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# Revitalizing India's Soil: Solutions to Combat Soil Erosion

## Introduction

Sweat dripped down my forehead as the taxi snaked through the busy streets toward the airport. My heart raced with anxiety, my mind consumed by thoughts of the journey ahead to India. I made it to the airport and made my way inside, my heart pounding with a mix of excitement and anxiousness. Finally boarding the plane, I was overwhelmed with emotions, my eyes filling with tears as the weight of four long years of absence lifted off my shoulders. I was eager to witness the colorful culture and spectacular natural beauty that I had read so much about as soon as I got to the airport in India. However, as I walked out into the city, the scent of freshly mowed grass, street vendors selling delicious snacks, and temples performing rituals was overwhelmed by the smell of pollution, choking me with dust, trash, and even human waste. My heart sank as I became aware that the air I was breathing was toxic and that no one had bothered to pick up the garbage from the street.

As I ventured away from the bustling city streets to my grandparents' hometown, my heart was heavy with the hardships faced by rural locals. Particularly hit hard are the Indian farmers who are under increasing pressure to feed the country's rapidly expanding population. To that end, some have resorted to extreme methods like suicide or the overuse of toxic pesticides and fertilizers. It was a grave situation that not only affected my family's community but the entire country. Urgent action was imperative to solve these pivotal problems. For the betterment of my community, the welfare of farmers, and the future of India, I recognized the need to act and improve the lives of millions. My tireless research and dedication over the past two months have led me to practical solutions for India's most pressing agricultural problem: soil erosion.

## Background

India, a diverse and vibrant country, offers a variety of traditions, cultures, and landscapes. With a population of approximately 4.44 people per household in 2021 (Global Data), India is a country marked by its demographic diversity. Around 40% of the population (Cook Unity) in India are vegetarian due to religious beliefs, compared to the measly 5% in the US (Cook Unity). Staples like rice, wheat, beans, dairy, and vegetables dominate their plates, often cooked in large amounts of oil

and ghee (clarified butter). The non-vegetarians, though fewer in number than in Western countries, do consume beef, although infrequently. This overwhelming demand for farm-grown food places immense pressure on Indian farmers exerting both mental and physical strains on their well-being.

The agricultural sector plays a huge role in employment. The unemployment rate decreased to 7.33% in 2022 (Statistica), and many found employment in farming, particularly in rural areas. However, rural life in India, especially for farmers, is marked by limited access to quality education and healthcare. Due to schools being hundreds of kilometers away from homes, rural families have little to no education, and thus start severely relying on agriculture to survive. In terms of healthcare, while urban areas boast accessible and affordable services, rural regions often struggle with inadequate healthcare infrastructure, resulting in expensive hospital visits. Additionally, only 4% (World Bank) of water sources are classified as clean, making India one of the most water-stressed countries globally. Seeing these horrifying obstacles farmers have to face, some state governments provide farmers with free electricity as a token of appreciation for their indispensable role in feeding India and the world. Understanding the multifaceted challenges faced by Indian farmers, encompassing income disparities, agricultural inequality, soil erosion, and agricultural production, provides crucial insights into the realm of agriculture in India.

## Income in India

Farming, a cornerstone of India's economy and a prevalent profession is failing to yield sufficient income for farmers and their households. In 2005, the India Human Development Survey (IHDS), encompassing crucial statistics such as annual income and source of income, showed the grim realities of the agricultural sector in India. To illustrate, the average annual household income in the country hovers around 22,400 rupees ($275.25), with certain regions such as Orissa plummeting even lower to approximately 15,000 rupees ($181.64). Specifically in agricultural and rural areas, the annual income stands at a mere 9000 rupees ($108.98), not even half the average income of other professions. Elevating the income of these farmers would significantly contribute to mitigating soil erosion within their fields, as it enables them to allocate greater financial resources toward preventive measures, such as fibrous rolls and narrow-spike hoe openers**.** The statistics get even more upsetting when considering that the headcount ratio of the population below poverty is 21.8, signifying that about 22 people are impoverished for everyone who isn't. However, the most intriguing statistic emerges from the comparison between annual income and consumption among rural agricultural families. This data reveals a sharp contrast: consumption, totaling around 7877 rupees, surpasses the income figure of about 7101 rupees. This underscores that Indian farmers not only earn meager salaries but also struggle with large sums of debt as they battle to cover their basic expenses. Aggravating these challenges is an important magnifying factor: the issue of overpopulation.

## The Challenge of a Growing Population in India

India's agricultural industry is presented with many difficulties due to India's population of 1.41 billion people (Data Commons). A massive population brings massive challenges. As agricultural production needs to intensify in both scale and on-farm efficiency, an increase in pests, erosion, and other dangers often destroy crops, leading to an immense loss in money for farmers. In response, many farmers resort to using chemicals like pesticides and fertilizers to protect their crops. This leads to further damage, not only to the quality of the crops but also to the soil. As a result, India has seen a horrifying trend in recent years, with over 400,000 farmers committing suicide between 1995 and 2018, translating to approximately 48 suicides every day (National Library of Medicine). A severe inequality in income and poverty has exponentially increased these numbers. The states most affected are Maharashtra, Karnataka, and Telangana. Implementing sustainable and integrated pest management techniques to address this issue can help farmers grow their crops healthily and sustainably. As the population increased, more and more land was cleared for buildings and agriculture that degraded soil. However, India has yet to find a promising solution to their largest problem, the result of severe soil degradation: erosion.

## Effects of Erosion

South American countries and Southeast Asian countries like Brazil and Pakistan have been trying to tackle erosion for centuries, and India has been no exception. Erosion is the process of when soil and other materials from the earth's surface are removed from one place by natural forces like water, is not only an environmental issue but an economic issue as well. It exacerbates water quality issues, as soil particles transport harmful chemicals such as fertilizers and pesticides into aquatic ecosystems. Moreover, the erosion-induced loss of nutrient-rich topsoil, which takes centuries to form, leaves behind infertile and acidic subsoil, posing long-term challenges for sustainable land use and agricultural productivity. Since almost 54% of India's land is agricultural, India's largest revenue comes from agriculture. According to the Indian State of Environment Report 2021, soil erosion affects approximately 36 million hectares of land in India, primarily concentrated in the states of Uttar Pradesh, Rajasthan, and Madhya Pradesh. Moreover, erosion leads to the degradation of natural resources and biomes which are crucial for the survival of local communities and the overall ecosystem. India has been putting a lot of time and resources into coming up with a solution for years now, but they still haven't been successful in stopping this problem that has lasted for over 3000 years.

## India's Efforts To Stop Erosion

India has made countless efforts to slow down erosion as much as possible to strengthen the future of their agricultural industry. The National Watershed

Development Program for Rainfed Areas (NWDPRA) is a program from the state of Mizoram, India, that aids the families of cultivators living below the poverty line through the treatment of arable and non-arable land, and the development of agriculture/horticulture crops, among other initiatives. Despite the modest success of the NWDPRA in reducing soil erosion and increasing agricultural productivity in several states, many farmers continue unsustainable practices creating a feed-forward loop that accelerates erosion. The biggest challenge though is the limited availability of resources and technology for soil conservation techniques. This, coupled with the pressure of feeding the world, demands too much from the country than what it can provide, causing chaos throughout the nation.

## Agroforestry

Agroforestry, the practice of growing trees alongside crops, is a promising technique to mitigate soil erosion in India. By binding their roots to the soil, the trees significantly reduce the chances of erosion. Additionally, agroforestry has also been found to be beneficial for other aspects of farming, such as improving soil nutrients, increasing overall crop yields, and providing shade and shelter for other animals in the ecosystem. They can also provide homes for countless organisms like birds and insects, creating a stable ecosystem. However, agroforestry also has some disadvantages, such as the potential competition between trees and crops for essential resources like water and nutrients. Agroforestry also takes a lot of time initially to start since most trees take years to fully grow. Still, the trees provide an additional source of income to farmers, as they can be harvested for timber and fruits like bananas and mangoes. In India, Rajasthan and the hilly areas of Himachal Pradesh have already started to implement agroforestry in hopes of decreasing soil erosion, and it has shown significant improvement (Frontiers 2023). Overall, the benefits of agroforestry for soil erosion prevention and its potential to provide additional income and improve overall farming sustainability make it a promising technique for farmers in India.

## Cover Crops and Crop Rotation

While agroforestry has been a popular solution to combat soil erosion in India, the combination of cover crops and crop rotation has emerged as the best management practice in stopping soil erosion in India. Cover crops are grown primarily to protect and improve the soil and crop rotation is the method of growing different crops in a sequence on the same land over time so that each crop grows under the best conditions with lots of nutrients. In India, typical crop rotations include cereals like rice and oats followed by legumes like cowpea and chickpeas, and finally by oil crops like soybeans. This not only optimizes the nutrient utilization in the fields but also reduces the pressure of using pesticides on farmers since different crops interrupt the life cycles of pests that are specific to a single crop. According to a study conducted by the Indian Council of Agricultural Research (ICAR 2022), the use of cover crops and crop rotation can reduce soil erosion by up to 90%, compared to the 50% from agroforestry, the second-best method. Unlike agroforestry, which is time-consuming, requires lots of arable land, and requires

multiple years for the trees to grow, cover crops, fix atmospheric nitrogen, and reduce the need for synthetic fertilizers, which, like crop rotation, improve soil retention capacity and nutrients. Some popular cover crops in India include Oats, Cowpea, Buckwheat, and Alfalfa, all of whom are very efficient at nitrogen fixation (Agrifarming 2022). The states of Madhya Pradesh and Bihar have reported significant improvements in soil health and crop yields after successfully implementing crop rotation and cover crops in their vast fields. Crop rotation and cover crops have been promising methods to stop soil erosion not only because they're the most efficient, but because they are also the most economically friendly.

India's economy could also benefit from implementing crop rotation and cover crops. This approach offers a dual advantage of cost-effectiveness and additional revenue generation. A report by the World Wildlife Fund (WWF) estimates that cover crops and crop rotation could lead to a 30% decrease in expenses and a 50% increase in agricultural production. The report also suggests that these practices could result in an additional income of up to 50,000 Indian rupees per hectare per year for Indian farmers through the sale of cover crops like mustard and wheat. This supplementary income not only helps impoverished families meet their basic needs but also protects them from hunger and indebtedness. To achieve these benefits, farmers should be taught about these practices by established agricultural agencies like the Ministry of Agriculture & and Farmers' Welfare. These government agencies can hold regular workshops to help guide farmers in states like Uttar Pradesh, where around 65% of the population is engaged in the agriculture sector. Several other agencies like the National Seeds Corporation exist to provide farmers with the best cover crop seeds for a cheap price. The help these farmers get can effectively make a significant difference in their agricultural outcomes.

Last but not least, using crop rotation and cover crops together is more effective in reducing soil erosion compared to using them independently because they complement each other's weaknesses. Crop rotation can prevent soil depletion by alternating crops and replenishing soil nutrients, but cannot protect the soil from erosion during fallow periods. Cover crops, on the other hand, can prevent soil erosion by holding the ground in place and adding organic matter, but cannot provide sufficient nutrients for the following crops. Together, crop rotation and cover crops create a perfect soil conservation strategy with no holes, leading to a more sustainable and productive agricultural system free from soil erosion.

## Other Problems with Similar Solutions

The idiom "two birds, one stone," a staple in English literature, conveys the art of solving multiple problems with one action. In the world of Indian agriculture, this idiom takes on a different connotation, and I believe the practice of using cover crops and crop rotation should coin the phrase "flock of birds, one stone". In this scenario, the flock of birds would effectively control pests, replenish soil nutrients naturally, increase biodiversity, maximize crop yield and efficiency, lower the cost and requirement for fertilizer, and fix atmospheric nitrogen. Embracing cover crops

and crop rotation on a nationwide scale in India could address numerous agricultural issues and potentially save millions of lives.

## Conclusion

Soil erosion has been a pressing issue in India, one that threatens the country's food security, environmental sustainability, and economic development. The consequences are severe, ranging from reduced crop yields to decreased biodiversity. Through the use of efficient methods like agroforestry, cover crops, and crop rotation, we can change the decline in India's agricultural industry. We cannot ignore the tireless efforts of Indian farmers as they work to grow enough crops to feed the whole world, despite their severe poverty. Government agencies should provide a stipend and additional payments to farmers who adopt sustainable farming practices as a way to show that we appreciate them for growing our food healthily. Such initiatives would not only help farmers improve their lives but also promote environmental sustainability for future generations. I hope to go back to rural India, the home of my family and ancestors, in a few years and see the lush green fields and the happy farmers planting the crops that feed the world, without worrying about soil erosion.

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