and political leadership, and demographic preferences in shaping election results. In Palakkad, widespread dissatisfaction with both the BJP and LDF created a favourable environment for the UDF, allowing it to capitalise on anti-incumbency sentiment and execute targeted campaign strategies to secure victory. Conversely, Chelakkara's outcome reflected a more complex interplay between anti-incumbency and the appeal of the LDF candidate, ultimately tipping the scales in favour of the LDF and reinforcing the constituency's distinct political landscape.

A key finding of this study is that in Palakkad, simultaneous anti-incumbency against both the state government and the BJP-ruled municipality, combined with the appeal of the UDF candidate, worked in favour of the UDF. Local controversies, such as the trolley bag issue and high-profile defections - including that of the contesting candidate - did not significantly impact the electoral verdict, as allegations and counter-allegations were neutralised by the intensity of campaign rhetoric. In Chelakkara, although anti-incumbency influenced voter behaviour, the appeal of the LDF candidate, along with the goodwill enjoyed by both the outgoing and incumbent representatives, contributed to the LDF's victory. Additionally, the organisational strength of the LDF proved instrumental in securing its win in Chelakkara, highlighting the crucial role of party machinery in electoral outcomes. However, the reduced margin of victory for the LDF compared to its previous election results points to growing anti-incumbency sentiment in the constituency.Notably, the UDF retained Palakkad with an increased margin, while the LDF secured victory in Chelakkara with a significantly reduced margin, dropping from 25.7% in 2021 to 7.8% in 2024. Though the BJP suffered a defeat in Palakkad, it substantially increased its vote share in Chelakkara, rising from 15.68% in 2021 to 21.49% in 2024 (ECI, 2021, 2024a).The single most important factor behind the contrasting verdicts in favour of the UDF and LDF in these neighbouring constituencies was voter perception of the appeal and merit of the winning candidates. Among all other factors, this stood out—with 37.97% of respondents favouring Rahul Mamkootathil in Palakkad and 52.34% favouring U.R. Pradeep in Chelakkara. These results indicate that the electoral prospects of different political fronts remain open for the upcoming local body and assembly elections, with no party or front assured of a decisive victory.For the LDF, shifting voter preferences signal a strong warning, as these trends suggest a growing disadvantage in its electoral positioning.

The findings offer valuable insights for future electoral strategies, emphasising the importance of addressing governance issues such as inflation, unemployment, and benefits distribution. They also highlight the role of candidate credibility, an unblemished political image, effective campaign messaging, and organisational strength in shaping voter preferences.Moving forward, political parties must balance systemic governance improvements with localised engagement and strategic outreach to sustain voter support. Ultimately, future electoral success will depend on credible leadership, targeted messaging, and the ability to respond effectively to the evolving expectations of a diverse electorate.

References

Anand, G. (2024). A trolley bag symbolises the intensity of Palakkad bypoll campaign. *The Hindu*. https://www.thehindu.com/news/national/kerala/a-trolley-bag-emerges-as-a-metaphor-for-sensationalist-politics-in-the-palakkad-bypoll-campaign/article68841133.ece

Chanakyya. (2021a). *Chelakkara (SC) Assembly Constituency Details*. https://chanakyya.com/Assembly-Details/Kerala/Chelakkara_(SC)

Chanakyya. (2021b). *Palakkad Assembly Constituency Details*. https://chanakyya.com/Assembly-Details/Kerala/Palakkad

ECI. (2018a). *Detailed results on state election, 2016 to the legislative assembly of Kerala.*https://old.eci.gov.in/files/file/3767-kerala-general-legislative-election-2016/

ECI. (2018b). *Statistical report on general election, 1957 to the legislative assembly of Kerala.*https://old.eci.gov.in/files/file/3746-kerala-1957/

ECI. (2018c). *Statistical report on general election, 1960 to the legislative assembly of Kerala.*https://old.eci.gov.in/files/file/3748-kerala-1960/

ECI. (2018d). *Statistical report on general election, 1965 to the legislative assembly of Kerala.*https://old.eci.gov.in/files/file/3749-kerala-1965/

ECI. (2018e). *Statistical report on general election, 1967 to the legislative assembly of Kerala.*https://old.eci.gov.in/files/file/3751-kerala-1967/

ECI. (2018f). *Statistical report on general election, 1970 to the legislative assembly of Kerala.*https://old.eci.gov.in/files/file/3752-kerala-1970/

ECI. (2018g). *Statistical report on general election, 1977 to the legislative assembly of Kerala.*https://old.eci.gov.in/files/file/3753-kerala-1977/

ECI. (2018h). *Statistical report on general election, 1980 to the legislative assembly of Kerala.*https://old.eci.gov.in/files/file/3754-kerala-1980/

ECI. (2018i). *Statistical report on general election, 1982 to the legislative assembly of Kerala.*https://old.eci.gov.in/files/file/3755-kerala-1982/

ECI. (2018j). *Statistical report on general election, 1987 to the legislative assembly of Kerala.*https://old.eci.gov.in/files/file/3756-kerala-1987/

ECI. (2018k). *Statistical report on general election, 1991 to the legislative assembly of Kerala.*https://old.eci.gov.in/files/file/3758-kerala-1991/

ECI. (2018l). *Statistical report on general election, 1996 to the legislative assembly of Kerala.*https://old.eci.gov.in/files/file/3759-kerala-1996/

ECI. (2018m). *Statistical report on general election, 2001 to the legislative assembly of Kerala.*https://old.eci.gov.in/files/file/3760-kerala-2001/

ECI. (2018n). *Statistical report on general election, 2006 to the legislative assembly of Kerala.*https://old.eci.gov.in/files/file/3762-kerala-2006/

ECI. (2018o). *Statistical report on general election, 2011 to the legislative assembly of Kerala.*https://old.eci.gov.in/files/file/3763-kerala-2011/

ECI. (2021). *Detailed results on state election, 2021 to the legislative assembly of Kerala.*https://old.eci.gov.in/files/file/13827-kerala-general-legislative-election-2021/

ECI. (2024a). *Bye election to assembly constituencies: Results November 2024: Kerala - Chelakkara constituency.*https://results.eci.gov.in/ResultAcByeNov2024/ConstituencywiseS1161.htm

ECI. (2024b). *Bye election to assembly constituencies: Results November 2024: Kerala - Palakkad constituency.*https://results.eci.gov.in/ResultAcByeNov2024/ConstituencywiseS1156.htm

Philip, S. (2024a). Ahead of crucial Palakkad bypoll, Kerala BJP's G Sandeep Varier joins Congress. *The Indian Express*. https://indianexpress.com/article/india/kerala-bjps-g-sandeep-varier-joins-congress-9672766/

Philip, S. (2024b). Congress expels Kerala youth face as simmering row over Palakkad ticket hits a

flashpoint. *The Indian Express*. https://indianexpress.com/article/political-pulse/p-sarin-rahul-mamkoottathil-congress-kerala-row-palakkad-ticket-9625098/

Shyam, P. V. (2024). Cracks appear in BJP's Palakkad fort due to infighting over chairperson post. *Onmanorama*.https://www.onmanorama.com/news/kerala/2024/01/07/palakkad-corporation-bjp-council-election-priya-ajayan-bjp-rss-candidate.html

SRC. (2024a). *Chelakkara by-election*[Unpublished data set]. Department of Political Science,University of Kerala.

SRC. (2024b). *Palakkad by-election*[Unpublished data set]. Department of Political Science, University of Kerala.

Sudhi, K. S. (2024). Complaint of corruption against Chief Minister, CMRL dismissed by vigilance court. *The Hindu*.https://www.thehindu.com/news/national/kerala/complaint-of-corruption-against-chief-minister-cmrl-dismissed-by-vigilance-court/article67849401.ece

The Economic Times. (2015). *BJP takes control of Palakkad Municipality, a first for party in Kerala*. https://economictimes.indiatimes.com/news/politics-and-nation/bjp-takes-control-of-palakkad-municipality-a-first-for-party-in-kerala/articleshow/49838338.cms?from=mdr

The Hindu. (2020). *BJP returns to power in Palakkad municipality*. https://www.thehindu.com/news/national/kerala/bjp-returns-to-power-in-palakkad-municipality/article33349704.ece

Thukral, R. K., & Rahman, S. (Eds.). (2024a). *Chelakkara Assembly Factbook*. Indiastat Publications. https://www.indiastatpublications.com/pdf_Samples/assembly_factbook/Kerala/Alathur/Chelakkara-Assembly-Factbook.pdf

Thukral, R. K., & Rahman, S. (Eds.). (2024b). *Palakkad Assembly Factbook*. Indiastat Publications. https://www.indiastatpublications.com/pdf_Samples/assembly_factbook/Kerala/Palakkad/Palakkad-Assembly-Factbook.pdf

Rethinking Gender Inequality through the Lens of Capability Approach

Rubsana N. Beegum
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Gender inequality is one of the most universal forms of social injustice. The various forms or manifestations of gender inequality can be observed across social, economic, cultural as well as political spheres all over the world. Further gender discrimination occurs at multiple levels including household, community and institutional levels. These disparities along with being a violation of human rights principles, also hinders the economic and social development of nations and societies. Addressing this issue requires an all-inclusive and multidimensional framework that can capture the intricacies of gender inequality and offer a solid solution to it. The capability approach, pioneered by Amartya Sen and further expanded and refined by Martha Nussbaum and several others, is a widely celebrated framework for evaluating human well-being. By focusing on the real freedoms of individuals, the capability approach offers a valuable framework for examining and tackling gender inequalities. Applying the capability perspective to explore gender inequalities also offers important policy implications for key domains like education, health, economic participation and political involvement.

Keywords : Amartya Sen, capability approach, discrimination, functionings, gender inequalities.

Introduction

Gender equality continues to be a persistent and deeply rooted issue in societies across the world. In spite of the tremendous advancements made towards reducing gender based inequalities and empowering women, disparities continue to exist in multiple forms. It can be found that gender inequalities are deeply embedded in societal structures, cultural and religious norms, and institutional practices that limit women's ability to access resources, opportunities, and freedoms. Traditionally most of the efforts to address inequalities have focused on resource based measures or rights based approaches. Considering the complex nature of gender discriminations as well as inadequacy of the existing methods for examining these disparities, a more nuanced approach for understanding and addressing the complexities of gender inequality is needed.

The capability approach, first proposed by Amartya Sen in the late 20th century, provides a more comprehensive conceptual framework for understanding gender inequality. The approach goes beyond analysing well-being in terms of resources or utility and focuses on what individuals are actually able to do and be, taking into account the real freedoms and opportunities to lead the life they value. The capability oriented perspective recognises that gender inequalities are not just about the differences in resources but it is more about unequal capabilities i.e. the lack of freedom or obstacles women face in accessing education, health care, economic participation and exercising their rights in general. The capability approach was further advanced by the contributions of Martha Nussbaum, who integrated notions of human dignity and bodily integrity to the approach (Nussbaum, 1999). These are crucial to understanding the specific ways in which gender inequalities manifest.

The article begins by outlining the importance of addressing gender inequalities and moves on to briefly summarize the capability approach and its core concepts. The main aim of the article is to examine how the

capability approach can be applied to understand and address the issue of gender inequality. Finally the article discusses how this approach can guide policy interventions aimed at achieving gender equality.

Understanding Gender Inequality and the Need for Addressing It

Gender equality refers to the equal rights, responsibilities, treatment and opportunities for all genders. It means that individuals should be free to follow their dreams and goals without being constrained by conventional gender roles or stereotypes. Gender equality is not only a fundamental human right; it is essential for a peaceful, prosperous, and sustainable world. Despite the significant progress made in recent decades, gender disparities and discriminations still persist in almost all spheres, including education, employment, health, and political representation. These inequalities need to be addressed for several reasons:

The foremost reason for addressing gender discriminations is that it is against the principles of human rights and social justice. Every individual has the right to fair and equal opportunities, rights, and treatment, irrespective of their gender. And allowing gender based discriminatory practices to prevail amounts to perpetuating injustice. Gender inequalities can adversely impact economic growth and development of a country or society as half of the population remains underutilized. Promoting gender equality in the areas of education, labour force participation and leadership roles leads to increased economic productivity, innovations and overall economic development of the society. Gender equality is linked to better health and education outcomes for both women and men in the society, and this can further enhance the economic productivity of the country. When women have unhindered access to healthcare, education, and economic resources, they can make informed decisions about their health and that of their families too. It is observed that societies in which gender inequalities are lower tend to have lower maternal and infant mortality rates, lower instances of malnutrition, lower dropout rates and better overall health as well as education outcomes. This is because in societies where gender discriminations are less, girls are more likely to attend educational institutions, marry later, have healthier children and send their own children to school. Gender equality is also closely connected to more stable and peaceful societies. Societies with lower gender inequality are more likely to have higher levels of social stability, lower rates of violence including gender based violence, and more cohesive communities. When women are involved in decision-making processes such as in politics or community organizations, they bring diverse perspectives to tackle social issues more effectively. Another need for eliminating gender inequality is because gender equality is directly connected to achieving sustainable development. Gender equality is one of the crucial aims of United Nations Sustainable Development Goals, since it is essential for tackling global concerns including hunger, poverty, and climate change. Moreover several studies have shown that encouraging gender equality promotes environmental resilience.

Therefore addressing gender inequalities is key to creating a more equitable, resilient and prosperous world, where everyone regardless of their gender can contribute to their fullest potential.

Capability Approach: An Overview

The capability approach has gained widespread popularity since it was first put forward by Nobel laureate Amartya Sen in the late 1970s. It was further advanced by Martha Nussbaum and others like Ingrid Robeyns, Sabina Alkire, David Clark etc. Over the years the approach has grown into a valuable and powerful framework for evaluating issues like poverty, inequalities and social justice. The capability approach shifted the focus of development studies from economic indicators like income and assets by focussing on individual freedoms and human diversities. The approach stems from Sen's critique of traditional resource based or utility based approaches to welfare. Sen argued that these approaches were insufficient to capture the full complexity of human well-being. Sen pointed out that resource based approaches fail to take into account the fact that different individuals require differing levels of resources to attain the same level of outcomes (Sen 1999, Robeyns, 2006). For example, a disabled person might need more resources and facilities connected with mobility in addition to normal transportation facilities. Sen also criticises utilitarian approaches as individuals could adapt to their deprived conditions and report higher levels of satisfaction, thus leading to incorrect results. The

capability approach advocates for the expansion of people's real freedoms i.e. their capabilities to lead the lives they have reason to value.

Capabilities and Functionings

The concepts of *capabilities* and *functionings* form the core of the capability approach. Functionings refers to the various things a person value being or doing. This includes being healthy, being literate, being safe, having employment etc. On the other hand, capabilities refers to the various combinations of beings or doings i.e. functionings that an individual can achieve (Robeyns, 2005; Sen, 2006; Kuhumba, 2018). The difference between capability and functionings is that of opportunity to achieve and that of actual achieved outcomes. For example, being educated is a functioning whereas the actual freedom to pursue education without social, cultural or economic barriers or any form of prejudices is a capability.

In the context of gender inequalities, this distinction is crucial. In many societies, women may have theoretical access to resources such as education, healthcare, or employment, but they may lack real opportunities or freedoms to access those resources due to social or religions constraints, discriminations or harassments. The capability approach emphasises the need for eliminating these restrictions so that women can fully exercise their capabilities and achieve their valued functionings.

Conversion Factors

According to Sen (1999), several factors influence the conversion of resources into capabilities and actual achievements. Robeyns (2005) categorises these 'conversion factors' into three:

Personal Conversion Factors: These are the individual attributes or qualities that influence how a person transforms resources into functionings and it differs from person to person. These include physical and mental health, gender, intelligence, skills etc. To give an example, a visually challenged or hearing impaired person may not be able to benefit fully from conventional educational facilities even if they are readily accessible.

Social Conversion Factors: Social conversion factors relate to the socio-cultural norms, beliefs and practices of the society in which a person lives. These include discriminations based on class, caste, race, gender etc. These social conversion factors are the most critical from the viewpoint of gender inequalities. For example, while females in one society may face greater restrictions in working outside, they may have greater freedom and support to pursue employment in another.

Environmental Conversion Factors: These factors which influence the conversion of resources into capabilities are associated with the physical environment in which a person lives. These include geographical location, transportation facilities, connectivity, climate, quality of air and water etc.

The Capability Approach: A Framework for Gender Equality

The capability approach, goes beyond measuring inequality through income or resources and instead concentrates on people's freedom to achieve what they consider valuable i.e. their capabilities to live a meaningful and fulfilling life. In the context of gender inequality, this approach highlights the importance of ensuring women have the same capabilities and freedoms as men, to achieve their potential in various spheres of life. Sen himself has given much importance to inequalities between men and women in his writings and achieving gender justice has been one of the objectives of his work. Building upon Sen's work, Nussbaum (2000) argues for a specified list of human capabilities. Nussbaum endorsed a list of ten central human capabilities that all societies should try to secure of all their citizens. These capabilities, which include life, bodily health, bodily integrity, practical reason, affiliation, and control over one's environment, are deeply interlinked with gender equality. Nussbaum (2000) claims that gender inequalities often undermines these fundamental capabilities, thereby depriving women of the freedom to live dignified and fulfilling lives.

The strengths of capability approach in examining gender inequality is discussed in detail.

1. Multidimensionality

The foremost advantage of the capability approach in exploring gender inequalities is its multidimensionality. Traditional approaches to inequality often focus narrowly on economic indicators like income, wealth or consumption. The capability approach by contrast recognises the multi-dimensional nature of well-being. It considers various aspects of life including education, health, economic participation and well-being, political participation, autonomy, respect, safety and security etc. all of which are crucial dimensions of gender equality.

2. Focus on capabilities over resources

The capability perspective emphasises that addressing gender inequality requires more than just equal access to resources. The capability approach gives more importance to the capabilities women have to be and do what they consider valuable in life. Gender inequality is often a result of the differences in the capabilities men and women have, even when resources are equally distributed (Sen, 2006; Robeyns, 2017) For example, even when women have the same educational qualifications as men, they may find it difficult to convert those qualifications into actual employment opportunities because of societal constraints, discriminatory hiring practices, workplace harassments, or unequal distribution of domestic responsibilities. Let us take another example. In many societies around the world, there is severe under representation of women in political filed, not because of the lack of skills or desire to lead, but because of social norms and institutional barriers. This underlines the need for addressing societal and institutional barriers that limits the expansion of women's capabilities. Thus a capability based investigation of gender inequality examines not only whether men and women have equal access to resources but also whether they have similar capabilities to use those resources so as to achieve the functionings they value. However the approach does not deny the importance of resources in attaining well-being.

3. Acknowledgement of human diversity

Another one of the strengths of capability approach in examining gender inequality is its acknowledgement of human diversity. It recognises that different individuals differ in their needs, abilities and desires (Nussbaum, 1999). To cite an example, a pregnant woman requires more nutrients and health care facilities than a non-pregnant women to achieve the same level of health functioning.

4. Importance to conversion factors

An important aspect of the capability approach is its recognition of the role of conversion factors in understanding gender inequalities. These factors influence how individuals can convert resources into capabilities and achieved functionings. Gender norms and expectations play a significant role in shaping these conversion factors and can limit the real freedoms available to women.

Social conversion factors are the most important with regard to gender inequalities. In many societies women and girls face severe hurdles in accessing education or participating in labour market since they are expected to prioritise household and caregiving responsibilities over their professional as well as personal growth. These expectations are further heightened by lack of affordable childcare, inflexible working hours and other workplace policies, which restricts women's ability to balance work and family life. Environmental conversion factors also play a role in gender inequality. For example, women in rural areas may face additional barriers to accessing healthcare or education due to lack of infrastructure or transportation facilities. Addressing gender inequality from a capability perspective requires acknowledging the role of conversion factors and evolving policies that take into account these unfreedoms confronted by women.

5. Recognition of adaptive preferences

Another strength of the capability approach in examining gender inequalities is its recognition of "adaptive preferences." Adaptive preferences refer to the tendency of people facing long-term discrimination,

to adjust their desires or preferences in accordance to the limitations imposed by the society (Sen, 1999; Nussbaum 2000). For instance, women in certain cultures may prefer to stay at home rather than work outside or they may be perfectly satisfied with having food after the men in the family had food. This is not because they lack aspirations or because they like to have leftovers, but because their beliefs and preferences have adapted to the social norms that limit their choices. Gender inequality, viewed through the capability approach, can provide an understanding of these adaptive preferences. Also the approach emphasises the need for addressing the underlying societal norms and conditions that shape these preferences.

6. Superior to rights based approaches

Although the capability approach has much similarity to human rights approach, it is superior to the latter in exploring and providing a better solution to gender inequalities. The human rights approach has repeatedly been criticised by feminists for being male-centric. They claim that the approach does not give the necessary importance to concerns of bodily integrity, domestic violence, and workplace harassments which are fundamental to women in their journey towards equality. Moreover even though there are provision of rights, in many spheres they may not be fully enforced. In the context of gender inequalities, women in many countries have the right to political participation, but in reality they may not have the capability to exercise this right in its true sense. Hence in Nussbaum's (2006) opinion, many of the rights like right to freedom of expression, freedom of religion, freedom of political participation etc. can be understood as secured to people only when the relevant capabilities exist.

7. Agency and empowerment

The capability approach also places great emphasis on agency. Agency refers to the ability to take decisions and act upon them to achieve preferred outcomes (Peter, 2006). In the case of gender inequality, women's agency functions are often curtailed by patriarchal norms, socio-cultural biases, and discriminatory laws. According to the capability approach, real women empowerment means expanding women's capabilities so that they can make choices and informed decisions about different aspects of their life including education, health, work and participation in society. Thus the capability approach argues for empowering women by enhancing their agency. This involves not only expanding their access to resources or opportunities but also transforming social structures that restrict their choices.

8. Addressing intersecting inequalities

Gender inequality is very often found to be overlapping with other forms of disadvantage, such as race, class, caste or disability. For instance, a woman from lower caste may face several additional constraints such as increased vulnerability to violence, poor access to quality healthcare, increased bias in labour market etc. as compared to an upper caste woman. These kind of situations often necessitates context specific solutions. The capability approach, with its emphasis on individual diversities, is particularly effective for examining how these intersecting inequalities impact women's ability to attain valuable functionings.

Policy Implications of Capability Approach to Gender Inequalities

Applying Capability approach to address gender inequality has clear implications for public policy. The capability approach emphasises the need for interventions focusing on expanding women's real freedoms and opportunities instead of focusing solely on economic indicators or resource allocation. Only when capabilities of women are improved, they can participate in social, cultural, economic, and political life to their full potential. Therefore the capability approach calls for comprehensive and multi-dimensional policies that address social, cultural, economic as well as legal hurdles to gender equality, so as to enable women to live their lives with dignity and autonomy.

For instance, take the case of education. Education is a fundamental capability which is often found to be unequally distributed between genders, particularly so in developing countries. Using capability approach for exploring gender inequality in education not just involves ensuring equal access to schools and institutions,

but also creating an environment in which girls can thrive. This includes addressing social norms that devalue girls' education, tackling socio-cultural barriers that prevent girls from completing education (such as child marriage, early pregnancy, disproportionate burden of domestic work etc.), clean toilet facilities and providing financial incentives for girls to continue their education. Moreover, addressing the issue of safety of girls in schools and during their travel can help reduce dropout rates.

Health is another domain where gender disparities are quite evident. Women and girls in many parts of the world still face significant health challenges, including malnutrition, maternal mortality, and lack of access to reproductive health services such as contraception, safe abortion services, post-partum care etc. In addition, gender-based violence, which is prevalent in many societies all over the world, severely undermines women's bodily integrity and autonomy (Pyles, 2008). These challenges not only adversely impacts women's health but also their ability to pursue education, employment, and engagement in society. A capability based approach to health emphasizes the need to ensure that women have the real freedoms to make decisions about their health and well-being. To give examples, in some societies women might need permission from a male relative to visit a doctor, or they may face stigma for seeking reproductive healthcare. Hence, the capability approach demands promoting women's autonomy in health decisions, including access to sex education, awareness about legal rights against violence, along with providing women with the information and resources they need to make choices about their health.

Gender inequality also continues to exist in the field of economic participation, even though some progress has been made in this regard in many parts of the world. Despite progress in labour market participation rates, women continue to face significant barriers in the workplace, including discriminatory hiring policies, pay disparities, phenomenon of glass ceiling or the denial of access to leadership roles, and lack of family-friendly working policies. Additionally, women often bear a disproportionate burden of unpaid domestic work, which limits their participation in economic activities (Gasper & Staveren, 2006). Women face gender disparities in not just earning income but also in spending income without anyone's permission as well as control over wealth and resources. As a solution to these problems, the capability approach argues for policies that not only promote equal remuneration and opportunities for growth, but also those that address the social and cultural factors that limit women's economic capabilities. Policies that encourage work-life balance and provide support for caregivers (such as flexible working hours, paid holidays, affordable childcare etc.) can help reduce the burden of unpaid labour and expand women's capabilities to pursue employment. Also empowering women through education, creating legal frameworks for reducing gender disparities in wealth and resources holding etc. can enable women in enlarging their economic capabilities.

Political participation is another crucial area where the capability approach can help us in understanding the complexities of gender inequality. Political participation is a key component of individual autonomy and agency. Women, globally, are quite under represented in positions of political leadership and decision making. This restricts their ability to influence the laws and policies that affect their day to day lives. As such the capability approach advocates for policies that will improve women's political capabilities in term of access to education, training of woman in leadership and legal frameworks that support gender equality in political representation. In addition, it postulates the need to address social and cultural norms that create discrimination and exclude women from political participations.

Conclusion

Inequalities based on gender has existed from ancient times all across the world. Gender development studies have gained prominence especially since the last century. These studies try to understand the barricades that societies, religions and other institutions have erected against women from effectively participating in key domains of life. Every human being, irrespective of gender identities, have the fundamental right to live their lives with dignity and without prejudices of any form. Gender discrimination is a complex phenomenon that occurs at multiple levels and these gender based inequalities adversely impact not just the individuals affected by it, but entire societies and nations as well. It can slow the economic as well as social development

of a country. Therefore it is essential to address and eliminate these inequalities for a better and more sustainable future. This requires innovative and flexible approaches for understanding and addressing gender discriminations. In this context the article has attempted to explore and understand gender inequalities from the perspective of the capability approach. The capability approach regards gender inequalities as deprivation of women's real freedoms or capabilities, shifting the focus from lack of access to resources. The capability approach also has great relevance in policy interventions. The approach argues for expanding women's basic capabilities in critical areas such as education, health and bodily integrity, economic participation and political engagements and thereby pave the way for more inclusive and equitable societies.

References

Gasper, Des and Irene Van Staveren. (2006). 'Development as Freedom-and as What Else?'. *Capabilities, Freedom and Equality: Amartya Sen's Work from a Gendered Perspective.* Pp-153-179. Oxford University Press.

Kuhumba, Shija (2018). 'Amartya Sen's capability approach as theoretical foundation of human development'. *Journal of Sociology and Development.* 2018.

Nussbaum, Martha C. (1999). 'Women and equality: the capabilities approach'. *International Labour Review.* 1999. Vol. 138 (3). Pp - 227-245.

Nussbaum, Martha C. (2000). *Women and Human Development: The Capabilities Approach.* Cambridge: Cambridge University Press. https://doi.org/10.1017/ cbo9780511841286

Nussbaum, Martha C. (2006). Capabilities as Fundamental Entitlements: Sen and Social Justice. *Amartya Sen's Work from a Gendered Perspective*. Pp -39-69.Oxford University Press.

Peter, Fabienne. (2006). Gender and Foundations of Social Choice: The Role of Situated Agency. *Amartya Sen's Work from a Gendered Perspective*. Pp -17-38.Oxford University Press.

Pyles, Loretta. (2008). 'The capabilities approach and violence against women: Implications for social development'. *International Social Work*, 51, 25–36.

Robeyns, Ingrid. (2005). The Capability Approach: A Theoretical Survey. *Journal of Human Development*. Vol. 6, No. 1, March 2005.

Robeyns, Ingrid. (2006). Sen's capability and Gender Inequality: Selecting Relevant Capabilities. *Capabilities, Freedom and Equality: Amartya Sen's Work from a Gendered Perspective*. Pp-70-105. Oxford University Press.

Robeyns Ingrid. (2017). *Wellbeing, Freedom and Social Justice: The Capability Approach Re-Examined.* Open Book Publishers.

Sen, Amartya. (1999). *Development as Freedom*. Pp -70-72. Oxford University Press.

Sen, Amartya. (2006). Gender, Inequality and Theories of Justice. *Capabilities, Freedom andEquality: Amartya Sen's Work from a Gendered Perspective*. Pp-420-436. Oxford University Press.

Sen, Amartya. (2006). Development as Capability Expansion. *Capabilities, Freedom and Equality: Amartya Sen's Work from a Gendered Perspective*. Pp-437-457. Oxford University Press.

Kerala's Healthcare Success: Exploring Economic Strategies

Sanoop S.

Kerala stands out as a model state in India for its exceptional healthcare outcomes, driven by a well-structured health economics framework. This article delves into the economic underpinnings of Kerala's healthcare system, highlighting its achievements, such as high institutional birth rates and low infant mortality. It discusses the challenges posed by rising healthcare costs, reliance on the private sector, and workforce shortages. Furthermore, the article explores innovative solutions like strengthening primary healthcare, implementing health insurance schemes, and leveraging digital health initiatives. Through detailed analysis supported by secondary data, tables, and figures, it offers insights into sustaining Kerala's healthcare model and its relevance to universal health coverage aspirations globally.

Keywords : Healthcare system, progressive governance, health economics, health insurance schemes, digital health technologies, public spending.

Introduction

Kerala, located in the southern part of India, is often celebrated for its remarkable achievements in healthcare. Over the decades, the state has set benchmarks in public health, achieving metrics comparable to developed nations. Its robust healthcare system is the result of a combination of high literacy rates, proactive government policies, and significant public investments in health. However, maintaining and advancing these outcomes require a deeper understanding of the economic dynamics that sustain the healthcare system.Health economics, which focuses on the efficient allocation of resources within healthcare systems, plays a crucial role in ensuring that quality healthcare remains accessible and affordable for all. The roots of Kerala's healthcare achievements can be traced to its unique socio-economic fabric, marked by high literacy rates, progressive governance, and a historical emphasis on equity in social services. Early public health measures, such as the establishment of primary healthcare centers (PHCs) and investment in sanitation and education, have laid a strong foundation for the state's health system. These efforts were further bolstered by proactive policy-making that prioritized access to affordable healthcare for all segments of the population. However, Kerala's success is not without its challenges. The state now faces a shifting healthcare landscape characterized by an aging population, the rising burden of non-communicable diseases (NCDs), escalating healthcare costs, and a dual system of public and private healthcare. These issues underline the importance of understanding and strengthening the economic dimensions of healthcare to ensure that its successes can be sustained and scaled. Health economics, a discipline that examines the allocation of resources to maximize health outcomes, provides valuable insights into addressing these challenges. By analyzing expenditure patterns, resource utilization, and the cost-effectiveness of interventions, health economics can guide policymakers in crafting strategies that balance quality, accessibility, and affordability. This article delves into the economic underpinnings of Kerala's healthcare system, offering a detailed exploration of its structure, achievements, and emerging issues. It highlights the critical role of public spending, the complementary yet complex relationship with private healthcare providers, and the challenges posed by workforce shortages and resource inefficiencies. The article also examines innovative approaches being adopted in Kerala, such as the strengthening of primary healthcare, implementation of health insurance schemes, promotion of public-private partnerships (PPPs), and leveraging digital health technologies.

Objective of the Study

The primary objective of this article is to analyze the health economics framework that underpins Kerala's exceptional healthcare achievements, exploring the interplay between policy, resource allocation, and health outcomes.

Methodology

The methodology adopted in this article combines qualitative and quantitative approaches to provide a comprehensive understanding of Kerala's healthcare system from an economic perspective. The study leverages secondary data, comparative analysis, and case-based insights to draw meaningful conclusions.

Kerala's Healthcare Success: Exploring Economic Strategies for Sustainability

Kerala is often cited as a model state for human development in India, largely due to its impressive health indicators, including high life expectancy, low infant mortality rates, and high literacy levels. These achievements are remarkable considering the state's modest economic resources compared to more affluent regions. The success in these health outcomes can largely be attributed to a strong healthcare system, backed by progressive policies and social determinants such as education and gender equality. However, the sustainability of Kerala's healthcare system is increasingly becoming a matter of concern as the state faces challenges related to population aging, rising healthcare costs, and limited fiscal space.At the heart of Kerala's healthcare success lies its unique health economics framework. Health economics is concerned with the optimal allocation of resources in the healthcare sector to ensure that public health is maximized while keeping expenditure in check. In Kerala's case, the state has managed to balance healthcare costs with outcomes through innovative approaches such as decentralized health services, extensive primary healthcare networks, and a robust public health system. Kerala's focus on preventive care and community health initiatives has helped keep the burden of disease low, despite challenges like rising non-communicable diseases and urbanization. The state's effective use of public-private partnerships (PPPs), along with the involvement of local governments in healthcare delivery, has been crucial in delivering quality healthcare at the grassroots level.

Nevertheless, the state is not without its challenges. While the state's focus on primary healthcare and preventive measures has yielded substantial benefits, the rising costs of healthcare, especially with the growth of non-communicable diseases like diabetes and cardiovascular conditions, are putting pressure on the existing system. The state also faces challenges in attracting and retaining healthcare professionals in rural areas, a problem compounded by the limited financial resources allocated to the sector. Moreover, the increasing population of elderly people, a result of the state's high life expectancy, is placing an additional burden on healthcare services, requiring a shift in focus towards geriatric care and long-term care facilities.In order to sustain its healthcare system, Kerala must focus on innovative health financing strategies that include public-private collaboration, optimizing the efficiency of healthcare service delivery, and investing in health information technology to improve data-driven decision-making. The state could also benefit from exploring new models of healthcare that prioritize patient-centered care, particularly in managing chronic diseases and aging populations. Strengthening community participation in healthcare delivery and promoting health literacy can further empower individuals to take responsibility for their health. Through these strategies, Kerala can continue to serve as a model for sustainable healthcare systems in India and the developing world.

The Economic Foundations of Kerala's Health Success

Kerala's health achievements are often attributed to a robust public health system, significant investments in primary healthcare, and a high literacy rate that fosters health awareness. Public spending on health in Kerala stood at 1.4% of its Gross State Domestic Product (GSDP) in 2021-22, higher than the national average of 1.2%. The extensive network of government hospitals and primary health centers (PHCs) ensures access to affordable healthcare services, even in rural areas. According to the National Family Health

Survey (NFHS-5) 2019-21, 94% of childbirths in Kerala occur in institutional settings, reflecting the effectiveness of its healthcare infrastructure.

Table-1

Health Indicator	Kerala	National Average
Institutional Births (%)	94	88
Infant Mortality Rate (IMR)	6 per 1,000	28 per 1,000
Public Health Spending (% GSDP)	1.4	1.2

Source: National Family Health Survey (NFHS-5) 2019-21& Economic Review (2022).

According to the Kerala Economic Review 2022, the private sector accounts for approximately 60% of inpatient care and 80% of outpatient care in the state. However, this dual system requires careful economic balancing to avoid inequities in healthcare access and quality.

Public Healthcare Investment

Kerala has consistently invested in its public healthcare infrastructure. The government's focus on health has been reflected in its budget allocations and priorities, which have translated into widespread access to basic healthcare services.

Table-2 : Public Healthcare Budget Allocation in Kerala (2020-2024)

Year	Total Budget (INR Crore)	Health Allocation (INR Crore)	Health Share of Total Budget (%)
2020-21	1,48,648	6,804	4.57%
2021-22	1,61,222	7,268	4.51%
2022-23	1,74,148	7,602	4.37%
2023-24	1,80,000	7,850	4.36%

Source: Kerala State Budget Reports (Government of Kerala)

The **Public Healthcare Budget Allocation in Kerala (2020-2024)** table highlights how the Kerala state government has consistently prioritized healthcare within its overall budget. Each year, a significant portion of the state's total budget has been allocated to the healthcare sector, reflecting the government's commitment to public health. For instance, in 2020-21, Kerala allocated INR 6,804 Crore to healthcare, which represented 4.57% of its total budget of INR 1,48,648 Crore. Although the percentage share of healthcare in the total budget has slightly declined over the years (from 4.57% in 2020-21 to 4.36% in 2023-24), the actual amount of money allocated to healthcare has steadily increased - from INR 6,804 Crore to INR 7,850 Crore. This steady increase in funding indicates Kerala's continued investment in improving its healthcare infrastructure, medical services, and public health programmes. The share of the budget devoted to healthcare remains relatively high compared to many other states in India, demonstrating the state's focus on providing quality healthcare services to its population. This sustained investment has enabled Kerala to achieve strong health outcomes, such as low infant mortality rates and high life expectancy, reinforcing the importance of public healthcare funding in achieving these successes.

Challenges in Health Economics

Despite its achievements, Kerala's healthcare system faces several economic challenges:

1. **Rising Healthcare Costs**: With an aging population (16.5% of Kerala's population is above 60 years, as per the 2021 Census) and increasing prevalence of non-communicable diseases

(NCDs), healthcare costs are escalating. According to the Global Burden of Disease Study 2019, NCDs account for over 80% of the disease burden in Kerala.

Table-3 : Explaining Healthcare cost percentage on various age group

Population Age Group	Percentage
Below 15 Years	23.5
15-59 Years	60
Above 60 Years	16.5

Source: Census 2021, Government of India

2. **Dependence on Private Sector**: While the private sector provides quality care, it is often expensive. Data from the Kerala State Planning Board indicates that out-of-pocket expenditure on health in Kerala accounts for approximately 60% of total health expenditure, higher than the national average of 48%.

3. **Workforce Shortages**: Despite producing a large number of medical professionals, the migration of healthcare workers to other states and countries creates a gap in the local workforce. For instance, nearly 30% of nurses trained in Kerala work abroad, as per a 2020 WHO report.

4. **Inefficiencies in Resource Utilization**: Overcrowding in tertiary care centers and underutilization of PHCs highlight the need for better resource allocation. The Kerala Economic Review 2021 found that only 40% of PHCs operate 24/7, limiting their effectiveness in addressing primary healthcare needs.

Innovations and Solutions

To address these challenges, Kerala is implementing several health economics strategies:

1. **Strengthening Primary Healthcare**: By enhancing the infrastructure and capabilities of PHCs, Kerala aims to reduce the burden on tertiary care facilities. Initiatives like the 'Ardram Mission', launched in 2017, focus on transforming PHCs into family health centers. As of 2022, over 500 PHCs have been upgraded under this mission.

Table-4 : Showing Health Statistics Before and After Ardram mission

Metric	Before Ardram Mission	After Ardram Mission
Functional PHCs (24/7)	250	500
Average Daily Footfall	50 patients	120 patients

Source: Kerala State Health Department and Ardram Mission 2022 Report

2. **Insurance-Based Health Financing**: The implementation of government-funded health insurance schemes like Karunya Arogya Suraksha Padhathi (KASP) has ensured financial protection for vulnerable populations.

Table-5 : Showing Health Insurance coverage

Health Insurance Coverage	Kerala (%)	National Average (%)
Public Insurance Coverage	62%	40%
Out-of-pocket Expenditure (OOPE)	15%	50%

Source: Ayushman Bharat Annual Report 2023

The higher percentage of the population covered by public insurance (62% in Kerala compared to the national average of 40%) helps reduce the burden on families, especially in rural areas. The state has focused on reducing out-of-pocket expenditures (OOPE), which are a major source of financial strain in healthcare systems. The state's **OOPE** of 15% is significantly lower than the national average of 50%, reflecting the state's efforts to fund healthcare through public and insurance-based financing.

3. **Focus on Non-Communicable Diseases (NCDs)**: Kerala has launched targeted programmes for NCDs like hypertension, diabetes, and cancer, which account for over 70% of deaths in the state.

Table-6 : Prevalance of Key NCD's

Prevalence of NCDs	Kerala (%)	India (%)
Diabetes (Adults) 16.2	8.9	
Hypertension (Adults) 30.5	25.3	

Source: Health of the Nation's States Report (IHME, 2019)

Non-communicable diseases (NCDs) such as diabetes, hypertension, and cancer have become a significant health challenge in Kerala, contributing to the majority of deaths in the state. The state's health policies have adapted by focusing on the prevention and management of NCDs. Diabetes and hypertension are more prevalent in Kerala compared to the national average, which can be attributed to lifestyle factors like high dietary intake of fat and low physical activity. The government has implemented regular screening programmes, health education campaigns, and chronic disease management protocols to curb the rise of NCDs.

4. **Digital Health Integration**: Kerala has integrated digital health tools like the e-Health project, which consolidates patient records for improved service delivery and policy planning.

Table-7 : Showing Digital Health Tools

Digital Health Indicators	Kerala	National Average
Coverage of e-Health Records (%)	82	50
Telemedicine Utilization (%)	48	25

Source: Kerala e-Health Project Reports (2022-23)

Kerala has made considerable progress in digital health integration through initiatives like the e-Health project, which allows healthcare providers to access and share patient information across multiple healthcare facilities. This improves the quality and continuity of care for patients, especially those with chronic conditions or requiring referral to specialists. The state's adoption of telemedicine (especially during the COVID-19 pandemic) has improved access to healthcare services in remote and rural areas, where specialist services are often limited.

5. **Public-Private Partnership (PPP) Models**: To meet resource gaps, Kerala has adopted PPP models in areas like diagnostics, tertiary care, and medical education.

Table-8 : Showing PPP Models in Health care

PPP Models in Healthcare	Kerala
Dialysis Units (PPP)	123 Centers
Medical Colleges with PPP	5 Institutions

Source: NITI Aayog PPP Health Model Evaluation Reports

PPP models have addressed infrastructure and service gaps, particularly in diagnostics and dialysis units. The approach has reduced waiting times and OOPE for patients requiring advanced care.

6. **Health Spending**: Kerala allocates a higher percentage of its GDP to healthcare compared to the national average.

Table-9 : Showing Health spending (GDP%)

Health Expenditure	Kerala (%)	India (%)
State GDP Allocation to Healthcare	5.3	1.5
Per Capita Health Expenditure	₹ 2,000	₹ 1,112

Source: Kerala Budget 2023-24

Kerala allocates a higher percentage of its GDP to healthcare than most other states in India, reflecting its commitment to public health. The **state GDP allocation** of 5.3% toward healthcare is significantly higher than the national average of 1.5%. Kerala's **per capita health expenditure** is ₹ 2,000, nearly double the national average of ₹ 1,112. This increased spending allows Kerala to maintain its public health infrastructure, offer comprehensive healthcare services, and reduce the reliance on out-of-pocket expenses for the population.

Major Findings

The article highlights the following key findings from the analysis of Kerala's healthcare system:

1. **Exceptional Health Outcomes**

- Kerala consistently outperforms national averages in key health indicators such as infant mortality rate (6 per 1,000 live births compared to the national average of 28) and institutional birth rates (94% vs. 88%).
- High literacy rates and public health awareness have significantly contributed to these achievements.

2. **Significant Public Health Investments**

- Kerala's public health spending, at 1.4% of its Gross State Domestic Product (GSDP), is higher than the national average of 1.2%, underscoring the state's commitment to accessible healthcare.
- The extensive network of government hospitals and primary health centers (PHCs) ensures affordable care, especially in rural areas.

3. **Dependence on the Private Sector**

- The private sector accounts for approximately 60% of inpatient care and 80% of outpatient care, providing high-quality services but often at a higher cost.
- Out-of-pocket expenditure in Kerala (60% of total health expenditure) is higher than the national average of 48%, indicating financial burdens on households.

4. **Rising Healthcare Challenges**

- The aging population (16.5% above 60 years) and increasing prevalence of non-communicable diseases (NCDs) now account for over 80% of the state's disease burden.
- Workforce shortages are significant, with nearly 30% of nurses trained in Kerala working abroad, creating gaps in local healthcare services.
- Inefficiencies in resource utilization are evident, with only 40% of PHCs operating 24/7, leading to overcrowding in tertiary care centers.

5. Impact of Innovative Initiatives

- The 'Ardram Mission' has enhanced primary healthcare, upgrading over 500 PHCs into family health centers, increasing their functionality and patient footfall.
- Health insurance schemes like the Comprehensive Health Insurance Scheme (CHIS) have provided financial protection to approximately 40% of the state's population.
- Digital health initiatives, such as the e-Health Kerala project, have digitized health records for over 8 million citizens, improving care coordination and accessibility.

6. Success of Preventive and Community Health Measures

- Programmes like the 'Sujitham Project' have demonstrated the state's focus on preventive healthcare, screening over 3 million individuals for lifestyle diseases like diabetes and hypertension.
- Community participation and awareness campaigns have played a pivotal role in the early detection and management of diseases.

Conclusion

Kerala's healthcare system stands as a testament to how strategic investments in health economics can yield exceptional outcomes, setting benchmarks in life expectancy, infant mortality, and overall public health. The state's achievements are rooted in a robust public health infrastructure, significant spending on primary healthcare, and a well-educated population that actively engages with health services. These elements have positioned Kerala as a model state for human development, with lessons that resonate globally. However, the evolving healthcare landscape presents new challenges. Rising healthcare costs, an aging population, increasing prevalence of non-communicable diseases (NCDs), and the duality of public and private healthcare systems highlight the need for adaptive strategies. The migration of healthcare workers and inefficiencies in resource allocation further emphasize the importance of re-evaluating and optimizing existing frameworks. Innovative solutions such as strengthening primary healthcare through the 'Ardram Mission,' expanding financial protection via health insurance schemes like CHIS, and embracing digital health technologies have demonstrated promising results. These initiatives not only address current challenges but also lay the groundwork for sustaining Kerala's healthcare achievements in the long term.

References

Government of India (2021). *National Family Health Survey (NFHS-5), 2019–21*. Ministry of Health and Family Welfare, Nirman Bhavan, New Delhi-110011.

Government of Kerala. *Economic Reviews (*2021 & 2022). State Planning Board, Pattom, Thiruvananthapuram, Kerala.

Government of India (2021). *Census of India 2021*. Office of the Registrar General & Census Commissioner, Ministry of Home Affairs, New Delhi-110 001.

Government of Kerala (2022). *Kerala State Health Department Reports, 2022,* Directorate of Health Services, Thiruvananthapuram.

Government of Kerala (2021). *Sujitham Project Reports, 2021*. Kerala State Health Department,Government Secretariat Annexe, 2, Thiruvananthapuram, Kerala 695001.

Government of Kerala (2023). *e-Health Kerala Project Reports*. Kerala State Health Department,Government Secretariat Annexe 2. Thiruvananthapuram, Kerala 695001, Available at https://ehealth.kerala.gov.in/

Government of India (2023). *Rashtriya Swasthya Bima Yojana (RSBY) Data,*Ministry of Labour and Employment. Rafi marg New Delhi-110001.

World Health Organization (2020). *Report on Nurse Migragion*. Available at https://www.who.int/

From Farm to Market: A Comprehensive Framework for Carbon Credit Trading and Climate Resilience in Indian Agriculture

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The agricultural industry now plays a significant role in the global market for voluntary carbon credits. Using India's diverse agroclimatic zones and its substantial involvement in international carbon credit programmes, this study investigates the integration of carbon markets into sustainable agriculture practices. With 860 projects registered till June 2023 and 1,451 under assessment, India has awarded 298 million carbon credits, indicating significant opportunities for both rural economic development and climate resilience. In order to address concerns including market opacity, regulatory shortcomings, and fair access for smallholders, this article offers a comprehensive framework for linking agricultural practices with carbon credit trading. By connecting carbon market mechanisms with climate policies, this paper highlights the potential to transform India's agriculture into a sustainable and economically empowered sector.

Keywords : Agricultural carbon markets, sustainable farming practices, climate resilience, carbon credit trading, india's agro-economy, voluntary carbon markets

Introduction

Under the Kyoto Protocol, carbon markets were established to help nations and companies effectively reduce emissions by enabling the trading of carbon credits between them. Voluntary programmes that benefit several stakeholders globally as well as mandatory carbon trading schemes like the EU carbon Trading System (EU ETS) are now part of the market. Carbon trading markets have grown significantly in recent years, reaching a global value of nearly $50 billion in 2015 (Peszko et al., 2015) and surpassing $900 billion in compliance markets by 2021 (Porciani et al., 2023). These markets are seen as effective tools for promoting economic growth and carbon mitigation (Tang et al., 2022). However, their impact on firm valuation is complex, with carbon prices negatively affecting stock values of thermal enterprises in China (Zhang et al., 2018) and allocation shortfalls negatively associated with firm valuation in the EU (Clarkson et al., 2014). The effectiveness of carbon markets in reducing global emissions has been questioned due to implementation challenges and policy inconsistencies (Porciani et al., 2023). Critics argue that the commodification of carbon is based on arbitrary acceptance of market principles rather than intrinsic ecological value (Leonardi, 2017). Despite these challenges, carbon markets continue to expand globally, with about 70 market mechanisms capturing 20% of greenhouse gas emissions (Lobovikov et al., 2024).

Carbon markets play a pivotal role in mitigating climate change by reducing emissions in a cost-effective manner. They establish a monetary value for carbon emissions, which creates a strong financial incentive for businesses and governments to invest in cleaner technologies. Well-designed carbon pricing mechanisms, such as ETS and carbon taxes, have been shown to significantly reduce emissions while promoting technological innovation (Digitemie & Ekemezie, 2024).

However, their integration into international frameworks faces challenges, including fragmented governance, environmental integrity concerns, and tensions between top-down and bottom-up approaches

(Ahonen et al., 2022; Betz et al., 2022). Article 6 of Paris Agreement provides a framework for international cooperation through carbon markets, emphasizing mitigation and sustainable development (Schneider, 2019). Critics argue that market-based approaches may not lead to significant emission reductions without addressing underlying social and economic structures (Elah & Okereke, 2014). Studies highlight the importance of considering local contexts, cultural values, and social norms in implementing carbon markets (Knox-Hayes et al., 2020; Smits, 2017). To ensure effectiveness, researchers suggest strengthening national regulations, improving coordination between sectors, and establishing linkages with regional and global mechanisms (Smits, 2017; Ahonen et al., 2022).

Significance of the Study

The growing demand for food grains in India, projected to reach 450 million tonnes by 2050, poses significant challenges amid climatic and demographic pressures (Padhee, 2018). While India has transformed from food aid dependency to a net exporter, increasing food production nearly six-fold since the 1950s (Mohapatra & Archak, 2022), future demands for pulses, edible oils, and sugar are expected to exceed supply (Praduman& Joshi, 2016). Climate change threatens agricultural sustainability, potentially impacting water resources and food production globally (Islam & Karim, 2019). Although global cereal production is projected to marginally surpass demand by 2050 (Islam & Karim, 2019), India faces the challenge of ensuring sustainable food supply for its growing population (Mohapatra & Archak, 2022).

Indian farmers face significant challenges in adapting to climate change, including limited access to financial capital, advanced technologies, and knowledge about climate-resilient practices. While many farmers are aware of climate-smart agriculture (CSA) techniques, adoption rates vary due to resource constraints (Shehrawat et al., 2023; Tanti et al., 2022). Institutional support, such as government extension services, subsidies, and credit facilities, plays a crucial role in promoting CSA adoption (Tanti et al., 2022; Villalba et al., 2024). However, farmers often prefer informal financing options due to bureaucratic hurdles in formal banking (Villalba et al., 2024). Custom-hiring centers have emerged as an important solution for accessing expensive CSA technologies (Villalba et al., 2024). Despite these challenges, farmers using CSA strategies have achieved higher yields and returns (Ghosh, 2019). To improve resilience, there is a need for increased investment in the farming sector, capacity building, and an integrated approach to assessing farmers' perceptions and adaptations (Datta et al., 2022; Suresh & Viswanathan, 2022).

Carbon sequestration through improved farming methods like biochar application, integrated nutrient management, and no-tillage can enhance soil carbon and provide economic benefits (Kumara et al., 2023). Implementing climate-resilient agriculture practices could potentially reduce India's annual emissions by 84% from 2019 to 2070 (Khurana et al., 2024). Carbon credit trading in agriculture could incentivize climate-conscious farming (Gorain et al., 2021). Various initiatives, such as the National Innovations on Climate Resilient Agriculture (NICRA), demonstrate effective land and water management interventions to enhance agricultural resilience (Sikka et al., 2018). However, there are gaps in resource allocation among vulnerable states (Suresh & Viswanathan, 2022). Adopting optimistic land-use policies could sequester additional carbon with significant economic value (Ansari et al., 2024). Research on climate change impacts, adaptation strategies, and sustainable agriculture is growing, particularly in certain Indian regions (Baraj et al., 2024).

Thus, agriculture sector has the ability to greatly reduce emissions while increasing farmers' financial gains by utilising tactics like carbon sequestration, climate-resilient farming, and cutting-edge systems like carbon credit trading. To overcome adoption barriers and guarantee fair resource distribution among states, frameworks that incorporate financial incentives, legislative interventions, and capacity-building initiatives are essential. In order to promote a sustainable agricultural future that not only satisfies domestic food demands but also complies with international climate obligations, this study attempts to provide a strategy to bridge this gap.

Objectives Framed for the Study

In order to integrate carbon markets with agricultural practices and advance sustainability and climate resilience, this article is driven by two main goals.

1. To investigate how Carbon Markets can improve sustainable agriculture in India.
2. To provide a framework for connecting Carbon Credit Trading with farm practices.

The proposed framework helps market players, policymakers, and agricultural stakeholders set up carbon credit trading in Indian agriculture. It increases the sustainability of farming and provides farmers with a financial means of combating climate change. Thus, the desired objective is to bridge the implementation and knowledge gaps.

Theoretical Framework

Carbon credit systems and trading mechanisms provide a robust market-based framework for incentivizing the reduction of greenhouse gas (GHG) emissions. By assigning a monetary value to emissions reductions, these systems internalize the external cost of carbon emissions into economic activities, offering both environmental and economic benefits. The theoretical underpinnings of these mechanisms draw from key principles in ecological economics, including the Coase Theorem, Pigovian Taxation, and the Circular Economy. Together, these principles form the basis for a sustainable and efficient framework for integrating carbon credit trading into Indian agriculture.

Property Rights and Market Efficiency: The Coasean Approach

The Coase Theorem emphasizes the allocation of property rights to address environmental externalities like carbon emissions. In the context of carbon markets, carbon credits act as property rights, enabling agricultural operators to reduce emissions and trade surplus credits in the market. This approach facilitates free-market transactions that align private incentives with societal goals, ensuring cost-effective emission reductions. For Indian agriculture, where smallholder farmers dominate, clear and enforceable property rights in the form of carbon credits can incentivize sustainable practices such as:

(a) *Agroforestry:* Increasing tree cover on farmland to sequester carbon.

(b) *Reduced Tillage:* Minimizing soil disturbance to enhance carbon retention.

(c) *Methane Reduction:* Adopting methods like alternate wetting and drying in paddy cultivation.

Thus, the Coasean framework highlights that with minimal transaction costs and well-defined property rights, voluntary market-based solutions can address GHG emissions efficiently.

Internalizing Externalities: Pigovian Principles in Carbon Pricing

It advocates for internalizing the costs of negative externalities by imposing taxes on environmentally harmful activities. While direct taxation is not the primary focus of carbon trading, the concept underpins the pricing mechanisms of carbon credits. Carbon pricing aligns with Pigovian principles by monetizing emissions reductions, creating financial incentives for sustainable farming practices. The two primary mechanisms are:

(a) *Cap-and-Trade Systems*: Establishing a cap on total emissions and allowing farmers to trade allowances based on their performance.

(b) *Baseline-and-Credit Systems*: Rewarding farmers who reduce emissions below a pre-defined baseline, enabling the sale of surplus credits.

For the Indian Farmers and to the Indian agriculture, carbon pricing can achieve these desired results:

- Drive the adoption of renewable energy sources, such as solar-powered irrigation.

- Promote efficient fertilizer usage, reducing nitrous oxide emissions.
- Incentivize organic farming methods that enhance soil organic carbon.

Pigovian principles ensure that the cost of emissions reduction is distributed equitably, encouraging widespread participation in the carbon market.

Advancing Sustainability through Circular Economy Practices

The circular economy emphasizes resource efficiency and waste minimization, providing a natural complement to carbon markets. By linking sustainable agricultural practices with carbon credit generation, this framework encourages:

(a) *Carbon Sequestration*: Practices like agroforestry and conservation agriculture that integrate biological cycles into farming systems.

(b) *Waste Reduction:* Reducing emissions from agricultural waste through composting and bioenergy production.

(c) *Nutrient Recycling:* Efficient use of organic waste to improve soil health, reducing dependency on synthetic inputs.

Carbon markets promote a circular economy by financially rewarding practices that reduce waste and enhance resource efficiency. For Indian farmers, this can translate into tangible benefits, such as:

- Reduced input costs through better resource management.
- Additional income streams from selling carbon credits.
- Long-term sustainability of agricultural productivity.

Foundation for Carbon Credit Trading in Indian Agriculture

The integration of Coasean, Pigovian, and circular economy principles into carbon credit trading for Indian agriculture requires a structured approach:

- *Establishing Property Rights:* Develop robust frameworks for carbon credit issuance, ensuring clarity and equity in credit allocation, especially for small and marginal farmers.
- *Monetizing Externalities*: Implement carbon pricing mechanisms that reflect the true cost of emissions while being accessible and fair to farmers of all scales.
- *Encouraging Resource Efficiency*: Link carbon markets with circular agricultural practices, creating incentives for farmers to adopt methods that reduce emissions and enhance sustainability.

This theoretical framework integrates Coasean principles of property rights, Pigovian concepts of carbon pricing, and circular economy ideals of resource efficiency to create a robust foundation for carbon credit trading in Indian agriculture. By aligning economic incentives with ecological goals, the framework offers a pathway to climate resilience and rural economic empowerment. The principles outlined not only ensure the effectiveness and inclusivity of carbon markets but also position Indian agriculture as a leader in Global Climate Action.

Methodology Adopted for the Study

This study investigated climate resilience, sustainable farming, and carbon markets using secondary data analysis. In order to synthesise information and obtain useful insights, this approach incorporated data from government reports, policy documents, research publications, and case studies. The process entails combining research results to create a thorough framework that is conceptually sound and customised for India in order to integrate agricultural practices with carbon credit trading.

Results and Discussion

Sustainability and climate resilience in the agriculture sector/industry address social, economic, and environmental issues while focussing on long-term productivity. "Climate resilience" is the ability of agricultural systems to adjust and bounce back from shocks connected to climate change. In agriculture, sustainability refers to methods that satisfy present needs without endangering the capacity of future generations to satisfy them. Conservation tillage, integrated pest control, agroforestry, organic farming, and effective water and nutrient management are a few instances of these methods. The process of improving resilience includes the creation of climate-resistant crop varieties, the application of water-saving technologies, cropping system diversification, and the use of carbon markets to encourage actions like soil carbon storage, agroforestry, and afforestation as ways to sequester carbon.

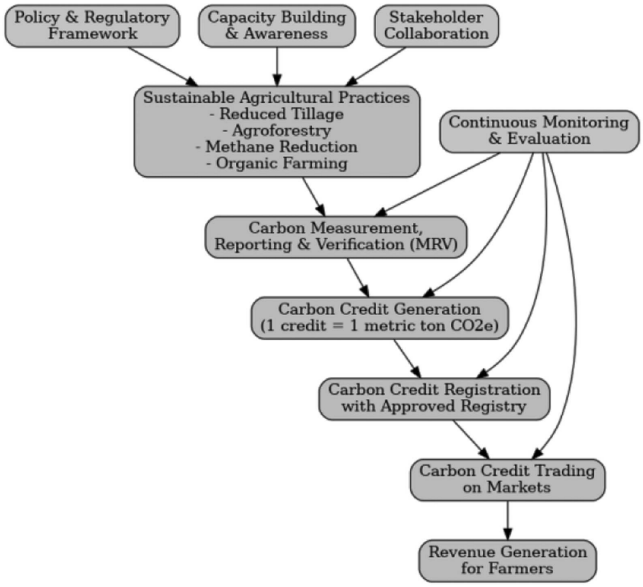
Integration of Carbon Markets into Agriculture: This integration represents a unique opportunity to align economic incentives with environmental sustainability. By leveraging policy frameworks and economic theories, these markets provide a structured approach to reducing greenhouse gas emissions while promoting sustainable farming practices. Economic principles like the Coase Theorem and Pigovian Taxation underpin the financial mechanisms that make carbon trading viable, emphasizing the internalization of externalities and market-driven solutions. Additionally, policy instruments, such as subsidies, carbon pricing, and international agreements like the Paris Accord, create a supportive environment for market development. Thus these theoretical framework establishes that carbon credit systems and trading mechanisms can act as powerful tools for incentivizing sustainable and climate-resilient agricultural practices. By combining economic theories with policy mechanisms, carbon markets can effectively integrate into agriculture, addressing environmental challenges while supporting rural livelihoods. The success of these initiatives depends on well-designed policies and equitable implementation strategies.

Comprehensive Process Flow for Carbon Credit Generation and Trading*:* The framework depicted below outlines a Comprehensive Process Flow for Carbon Credit Generation and Trading, specifically focusing on agricultural practices. Its primary objective is to incentivize sustainable agricultural practices that not only reduce greenhouse gas (GHG) emissions but also create an additional revenue stream for farmers through the generation and trading of carbon credits. By linking sustainable farming with a structured carbon market, this framework serves as a dual-purpose system: mitigating climate change while ensuring economic benefits for rural farming communities.This framework is particularly relevant to India due to the following reasons:

1. *Agrarian Dominance:* With nearly 70% of India's population engaged in agriculture, the sector is a critical component of India's economy and its efforts to reduce carbon emissions.
2. *High Emission Potential in Agriculture:* Agriculture contributes significantly to India's GHG emissions, especially from activities like methane production in rice paddies, improper fertilizer use, and livestock management. Transitioning to sustainable practices offers a significant opportunity for emissions reduction.
3. *Farmer-Centric Economic Growth:* Indian farmers face economic pressures due to small landholdings, fluctuating prices, and limited resources. Carbon credit trading presents a unique opportunity to generate additional income by monetizing their efforts in sustainable agriculture.
4. *Alignment with Global Climate Goals:* India's commitments under the Paris Agreement and the updated Nationally Determined Contributions (NDCs) emphasize reducing GHG emissions intensity. This framework directly supports such objectives while integrating local stakeholders.
5. *Custom Fit for India's Diverse Agriculture:* The framework accounts for varied agricultural practices, including reduced tillage, agroforestry, organic farming, and methane reduction, making it adaptable to India's diverse agro-climatic zones.

This framework particularly suitable for India as it emphasis on capacity building, collaboration, and robust carbon measurement mechanisms. These are tailored to address the challenges Indian farmers face, such as lack of awareness, limited access to technology, and regulatory hurdles, ensuring practical implementation and scalability. The following sections will detail each component of the framework and explain how it contributes to achieving the overall objective, supported by research and literature.The diagram (Figure – 1) below illustrates the comprehensive process flow for carbon credit generation and trading within the context of sustainable agricultural practices.

Figure – 1 : **Comprehensive Process Flow for Carbon Credit**



Source: Illustration Developed by the Author Using Secondary Data Sources (Verra Reports, Ecosystem Marketplace Reports, 2023)

1. *Policy & Regulatory Framework :*A robust policy and regulatory framework is essential to standardize carbon credit mechanisms. This includes setting guidelines for carbon offset practices, creating incentives for farmers, and ensuring compliance. Policies such as those outlined in the Kyoto Protocol and Paris Agreement provide frameworks for carbon trading and sustainable practices (UNFCCC, 2020).

2. *Capacity Building &Awareness :*Training farmers and stakeholders on carbon farming techniques ensures they understand the benefits of participating in carbon credit programmes. This includes knowledge about agroforestry, reduced tillage, and methane reduction methods. Awareness programmes have been shown to improve farmer participation and compliance with climate-smart agriculture initiatives (World Bank, 2018).

3. *Stakeholder Collaboration :*Collaboration between governments, private sectors, NGOs, and farming communities ensures a unified approach to sustainable agriculture and carbon markets. Public-private partnerships have been crucial in successful carbon credit projects (FAO, 2019).

4. *Sustainable Agricultural Practices*

- Core practices include:
  - Reduced Tillage: Minimizes soil disturbance, enhancing carbon sequestration.
  - Agroforestry: Combines trees with crops or livestock to store carbon.
  - Methane Reduction: Targets methane emissions from rice paddies or livestock.
  - Organic Farming: Avoids synthetic fertilizers, improving soil organic carbon.

Studies confirm that reduced tillage increases soil carbon retention (Lal, 2020), while agroforestry enhances biomass carbon storage (Zomer et al., 2016).

5. *Continuous Monitoring & Evaluation*

- Ongoing assessments ensure that sustainable practices are adhered to, and the expected carbon savings are achieved.
- Monitoring, reporting, and verification (MRV) protocols are critical for credibility in carbon markets (Gold Standard Foundation, 2021).

6. *Carbon Measurement, Reporting & Verification (MRV)*

- MRV involves calculating and verifying the amount of CO2e reduced or sequestered to ensure transparency in carbon credit generation.
- MRV frameworks like IPCC guidelines are widely used to ensure accurate carbon accounting (IPCC, 2019).

7. *Carbon Credit Generation*

- Carbon credits are issued for verified reductions, with one credit equivalent to one metric ton of CO2e.
- Verified Carbon Standard (VCS) and Clean Development Mechanism (CDM) have issued millions of credits globally for projects reducing greenhouse gases (UNFCCC, 2020).

8. *Carbon Credit Registration with Approved Registry*

- Credits must be registered with credible organizations (e.g., Gold Standard, VCS) to ensure legitimacy.
- Registration ensures market acceptance and compliance with global standards (Gold Standard Foundation, 2021).

9. *Carbon Credit Trading on Markets*

- Carbon credits are sold on voluntary or compliance markets, enabling emitters to offset their emissions.
- Carbon markets like the European Union Emissions Trading System (EU ETS) have facilitated significant emission reductions (Ellerman et al., 2016).

10. *Revenue Generation for Farmers*

- Farmers benefit financially from selling credits, incentivizing the adoption of sustainable practices.
- Carbon farming has proven to be a viable income source for farmers in developing countries (World Bank, 2018).

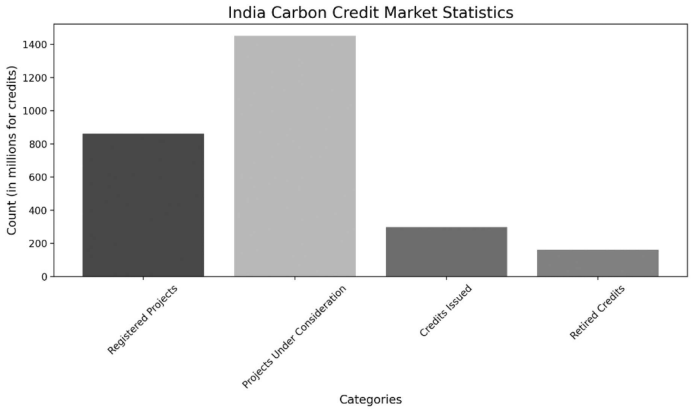
This process integrates policy, science, and market mechanisms to enable farmers to reduce emissions while earning revenue through carbon credits. Each step is backed by literature to ensure credibility and effectiveness.

Opportunities and Challenges in the Agricultural Carbon Market in India

India's agricultural carbon market presents a transformative opportunity to align sustainable farming practices with climate mitigation goals. With 860 registered projects and 1,451 projects under review by global carbon credit certifying bodies like Verra and Gold Standard as of June 2023, India's agricultural sector plays a pivotal role in contributing to the voluntary carbon market. These projects offer a platform

for farmers to generate carbon credits through climate-resilient practices such as agroforestry, reduced tillage, and methane emission reduction.

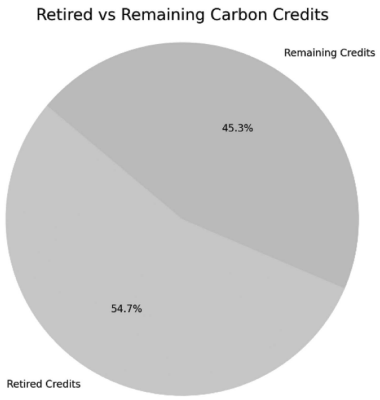
Figure – 2



Source: Developed by the Author Based on Secondary Data from Verra, Gold Standard Reports and Ecosystem Marketplace Reports (2023)

Volume of Agricultural Carbon Credits :By June 2023, India's agricultural initiatives contributed significantly to the issuance of 298 million carbon credits. These credits represent avoided or sequestered emissions, equivalent to nearly 10% of India's annual greenhouse gas emissions in 2020. Of this, 163 million credits have been retired, showcasing the successful integration of sustainable agricultural practices into global carbon credit trading systems.

Figure – 3



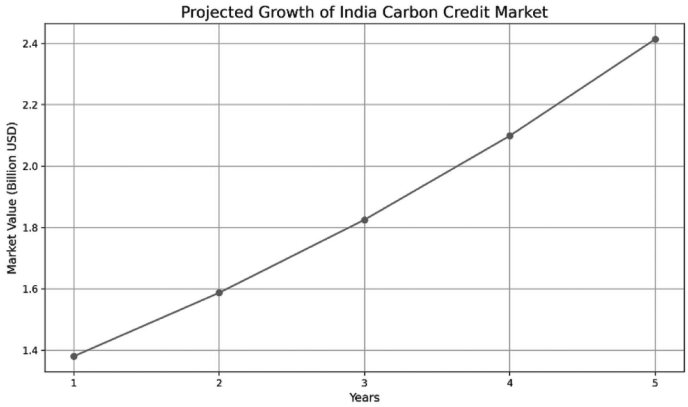
Source: Developed by the Author Based on Secondary Data from Verra, Gold Standard Reports and Ecosystem Marketplace Reports (2023)

Market Share and Agricultural Potential :India outpaces competitors like China in the voluntary carbon market, with retired credits surpassing 163 million compared to China's 100 million by May 2023. This leadership is driven by agricultural projects that generate high-quality carbon credits, attracting major international buyers like Vitol Asia PTE Ltd, Michelin Group, and Shell. The integration of carbon markets with agriculture enhances India's global competitiveness while empowering rural communities.

Market Value and Farmer Benefits :The agricultural carbon credit market in India is valued at an estimated $1.2 billion (₹ 9,894 crore), based on a global average price of $4 per credit. Retired credits alone have generated approximately $652 million (₹ 5,376 crore), offering a promising revenue stream for farmers adopting sustainable practices. By linking agricultural activities to carbon trading, India creates dual benefits: climate mitigation and improved rural incomes.

*Opportunities for Growth in Agricultural Carbon Markets :*International firms' net-zero ambitions will raise demand for agricultural carbon credits, giving Indian farmers a worldwide platform. Agroforestry, decreased tillage, and animal methane emission reductions are possible in India's different agro-climatic zones. Environmental and economic gains can be achieved by aligning agricultural carbon markets with India's Paris Agreement climate targets.

Figure – 4



Source: Developed by the Author Based on Secondary Data from Verra, Gold Standard Reports and Ecosystem Marketplace Reports (2023)

India's agricultural carbon market exemplifies a unique convergence of climate action and economic opportunity. By empowering farmers through access to carbon credit revenues and adopting sustainable farming practices, the sector can enhance rural livelihoods while contributing to global climate goals. Addressing challenges like market transparency and equity through regulatory reforms and capacity building will be crucial to unlocking the full potential of agricultural carbon markets in India. With targeted interventions, this sector could become a cornerstone of India's climate policy and rural development strategy.

Challenges in the Agricultural Carbon Market : India's agricultural carbon market lacks transparency. Farmers and other stakeholders struggle to understand carbon credit prices, which range from $2 to $10 per credit. Despite their importance to sustainable agriculture, marginalised farmers and smallholders rarely benefit from carbon credit markets. Although certifying institutions verify credits, weak local regulation limits agricultural carbon market scalability and equality.

Conclusion

India's agricultural carbon market demonstrates immense potential as a dual driver of climate action and rural economic growth. The integration of sustainable farming practices with carbon credit trading offers a promising pathway to reduce greenhouse gas emissions while improving farmer incomes. However, challenges such as pricing opacity, regulatory gaps, and inequitable distribution of benefits must be addressed to realize this potential fully. Strengthening regulatory frameworks, promoting capacity building among small-scale farmers, and enhancing transparency in market operations are key to achieving these goals. As global demand for carbon credits grows, India is uniquely positioned to lead through innovative policies and scalable practices. By leveraging its agricultural diversity and aligning market mechanisms with national climate objectives, India can establish its agricultural carbon market as a cornerstone of sustainable development and global climate solutions.

References

Ahmad, J., Alam, D., & Haseen, M. (2011). Impact of climate change on agriculture and food security in India. *International Journal of Agriculture, Environment and Biotechnology, 4*, 129–137.

Ansari, R., Verma, P., & Gupta, S. (2024). Adopting optimistic land-use policies to enhance carbon

sequestration: Strategies and economic implications. *Journal of Agricultural Sustainability Studies, 13*(2), 143–156.

Baimwera, B., & Wangombe, D. (2018). A reflection on the role of carbon markets in climate governance in Kenya. *International Journal of Critical Accounting, 10*, 70–96.

Bansal, R. (2020). Stubble burning in Punjab: Problems and issues. In *International Journal of Science and Research (IJSR)* [Journal-article]. https://www.ijsr.net/archive/v9i9/SR20912112854.pdf

Baraj, R., Kumaran, S., & Patel, T. (2024). Regional disparities in climate change impacts and sustainable agriculture in India. *Environmental Research and Policy Review, 18*(4), 305–319.

Benessaiah, K. (2012). Carbon and livelihoods in post-Kyoto: Assessing voluntary carbon markets. *Ecological Economics, 77*, 1-6.

Bryan, E., Akpalu, W., Yesuf, M., & Ringler, C. (2008). Global carbon markets: Are there opportunities for sub-Saharan Africa? Intl Food Policy Res Inst.

Calel, R. (2013). Carbon markets: A historical overview. *Wiley Interdisciplinary Reviews: Climate Change, 4*, 107–119.

Carbon Farming: Opportunities for agriculture and farmers to gain from decarbonization. (n.d.). S&P Global. https://www.spglobal.comesg/insights/topics/carbon-farming-opportunities-for-agriculture-and-farmers-to-gain-from-decarbonization

Chassagneux, J., Chotai, H., &Muûls, M. (2017). A description of the carbon markets and their role in climate change mitigation:*A Forward-Backward SDEs Approach to Pricing in Carbon Markets*. In Springer e-Books (pp.1-9). https://doi.org/10.1007/978-3-319-63115-8_1

Datta, S., Patel, R., & Chatterjee, A. (2022). Capacity building for climate resilience in Indian agriculture: An integrated approach. *Agricultural Development Quarterly, 29*(1), 56–72.

Dhyani1S K, Ram Asha And DevInder (2016) Potential of agroforestry systems in carbon sequestration in India Indian Journal of Agricultural Sciences 86 (9): 1103–12, September 2016/Review Article

Digitemie, W. N., &Ekemezie, I. O. (2024). Assessing the role of carbon pricing in global climate change mitigation strategies. *Magna Scientia Advanced Research and Reviews.10*(2), 022-031

Frank, S., Lessa DerciAugustynczik, A., Havlík, P. *et al.* Enhanced agricultural carbon sinks provide benefits for farmers and the climate. *Nat Food* **5**, 742–753 (2024). https://doi.org/10.1038/s43016-024-01039-1

Ghosh, S. (2019). Economic benefits of climate-smart agriculture: Evidence from Indian farms. *Journal of Climate Resilient Agriculture, 12*(3), 231–246.

Gorain, S., Sen, A., & Bhattacharya, P. (2021). Carbon credit trading as an incentive for sustainable farming in India. *Carbon Management, 16*(2), 112–125.

Government of India. (2023). *State-wise agricultural policy documents.* Ministry of Agriculture and Farmers' Welfare. https://naas.org.in

Intergovernmental Panel on Climate Change (IPCC). (2022). *Mitigation of climate change in agriculture*.https://www.ipcc.ch/report/ar6/wg3/downloads/report/IPCC_AR6_WGIII_FullReport.pdf

Islam, S., & Karim, M. A. (2019). Global cereal production and demand projections by 2050: Implications for agricultural sustainability. *Global Agricultural Review, 14*(4), 321–337.

John,S.E.,, & Raj.M. (2021). Impact of climate change on agriculture production in India.

Jose, A. (2015). Impacts of climate change on the agricultural sector. *TIJ's Research Journal of Economics & Business Studies.*

Khajuria, A., & Ravindranath, N. H. (2012). Climate change in context of Indian agricultural sector. *Journal of Earth Science & Climatic Change, 2012*, 1–4.

Khurana, P., Sharma, V., & Singh, J. (2024). The role of climate-resilient agriculture in reducing India's emissions: A long-term analysis. *Journal of Environmental Economics and Policy, 22*(1), 78–91.

Kumar,R., et al. (2020). Challenges in implementing agricultural carbon markets in developing countries. https://www.fao.org.

Kumara, R., Pillai, A., & Das, G. (2023). Enhancing soil carbon through improved farming practices: A review of biochar and no-tillage techniques. *Soil and Crop Management Journal, 27*(3), 201–217.

Lal, M., Singh, K., Rathore, L. S., Srinivasan, G., &Saseendran, S. A. (1998). Vulnerability of rice and wheat yields in NW India to future changes in climate. *Agricultural and Forest Meteorology, 89,* 101–114.

Mohapatra, S., & Archak, P. (2022). India's agricultural transformation: From food aid dependency to net exporter. *Indian Journal of Agricultural Economics, 77*(1), 19–33.

Newell, R., Pizer, W., & Raimi, D. (2013). Carbon markets 15 years after Kyoto: Lessons learned, new challenges. *Journal of Economic Perspectives, 27*(1), 123–146.

Padhee, A. (2018). Meeting India's growing food grain demand by 2050: Challenges and opportunities. *Economic and Political Weekly, 53*(22), 45–49.

Patel,A., et al. (2021). Opportunities in agroforestry for carbon sequestration in India. https://kishi.icar.gov.in

Praduman, K., & Joshi, V. (2016). Projected demand-supply gap for pulses, edible oils, and sugar in India by 2050. *Agricultural Policy Perspectives, 8*(2), 150–168.

Sharma,P., et al. (2020). Stubble management and carbon markets: Opportunities for Haryana. https://ciiblog.in

Shehrawat, R., Singh, H., & Verma, K. (2023). Exploring the adoption of climate-smart agriculture techniques in India. *Indian Journal of Sustainable Farming, 15*(4), 314–328.

Shinde, S., & Modak, P. (2013). Vulnerability of Indian agriculture to climate change.Academic Press. 139-152

Shukla, R., Chakraborty, A., & Joshi, P. (2017). Vulnerability of agro-ecological zones in India under the earth system climate model scenarios. *Mitigation and Adaptation Strategies for Global Change, 22,* 399–425.

Singh,R., et al. (2021). Reducing methane emissions in paddy cultivation: Lessons for Haryana and Madhya Pradesh. https://www.sciencedirect.com

Sikka, A. K., Singh, K., & Vasishta, P. (2018). National Innovations on Climate Resilient Agriculture: An overview of interventions and impacts. *Indian Agricultural Research Bulletin, 65*(2), 100–113.

Smith,J., et al. (2020). The role of agricultural carbon markets in climate resilience. https://www.nature/articles/s44168023-0055

Sridevi, G., Jyotishi, A., Mahapatra, S., Jagadeesh, G., &Bedamatta, S. (2014). Climate change vulnerability in agriculture sector: Indexing and mapping of four southern Indian states. *Econometric Modeling: Agriculture.*

Suresh, N., & Viswanathan, P. (2022). Resource allocation gaps and their impact on agricultural resilience in India. *Journal of Rural Development and Policy, 38*(2), 121–136.

Tanti, R., Mishra, S., & Banerjee, P. (2022). Factors influencing the adoption of climate-smart agriculture in India. *Climate Policy and Practice, 11*(1), 95–109.

Villalba, C., Kumar, A., & Singh, R. (2024). Overcoming barriers to financing climate-smart agriculture: The role of custom-hiring centers in India. *Journal of Agricultural Economics and Finance, 18*(3), 251–265.

World Bank.(2022). Agricultural carbon markets and climate resilience in India: Policy and practice. https://worldband.org/topic/climate-smart-agriculture