



Smart Farming: Data
Transformation in Ghana's
Agriculture Sector

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Foreward

This white paper, *Smart Farming: Data Transformation in Ghana's Agriculture Sector*, reflects our dedication to collaboration in order to navigate the complexities and opportunities that lie ahead.

In today's rapidly evolving business landscape, the ability to harness the power of data and emerging technologies is a necessity for sustainable growth and development in agriculture.

At Hiedberg, we focus on empowering stakeholders to leverage these technologies effectively. This white paper, **Smart Farming: Data Transformation in Ghana's Agriculture Sector**, reflects our dedication to collaboration in order to navigate the complexities and opportunities that lie ahead.

We have compiled this white paper to provide you with actionable insights and strategies that can apply to your own operations. Whether you are looking to optimize productivity, enhance the farmer experience, or explore new market opportunities, we believe this document will serve as a valuable resource.

Thank you for taking the time to explore our findings. We look forward to the possibility of partnering with you on your journey towards innovation and success.

Best Regards,

Miriam MacCarthy

CEO, Hiedberg



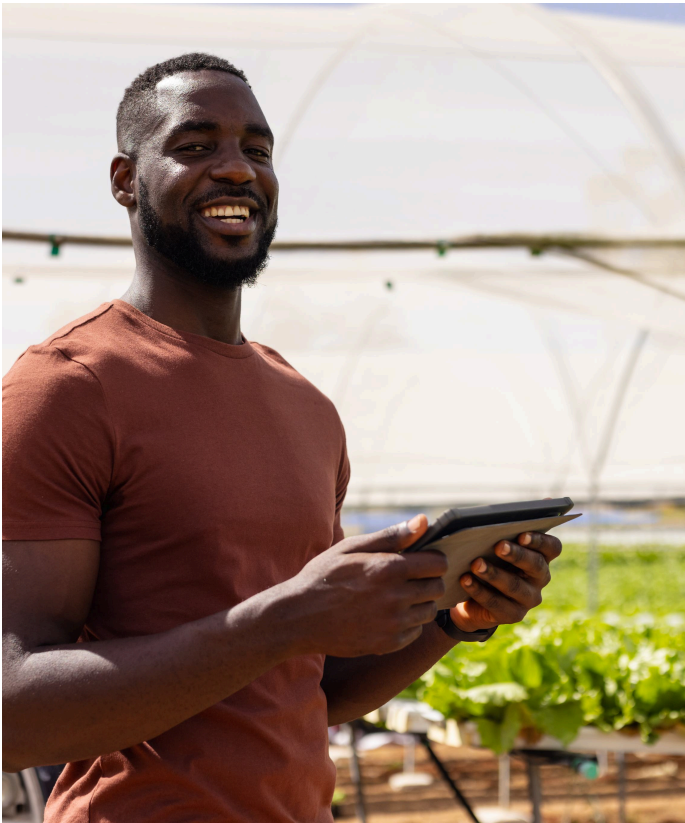
Current State

Ghana's agricultural sector is a pillar of its economy, engaging a significant portion of the population and contributing substantially to the nation's GDP

Approximately 41.9% of Ghana's labor force is employed in agriculture, encompassing crops and livestock production, fishing, processing, and marketing of agricultural products¹. The sector utilizes a substantial portion of the country's land, with specific figures detailed in the Ministry of Food and Agriculture's reports². Agriculture significantly contributes to Ghana's GDP, with the agriculture, forestry, and fishing sector's value added to the gross domestic product increasing by 1.6 percentage points in 2023 compared to the previous year³.

Ghana's primary agricultural products include :

- Cocoa Beans: Ghana is one of the world's leading producers of cocoa, a vital export commodity.
- Cereals: Maize and rice are staple foods, with maize being a significant crop for both domestic consumption and exports.
- Root Crops: Cassava and yam are essential components of the Ghanaian diet and agriculture.
- Oilseeds: Palm oil production is a growing industry, contributing to both domestic use and export markets.



Despite the sector's importance, challenges such as limited access to modern farming tools, fertilizers, pesticides, and technology hinder high productivity. The majority of farmers grow food mainly for their own needs rather than for sale, and there aren't many large farms or businesses investing in biofuels and energy production. This makes it harder for the agricultural sector to grow and modernize. Notably, a substantial portion of the food consumed in Ghana is still imported, highlighting a clear gap and opportunity to support farmers in creating a robust, sustainable, and thriving industry.

The Ghanaian government has implemented several initiatives to address these challenges and promote agricultural growth. These initiatives aim to modernize the agricultural sector, improve productivity, and reduce the reliance on food imports, thereby fostering a more sustainable and self-sufficient agricultural economy.

Key projects that are completed and/or currently underway are:

Ghana Agriculture Sector Investment Programme (GASIP)

A private sector-led value chain program designed to provide a framework for long-term engagement and financing to scale investments in value chains. GASIP is structured as a six-year long program, divided into two cycles of three years each. The program is financed through a combination of resources from the International Fund for Agriculture Development (IFAD) and the Government of Ghana.

Key Objectives

1. Improve the financial viability of agribusinesses and smallholder farmers by facilitating access to quality inputs, markets, and financing.
2. Encourage the adoption of climate-smart agricultural practices to mitigate the impacts of climate change on farming activities.

[National Agricultural Investment Plan \(IFJ\)](#)

[Agriculture In Ghana \(Facts & Figures\) 2021.pdf](#)

<https://www.statista.com/statistics/1118763/share-of-agriculture-value-added-to-gdp-in-ghana/>

Planting for Food and Jobs (PFJ)

A flagship program aimed at increasing food production and creating jobs through the provision of improved seeds, fertilizers, and extension services. This program was launched by the Ghanaian government in 2017 to boost food production, create employment opportunities, and reduce the country's reliance on food imports. Since its launch, PFJ has made significant contributions to Ghana's agricultural sector.

Key Components of the PFJ Program

- > Provision of Improved Seeds
- > Subsidized Fertilizers
- > Marketing and Distribution Support
- > Digitalization and Technology Integration

National Agriculture Investment Plan (NAIP)

A strategic plan focusing on enhancing agricultural productivity, promoting value addition, and ensuring food security. The NAIP is executed through collaborations between the Ministry of Food and Agriculture, international development partners, and private sector investors.

Key programs under NAIP include:

- Ghana Agriculture Sector Investment Programme (GASIP)
- Planting for Food and Jobs (PFJ)
- Savannah Agricultural Development Initiative (Focused on the Northern Regions)

Key Components of the PFJ Program

- > Enhance Agricultural Productivity
- > Improve Food Security and Nutrition
- > Promote Agribusiness and Value Addition
- > Enhance Climate Resilience and Sustainability
- > Strengthen Agricultural Financing and Investment

Foreign Direct Investment (FDI)

Foreign Direct Investment (FDI) plays a critical role in modernizing Ghana's agricultural sector by providing capital, technology, expertise, and market access. Over the years, the government has introduced policies and incentives to attract investors into various aspects of agriculture, from crop production and agro-processing to irrigation and mechanization.

- > Agro-businesses enjoy a corporate tax holiday of up to 5-10 years, depending on the location and nature of the business
- > Agro-processing companies pay a reduced corporate tax rate of 20% instead of the standard 25%.
- > For businesses in the Northern, Upper East, Upper West, and other rural areas, the corporate tax rate is further reduced to 5% after the tax holiday.
- > Import duty exemptions on agricultural machinery and equipment
- > Tax waivers on agro-processing raw materials that are not available locally





Gap Analysis

Data will help bridge the gap in the growing insurance sector by creating opportunities to create products geared toward smallholder farmers and cooperatives.

With Hiedberg's assistance, Ghana can build the infrastructure to support, collect, mine, and visualize data in order to create a more robust decision-making process. With data, the Ministry of Food and Agriculture will make strides towards increasing sustainable farming cooperatives and increase the number of commercial farms.

By having access to the current productivity levels, number, number resources per farm, prevalent crops growing around the country, and time to market, the Ministry of Food and Agriculture will make better decisions to support smallholder farmers optimize or even consolidate their farms. They will also be able to decide on what crop these farms will specialize in.

There will also be more data that can be used in planning and budgeting for commercial farms and how/if to incorporate Agro-inputs into the mix of exports. Data will also help the ministry optimize the marketplace and work with other government entities to improve infrastructure for intra-country trade as well as facilitate trade outside of Ghana. Data will help bridge the gap in the growing insurance sector by creating opportunities to create products geared toward smallholder farmers and cooperatives.

Data Collection and Aggregation

The foundation of the project lies in the collection and aggregation of comprehensive data sets. These data sets encompass a wide range of information, including crop yield data, soil quality, weather patterns, and farmer motivations. We will work closely with farmers, cooperatives, and other relevant stakeholders to access and consolidate these data sources.

Crop Yield Data

This critical component provides insights into the productivity of different agricultural regions, gathering accurate and real-time data. It includes metric data on crop yields, planting and harvesting times, and crop types, allowing us to understand peak seasons and potential issues affecting yields. We will work with agricultural agencies to access data directly from farm records and any relevant agricultural monitoring systems to get a granular view of crop production, including region-specific productivity, peak farming periods, and crop types used.

Demographic Data

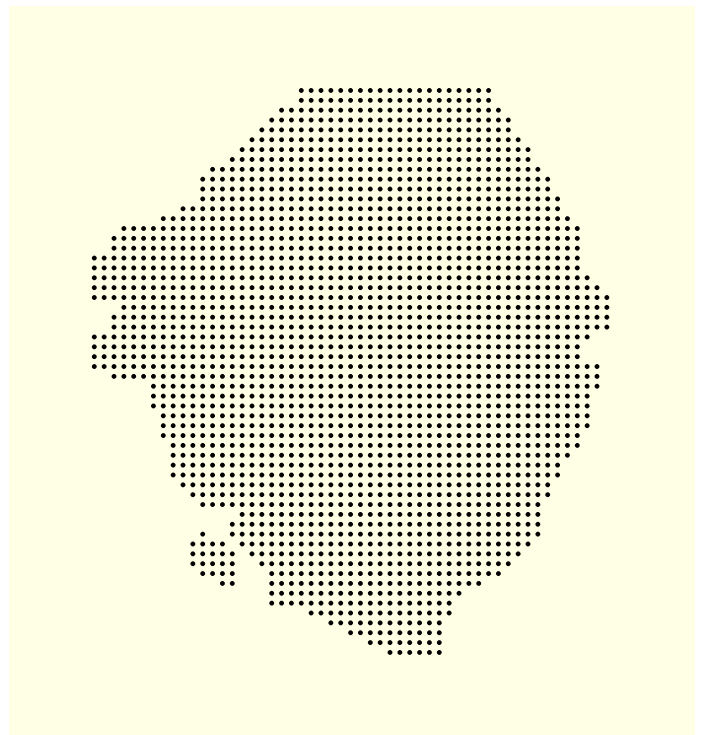
Understanding the demographics of farmers and agricultural workers is pivotal to the needs of the project. Data on age, gender, income levels, and farming preferences will be analyzed. Our approach will employ data enrichment techniques by merging data from multiple sources (as available) to build a comprehensive profile of farmers.

Weather Patterns

Mapping the weather patterns and their impact on agriculture will offer insights into the efficiency of farming practices and crop resilience. Data collected from multiple sources will enable the mapping of weather and identify critical periods for farming activities.

Motivational Data

This data on reasons for choosing one farming method over another will help plan strategies to support farmers and enhance their productivity. To uncover the motivations behind agricultural practices and choices, we will implement surveys, interviews, and sentiment analysis of social media conversations. This comprehensive approach will capture both explicit and implicit motivations, offering valuable insights into farmer behavior.



TASK	KPI
<p>Data Parameters and Scope</p> <p>Description: Determine the forms of data to be used, collection methods, and set procedures for collection.</p>	<p>Comprehensive list of data sources and types to be analyzed. Establish data collection methods.</p>
<p>Data Audit and Assessment</p> <p>Description: Audit the existing data and assess its quality, completeness, and consistency specifically focused on web/mobile apps, machines, transactions, and social media.</p>	<p>Completed audit report with recommendations for data optimization and standardization.</p>
<p>Data Optimization and Preprocessing</p> <p>Description: Optimize the data by removing duplicates, filling in missing values, and correcting errors. Ensure the data is clean and ready for analysis.</p>	<p>Optimized data that is clean, complete, and accurate.</p>
<p>Data Standardization</p> <p>Description: Standardize the data by using consistent naming conventions, formats, and units. We will segment and employ descriptive analytics which will help create a snapshot of current conditions such as crop yield patterns, demographics, and farming behaviors.</p>	<p>Standardized data that is consistent and easy to understand.</p>
<p>Data Consolidation</p> <p>Description: Consolidate the data by combining multiple data sources and eliminating redundancies.</p>	<p>Consolidated data that is streamlined and efficient.</p>
<p>Data Modeling</p> <p>Description: Build a data model to support the analytics with an element of training to recognize patterns and themes.</p>	<p>Data model that supports the requirements of the analytics.</p>
<p>Data Validation</p> <p>Description: Validate the data model by testing it with sample data and ensuring that it meets the requirements.</p>	<p>Validated data model that meets the requirements of the analytics. Successfully tested a sample of the data and achieved satisfactory results that meet the project objectives.</p>



Visualization and Reporting

We will employ data visualization techniques to create easy-to-understand reports and dashboards

Data insights are most impactful when presented clearly and intuitively. We will employ data visualization techniques to create easy-to-understand reports and dashboards. Visualization tools will allow stakeholders to interact with the data, exploring different aspects and scenarios. All reports will be tailored to address the specific goals of the project, including:



Farmer Access Optimization

Flowcharts and simulations will be created to model farming activities within the regions and identify bottlenecks or areas for improvement.

These visualizations can support optimizing farm layouts and resource allocation around the agricultural areas.



Optimized Agricultural Practices

Visualizations will include heat maps that illustrate crop productivity during different times of the year, allowing agricultural agencies to identify areas for improvements.

Custom real-time dashboards will provide insights into crop yields within the regions and the parameters of specific agricultural areas.



Commercialization Strategies

Visualization tools will depict commercial activities and farmer foot traffic in the agricultural areas.

Data-driven recommendations will be presented to attract events and stakeholders based on historical data and projected agricultural activities.



Data-driven Strategy

Visual representations will outline data-driven agricultural plans for the agencies.

These plans will incorporate crop yield data, demographic insights, and weather patterns to guide agricultural development decisions.



Climate Risks

Visual representations will be developed to illustrate climate risks such as floods, droughts, and other extreme weather events. These visual tools will highlight potential effects on agricultural regions, identifying vulnerable areas and informing strategies for mitigation and adaptation.

By clearly illustrating these risks, stakeholders can better understand and prepare for the effects of climate change on agriculture, optimizing farming practices and resource allocation to enhance resilience.



Insights Generation

The goal of data analysis is to generate actionable insights to drive decision-making, inform strategies, and guide the transformation of the agricultural system. Our approach to insights generation involves the following steps:

Segmentation Analysis: We will segment farmers and agricultural activities based on various criteria, such as demographics, farming behavior, and motivations. This segmentation will help tailor strategies to specific farmer groups. For instance, we will identify segments of occasional farmers, daily agricultural workers, and commercial farmers.

Pattern Recognition: We will identify patterns and trends within the data, such as peak farming times, seasonal variations, and the impact of events or promotions on crop yields. Recognizing patterns will allow us to optimize farming activities during peak seasons and plan targeted campaigns.

Correlation Analysis: We will explore the relationships between different variables to uncover correlations. For example, we may investigate the correlation between soil quality improvements and crop yield growth. This analysis will help us identify factors that influence agricultural productivity.

Predictive Insights: Predictive models will provide insights into future agricultural trends and the potential impact of various interventions. This will allow stakeholders to make proactive decisions. We will create predictive models to forecast crop yields under different scenarios, such as soil enhancements or promotional campaigns.

Risk Mitigation

Risk	Solution	Risk Level	Category
Failure in project coordination is a risk especially within nonstate actors and private agribusiness	Develop and implement standardized project management processes and systems that align with the financing agreement and relevant IFAD legal documents	Medium	Operational
Inaccuracy/not complete data collected	Establish data validation checks and processes to ensure the accuracy and completeness of collected data	High	Technical/ Operational
Buy-in from other data vendors to share data	Create formal agreements outline the benefits, terms, and conditions of data sharing to ensure mutual understanding and commitment	Medium	Operational
Migration might not meet legal requirements	Follow regulations carefully and consult experts to ensure compliance	High	Compliance
Data security breaches during migration Sensitive Insurance data may be exposed during migration Leading to security breaches	Implement encryption, secure access controls, and regular security audits to protect data during migration	High	Security
Difficulty in integrating migrated data with existing insurance systems could affect functionality	Conduct thorough testing and validation of data integration processes to ensure compatibility and functionality	Medium	Technical
Analytics involving personal data may lead to privacy concerns and potential breaches	Adhere to data privacy regulations and use anonymization techniques to protect individual data during analyst	High	Analytical
Analytics outcomes may not align with business objectives or strategic goals	Regularly review and align analytics projects with business objectives and involve stakeholders to ensure alignment and relevance	Medium	Analytical / Operational
Predictive models may be overfitted to historical data, leading to poor performance on new data	Use cross-validation techniques and regularly update models with new data to maintain relevance and accuracy	Medium	Analytical



Case Study of Agriculture Growth: Vietnam

To maintain Vietnam's agriculture's long-term resilience and competitiveness, the government and stakeholders are aggressively tackling issues such as climate change, water scarcity, and the need for sustainable farming practices.

Southeast Asia is well-known for its varied and fruitful agricultural industry, which is vital to the economy of many of the region's member states. Southeast Asia's agriculture has a wide range of crops, with a focus on rice, rubber, palm oil, and other varieties of fruits and vegetables. Among the countries in Southeast Asia, Vietnam stands out as a top producer of agricultural goods, with a sector that makes a substantial economic contribution.

Vietnam is currently the second-largest rice exporter in the world. Its agricultural industry has grown rapidly in recent years due to advances in productivity and the export of high-value goods like rice, coffee, and seafood. To maintain Vietnam's agriculture's long-term resilience and competitiveness, the government and stakeholders are aggressively tackling issues such as climate change, water scarcity, and the need for sustainable farming practices.

Background

Vietnam's agricultural sector faces challenges such as climate change, water scarcity, and soil degradation. The government has implemented initiatives to promote sustainable agriculture practices, increase irrigation efficiency, and enhance rural livelihoods.

Vietnam's agricultural history dates back over 4,000 years, with rice production being a pillar of the economy. As the world's second-largest exporter of rice, it accounts for over 20% of global exports. Other major crops include coffee, rubber, sugarcane, and various fruits and vegetables.

The country's agricultural sector has undergone significant transformations in recent years. The government economic reforms, known as Doi Moi, introduced market-oriented policies, leading to increased productivity and exports. Vietnam has also become a major player in global agricultural trade, with key markets including China, Japan, and the United States.

According to the Vietnam Briefing from Dezan Shira and Associates, in 2022, Vietnam's agricultural sector experienced

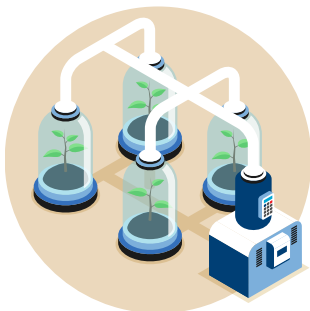
its highest growth in recent years reaching 3.36%; a total of 2.88% in farming, 4.43% in fishing, and 6.13% in forestry were included in the statistics. The industry as a whole saw export revenue of more than \$53.22 billion USD. Vietnam presently exports a wide variety of agricultural goods worldwide.

Despite its successes, Vietnam's agricultural sector faces challenges such as climate change, water scarcity, and soil degradation. The government has implemented initiatives to promote sustainable agriculture practices, increase irrigation efficiency, and enhance rural livelihoods. Overall, Vietnam's agricultural sector is a vital component of the country's economy and food security, with opportunities for growth and development in the face of challenges



Government Initiatives

The Vietnamese government has implemented several initiatives to develop the country's agricultural sector. These initiatives have contributed to the growth and development of Vietnam's agricultural sector, making it a leading exporter of agricultural products. Some of these initiatives include:



Vietnam's Strategy for Sustainable Agriculture and Rural Development (2021-2030, with a vision to 2050)

aims to transform the country into a leading agricultural nation with a modern, efficient, and environmentally friendly agricultural product processing industry.

The strategy focuses on sustainable domestic agricultural products, green technology, and minimal environmental pressure, targeting GDP growth, increased export values, and improved socio-economic growth. It also prioritizes environmental protection, climate resilience, and green agriculture, with specific measures including research, conservation, eco-villages, climate risk assessment, adaptation, and mitigation solutions, emphasizing sustainable development, reduced environmental pressure, and increased climate resilience.

Another government initiative is the **Doi Moi (Renovation)**. This is a significant economic reform program initiated in Vietnam in 1986. It aimed to transition the country from a centrally planned economy to a socialist-oriented market economy. The Doi Moi reforms had a significant impact on Vietnam's agricultural sector, including:



- **Decollectivization of agricultural land**, allowing farmers to work on their own plots
- **Introduction of market-oriented mechanisms**, enabling farmers to sell their products at market prices
- **Encouragement of private enterprise in agriculture**, leading to increased investment and innovation
- **Development of new crops and farming techniques**, improving productivity and efficiency
- **Increased focus on export-oriented agriculture**, leading to growth in agricultural exports

These changes helped to increase agricultural productivity and output, improve farmers' incomes and living standards and reduce poverty in rural areas. Today, the legacy of Doi Moi continues to shape Vietnam's agricultural sector, with ongoing efforts to:



Enhance competitiveness and sustainability in agriculture,



Improve value chain linkage and market access for farmers,



Promote high-tech agriculture and digitization,



Address environmental; and social challenges such as climate change and labor rights.

Private Sector and Foreign Investment

Private sector and foreign investors have played a significant role in transforming Vietnam's agricultural sector, particularly in rice production. Through their investments, initiatives, and expertise, they have enhanced productivity and quality, improved supply chain efficiency, increased farmers incomes, promoted sustainable agriculture practices, etc.

These contributions have positioned Vietnam as a leading global rice exporter, with the country's agricultural sector experiencing significant growth and development. The collaborative efforts between the private sector, foreign investors, and the government have been instrumental in driving this success, paving the way for a more sustainable and prosperous agricultural future in Vietnam. Some notable private and foreign investors include:

Olam International is a leading global Agribusiness company with a diverse portfolio of operations across various commodities, including rice. Olam is one of the largest rice merchants in Vietnam, with a strong network of farmers and suppliers. Olam has formed partnerships with local Vietnamese companies, enhancing its reach and impact in the country and also invested in modern rice processing facilities and logistics infrastructure in Vietnam, improving efficiency and quality.

The International Rice Research Institute (IRRI) has a long-standing partnership with Vietnam, focusing on improving the country's rice sector through various collaborative projects. IRRI has worked with Vietnam's Ministry of Agriculture and Rural Development to develop high-yielding, disease-resistant, and climate-resilient rice varieties, and introduced sustainable rice production practices like alternate wetting and drying (AWD) to reduce environmental impact. Additionally, IRRI has provided training and capacity-building programs for Vietnamese researchers, extension workers, and farmers, and collaborated on improving the rice value chain, including post-harvest management, processing, and marketing. IRRI has also worked with Vietnam to develop strategies for adapting to climate change, including the use of climate-resilient rice varieties and innovative farming practices.

The Japan International Cooperation Agency (JICA) has been actively involved in Vietnam's agricultural sector through various projects and initiatives. These include the "Rice Industry Development Project" and "Sustainable Rice Production and Trade Development Project", which aim to enhance rice productivity and quality. Additionally, JICA has invested in agricultural infrastructure development, such as irrigation systems, rural roads, and markets, to improve market access. Capacity building and training programs have also been provided for Vietnamese agricultural officials, farmers, and researchers, while Japanese agricultural technologies and techniques like precision agriculture and post-harvest management have been introduced. Furthermore, JICA supports private sector development through initiatives like the "Agricultural Business Development Project". As a result, JICA's agricultural projects in Vietnam have achieved notable impacts, including improved rice productivity and quality, enhanced agricultural infrastructure and market access, increased adoption of sustainable agricultural practices, strengthened capacity of Vietnamese agricultural institutions and farmers, and promotion of private sector investment in agriculture.

<https://www.olamagri.com/locations/vietnam.html>

<https://www.irri.org/where-we-work/countries/vietnam>

<https://www.jica.go.jp/english/overseas/vietnam/index.html>

Technological Integration

The country is adopting innovations like precision agriculture technologies, internet of things (IoT), artificial intelligence (AI), and blockchain to enhance farm management and decision-making

Vietnam's agricultural sector is largely traditional and labor-intensive, with a growing need for technological integration to increase efficiency, productivity, and competitiveness. To address this, the country is adopting innovations like precision agriculture technologies, internet of things (IoT), artificial intelligence (AI), and blockchain to enhance farm management and decision-making. Despite challenges like limited infrastructure and high upfront costs, initiatives by the government, private sector, and international partners are driving adoption.

The Ministry of Agriculture and Rural Development (MARD) has launched programs to promote technological adoption. According to Vietnam Briefing, the MARD in Vietnam has signed several Memorandum of Understanding (MOUs) with developed countries such as Japan, Ireland, the Netherlands and Australia to learn experiences from high technology-based agricultural systems.

Conclusion

Vietnam's agricultural sector has made significant progress. However, challenges like climate change, water scarcity, and soil degradation require sustained efforts to promote sustainable practices. Government initiatives, private sector investment, and technological integration are critical for modernizing the sector and ensuring its long-term resilience and growth.

Human Resource Empowerment

The Government and private investors are also working to give farmers the tools they need to thrive, from digital training to access to the latest agricultural technology

According to the World Bank Report, Vietnam's agricultural sector has a significant workforce, with approximately 27.5% of the labor force engaged in agriculture, but faces a shortage of skilled laborers, particularly in areas like farm management, technology application, and marketing. To address this, the agricultural sector is focused on improving education, training, and technological access to modernize and improve productivity.

The Government and private investors are also working to give farmers the tools they need to thrive, from digital training to access to the latest agricultural technology, and bringing farmers together through cooperatives, encouraging a sense of community and shared learning. Despite challenges like infrastructure gaps, ongoing initiatives aim to attract the youth and foster continuous learning, ensuring a more skilled and innovative agricultural workforce, which will contribute to the sector's sustainable development and food security.

Conclusion

As the agricultural landscape continues to evolve, the integration of data in the decision-making and strategizing processes is no longer a luxury but a necessity. This white paper has explored the transformative potential of data transformation and provided actionable insights to help the Ghanaian government navigate this shift.

In collaboration with Hiedberg, Ghana's agriculture sector will unlock new levels of efficiency, agility, and competitiveness. The strategic use of data analytics can significantly impact growth and support development goals.

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