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Management of Ecological Disparities to Ensure the Long-Term Sustainability of Agriculture in Vaishali District of Bihar, India

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Abstract

This paper entitled “Management of Ecological Disparities to Ensure the Long-Term Sustainability of Agriculture in Vaishali, Bihar, India” (An understanding of how to balance environmental sustainability with agricultural development in the context of Vaishali) is truly related with the quality of agricultural life in Vaishali district of Bihar. Vaishali, a historical district situated in the state of Bihar, India, is known for its fertile alluvial soil, generally owing to its location along the Ganges River basin. Agriculture in Vaishali is the primary source of livelihood for the vast majority of its population. However, the agricultural productivity of Vaishali is severely impacted by ecological disparities that arise due to a mixture of erratic weather patterns, soil degradation, water scarcity and natural disasters such as flooding. The effects of these ecological disparities are widespread and complex, with severe implications for food security, income generation and the overall economic stability of the region. In fact, this article explores the ecological challenges faced by Vaishali and provides an overview of the management strategies that can be employed to reduce these disparities, enhance agricultural productivity and nurture long-term justifiable development in the region. By discussing the ecological disparities, their impact on agriculture and possible solutions for managing these challenges, the article aims to contribute to a better understanding of how to balance environmental sustainability with agricultural development in the context of Vaishali.

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1. Introduction

Section I

This section of study deals with all about the preliminary part of the research that is “Management of Ecological Disparities to Ensure the Long-Term Sustainability of Agriculture in Vaishali, Bihar, India”. Actually this part discusses the introductory part of this study.

1.1 Vaishali: a historical background

The word Vaishali derives from the name of the King Vishala, a son of ikshvaku and his queen Alambusha. He is the king in Hinduism which is mentioned in Ramayana and also found in Puranas and Mahabharata. Vaishali holds a massive historical importance. It was the capital of the Licchavi republic and it is one of the earliest republics in the world, dating back to the 6th century BCE. As it mentioned in different Buddhist, Jain and Hindu texts. It is believed to be the birthplace of Vardhamana Mahavira, the 24th Tirthankara of Jainism. Additionally, it is also associated with Lord Buddha. It was one of the homes where Buddha preached and it was also the place of the Second Buddhist Council. In that period, Vaishali was an ancient metropolis

and the capital city of the republic of the Vajji confederation and it covered most of the Himalayan Gangetic region of the present day Bihar.

1.2 Vaishali: a geographical setting

Vaishali is a part of Tirhut Division and is located in the northern part of Bihar, India. It lies at 25.68°N latitude and 85.25°E longitude. It is bounded by Muzaffarpur district from north side, Samastipur district in the east, Patna district in the south and Saran district in the west.

Vaishali is characterized by alluvial plains and it is very fertile region of the Ganges basin with flat and low lying land which is very good for agriculture. The soil alluvial is rich in nutrients and supports extensive rice and wheat cultivation. Actually, it belongs to the Ganges so certain part of it is prone to flooding during the monsoon season. Sometimes, the river's seasonal rise and fall affect agriculture and infrastructure.

Vaishali district experiences a Tropical Monsoon Climate with summer, monsoon and winter seasons.

Summer: Here in Vaishali, this summer (from March to June) temperature exceeding 40°C corresponding 104°F during peak summer months. So, summer is hot and dry with occasional thunderstorms.

Monsoon: Vaishali receives very heavy rainfall during the monsoon season (from June to September) due to south west monsoon winds coming from Bay of Bengal. This district's agriculture based upon this monsoon particularly rice cultivation.

Winter: This district faces a mild and pleasant with temperature ranging between 7°C (45°F) to 22°C (72°F). Generally, foggy mornings and cool nights are common here.

Humidity: This district generally have high humidity during the monsoon season and in summer which can make the heat feel more extreme.

Section II

This section of study deals with all aspects of Ecological Disparity. Different modules and sources to understand Ecological Disparity like meaning, concepts, indicators etc. among the different environment.

2.1 Disparity: meaning and understanding

The dictionary meaning of disparity is "a difference, especially one connected with unfair treatment". The word Disparity refers a difference in unfair behavior, or "a lack of equality or similarity, especially in a way that is not fair". Sometimes, the term 'disparity' also used as unevenness, disproportion or dissimilarity etc.

The word 'Disparity' is often used to describe a social or economic circumstance that is considered unfairly or unequal. A racial disparity in hiring, a health disparity between the rich and the poor, an income disparity between men and women etc. is the best example to understand disparity.

Disparity, is how morphologically different they are from each other. For example, an ecosystem with one species of grass, one rabbit and a hawk would have very low diversity, but very high disparity. Here, disparity highlights inequalities while a diversity refers to differences in culture and geography.

2.2 Ecological disparity: conceptual framework

Ecological Disparity is an imbalance or inequality among

inhabitants of the same living environment deemed inappropriate, unjust or detrimental to that environment's reliability. It denotes to the uneven distribution of environmental benefits and burdens among different societies or groups. It highlights how factors like socio-economic status, race and geographic position influence access to clean resources, green spaces and exposure to pollution. This disparity often results in marginalized communities facing greater environmental risks and health challenges, emphasizing the need for equitable environmental policies and practices.

In other words, 'Ecological disparity' refers to the unequal distribution of environmental benefits and burdens among different groups or societies. These concept highlight how numerous factor such as socio-economic status, race and geographic location can influence access to clean water, air, green spaces and other natural resources as well as exposure to pollution and ecological threats.

It is very crucial to Understand and address ecological disparity for promoting sustainability and ensuring that all societies can flourish in a healthy atmosphere. Efforts to combat these disparities often involve community engagement, policy reform and increased awareness of environmental justice.

2.3 Ecological disparity: key indicators

Environmental Indicators: Certain communities are more open to ecological risks like pollution, flooding and climate change impacts due to their geographic locations. Considering the quality of air, water and soil in different societies can reveal disparities in exposure to pollution and other environmental hazards. Evaluating the cumulative impressions of multiple ecological stressors on specific populations can highlight vulnerabilities and disparities in exposure to a given period of time in a region. The movement encouraging for equal environmental protection for all groups, particularly marginalized clusters that often bear an unbalanced share of environmental problems.

Health and Fitness Indicators: Considering health statistics, such as rates of respiratory illnesses or other conditions linked to ecological factors, can show disparities in health impacts related to environmental conditions. Marginalized clusters typically experience higher rates of health hitches linked to ecological factors, such as pollution and lack of access to nutritious food items and inadequate recreational spaces.

Economic position plays a significant role in ecological disparity. As low-income communities often lack the resources to advocate for better environmental settings. Examining income levels, education, and employment rates within communities can provide a framework to understand how socioeconomic status influences environmental access and publicity. (Socioeconomic Indicators)

Disparities can affect access to clean air, water, energy and green spaces is often unevenly distributed, favoring wealthier or more privileged communities around the region. (Resource Distribution Indicator)

Employing Geographic Information System technology to record environmental resources, pollution causes and demographic data can visually represent ecological disparities across the whole area. (Geographic Information Indicator)

Measuring the availability and accessibility of parks and natural areas in urban and rural settings can highlight

inequalities in entertainment opportunities in a particular region. (Recreational Indicator)

Ecological disparity intensifies the effects of climate variation, with susceptible communities facing greater risks due to their lack of different resources for adaptation and mitigation. Some groups are more vulnerable to climate impacts like flooding, heat waves etc. due to their location & association, socio-economic status and deficiency of adaptive capability. (Climate Change Indicator)

Assessing and evaluating the impact of environmental policies and regulations on different communities can help identify inequities in resource distribution and security and safety protection. Combining these all policies and methods researchers and other policymakers can gain a comprehensive understanding of ecological disparity and its impacts on the different societies. (Environmental policy indicator)

Section III

This section of study discusses about the ecological challenges directly or indirectly affect the livelihood of the people of this district Vaishali.

3.1 Prominent ecological challenges in Vaishali:

The ecological disparities in Vaishali, such as flooding, soil erosion, water scarcity and the impacts of climate change etc. significantly affect the agricultural sector. These ecological challenges not only damage crop yields but also put the livelihood of farmers at risk, making agriculture increasingly unsustainable.

Vaishali is located in Ganges floodplain so, here Flooding is one of the most prominent ecological challenge. During the monsoon season heavy rainfall causes the Ganges and its tributaries to swell and resulting in floods almost seventy two percent (72%) area of the district. (Flooding and Waterlogging)

Here in Vaishali, Soil erosion along riverbanks is common due to the constant rise and fall of riverbanks of the Ganges and its tributaries. During rainy seasons and floods, fast-moving water can wash away the nutrient-rich topsoil which leads to soil degradation. (Soil Erosion and Degradation)

Vaishali faces a Climate change which leads to irregular weather patterns, including unpredictable rainfall, rising and fall in temperatures (very hot in summer and very cold in winter) as well as more extreme weather events such as droughts and floods. (Climate change and irregular weather pattern)

While Vaishali has abundant surface water sources like the Ganges and Hiranyavati, the over-extraction of groundwater for irrigation is becoming a concern, especially in dry spells or when floods recede. (Water scarcity and over extraction)

To upturn productivity, maximum farmers use high levels of pesticides, insecticides and chemical fertilizers. Whereas, it boosts crop yields in the short term but on the other hand it can lead to long-term ecological imbalances. (Pesticide, Insecticide and Chemical usage).

A mass level of forest cutting or deforestation and loss of green shield in Vaishali have impacted the natural ecosystem. Urbanization, population pressure and the demand for agricultural land have contributed to reduced forest cover. (Loss of Biodiversity and Deforestation).

A small landholdings reduce the scale of farming operations. Over time, agricultural land in Vaishali has become increasingly fragmented due to population growth and land division. (Land Fragmentation).

Addressing above all these issues through better water management, climate-resilient crops, improved soil conservation techniques and sustainable agricultural practices will be essential for ensuring the long-term productivity and sustainability of agriculture in Vaishali District in Bihar, India.

Section IV

This section of study discusses about the 'Ecological Disparity's Impact on Agricultural Productivity' in Vaishali.

4.1 Impact of ecological disparity an agricultural productivity:

The natural disaster like flooding destroys standing crops especially rice, which is the dominant crop of the region. Excess water can also lead to the washing away of seeds and soil erosion. Recurrent floods interrupt sowing and harvesting times, making it difficult for farmers to adhere to regular farming cycles. Persistent waterlogging especially in the post-monsoon period, suffocates plant roots, reduces soil drying and affects crops like wheat, sugarcane, maize etc.

Soil destruction drains the fertile topsoil that is essential for high agricultural productivity. It reduces soil fertility resulting harder to grow high-yield crops. Eroded soil leads to poorer soil quality, which leads to affect crop growth and reduce harvest quantities. It affects local food security and livelihoods. Some areas, especially those near river deltas, experience saltwater intrusion, further damaging soil fertility and making it difficult to grow crops like paddy crops and vegetables.

Irregular rainfall affects planting schedules, particularly for crops that are highly dependent on specific monsoon patterns, such as rice. Delayed rains can lead to poor seed germination, while early rains may lead to waterlogging. Rising temperatures during the summer can cause heat strain on crops like maize and sugarcane, which are sensitive to temperature extremes. Traditional crop varieties may not be vigorous to changing climatic conditions and farmers may struggle to adapt to new weather patterns without access to improved agricultural seeds or techniques.

Over-reliance on groundwater for irrigation can reduce aquifers, leading to water shortages, especially during the dry months when surface water is insufficient. Without proper water management systems, inefficient irrigation techniques can cause excessive water use, leading to water scarcity in some areas, which affects crop growth and productivity.

Excessive use of chemicals destroys soil health and killing beneficial microorganisms which is reducing soil fertility. it leads harder to grow crops sustainably. On the other hand over-use of pesticides can lead to the development of pesticide-resistant pests, making it harder for farmers to control crop-damaging insects. Runoff from farms can infest nearby water sources, which is directly or indirectly affecting both aquatic ecosystems and human populations relying on these water sources for irrigation and drinking purposes.

Deforestation leads to a decline in biodiversity, including the loss of pollinators like bees and butterflies, which are essential for many crops, including fruits and vegetables. The loss of natural predators (such as birds and insects) that control pests in agriculture leads to increased pest attacks on crops which require more frequent uses of pesticide. Natural vegetation play a role in regulating local microclimates and their loss can lead to more extreme temperature fluctuations which affect yield and productivity of different crops.

Smaller landholdings make it difficult for farmers to afford modern agricultural machinery, leads to increase labor costs. Small farms may lack the resources to invest in irrigation systems, fertilizers or pest control resulting per hectare lower productivity.

Burning crop deposits reduces the organic matter in the soil, which is essential to maintain soil fitness and fertility. On the other hand agricultural residue burning contributes to air pollution, which can harm the health of human and environment.

Section V

This section of study deals the strategy to manage the ecological disparity to enhance the agricultural productivity in Vaishali district of Bihar India.

5.1.1 Management strategies to diminish ecological disparities:

To manage the ecological disparities and mitigate their impact on agriculture, a multi-pronged approach is required. Several management strategies can be employed to reduce the negative effects of ecological disparities on agricultural productivity and ensure justifiable livelihoods for ranchers in Vaishali.

5.1.2 Soil management and fertility re-establishment

Restore soil fertility and combat soil degradation is one of the primary strategies to improve agricultural productivity in Vaishali. It can be achieved through the promotion of sustainable farming practices, crop rotation, organic farming and the use of green fertilizer. The use of bio-fertilizers can help restore nutrients to the soil and reduce the dependency of chemical fertilizers, which further reduces soil quality.

Additionally, soil testing amenities should be made available to farmers, enabling them to monitor soil strength. Education and awareness programs should focus on suitable irrigation practices and methods to stop waterlogging and salinization.

5.1.3 Water management and improving irrigation system

It is very difficult to improve the irrigation infrastructure and water management practices for addressing water scarcity and improving agricultural productivity. The introduction of well-organized irrigation systems, like drip irrigation and sprinkler systems can help to use optimal and conserve water resources. Side by side rainwater harvesting techniques should be encouraged to capture surplus water during the rainy season and store it for dry periods.

Flood control procedures like construction of embankments, ridges and flood retention basins can help to minimize the damage caused by flooding. Early Warning Systems (EWS) for floods should also be implemented to provide farmers with sufficient time to prepare for future calamities.

5.1.4 Climate management and smart agriculture

Embracing climate-smart agricultural (CSA) practices is needed for adjusting to the changing weather patterns and improving flexibility in the face of climate change. This practice includes the use of flood-resistant and drought-tolerant crop varieties, the promotion of agro-forestry to improve biodiversity and the application of conservation spade to reduce soil destruction.

For reducing the risk of crop loss due to unexpected weather conditions, farmers should also be trained to use weather

forecasting devices. It helps them to make effective and efficient seeding plan and harvesting schedules.

5.1.5 Disease management and pest control

Pest control techniques should be encouraged to reduce dependency on chemical pesticides and minimize the environmental impact of their use. It involves a combination of biological, mechanical and chemical control systems to manage pest inhabitants in an environmentally friendly manner.

By fostering natural predator populations, like birds and insects, farmers can reduce the dominance of harmful pests. To control pests and maintain the health of ecosystem, farmers should also be educated on the importance of biodiversity.

5.1.6 Policy management and government support

Government playing a very crucial role in addressing ecological disparities and their impact on agriculture. Government policies should focus on different schemes like providing financial support to farmers through insurance, loans and subsidies. Particularly, crop insurance can provide farmers with a safety net in a case of crop failure due to floods, droughts or other ecological disasters.

Public and private partnerships can also play a vital role in introducing advanced technologies and solutions that can help farmers to adjust in changing environmental conditions. So, government should also participate in research and development to identify region-specific solutions to improve agricultural practices and address ecological challenges.

Section VI

This section of study related with short summary and conclusion of the article entitled "Management of Ecological Disparities to Ensure the Long-Term Sustainability of Agriculture in Vaishali, Bihar, India".

6.1 Summary and Conclusion:

Management of Ecological Disparities to Ensure the Long-Term Sustainability of Agriculture in Vaishali, Bihar, India's article is genuinely related with the natural calamities and its remedies for long time survival of the regional farming. Ecological disparities are defined as the uneven distribution of environmental resources and risks, resulting in marginalized groups facing greater environmental threats. The study breaks down the issues that intensify these disparities such as socio-economic position, race and geographic location and explores the key indicators like environmental, health, socio-economic and resource distribution that highlight these differences.

Vaishali faces numerous ecological challenges. Heavy rainfall during the monsoon season results in the flooding of over 70% of the district, disrupting agricultural activities. The constant rise and fall of riverbanks lead to soil erosion, depleting the nutrient-rich topsoil essential for agricultural productivity. Over-extraction of groundwater, particularly in dry spells, exacerbates water scarcity issues. Uneven weather patterns, including extreme temperatures and unpredictable rainfall affect crop cycles and yields. Loss of forest cover influences biodiversity, pollinators and microclimates essential for healthy cultivation.

The ecological challenges lead to several direct consequences for agriculture. Flooding damages crops like rice, the region's dominant crop and affects other crops like wheat, sugarcane

and maize. Erosion cuts soil fertility making it harder to sustain crop production. Over-reliance on groundwater and ineffective irrigation systems lead to water shortages that affect crop growth. Excessive use of pesticides and fertilizers degrades soil fitness and reduces biodiversity, leading to a reliance on chemical inputs to sustain yields.

Several management strategies are proposed to address ecological disparities and improve agricultural sustainability. Promoting sustainable farming practices, crop rotation and the use of bio-fertilizers can reestablish soil fertility. Implementing effective irrigation systems, such as drip and sprinkler systems alongside rainwater harvesting, can optimize water use. Adopting flood-resistant and drought-tolerant crops and using weather forecasting can help farmers adapt to climate variation. Reducing dependency on chemical pesticides and fostering natural predators can help manage pests sustainably. Government policies should focus on providing financial funding, crop insurance and promoting research and development for region-specific agricultural solutions.

The management of ecological disparities is essential for ensuring the long-term sustainability of agriculture in Vaishali, Bihar. The region's agricultural sector faces several challenges because of flooding, soil degradation, water scarcity and irregular weather patterns. However, with the help of right management strategies ranging from soil fitness restoration and enhanced irrigation practices to climate-smart agriculture and government support the ecological disparities can be diminished and it confirming that the agricultural sector remains feasible and justifiable.

By focusing on sustainable agricultural practices, improved water management, enhanced biodiversity and satisfactory support to the farmers, it is possible to reduce the adverse effects of Ecological Disparities and foster a more resilient agricultural economy in Vaishali. The collective efforts of government, NGOs, local populations and researchers will be essential to manage these ecological disparities and achieving sustainable agricultural development in the most part of Vaishali.

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