ASSESSMENT OF THE IMPACT OF INTENSIVE AGRICULTURAL PRACTICES ON SOIL EROSION - A CASE STUDY OF HASSAN DISTRICT, KARNATAKA

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Abstract
` *Agriculture, the cultivation of crops and rearing of animals, is a cornerstone of human sustenance and economic growth. In the pursuit of higher yields, intensive agricultural practices characterized by mechanization, synthetic inputs, and advanced irrigation techniques have gained prominence. However, these practices can pose significant threats to soil quality and erosion. This study is focused on Hassan District, a region of agricultural significance in Karnataka, Southern India. The intricate interplay between agricultural management practices and their effects on soil quality and erosion rates are examined in the context of this specific locale. The study maintains its objectives, including providing an introductory overview of agriculture in Hassan District, detailing prevalent agricultural practices, discussing soil erosion dynamics, and evaluating the impact of intensive agriculture on soil quality. The methodology is rooted in the use of secondary data sources, drawing upon scholarly articles, government reports, and research publications. This approach harnesses existing knowledge and research to comprehensively analyze soil erosion in Hassan District, particularly in relation to the practices of intensive agriculture and the possibilities of transitioning towards more sustainable agricultural methods. The study emphasizes the need for localized assessments in Hassan District to understand soil erosion's impact on agriculture and the environment. It highlights the reliance on tanks and tube wells for irrigation, the significant distribution of chemical fertilizers, and recommends strategies for sustainable practices and further research in soil erosion modeling and agroforestry. The findings underscore the importance of tailored agricultural policies and raising awareness among farmers to ensure food security and environmental sustainability in the region.*
Key-words: *Intensive agricultural practices; soil erosion; Hassan District; secondary data; agricultural management; sustainable agriculture*

Introduction

Agriculture represents the cultivation of crops and the rearing of animals for food, fiber, and other agricultural products (Sharma, 2018). It is a cornerstone of human survival, providing sustenance, livelihoods, and economic development. Through the ages, agriculture has undergone transformations driven by technological advancements, shifting societal needs, and growing global demands (Sumberg & Giller, 2022). These changes have given rise to a spectrum of agricultural practices, ranging from traditional subsistence farming to intensive, high-input systems.

Intensive agricultural practices are characterized by a high level of mechanization, increased use of synthetic fertilizers and pesticides, and the application of advanced irrigation techniques (Morgan, 2009). These practices aim to maximize agricultural output, often through monoculture and high cropping intensity. While intensive agriculture has substantially increased global food production, it has also raised concerns about its environmental consequences.

Soil, the very foundation of agriculture, is vulnerable to erosion when subjected to intensive agricultural practices (Zachar, 2011). Soil erosion involves the detachment and transport of soil particles by various agents such as wind, water, and human activity. The significance of soil erosion cannot be understated, as it leads to the loss of fertile topsoil, decreased agricultural productivity, and adverse environmental impacts, including sedimentation of water bodies.

Hassan District, this paper's area of focus, located in the southern Indian state of Karnataka, is an area of agricultural significance (Government of Karnataka, 2020). The region boasts a diverse agricultural landscape, with a wide range of crops and farming practices (Hassan District Administration, 2021).

However, the increasing adoption of intensive agricultural practices in Hassan District raises concerns about their potential contribution to soil erosion. Understanding the dynamics of soil erosion in this context is vital, given its implications for food security, environmental sustainability, and the livelihoods of the local population.
Numerous scholarly investigations have delved into the intricate relationship between agricultural management practices and their repercussions on soil quality and erosion rates. In a comprehensive review conducted by Bai et al. (2018), the focus was on long-term experiments carried out in both Europe and China. Their findings underscored the imperative to thoroughly evaluate the impact of diverse agricultural practices on soil quality. By scrutinizing the outcomes of extended experiments, Bai et al. shed light on the significance of adopting a holistic approach to understanding the complex interplay between agricultural practices and the health of soils in different geographic contexts.
In the realm of sustainable agriculture, Doran and Zeiss (2000) highlighted the crucial link between soil health and sustainable agriculture, emphasizing the importance of managing soil biotic components for long-term farming viability. Parr et al. (1992) explored the intricate relationships between soil quality attributes and sustainable farming methods. Their research underscored the need for a nuanced understanding of soil quality for successful implementation of alternative agricultural practices, providing foundational insights still relevant today.
A more recent contribution to the discourse comes from Cárceles Rodríguez et al. (2022), who focused on conservation agriculture as a sustainable system for soil health. Their review critically examined the merits of conservation agriculture in promoting soil health. By offering a contemporary perspective, they contributed to the ongoing conversation about adopting conservation-oriented agricultural practices to mitigate the negative impacts on soil health. Adding to this body of knowledge, Datta et al. (2022) investigated climate-smart agricultural practices (CSAP) in Karnal, Haryana, India, focusing on zero tillage, crop residue retention, and crop diversification. Their study found that CSAP improved soil quality through organic carbon enrichment and reduced greenhouse gas emissions, offering valuable insights for addressing climate change impacts on Indian agriculture.
Moreover, Balooragi et al. (2022) conducted a geographically relevant study within the eastern dry zone of Karnataka, focusing on the impact of vegetative barriers on runoff, soil moisture, and crop productivity. Their study provides region-specific insights into soil conservation practices and their effects on soil moisture dynamics and crop yields, which can contribute to our understanding of soil erosion mitigation in Karnataka.
Collectively, these studies highlight the global significance of sustainable agricultural practices in maintaining soil health and mitigating erosion. They underscore the urgency of adopting innovative approaches in the face of climate change and the critical importance of region-specific research in addressing the multifaceted challenges of soil erosion and degradation. Keeping this background in mind, this study aims to comprehensively investigate how intensive agricultural practices, including irrigation and land use changes, contribute to soil erosion in Hassan District, Karnataka. Therefore, it is titled, *"Assessing The Impact Of Intensive Agricultural Practices On Soil Erosion In Hassan District, Karnataka."*

Objectives:

i. Introductory overview of agriculture within the Hassan District.
ii. Offer a detailed and accurate portrayal of the various agricultural practices adopted in Hassan District.
iii. Discuss the soil erosion occurring in Hassan District
iv. Evaluate how intensive agricultural practices impact the overall quality of soil in Hassan District.

Data Sources:

The methodology for this study exclusively utilizes secondary data sources, comprising reports and previous research studies.

Methods:

The use of secondary data allows for a comprehensive analysis of existing knowledge and findings related to the impact of intensive agricultural practices on soil erosion in Hassan District, Karnataka.

These secondary sources encompass a range of scholarly articles, government reports, and research publications that have explored agricultural practices, soil erosion rates, and their interconnections within the study area.

Data Synthesis and Analysis:

The following sections will discuss and synthesize secondary data to meet the study's objectives. The agricultural practices in Hassan District will be detailed using existing reports and studies, and the current state of soil erosion will be assessed based on available data. The impact of intensive agricultural practices on soil quality will be examined through relevant research findings, utilizing existing literature to understand the relationship between these practices and soil erosion in Hassan District.

Overview Of Agriculture In Study Area

The Hassan district, with a total geographical area of 6.78 lakh hectares, is situated between 12°31' and 13°33' North latitude and 75°33' and 76°38' East longitude in the south western part of Karnataka, India. It shares its boundaries with Chikmagalur district to the north, Tumkur and Mandya districts to the east, Mysore and Kodagu districts to the south, and South Kanara district to the west. This district comprises eight talukas.

The region's major rock formations include granites, gneisses, schist, and quartzite. Geographically, it is part of the Karnataka plateau, characterized by gently rolling surfaces with occasional monadnocks. The tilting of the plateau due to the elevation of the Western Ghats in the geological past led to a shift from a humid to a semi-arid climate. There are two distinct erosional surfaces: the high hilly 'Malnad' region and the plain 'Maidan' region.

The Hassan district has a moderate climate with an average annual rainfall of 1041 mm. Rainfall is heaviest in the western part and decreases towards the east. The main rainy season is during the southwest monsoon (May to August), with additional rainfall in October to November. Rainfall exceeds potential evapotranspiration for about 120 days a year, allowing for rain-fed kharif crop cultivation. The average annual air temperature is 23.3°C, with April as the hottest month and December as the coldest. The temperature variation between summer and winter is less than 5°C. The soil temperature regime is iso-hyperthermic. The area's flora varies from scrub forests (Acacia and Lanterna spp.) in the east to evergreen forests (Terminalia spp.) in the west.

Approximately 70% of the population in the district depends on agriculture, forming a robust agricultural foundation that supports agro and food processing industries. A new cattle feed plant with a capacity of 300 metric tons has been established in Hassan. The district has allocated 265 acres of land for a dedicated food processing Special Economic Zone (SEZ) aimed at export-oriented units. It is also a significant coffee producer in the state and is recognized as an agri-export zone. In terms of contribution to the Gross State Domestic Product (GSDP) of Karnataka, the agriculture and allied sectors (including Agriculture, Animal Husbandry, Forestry, and Fishing) from Hassan district accounted for INR 1,787 crore, representing 4.3% of the GSDP (State and District Domestic Product of Karnataka, 2014-15). The district had 475,816 agriculturists and 126,659 agricultural laborers, according to data from Karnataka at Glance- 2013-14 (Census of India, 2011).

AGRICULTURAL PRACTICES IN HASSAN DISTRICT

Understanding the agricultural practices of Hassan district is a crucial objective for us to understand after the data presentation on the patterns and variations of the same across the taluks of Hassan District. These insights are further vital for understanding the region's agricultural dynamics, optimizing resource allocation, and promoting sustainable agricultural practices, importantly, to also understand the intensity of the same.

To gain a comprehensive understanding of the agricultural landscape in Hassan District, it is essential to examine various facets of farming, including crop choices, irrigation methods, and the use of fertilizers. The data provided in the previous tables offers valuable insights into the key elements of agricultural practices in the district for the year 2019-20.

One of the central aspects of agriculture in Hassan District is irrigation, as it directly impacts crop yields and agricultural sustainability. The district's choice of irrigation sources, whether from canals, tanks, wells, or other means, reveals the local farming community's reliance on specific water resources. Furthermore, the data on chemical fertilizer distribution sheds light on the approach to enhancing soil fertility and crop production, emphasizing the need for sustainable practices and potential disparities among different taluks.

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- **Irrigation Sources:**

Table 1: Gross & Net area Irrigated under different Sources (Hectares) 2019-20

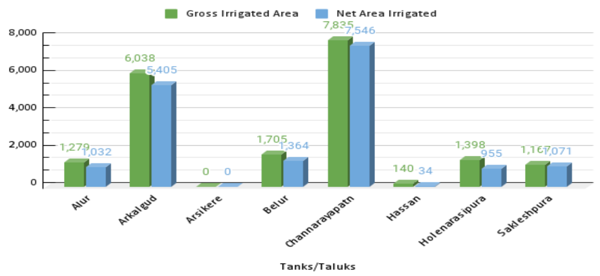
		Canals		Tanks		Wells	
SI.No.	**Taluks**	**GIA**	**NAI**	**GIA**	**NAI**	**GIA**	**NAI**
1	Alur	0	0	1279	1032	30	23
2	Arkalgud	4080	3750	6038	5405	126	104
3	Arsikere	0	0	0	0	0	0
4	Belur	0	0	1705	1364	65	53
5	Channarayapatna	0	0	7835	7546	163	152
6	Hassan	0	0	140	34	152	104
7	Holenarasipura	0	0	1398	955	63	41
8	Sakleshpura	0	0	1167	1071	58	24
-	Dist. Total	4080	3750	19562	17407	657	501

Note: GIA - Gross Irrigated Area; NAI - Net Area Irrigated

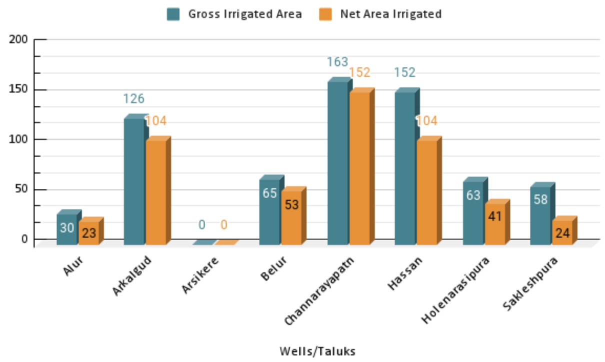
Secondary Source: District at a Glance - Hassan District 2019-20

The table 1 provides data on the gross and net area irrigated under different sources in Hassan District for the year 2017-18. It is organized by taluks and differentiates between three sources of irrigation: Canals, Tanks, and Wells. The table distinguishes between gross irrigated area (GIA) and net area irrigated (NAI). Gross irrigated area represents the total area irrigated through a particular source, while net area irrigated accounts for any overlap or double counting in cases where multiple sources are used for irrigation. NAI provides a more accurate measure of the actual area benefiting from irrigation.

Graph 1: Usage of Tanks in Agricultural Irrigation Areas in Hassan District



Tanks are the most common source of irrigation in Hassan District, as indicated by the significant gross and net irrigated areas attributed to tanks in several taluks. Channarayapatna, in particular, relies heavily on tanks for irrigation, with the highest gross and net irrigated areas among the taluks.



Graph 2: Usage of Wells in Agricultural Irrigation Areas in Hassan District

Canals and wells play a significant role in some taluks. Arkalgud taluk has the highest gross and net irrigated areas through canals. Wells also contribute to irrigation, especially in Belur and Channarayapatna taluks. Notably, Arsikere and Hassan taluks do not report any gross or net irrigated areas under canals, tanks, or wells. This indicates limited access to these sources of irrigation or different irrigation practices in these taluks.

Table 1 (cont'd): Gross & Net area Irrigated under different Sources (Hectares) 2019-20

SI. No	Taluks	Tube wells		Lift Irrigation		Other sources		Total	
		GIA	NAI	GIA	NAI	GIA	NAI	GIA	NAI
1	Alur	426	350	0	0	1167	1037	2902	2442
2	Arkalgud	1723	1545	0	0	1721	578	13688	11382
3	Arsikere	4943	4145	0	0	0	0	4943	4145
4	Belur	1305	1086	0	0	1305	1087	4380	3590
5	Channarayapatna	7923	7559	0	0	0	0	15921	15257
6	Hassan	6764	3254	0	0	0	0	7056	3392
7	Holenarasipura	12556	8564	0	0	0	0	14017	9560
8	Sakleshpura	218	202	0	0	281	37	1724	1334
-	Dist. Total	35858	26705	0	0	4474	2739	64631	51102

Note: GIA - Gross Irrigated Area; NAI - Net Area Irrigated
Secondary Source: District at a Glance - Hassan District 2019-20

The table provides data on the gross and net area irrigated under different sources in Hassan District for the year 2017-18. It is organized by taluks and differentiates between three sources of irrigation: Tube wells, Lift Irrigation, and Other sources. The "Total" columns represent the sum of gross and net irrigated areas for each source, as well as the grand total for each taluk and the entire district.

Lift irrigation appears to be less common in the district, with very limited gross and net irrigated areas, mainly in Alur and Arkalgud taluks. This could be due to factors such as topography, availability of surface water sources, or the cost associated with lift irrigation infrastructure.

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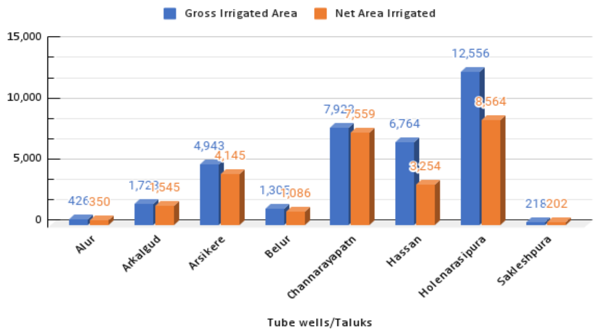
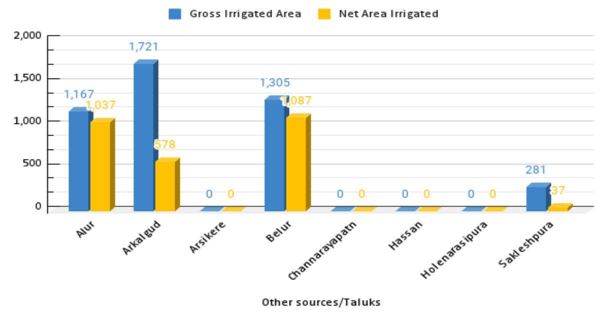


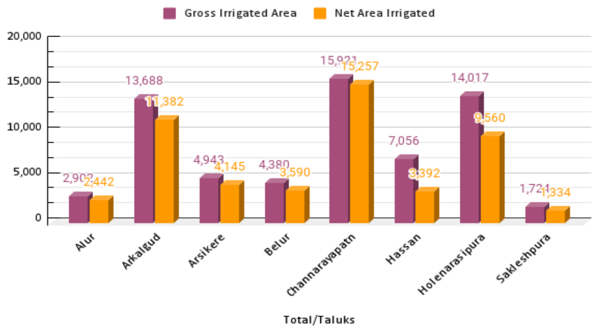
Graph 3: Usage of Tube Wells in Agricultural Irrigation Areas in Hassan District

The data shows that tube wells are the most prevalent source of irrigation across all taluks in the district. Alur, Arkalgud, Arsikere, Belur, Channarayapatna, and Holenarasipura taluks all have significant gross and net irrigated areas through tube wells. This may indicate the widespread use of groundwater for irrigation purposes in these areas.



Graph 4: Usage of Other Sources in Agricultural Irrigation Areas in Hassan District

Some taluks, like Alur and Sakleshpura, have a small portion of their irrigated areas sourced from "Other sources." The nature of these other sources is not specified in the table, and further information would be needed to understand this category better.



Graph 5: Usage of Total of All Types of Agricultural Irrigation in Areas in Hassan District

There are significant variations in the gross and net irrigated areas among the taluks. Holenarasipura taluk has the highest gross irrigated area, and Alur taluk has the highest net irrigated area. These differences may be influenced by factors such as water availability, agricultural practices, and infrastructure development.

Chemical Fertilizers:

Table 4: Distribution of Chemical Fertilizers (In Tonnes) - 2018-19

SI. No	Taluks	Nitrogen	Phosphorus	Potash	Total
1	Alur	1,936	1,043	853	3832
2	Arkalgud	8,063	4,345	3,551	15959
3	Arsikere	7,344	3,957	3,235	14536
4	Belur	3,621	1,951	1,595	7167
5	Channarayapatna	6,153	3,316	2,710	12179
6	Hassan	5,007	2,698	2,205	9910
7	Holenarasipura	4,920	2,651	2,167	9738
8	Sakleshpura	1,525	822	672	3019
-	Dist. Total	38569	20783	16988	76340

Secondary Source: District at a Glance - Hassan District 2019-20

The table 4 provides data on the distribution of chemical fertilizers (in tonnes) in Hassan District for the year 2018-19. It is organized by taluks, with information on the quantities of three major types of chemical fertilizers: Nitrogen, Phosphorus, and Potash. The "Total" column represents the sum of these three types of fertilizers for each taluk, as well as the district as a whole.

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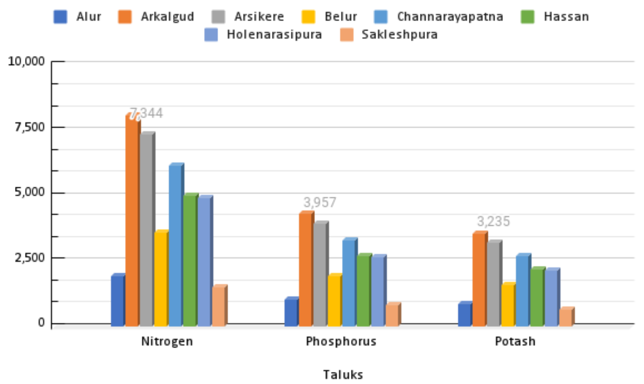
The table shows variations in the distribution of chemical fertilizers among different taluks in Hassan District. For instance, Arkalgud taluk has the highest distribution of all three types of fertilizers, whereas Sakleshpura taluk has the lowest distribution. These disparities may indicate differences in agricultural practices, soil fertility, or crop choices among the taluks.

The "Dist. Total" row at the bottom of the table summarizes the fertilizer distribution for the entire district. In 2018-19, a total of 76,340 tonnes of chemical fertilizers were distributed in Hassan District. This data suggests that chemical fertilizers play a significant role in agricultural practices in the region, indicating a reliance on them to enhance crop productivity.

Graph 6: Distribution of Chemical Fertilizers (In Tonnes) - 2018-19 in Hassan District



The table also provides data on the distribution of three key nutrients: Nitrogen, Phosphorus, and Potash. The quantity of Nitrogen is the highest, followed by Phosphorus and then Potash. This distribution reflects the importance of Nitrogen in promoting vegetative growth in crops and may indicate that nitrogen-intensive crops are prevalent in the district. The high distribution of chemical fertilizers, particularly Nitrogen and Phosphorus, raises questions about their impact on soil health. Over Reliance on chemical fertilizers without proper soil management practices can lead to soil degradation and environmental issues in the long run. Sustainable agricultural practices, including soil testing and nutrient management, should be considered to maintain soil fertility.

The data can also prompt a discussion about crop diversification in Hassan District. Some taluks may benefit from diversifying their crop portfolio to reduce the dependency on specific types of fertilizers and improve sustainability in agriculture.

This examination of irrigation sources, chemical fertilizer distribution, and their implications for agricultural practices in Hassan District serves as a foundation for understanding the challenges and opportunities that the region's farmers face, which includes an emerging issue of soil infertility (Biradar et al. 2020) which will lead to soil erosion, casued by the intensive cropping practices.

Soil Erosion Of Hassan District

Soil infertility, characterized by poor soil quality and low nutrient content, can indeed lead to soil erosion. Infertile soils are often associated with reduced vegetative cover, weakened soil structure, limited root development, lower organic matter, and increased vulnerability to weathering. These factors collectively make the soil more susceptible to erosion by wind and water. Hassan District in Karnataka, India, is renowned for its agricultural significance, where agriculture serves as the chief occupation for a significant portion of the population. However, the extensive and intensive agricultural practices in the district, including mechanization, increased use of synthetic fertilizers, and advanced irrigation techniques, have raised concerns regarding soil erosion and degradation. Understanding the dynamics of soil erosion in this context is crucial, given its implications for food security, environmental sustainability, and the livelihoods of the local population.

Despite the evident significance of soil erosion in Hassan District, there exists a noticeable research gap when it comes to a comprehensive assessment of erosion rates and the consequences of intensive agricultural practices on soil quality. Existing studies have touched upon related topics, such as soil quality and agricultural management, but the specific examination of soil erosion remains relatively unexplored.

Several studies have explored the intricate relationship between agricultural management practices and their consequences on soil quality and erosion rates. Bai et al. (2018), in their comprehensive review, emphasized the need to evaluate the impact of various agricultural practices on soil quality. Doran and Zeiss (2000) highlighted the critical link between soil health and sustainable agricultural systems, underscoring the importance of managing the biotic component of soil quality. Parr et al. (1992) provided insights into the multifaceted nature of soil quality and its role in implementing sustainable agricultural methods. More recently, Cárceles Rodríguez et al. (2022) examined conservation agriculture's role in promoting soil health. Datta et al. (2022) focused on climate-smart agricultural practices in a region of India and their impact on soil quality. Balooragi et al. (2022) conducted a region-specific study on soil conservation practices in Karnataka, contributing to the understanding of soil erosion mitigation.

While these studies offer valuable insights into the global significance of sustainable agricultural practices, they do not specifically address the soil erosion situation in Hassan District. The district's unique geographical, climatic, and agricultural characteristics necessitate a localized assessment to understand the extent of soil erosion and its repercussions on agricultural productivity and the environment. To address this research gap, it is imperative to conduct a focused evaluation of soil erosion rates in Hassan District, particularly in the context of intensive agricultural practices. This assessment should encompass data on erosion rates, their spatial distribution, and their impact on the overall quality of soil. Such research will serve as a foundation for formulating effective strategies and policies to mitigate soil erosion and ensure the sustainability of agriculture in the region.

Therefore, another objective of this article is to make the research gap in assessing soil erosion rates in Hassan District due to intensive agricultural practices evident. While existing studies provide valuable insights into soil quality and related agricultural practices, a specific evaluation of soil erosion in this district is lacking. Localized research is crucial to address this gap and take necessary steps to preserve soil health, maintain agricultural productivity, and safeguard the environment.

Impact Of Intensive Agricultural Practices On Soil Erosion In Hassan District

Intensive agricultural practices have become increasingly common in many regions, including Hassan District. These practices often involve the heavy use of chemical fertilizers, irrigation, and the cultivation of high-yield crops to maximize agricultural output. While intensive agriculture can lead to increased productivity, it also carries the risk of adverse environmental consequences, one of which is soil erosion.

1. Various sources of irrigation, including canals, tanks, and wells, significantly contribute to both net and gross irrigated areas in Hassan District, potentially altering the natural water balance and increasing soil erosion susceptibility (Smith et al., 2015).
2. High levels of nitrogen, phosphorus, and potash fertilizers are distributed across the district, which can enhance crop yields but also negatively affect soil erosion by altering soil properties and increasing surface runoff (Hao et al., 2019).
3. Intensive agriculture in Hassan District often involves monoculture and high-yield crop varieties, reducing soil biodiversity and increasing vulnerability to erosion, which can be mitigated by crop diversity and rotational planting (Montgomery, 2007).
4. The construction of irrigation channels, reservoirs, and roads as part of infrastructure development in intensive agriculture alters surface runoff patterns, potentially accelerating soil erosion, necessitating careful planning and maintenance to minimize these impacts (Pimentel et al., 2006).

Hence, intensive agricultural practices, as indicated by the data in the tables, can have significant implications for soil erosion in Hassan District. While these practices can increase agricultural productivity, they also have the potential to degrade soil quality and increase erosion risk.

Major Findings

- Hassan's unique geographical, climatic, and agricultural characteristics necessitate a localized assessment to understand the extent of soil erosion and its repercussions on agricultural productivity and the environment.
- Tanks are the primary source of irrigation in Hassan District, contributing significantly to both gross and net irrigated areas.

- There is widespread reliance on tube wells for irrigation across Hassan District, with significant variations in irrigated areas among different taluks.
- The distribution of chemical fertilizers in Hassan District suggests that agricultural practices in the region heavily rely on these fertilizers.

Suggestions

- Investigate the long-term effects of different crop rotation and diversification strategies on soil erosion in Hassan District.
- Assess the effectiveness of precision agriculture and advanced technologies in reducing the environmental footprint of intensive agricultural practices.
- Examine the socio-economic factors influencing farmers' adoption of sustainable soil conservation practices in the context of intensive agriculture.

Recommendations For Further Research

- Conduct a comprehensive soil erosion modeling study to predict erosion rates and identify vulnerable areas within Hassan District.
- Explore the potential benefits of agroforestry and afforestation as means to mitigate soil erosion and enhance landscape resilience.
- Investigate the role of local and regional policies in promoting sustainable agricultural practices and their impact on soil erosion reduction in the region.

Implications Of The Study

- The findings highlight the need for tailored agricultural policies that encourage sustainable practices to mitigate soil erosion and safeguard long-term soil health in Hassan District.
- This study underscores the importance of raising awareness among farmers about the consequences of intensive agricultural practices on soil erosion and promoting best management practices.
- The results emphasize the significance of integrating environmental considerations into agricultural planning to ensure food security and environmental sustainability in the region.

Conclusion

This context-specific analysis is essential for tailoring effective strategies to address the challenges associated with intensive agricultural practices and to safeguard the sustainability of the region's agricultural sector and ecosystem. The assessment of the impact of intensive agricultural practices on soil erosion in Hassan District underscores the necessity of adopting sustainable and integrated approaches. The data presented in this study reveals the potential risks posed by extensive irrigation and chemical fertilizer application. To ensure long-term agricultural productivity and environmental health, there is a compelling need for strategic land-use planning, improved water management, and the promotion of practices that reduce erosion. Sustainable agriculture can play a pivotal role in mitigating soil erosion and fostering resilience in this vital agricultural region.

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