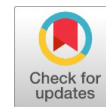


Sustainability of Rice Wheat Cropping System in India

Shubham Singh



Abstract: India's rice-wheat cropping system (RWCS), responsible for 40% of the nation's food grain production, has been a successful contributor to food security. However, despite nearly half of India's population relying directly or indirectly on agriculture, and agriculture itself contributing 18% to the country's economy, challenges loom large. One pressing issue is the Russia-Ukraine conflict, disrupting grain and fertilizer supplies, causing fertilizer prices to surge, and adding to the burden of already debt-ridden farmers. This crisis highlights the vulnerability of an agricultural system heavily reliant on external factors. Moreover, the RWCS faces environmental threats. Depleting groundwater levels from over-irrigation and excessive chemical use pose long-term risks. The use of chemicals, in response to diminishing soil health, leads to the harmful effects of biomagnification and eutrophication, disrupting food webs and chains, and impacting both ecosystems and human health [5] [7]. A shift toward sustainable and diversified agriculture is imperative to secure the future. Investing in modern farming practices, promoting organic farming, and encouraging crop rotation can help reduce the system's environmental toll. Additionally, improving access to credit and insurance for farmers can ease their financial burdens and ensure their livelihoods. In the face of these challenges, India must consider long-term sustainability to safeguard its food security, environment, and the well-being of its agricultural workforce.

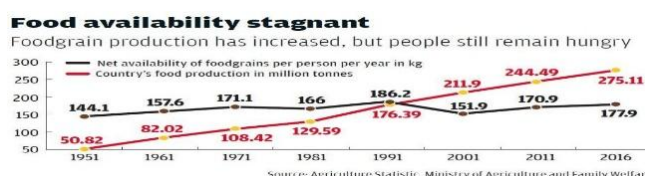
Keywords: Green Revolution, Accelerated Eutrophication, Biomagnification, Food Web, Pollen and Pistil Interaction, Bio Amplification, Milankovitch Cycle

I. INTRODUCTION

Today our farmers are in terrible condition in 2014 alone 5650 farmers committed suicide, which is 4.3% of the total suicides in India, excluding agriculture laborers, bankruptcy, and family issue are the main reasons with 20.6% and 20.1% share according to ADSI report (bureau, 2021). That is 15 farmer every single day, more than 1 farmer every 2 hours, and most of the farmers are in debt and trapped in formal or informal institutions, we should be aware of the conditions the yield is going down, unusual rain and acid rain are destroying land, and the unusual fluctuations in the market that most of the farmers will never have a financial surplus to meet their loans. Other less-known facts about the financial crunch that farmers are facing are depleting groundwater levels, and water quality deterioration the most fertile lands

of our country is ruined due to the effect of pesticides and fertilizers, and day by day the food that we eat is getting poisonous due to groundwater contamination, and chemicals used in the fields. This is destroying the soil's health and structure. In the 1960s India was facing a food shortage then our Prime Minister India requested 10 million tonnes of wheat from the United States to avoid shortages but President Lyndon Johnson resented Mrs Gandhi's proposition, due to the Vietnam War. Norman e Borlaug who was the "father of the green revolution" in the world due to its semi-dwarf varieties shifted its focus on the hungriest country on the planet that was India where 3 million of them died due to hunger, this was the point when the green revolution was initiated in India where we implemented the most efficient and high-yield systems, to become self-sufficient with our food supply, this included importing machinery and techniques from abroad using pesticides and fertilizers and many other methods to increase our production capacity so that we can feed our people [2] [3].

Based on the findings of the Global Food Security Index 2022, it is evident that India exhibits a prevalence rate of undernutrition amounting to 16.3%. Moreover, it is noteworthy that in India, a significant proportion of children, specifically 30.9%, experience stunted growth, while 33.4% are classified as underweight, and a smaller percentage, namely 3.8%, are categorized as fat. The Human Development Index (HDI) of India stands at 0.65. (nayaran, 2023) [1].



[Image Source: (Jitendra, 2018)]

II. RICE-WHEAT CROPPING SYSTEM

It is a cropping system in which rice and wheat are grown in sequence in the same field, so rice is cultivated in the kharif season or monsoon season and wheat in the rabi season or winter season reason for this was it increases the crop productivity, reduced labor cost and has economic benefits also than compared to others and this was the main reason because of which we were able to come out of the shortages and green revolution in India also started. Today the rice-wheat cropping system has become the backbone of our Indian farming, especially in the northwestern zone of India Uttar Pradesh, Haryana, and Punjab. If we talk about the statistics of the rice-wheat farming system it was 10 million hectares [4].

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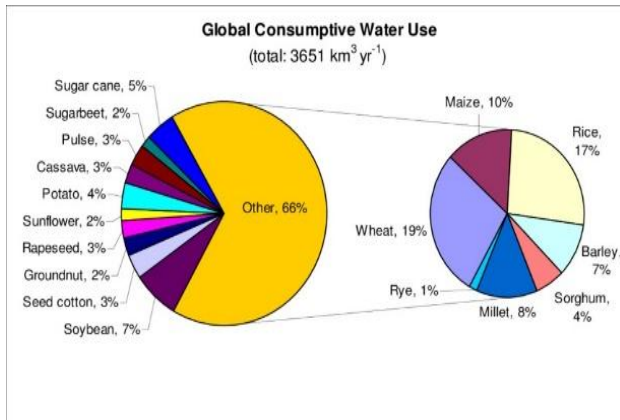


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If we talk about wheat and rice in India, it's not just a commodity, they are the staple food. They are used in our houses as well as act as a raw material in a lot of food processing industries, 70 % of the population consumes wheat and rice, and become a critical part of the population and economy. In the 1960s, the rice-wheat system became a savior for the population by fighting hunger but now it has become a major flaw. The first problem that could be witnessed is the water consumption of rice and wheat [6][13][14].

Food Produced	Water needs for food production kg of water per kg of food
Rice	1900-4000
Wheat	900-2000
Potato	500-1500
Chicken	3500-5700
Beef	15000 – 70000

[Image source: Schreier, Hans. (2023). *Water and Agriculture: Harvesting Water Before Harvesting the Crop*]



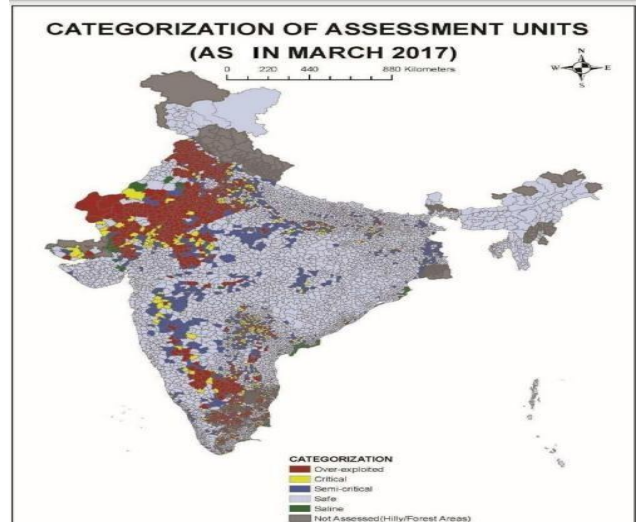
[Image Source: Liu, Junguo & Zehnder, Alexander & Yang, Hong. (2009). *Global Consumptive Water Use for Crop Production: The Importance of Green Water and Virtual Water*. *Water Resources Research*. 45. 10.1029/2007WR006051]

It can be summarised from the above chart that both wheat and rice have high water requirements, that too both are grown on the same field and the majority of the water which is used in the fields comes from the borewells which pump groundwater.

III. IMPACT ON GROUNDWATER

We always say that groundwater is the lifeline of India it's the water that flows under the ground and is used by the majority of the country. The same groundwater is being polluted and mismanaged. today the water of Punjab is neither fit for drinking nor good for irrigation purposes.

There is also a prediction that has been done that if water management is done properly in India, then 35 % of the Indian population will not have access to drinking water by 2030. (board, 2019-20)



[Image source: *Ground Water Year Book 2019-2020 by Central Ground Water Board, Ministry of Jal Shakti, Government of India*]

When the green revolution started and the rice-wheat system was there, more surface water was used as mostly farming was done on a rainfed basis which means that rainwater was involved and less groundwater was used then. But now the scenario has reversed we use more groundwater and less surface water. the results are very dangerous to see the red area such as Delhi, Rajasthan, Punjab, Tamil Nadu, and Karnataka where the groundwater is being over-exploited. as shown in the assessment report it's calculated by annual groundwater extraction to the available groundwater, if you will them very carefully then we can observe that most fertile lands of our country are in a depleting groundwater state year after year the situation is the same. Because these states mainly produce wheat and rice if it continues till 2050 then states like Punjab and Haryana and Uttar Pradesh will create a water famine and create a shortage of water that will kill the livelihood of the farmers and shortage of food. therefore, the rice-wheat system is creating a problem that it was meant to solve [11] [12].

A. Basic Anatomy of the Root System

As winter wheat has deep-rooted (2 to 2.2 meters) so it extracts nutrients from deeper layers and the rice root system is till 90 cm the root system absorbs nutrients, as we all know that plants absorb nutrients from the root hairs present at the extreme ends of the roots, therefore, the topmost layer of the soil where most of the fertilizers are applied is not been utilized fully to its capacity and it then attracts weeds and causes nutrient loss to the main crop, to remove that weed we use weedicide which in turn hamper the quality of the soil.

IV. DETERIORATION OF SOIL HEALTH

Rice is a crop that requires puddling of the soil that water is being flooded on the rice field and with the help of a tractor it puddles or breaks the components of the soil into sand, silt, and clay as clay is the lightest it will be there on the top and will not allow water seepage or percolation of water into the ground as it helps in plantation and development of the sapling.



After puddling it destroys the soil structure and therefore requires deep tillage to cultivate a new crop. Deep tillage leads to soil erosion, nutrient depletion, and loss of soil organic matter [8] [9]. There is the image puddling looks like



[Image Source: Ali, Muddassir. (2019). Journal of Rice Science Citation: Haider Z, Pros and Cons of Mechanized Transplanting in Basmati Rice -A Case Study]

V. LOSS OF HABITAT

To compensate for it we heavily use chemical fertilizers causing soil acidity and nutrient imbalance which causes loss to soil productivity and soil health. Some of the harmful chemicals we use in agriculture have entered the grassland or aquatic food chain and are destroying the food chain and the ecosystem, and some chemicals are present in our bodies due to biomagnification [10] [15].

VI. CONCLUSION

The chemical that was present in the field goes into a water body by excessive irrigation and then enters into zooplankton which is consumed by phytoplankton that are then consumed by small fishes that are in turn consumed by large fishes and finally, large fishes are eaten by fish-eating birds and these chemicals when present in the body disturb their calcium metabolism leading to thinning of the egg shells leading to premature birth leading to decrease in their number [16]. To get a clear idea of how it is transferred into our body is shown in the figure below [17].

We annually use 5 billion pounds of pesticides across the world they impact biodiversity by killing insect pollinators which could lead to destruction as told in the “rivet popper hypothesis” by Paul Enrich which states that destroying one or two components of a food chain does not impact the whole ecosystem but if the keystone species is removed it could destroy the whole food web and lead to a huge ecosystem loss as he compared it to an airplane as removing one or two bolts will not cause any problem but if bolts of wings are taken out then it can cause the plane to crash [18].

As pesticides are sprayed on the crops it comes in contact with the flower and as soon as the pollen is brought by a biotic or abiotic agent it can impact pollen-pistil interaction up to some extent [19]. The use of pesticides in soil can lead to a significant reduction in populations of beneficial soil microorganisms. which will lead to soil acidity as no conversion of inorganic matter into organic one, therefore, damaging the soil quality. According to soil scientist Dr. Elaine Ingham, “If we lose both bacteria and fungi, then the soil degrades”. It also pollutes the groundwater as pesticides majority of which are soluble in water. if excessive rainfall or irrigation is there so these are even percolate. They can even cause accelerated eutrophication in a nearby lake [7].

Thirdly greenhouse gases from agriculture especially from rice fields which release methane is one of the reasons responsible for global warming and transformation into the Anthropocene epoch. 16% of the greenhouse gases are from agricultural fields and in it, 37% of the emission comes from rice alone.

Global warming and climate change have disturbed the Milankovitch cycle which is related to ice ages ,a pattern in the earths tilt ,distance of moons because of which we are stuck into and inter glacial phase.

Soil is in danger, groundwater is in danger, farmer livelihood Is in danger and our country's food security is in danger, if not taken care our economy can come into danger.

Some say our per capita income has doubled but still, there are very poor section in India which has daily earning of 50 to 100 rupees and cannot afford good nutrient-rich food. As the price of wheat and rice increases as they both are major parts of the diet. They will not be able to purchase food and will land in a state of malnutrition.

DECLARATION STATEMENT

I must verify the accuracy of the following information as the article's author.

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- **Data Access Statement and Material Availability:** The adequate resources of this article are publicly accessible.
- **Authors Contributions:** The authorship of this article is contributed solely.

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