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Challenges Faced by Agriculture and Biodiversity Conservation in Kuttanad

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Abstract

This article critically examines the complex environmental and agricultural challenges facing Kuttanad, the unique below-sea-level farming region situated in the basin of the Vembanad Lake system. Historically, Kuttanad employed an indigenous, nature-aligned farming model that integrated rice cultivation with seasonal tidal flows, riverine silt deposition, and rich biodiversity. However, major post-1950s interventions, particularly the construction of the Thottappally Spillway and the Thanneermukkom Bund (TB Bund), were implemented based on the mistaken belief that monsoon floods and summer salinity were the primary problems. These projects, driven by a national agenda favoring chemical-intensive Green Revolution practices, destroyed the delicate ecological balance. The resulting environmental degradation includes increased soil acidity, water pollution, a collapse in native fisheries (including the Prawn and Cockle populations), and a significant decline in rice cultivation acreage and profitability. The article concludes by endorsing the recommendations of the Dr. Swaminathan Package, asserting that only comprehensive ecological restoration, respecting Kuttanad's status as a Globally Important Agricultural Heritage System (GIAHS), can protect the region's culture, economy, and unique biodiversity.

Key Words: Kuttanad, Vembanad Lake, Biodiversity Conservation, Thanneermukkom Bund, Ecological Degradation, Below Sea Level Farming, Soil Acidity, Integrated Farming.

Introduction

The Vembanad Lake, the largest backwater system on India's western coast, is fed by six rivers: Pamba, Achankovil, Manimala, Meenachil, Muvattupuzha, and Periyar. A total of 14,074 million cubic meters of water flows into the lake. Of this inflow, 67% is received during the Southwest Monsoon (Kalavarsham), 12% during the Northeast Monsoon (Thulavarsham), and the rest is obtained from intermittent rains.The natural connection of the Vembanad Lake with the Sahyadri (Western Ghats) mountains via the rivers, and its link to the Arabian Sea through its estuary, sustains its ecological conditions. Consequently, the lake essentially transforms into a freshwater body during the rainy season. After the rains subside, salinity gradually begins to intrude (oru kayari thudangum). A multitude of organisms, thriving in both saline (brackish)

and fresh water, are found in various environments stretching from the estuary up to the river basin. The lake's unique characteristics include a diverse plant cover (flora) and a variety of agricultural crops.

Vembanad and Kuttanad

The backwater system is also a habitat for millions of organisms that enter with the tidal flow from the Arabian Sea. The biological wealth and fertility brought by the water flowing from the rivers make our coastal sea one of India's most abundant marine regions. Kerala's coast, which makes up only 10% of India's coastline, contributes close to 20% of the total marine fish production in the country.

Kuttanad is the shallow river-basin area of Vembanad Lake. The Kuttanad paddy fields (Padashekharams) were created by reclaiming these shallow river-basin areas of the lake with the construction of mud embankments (manchirakal / puravelikal).It is natural that these areas, where silt (alluvium) brought by the rivers from the densely vegetated eastern hills was deposited, became most suitable for rice cultivation. Kuttanad, where farming takes place below sea level, sustained by the strength of the outer bunds reclaimed through human effort, is truly one of the world's rarest rice cultivation regions.

Farming in Tune with Nature

In this verdant land, which was raised from the backwater expanse through human effort, our ancestors devised land-use systems that were in tune with the rhythm of nature. They developed different rice varieties suited to the ecological conditions of the backwaters and formulated cultivation practices according to the rhythm of the climate. In the regions adjacent to the Kochi backwater, where salinity intrudes, they practiced Pokkali rice cultivation, which is salt-tolerant, alongside prawn farming during the summer. In the southern regions of the backwater, where rivers bring copious amounts of water, different types of rice were cultivated.

After the rice harvest, the paddy fields were naturally maintained as water reservoirs. This created natural habitats for fish, Kuttanad ducks, and other organisms to grow and multiply.They allowed the floodwaters brought by the rivers during the Southwest Monsoon to enter the paddy fields. Adopting a rice cultivation method that utilized the deposited silt (alluvium) and biological richness, our ancestors implemented an eco-friendly farming system that concluded the harvest as early as October-November, after the Southwest and Northeast Monsoons subsided.

This kind of farming system, which gently engaged with nature, was our tradition until the 1960s. The rice cultivation was completed before the tidal inflow from the sea—and the consequent intrusion of salinity (oru rasam)—began as the river flow diminished. Realizing

that the northern Kuttanad region, closer to the estuary, was the first to experience salinity, they cultivated earlier there and, where necessary, constructed small, temporary bunds (oru muttukal) to prevent salt ingress.

Fish Production Along with Agriculture

Another significant part of the backwater is utilized in a way that allows the marine life and fish species entering the lake to grow, multiply, and migrate. Our ancestors devised a land-use pattern here that ensured both fish production and the conservation of the backwater's biodiversity.They recognized that rice cultivation and fish production were the fundamental functions of the backwater. They believed that rice farming should utilize the silt brought by the rivers, and fish production depended on a strong, consistent connection with the sea.It was accepted that the primary communities here were the rice farmers, the agricultural laborers, and the poor laborers in the fisheries sector. They acknowledged that agriculture and fish production, in connection with the backwater, constituted the main livelihoods in the region.

The Reclaimed Kuttanad (Kuthiyedutha Kuttanad)

The most significant ecological intervention in the history of Kuttanad was the formation of the backwater wetlands and the development of backwater farming. The process of reclaiming the backwater (kayal kuthal) began in the latter half of the 19th century with the generous support of the Travancore Government.

Initially starting near the shoreline, the reclamation gradually extended into the deeper areas of the backwater. The first step in this process was the construction of the outer bunds (puravelikal), built inch-by-inch by splitting and crushing bamboo, cutting down coconut trees, planting stakes, digging and piling up backwater mud, and reinforcing them with branches and bushes.

The lake paddy fields we see today are the eternal monuments to the sheer physical strength and mental fortitude—a combination of the hard labor of incredibly adventurous workers and the determination of the farmers—who defied the roaring waves and the strong winds.

Pioneer Farmer Heritage (Athisahasika Karshaka Paithrukam)

The backwater reclamation (kayal kuthal) that began in the 19th century with the generous approach and support of the government expanded to 23,100 acres by the mid-20th century. Numerous prominent farmers spearheaded this effort, including Chalayil Iravi Kesava Panicker, Shree Kalathil Antony, and Chirayil Thomman Mappila.Among these pioneering farmers, Pallithanamattu Lukka Mathai took the initiative in 1089 ME (Malyalam Era, which corresponds to 1913-1914 CE) to reclaim the R-Block padashekharam, which was the largest paddy field in Asia at 24,000 acres (Note: *The text implies R-Block was 24,000, but records

show it's closer to 2,400 acres, possibly a typo in the original text or a reference to a larger combined area that includes nearby fields). After 1921, Shree Thomas Murickan took over this venture, reclaiming 2,340 acres of backwater lands in the deeper parts of the lake. It is history that Shree Thomas Murickan earned the title "Kayal Raja" (King of the Backwaters).The Rani, Chithira, and Marthandam kayals (reclaimed lands), named after the Maharani of Travancore and her sons, remain an eternal marvel in the backwater depressions.

Environmental Interventions

The human interventions in the environmental history of the Vembanad Lake intensified in connection with the agricultural development of Kuttanad. These interventions were driven by the belief that the river water flowing into Kuttanad during the monsoon and the saline water intruding from the sea during summer were the fundamental problems of the region. To quickly drain the water brought by the five rivers in Kuttanad into the Arabian Sea, the Thottappally Spillway was constructed in 1955. To prevent the ingress of seawater, the Thanneermukkom Bund was also constructed. Beyond the earthen outer bunds built by humans to stop water from flooding the paddy fields, stone walls were constructed—all intended to protect and expand rice cultivation.

As the lake areas were enclosed and converted into paddy fields to increase cultivation area, the lake and the intermediary canals became unable to accommodate the water brought by the rivers. We know that if this water were stored and allowed to flow naturally across the paddy fields during the rainy season, the flooding would not become a major problem.

However, the spillway did not save Kuttanadu from the flood calamities. Experts failed to understand that the sea level would rise during the monsoon, and that the water would not drain into the sea due to the intense wave action and counter-currents (odichu kuthu). The spillway, which stands as an eternal monument to construction defects, could not drain even one-third of the intended volume of water, becoming an irreparable blemish on the Kuttanad environment.

The new IIT study team assigned to fix these defects now states: the leading channel that carries water from the rivers to the sea needs to be doubled in width. Thousands of people living on the outer bunds must be evicted. The height of the outer bunds must be raised above the level of the sea's counter-currents. They are now in a situation where they may need to commission yet another study team to assess how practical these suggestions are.

Local Conditions Unsuitable for the National Agenda

In 1960, Kuttanad was included in the Integrated Agricultural Scheme formulated by the Central Government. The ripples of the Green Revolution also reached this area, introducing high-yielding rice varieties and modern agriculture based on the heavy application of chemical

fertilizers and pesticides. Kuttanadu people realized too late that the main problems arising from implementing a farming system—developed for the irrigated agricultural regions of the country—in a water-logged catchment like Kuttanad were waterlogging and pollution. They ultimately entered the vicious cycle of chemical-intensive agriculture.

Backwaters Turning into "Kaliya's Pool" (Kalindiyākunnna Kāyalpparappukaḷ)

Kuttanad is today the agricultural region in Kerala facing the most severe environmental pollution. Chemical contamination, pesticide residues, and heavy metal elements have combined to make the soil and water of Kuttanad frighteningly toxic today. Illness and cancer rates are escalating. Experts fear that Kuttanad will transform into an unhealthy region, raising the most alarming contamination issues within the next ten years. The indications provided by the latest various studies are highly disturbing.

(* Note: The heading uses "Kaliya's Pool" as a cultural reference. In Hindu mythology, the river Yamuna's pool became poisonous due to the serpent Kaliya, hence the phrase "Kāliṅdiyākunnna" (turning into Kaliya's river/pool) signifies severe toxic contamination.)

The Backwater That Ceased to Be a Backwater

The entire farming methodology, which was aligned with the seasonal cycles of salinity intrusion and water flow, was completely abandoned. The Thanneermukkom Bund was constructed as a permanent solution to salinity intrusion.

The regulations decided upon when this regulator was built were: closure on December 15th and opening on March 15th. These were conveniently ignored. There was also a provision for reviewing the issues caused by the bund every five years; this, too, did not happen. Furthermore, the bund was kept closed for up to six consecutive months in some years. From 1975 to 1990 (15 years), the bund was opened during summer for an average of only 14 days. Between 1990 and 1996, it was open for 44 days, and between 1997 and 2004, it was open for 27 days.

Consequently, the backwater south of the bund transformed into a freshwater lake. The maximum recorded salinity (oru rasam - measured in parts per thousand) decreased dramatically: from 22.21‰ in 1974 to 11.0‰ in 1986, then to 5.0‰ by 1998-2000, and finally to a maximum of 2.5‰ by 2011.

Even with this reality, proponents change their stance like chameleons, shouting that salinity is still rising in Kuttanad and destroying rice cultivation. Experts hesitate to state that the main reason for the failure of rice cultivation, like in other agricultural regions that practiced continuous chemical farming, is the collapse of soil nutrient balance and severe soil health deterioration, or the appearance of dangerous chemical substances in the soil.

We also fail to understand that many problems are caused by the disruption of tidal flows and the lack of natural self-purification and biological enrichment processes. Tidal action (ebb and flow) and the deposition of silt through the rivers are Nature's way of ensuring the biological enrichment of the Kuttanad fields.

The Thanneermukkom Bund was originally constructed to end the breaching of bunds (madaveezhcha) that occurred in Northern Kuttanad (especially in the kayal areas) during the conjunction of the Vrischikam tides and the Thulavarsham floods, and to prevent salinity during the final days of the punja (rice) crop. However, the construction lobby and agro-business advocates, who falsely propagated that the bund was for facilitating two crops across all of Kuttanad, reaped a rich harvest (chākarakālam - a period of abundance) due to its construction.

Agriculture Out of Sync

With the bund becoming a fixture as the permanent solution to salinity intrusion, the discipline in rice cultivation was completely destroyed. Farming began to be conducted carelessly. Even with extensive discussion and pleas not to torture the community by closing the bund indefinitely, there are paddy fields in Kuttanad today that start cultivation as late as the end of January. Those responsible for this are punishable. The losses and responsibility for the pollution issues arising from keeping the bund closed even a single day past March 15th should be placed on the officials who create such circumstances.

In the backwater, where tidal flows were blocked, polluted water stagnated. Weeds proliferated, increasing the weed menace in rice cultivation as well. Pests and diseases multiplied, making the application of dangerous herbicides inevitable. With the stagnation of polluted water, contagious diseases spread. The water level of the lake also dropped. The repercussions of this can be seen even in the Idanad (midland region); water levels in the wells have fallen severely.

The Complete Collapse of the Fisheries Sector

The environmental degradation of Vembanad has most severely impacted the fisheries sector. The annual fish production of the backwater has dropped from 16,000 tonnes to just 7,000 tonnes. In Kuttanad, which constitutes half the backwater's expanse, the production is only a mere 500 tonnes. The fish productivity of the backwater is now just 500 kg per hectare.

The reason for this is the extinction of many fish species that fed on the microscopic plants and other organisms produced through the basic productivity of the ecosystem. Previously, there were 150 fish species; now, there are only 62 species. Of these remaining species, more than 12 are facing extinction threats. Although population recovery has been achieved by artificially culturing and releasing species like Chittinangal (native species of fish), Manjakuri (Yellow Catfish), and Thuli fish into the backwater, these are merely artificial remedies.

The Decline of the 'Kuttanadu Prawn' (Kuttanadan konchu)

The Kuttanad prawn (Kuttanadan konchu), endemic to Vembanad, is the world's fastest-growing prawn species. However, its annual production, which was 420 tonnes before the construction of the bund in the 1970s, is now a mere 24 tonnes. The reason is clear: the prawn requires saline water (oru rasam) for reproduction. It needs the facility to migrate to the brackish water zones of the backwater, and the juveniles must be able to return to the freshwater areas. The bund destroyed both these necessities. Salinity is absent, and the bund has become a physical obstruction. The migratory process has been halted. Consequently, the Kuttanad prawn is facing extinction in its own homeland.

The Black Gold of the Backwater

The Black Cockle/Clam (Karutha Kakka) is the native wealth of the backwater. Annual production was once up to 75,000 tonnes. These too require the backwater environment for reproduction—salinity must intrude. Production dropped to 13,000 tonnes in some years, though it has recently risen to about 29,000 tonnes. This is the pride of Kerala's Vembanad, contributing 90% of the natural lime (calcium carbonate). Today, all the major factories in Kerala that relied on this clam wealth have been shut down. The livelihoods of the poor labor communities, who earn a living by collecting the clams, shucking the meat, and delivering it door-to-door, have also been destroyed.

The Karimeen (Pearl Spot) is a fish species unavailable anywhere else in the world except Sri Lanka. Its home is the Vembanad Lake. Karimeen, the state fish of Kerala, spawns and thrives only on pollution-free backwater shores. The production and survival of Karimeen, which is also a unique product of backwater tourism, are under threat from pollution. The loss of water transparency and the disappearance of mangrove forests are issues that are destroying its reproduction.

Setback to Rice Cultivation

The irony is that the various interventions undertaken in Kuttanad to improve rice farming have turned into a setback for the expansion and very survival of rice cultivation.Four decades ago, the extent of rice cultivation was 56,000 hectares. Today, it is only 37,624 hectares. In the 1970s, the land use intensity was 130% (meaning 30% of the paddy fields cultivated two crops). By 2004, this had fallen to 114% (meaning 86% of the paddy fields cultivated only one crop).

The Thanneermukkom Bund and other interventions, which were proclaimed as measures to increase cropping intensity, largely succeeded in increasing the cost of cultivation. According to a study from the year 2000, the production cost of one quintal of rice in Kuttanad was ₹528. The average cost of rice production across various states in India was ₹240 per quintal. In

Punjab, the cost for one quintal of rice was ₹185 (The text notes a current price of ₹201, suggesting a proportionate increase). The reality is that every scheme implemented to increase and improve rice cultivation has become detrimental to the very existence of rice farming. It is doubtful whether our farmers and the general public have evaluated these problems with the seriousness they deserve.

Soil Acidity and Agricultural Crisis in North Kuttanad

North Kuttanad is one agricultural region that should have benefited most from the Thanneermukkom Bund. This area, which includes Kumarakom, Thiruvārppu, Aymanam, Vaikom, and Kallara, lies adjacent to the bund and constitutes the river basin areas of the Meenachil River.Like other regions in Kuttanad, the main crop here was punja (winter/dry-season rice crop), typically starting in October and finishing in February. Due to its proximity to the bund, North Kuttanad was the first area to experience saline water intrusion before the bund was built. Farming was carried out in these areas by constructing temporary salinity bunds (oru muṭṭukaḷ).

Today, however, the punja crop is absent here due to soil problems. These fields have a high degree of acidity (puḷirasam - sourness/acidity). With the permanent blockage of both saline water and river water inflow, the soil acidity increased and the soil lost its health. Conditions changed. As the river flow decreased during summer, the soil's productivity declined. With the shift to monsoon-season cultivation, the inflow of river water is also being denied here. This points to extremely serious agricultural problems. Due to these complex issues, farming in about 10,000 acres of this region can only be undertaken during the monsoon season today. The punja crop has become virtually impossible.

One Rice, One Fish (Oru Nellum Oru Meenum)

It is against this backdrop that studies began on farming methods that integrate rice cultivation and fish farming, suited to the economy and socio-ecology of Kuttanad. Farming models that integrate fish farming in paddy fields that remain waterlogged after a single rice crop began with studies initiated at the Kumarakom Agricultural Research Centre in the 1980s.

This farming model, named "One Rice, One Fish," gained popularity in Kuttanad after 1990. Farmers enthusiastically adopted this model, which involves cultivating rice in the appropriate season without making any changes to the native conditions of the paddy fields, and cultivating fish during the remaining period. It was found that this method helped reduce the cost of rice cultivation by 40% and increase the yield by 15-20%.

However, some argued that the profitable spread of fish farming would lead to the complete disappearance of rice cultivation and that the fish stored in the paddy fields—by controlling

weeds and other pests—would reduce employment opportunities. The history is that the "One Rice, One Fish" cultivation, which should have been developed as a potential agricultural system for Kuttanad, became merely a Fisheries Department scheme.

During this period, integrated farming models—combining fish with ducks and cattle rearing alongside rice in the paddy fields—were also developed at the Kumarakom Research Centre. Although proven to be the most profitable, the truth is that these models have not yet gained widespread acceptance.

Fisheries Development Projects

Given the situation where schemes implemented to improve rice cultivation in Kuttanad caused major setbacks in the fisheries sector, the Fish Ranching and Fish Sanctuary Projects developed by the Kumarakom Research Centre, along with polyculture in the open backwaters, present possibilities for significant positive change in fish production.The Ranching Project, which involves artificially producing the endangered Kuttanad prawn and growing it in net cages before releasing it into the backwater, and the Fish Sanctuary Project, which creates protected habitats for indigenous fish like Karimeen by depositing concrete reefs, coconut shells, and laterite stones, or planting stakes in the shallow areas of the backwater, are both assessed to be beneficial for increasing fish production.However, it is also noted that such projects need to be made more efficient.

Conclusion

The problems and distress in Kuttanad's agricultural sector are deeply connected to the environmental changes and degradation of the Vembanad Lake—a fact assessed in the Dr. Swaminathan Package Report. Most of these interventions were implemented with the goal of improving rice cultivation, yet these actions entirely disregarded the diverse, other functions of the backwater. Even the scientific principle that the Master Factor (Adhīśaghaṭaka) of the backwater is biodiversity was not accepted. As a result, the biodiversity has been destroyed one by one.

Against this background, the study team led by Dr. Swaminathan proposed the idea in the Kuttanad Package that Kuttanad and the Vembanad Lake can only be saved through ecological restoration. The ultimate goals of the Package were the environmental restoration of Kuttanad and the improvement of the livelihoods of the local communities.

However, it cannot be claimed that the projects asserted to have been implemented have truly embodied this core philosophy of the Package. The situation where the Package projects were converted into the routine programs of various government departments, rather than

prioritizing integrated development, has faced criticism. Not only the technical perfection of the project, but also its ecological friendliness, has not been subjected to rigorous evaluation.

Kuttanad is one of the few regions in the world where agriculture and sustenance activities have been shaped below sea level. Acknowledging the contributions of its pioneering farmers, the Food and Agriculture Organization (FAO) of the United Nations declared Kuttanad a Globally Important Agricultural Heritage System (GIAHS) in 2013. This status was granted based on the recommendations of the renowned agricultural scientist Prof. M. S. Swaminathan.

In the context of climate change, ensuring the conservation of Kuttanad's biodiversity requires the development and propagation of farming methods that are compatible with the region's topography and climate. Water abundance is Kuttanad's strength. Kuttanad can only be saved through integrated farming systems focused on biodiversity. Agriculture is the Indian culture. It is life. Therefore, the farmlands must be protected.

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