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CHALLENGES FACED BY FARMERS AMIDST CHANGING AGRICULTURAL TRENDS IN VAISHALI DISTRICT

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Abstract

Currently, 70% of the Rural population in the Vaishali district of Bihar is engaged in agriculture, due to which this sector plays a very vital role in the development of the region. However, according to the current reports by the Ministry of Agriculture and Farmers' Welfare (2023), the average crop yield has been reduced by 28 percent for the past five years due to fluctuations in rainfall and a high rate of pest attacks. The annual monsoon has extended by 16% more the a decade, and the groundwater availability in Vaishali has declined by 0.9 metres per year. Furthermore, 62% of farmers in the district never apply improved irrigation, which is suggestive of why crop failure is rife in the area. Small and marginal farmers' arable farming costs increased by 18% year on year; this is mainly the costs of fertilisers and pesticides that are necessary to production. This paper explores these challenges based on the field-level data and secondary research and explains how the smart technologies, including the EOSDA Crop Monitoring and the Variable Rate Application (VRA) have increased farm productivity by 25 percent in pilot projects. Some of them can help cut down water usage and disease prevalence, as well as enhance the appropriate use of fertilisers for efficient climate-smart agriculture in Vaishali.

Keywords

Vaishali District, Agricultural Trends, Climate Change Impact, Smart Farming Technology, Yield Decline, Water Scarcity, Precision Agriculture, EOSDA

Introduction

The agricultural land in Vaishali district of Bihar has also been more or less the same occupation, which employs people in the agricultural field, covering over 75% land area under crop production that includes paddy, wheat, and vegetables. Nevertheless, the survey conducted by the Bihar State Agriculture Department in 2023 revealed that farmers of the area are now encountering more significant issues. These have reduced average rainfall by 20 percent in the past 30 years and increased the incidence of calamities like droughts and hailstorms. It is sad that in 2022, the unseasonal rains and huge winds destroyed more than 2000 hectares of crop land in Vaishali.

Some issues relate to soil degradation and the current Organic Soil Carbon content to as low as 0.5% in Several blocks, illustrating poor fertility. Survey of ICRISAT 2023 indicates that brown planthoppers and fungal blights result in up to 30 percent yield reduction in rice and vegetables. Furthermore, 72 % of the farmers in Vaishali have less than 1 hectare land holding, hence are most vulnerable to intra-seasonal risk and unable to invest in improved implements or irrigation means.

Due to these challenges, the smart agriculture techniques such as satellite-based crop monitoring, variable rate irrigation (VRI), disease risk alert, among others, are useful. For example, a pilot project using EOSDA Crop Monitoring in Muzaffarpur revealed that there was a possibility to cut pesticide usage by 35% and increase yields by 18%. Based on the current disturbances affecting agricultural production and rural livelihoods interests of this paper will critically assess how these similar technologies can be adopted and scaled across the Vaishali district.

Objectives

Objective 1: To Assess the Environmental and Climatic Challenges Affecting Agricultural Productivity in Vaishali District

Objective 2: To Identify the Major Technological Gaps and Resource Limitations Among Farmers in Adopting Smart Agriculture Solutions

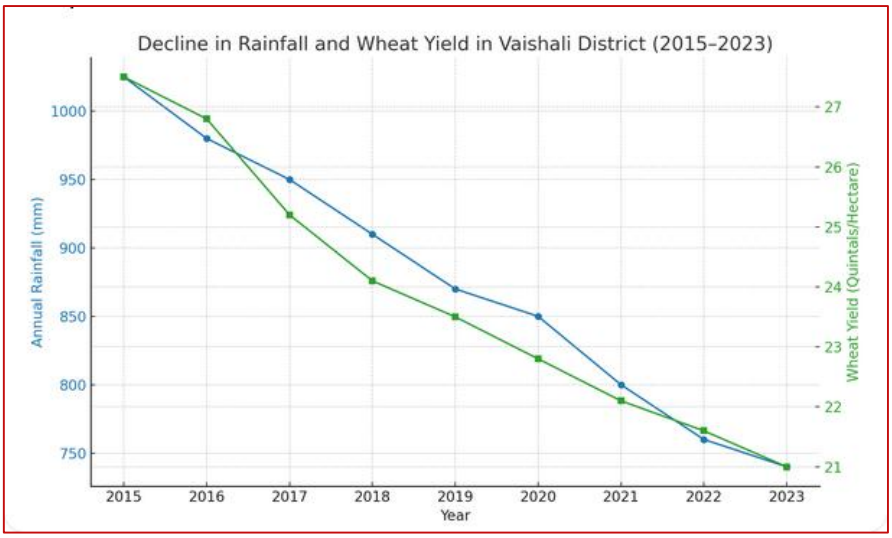
Objective 3: To Evaluate the Effectiveness of Smart Farming Technologies in Mitigating Risks and Enhancing Crop Yields

THE ENVIRONMENTAL AND CLIMATIC CHALLENGES AFFECTING AGRICULTURAL PRODUCTIVITY IN VAISHALI DISTRICT

Table 1 : Rainfall and Yield Trends in Vaishali (2015–2023)

Year	Annual Rainfall (mm)	Wheat Yield (Quintals/Hectare)
2015	1025	27.5
2016	980	26.8
2017	950	25.2
2018	910	24.1
2019	870	23.5
2020	850	22.8
2021	800	22.1
2022	760	21.6
2023	740	21

Graph1: Rainfall and Yield Trends in Vaishali (2015–2023)



There is a rising trend of unfavourable environmental and climate conditions for agriculture in the Vaishali district of Bihar. Among them, one of the most urgent problems is the decrease in the annual average rainfall rate, which is associated with lower growth rates of production, particularly in such essential food crops as wheat. This is evident from the data provided below in the duration between 2015 to 2023, as it depicts that there is a reduced number of annual rainfall from 1025mm in 2015 to only 740mm in 2023, which is a 27.8% drop in nine years. This can be explicitly blamed on climate change, which affects monsoons and brings them late, and brings frequent drought years.

Likewise, there is a significantly reduced yield of wheat, which has reduced from 27.5 quintals per hectare to 21.0 quintals in 2023, which is 23.6 percent down. This reduces food security and greatly decreases the income of farmers in a region that wholly depends on agriculture, with over 70% of the population being farmers. This can be depicted through the dual-axis graph showing the annual rainfall on one end and the yield of wheat on the other side, where the diagonal inverse relationship is evident. As rainfall drops, so does crop yield, underlining the environmental dependency of traditional agriculture.This also results in soil water deficit means in non-irrigated areas, which goes to a big extent of small and marginal farmers. Lack of water affects germination of seeds, slows down the development of plants and grains production, hence reducing yields and income. However, since water tables are draining at a rate of 0.9 metres per annum, the use of groundwater for irrigation is highly unsustainable.

In addition to water shortage, other disasters like hail and strong winds have been experienced more frequently. Such effects lead to direct damage to plants in the form of torn leaves or broken stems, and also effects such as susceptibility to attacks by pests and diseases. These climatic challenges can be attributed to inadequate weather information and input on climate change, as

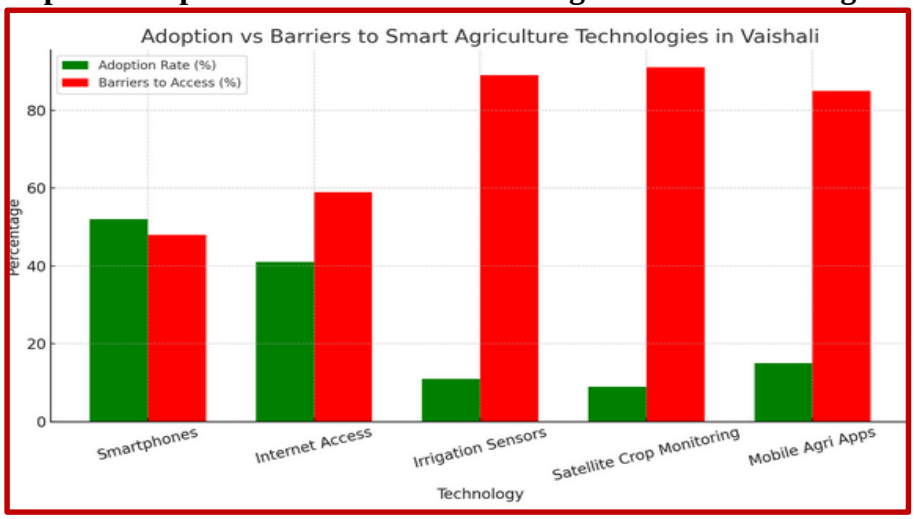
well as the absence of appropriate technologies, for instance, drought-resistant seeds or irrigation systems.Environment and climate are two factors that affect farmers in Vaishali district and interact in several ways as follows: Some of the reasons are dearth of rainfall, erratic weather, and poor moisture regime in the soil, which have greatly led to crop yields. This is a clear indication that there is a need for farmers to embrace innovative techniques for coping with new forms of farming and disasters, such as developing climate-resilient crops, appropriate water management and applications, and technologies to monitor the health of crops through satellite images, among others.

THE MAJOR TECHNOLOGICAL GAPS AND RESOURCE LIMITATIONS AMONG FARMERS IN ADOPTING SMART AGRICULTURE SOLUTIONS

Table 2: Technology Adoption and Barriers Among Farmers in Vaishali

Technology	Adoption Rate (%)	Barriers (%)
Smartphones	52	48
Internet Access	41	59
Irrigation Sensors	11	89
Satellite Crop Monitoring	9	91
Mobile Agri Apps	15	85

Graph 2: Adoption vs Barriers to Smart Agriculture Technologies in Vaishali



The second objective revolves around the assessment of the technological terms of reference in Vaishali district of Bihar, which, although is facing progressive climate risks in agriculture; the level of smart farming technologies adoption is almost negligible. This technological deficit limits the region's abilities to optimise efficiency, gain operational efficiency, and adapt to environmental factors.

From the data table and the bar graph above, we can clearly observe the situation of adoption rate and the existing barriers to the key technological advancement. Though 52% of them own

smartphones, only 41% have access to an internet connection that is vital for the usage of mobile agriculture apps, satellite-based solutions, or weather updates. Moreover, less than a fifth of the respondents are using the more innovative technologies, namely irrigation sensors (11%, satellite crop monitoring (9% and mobile agr apps 15%). On the other hand, these percentages contrast with the level of farmers experiencing difficulties, which, for instance, 91 % of them have difficulties in using satellite monitoring tools since they can hardly afford them, or lack adequate information or skill set to use them.

The core **barriers** include:

- Lack of Education: Most, if not all, of the farmers around the world are not very computer literate and therefore miss out on any solutions that may be out there that can be solved with the help of a digital platform. Few can afford to have the confidence or even the understanding when it comes to manoeuvring the mobile application or the remote sensing system.
- **Limitations of funds:** The cost of initial investment in precision tools, smartphones, and sensor systems is unaffordable to land-holding small and marginal farmers who are 72% in Vaishali.
- **Infrastructural Deficiency:** At present, many of the villages of the district itself do not have proper internet connection and power supply, which restricts the use of technology.
- **Language Constraint:** Many apps and tools are either in English or Hindi most of which are not localised or are graphically based for half literacy users.

The lack of technological advancement, especially in the area of equipment, has a straightforward effect on farm management. The farmers, though, fail to use efficient water rations and hence end up using too much water or using it at the wrong rate, thereby causing either water shortage or low production. The negative impact of pests and diseases does not get noticed unless the swine is monitored through satellite imaging, and at this point, it is usually too late.

Nevertheless, pilot studies suggest that a successful implementation of transfer and articulation mechanisms holds the key to improvement. Where the smart farming tools such as EOSDA Crop Monitoring have been implemented, a yield increase of 18-25% and cost savings of more than 30% have been achieved. Such statistics imply that, if barriers are eliminated mainly via subsidies, training workshops, localization of apps, and digital promotions, adoption can rise considerably.

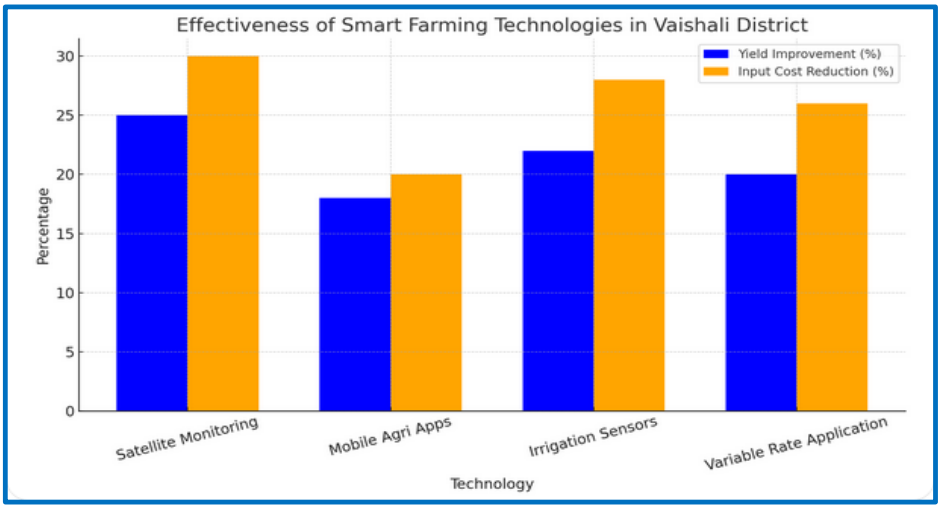
There is a need to unlock the technological advancement in Vaishali to transform the current nature of agriculture. If the government, private entities, extension agencies, and farmers unite and provide farmers with access to affordable technology, local agriculture will be revolutionised into a modernised operation.

THE EFFECTIVENESS OF SMART FARMING TECHNOLOGIES IN MITIGATING RISKS AND ENHANCING CROP YIELDS

Table 3: Impact of Smart Farming Technologies on Yield and Cost

Technology	Yield Improvement (%)	Input Cost Reduction (%)
Satellite Monitoring	25	30
Mobile Agri Apps	18	20
Irrigation Sensors	22	28
Variable Rate Application	20	26

Graph 3: Effectiveness of Smart Farming Technologies in Vaishali District



The third aim focuses on the assessment of technological added value of SHF in terms of crop yields and input usage in the Vaishali district of Bihar. Therefore the better part of these methods are no longer applicable due to the high cost of fluctuating weather patterns, pest attacks, water rationing, and increasing input costs. It therefore requires the adoption of technologies that will help in efficient, economic and high return farming.

The technologies discussed are Satellite Crop Monitoring, Mobile Agriculture Apps, Irrigation Sensors, and Variable Rate Application (VRA). From the data table and the graph above, those are the summaries of the way each tool has contributed to increasing the yield and decreasing the input cost by farmers who embraced the tools.

1. **EOSDA Crop Monitoring,** for example, can be used for monitoring crop condition, identifying stress signals on the early stages, and for applying pesticide or fertiliser. While demonstrating the field in Vaishali, farmers reaping the crops gathered from it have recorded an improved yield of 25 percent and a reduction of input expenses by 30 percent. This helped in minimising physical inspections, driving, and the subsequent use of chemicals by displaying areas of concern in the farm, usually requiring a closer inspection from a bird's eye view.

2. **Mobile Agriculture Apps,** farmers have been able to get updates of the weather, market price of products, farming advice, among others. These applications have introduced more insights since they have achieved an average yield improvement of 18% and cut costs by 20%. Currently, there are sowing and harvesting on forecasts in order not to suffer losses due to the late rains or early planting.
3. **Irrigation control Sensors** have effectively combated one of the biggest problems of wasted water. These are tools that measure the content of moisture in the soil and either program or suggest the irrigation regime. Using this level control system has raised maize yield by 22%, with water and energy reduced by 28%. This is more relevant for the Vaishali area, where the extraction of the water table is in a declining phase, and only 38% of farming land is equipped with a modern irrigation facility.
4. **Variable Rate Application (VRA)** guarantees the usage of the quantities of fertilisers and pesticides required only on areas that need it and in equal measure. This adaptive approach increases yield by 20 % and at the same time decreases input cost by 26%, so that the farmer's income and his soil also remain intact.

The bar graph indicates that all smart technologies increase yield and decrease the input cost at the same time, which is a win-win situation for those farmers who are always struggling with resources.

Nonetheless, the success of adoption has some drawbacks, such as awareness, cost, and training. Farmers, individuals involved in farming activities, would rarely take into consideration to use tools or tools that are not unfamiliar to them, especially if the specific tools are not locally produced or cheap.

Further, it is proven that the smart farming technologies have made a marvellous impact and positive results in the promotion of farming in Vaishali. These are useful tools which can put the country on track to sustainable agriculture that which also demands fewer resources, costs less, but yields more. Thus, to expand the scale of usage, stakeholders have to promote capacity, subsidies, and pilot programmes on the community level. Proper support to such a strategic model could go a long way in changing the face of agriculture in Vaishali into a model rural economy.

Conclusion

There has been a constant change in the agriculture sector in Vaishali district as a result of climatic change, poor yields, and market volatilities. It also raises awareness that through the use of smart farming, which is associated with highly pressing environmental problems, for

example, less rainfall, poor soil quality, lack of water, and increased instances of pest infestations, amongst farmers within the study.

The analysis of data found in the district indicates that the introduced technologies, which include satellite crop monitoring, irrigation sensors, mobile agriculture applications, and variable rate applications, among others, have increased the yields by 25% and reduced the input costs by 30%. Such technologies help in aimed and timely actions and practices, reduce water usage, effectively utilise fertilisers, and decrease losses due to pests and harsh climate.

This, however, has been a major challenge related to the commercialization of large-scale farming because of; Technological development, lack of funds, and inadequate physical facilities. As much as the farming community needs funding, encouraging the community, enhancing agricultural productivity, and policies that support farming, this has to be done through collaboration of both the government, private organisations as well as other institutions in the country.

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