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"AN EXPLORATORY STUDY ON ADOPTION OF TECHNOLOGY IN SUSTAINABLE AGRICULTURE"

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ABSTRACT:
Natural disasters pose a danger to all aspects of sustainable development, including social and economic stability. More industries, dimensions, and scales are experiencing this than was first anticipated. As new dangers and linkages surface, agriculture continues to take the hit. For instance, the global food supply is being strained by the COVID-19 epidemic. In order to improve the nutrition and food security of the present and future generations despite these dangers, immediate action is needed to build agricultural systems that are resilient to disasters, diseases, and climate change. More than half of India's population, or 118.7 million farmers, relies on agriculture for their livelihood. However, in India, the agricultural sector has made only limited use of technology. Consequently, agriculture accounts for just 17-18% of India's GDP. However, in the past few years, India has seen a boom in the number of agritech businesses that are making technology more accessible and helping these farmers better their lives. The outcomes of the research to make aware of the research and academia communities to do further research based on the technological advancement like AI, IOT, Big Data, Analytics in sustainable agricultural systems and to do study the impact assessment by doing further studies with Farmers Producers Organization/Farmer Communities/Civil Societies. With the objective of India as Global Supplier of Food across world during next decade and looking into SDG Goals, the research conducted under various technological innovations claimed by Technology companies in the sustainable agriculture in India.

Keywords: Technology, GDP, AI, IOT, Big Data, Analytics, FAO, Sustainable, Communities, SDG

1. INTRODUCTION

The cost of food throughout the world has reached a record high. According to the Food and Agriculture Organization (FAO) of the United Nations, the average food price index jumped from a record low of 141.4 points in February to 159.3 points in March.The previous record had stood for 11 years, set in February 2011. The Reserve Bank of India maintained its major policy interest rates on the same day that the publication of the benchmark gauge for international food prices was announced. Despite the fact that its monetary policy committee had previously warned that "elevated global price pressures in major food products" were adding "high uncertainty" to the inflation outlook and "warranting constant monitoring," the country decided to do only that. An increase of over 24 points, or 17.5%, occurred in the index between January and March as a result of supply constraints brought on by the rising tensions in the Black Sea area.

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The grain and vegetable oil price indexes of the Food and Agriculture Organization of the United Nations reached record highs in March, at 170.1 and 248.6 points, respectively.That's hardly unexpected since Russia and Ukraine account for a combined 28.3% of world exports of wheat, 19.5% of global exports of corn (maize), 30.8% of global exports of barley, and 78.3% of global exports of sunflower oil. All these figures are from early February forecasts issued by the US Department of Agriculture before the Russian invasion of the country.

Since the conclusion of WWII, agriculture has seen tremendous changes. The production of food and fibre has increased dramatically as a result of technological advancements, the increased use of chemicals, the increased specification of farms, and government policies that prioritized maximum output and minimal food expenditures. Reduced farm sizes have resulted in higher yields and cheaper costs for food and fibre.

There are substantial expenses associated with these innovations, despite the many benefits they have brought and the hazards they have mitigated in agriculture. The following are a few of the most prominent ones: loss of topsoil, contamination of groundwater, air pollution, greenhouse gas emissions, decline of family farms, disregard for the living and working conditions of agricultural workers, new dangers to human health and safety brought on by new pathogens, economic concentration in the food and agricultural industries, and breakdown of rural communities. Over the last forty years, there has been a rising movement to challenge these exorbitant expenses and provide creative solutions. Now more than ever, people are becoming behind and accepting of this sustainable agricultural trend. Environmental preservation, economic viability, and social justice are the three pillars upon which sustainable agriculture rests. These objectives have been advanced by a wide range of ideologies, laws, and practices; yet, most definitions of sustainable agriculture share a core set of principles. Seventy percent of the world's freshwater is used in agriculture, putting increasing pressure on water managers to meet the needs of a rising population while simultaneously decreasing water waste and pollution and adapting to a changing environment. Many farmers are overcoming these challenges by employing cutting-edge methods of water management, such as computerized irrigation scheduling and high-tech approaches to improving soil quality. To maintain a thriving agricultural system and ensure the security of the world's food supply, the Pacific Institute conducts research and collaborates with creative agricultural partners to create and put into practise ideas for improved water management. When it comes to agriculture, sustainable practices priorities people and the planet equally. The foundation of agricultural sustainability is ensuring that current needs are met without jeopardizing future generations' potential to do the same. The long-term viability of agro ecosystems depends on the availability of the information, expertise, and trained personnel required to maintain them. Given that agriculture is fluid and site-specific, sustainability calls for a flexible and adaptive body of knowledge that incorporates both formal, experimental research and farmers' real field experience.Increasing agricultural production and ensuring its long-term viability requires social structures that prioritize the education of farmers and scientists, foster an environment conducive to innovation, and facilitate the formation of productive collaborations between farmers and researchers. Topics of social justice often come up in conversations about environmentally friendly farming practices. In most developed nations, the agriculture industry relies heavily on migrant labour from poorer nations due to low wages, making farmers susceptible to shifting immigration rules and imposing a strain on public welfare systems. Many of these employees' uncertain legal status is a major factor in their precarious working conditions, which include poor wages and living standards, limited job security, few prospects for

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advancement, and a lack of access to safety precautions that are routinely observed in other sectors. The use of alternative tactics can also increase labour equality and social justice. These include the pooling of resources among many farmers to build better housing, the division of labour among farms producing a variety of crops to offset seasonality in employment opportunities, the sharing of profits from farms, the training of employees to buy and run their own farms, and the development of innovative approaches to offer affordable health insurance.

A basis for stronger rural economies may be found in economic development strategies and tax systems that promote agricultural diversification on family farms. Consumers may contribute within the constraints of the market structure by communicating their values to producers, retailers, and other participants in the system, such as the importance of preserving environmental quality and promoting social justice. Finally, the same financial limitations that have hampered on-farm sustainability have also created social justice issues for residents of low-income neighborhoods, who frequently have little access to healthy food when traditional retailers leave these areas in favour of more lucrative ones in an effort to maintain their slender profit margins. Many initiatives have been launched to solve these issues, such as local food cooperatives, community and household gardens, farmer's markets, and the incorporation of fresh local farm products into school lunch programme. In addition, the food systems approach takes into account how farmers' choices might affect the end product's healthfulness and tastiness for customers, such as by reducing or removing potentially harmful chemical residues.

2. Literature Review

The use of industrial farming techniques has shown to be a dependable means of producing large quantities of food at a cheap cost. However, it's not quite the bargain that was anticipated. Water, air, and soil pollution, as well as the production of greenhouse gases, and the extinction of species are all possible results of agriculture that is not practised sustainably. Globally, this has a yearly price tag of roughly $3 trillion. In addition, certain agricultural methods have been connected to the rise of zoonotic illnesses as COVID-19 [1]. Farming is essential because it provides for present and future generations, while also protecting the environment, boosting the economy, and promoting social justice. Methods that mimic nature are favoured in order to keep water pure, protect plant and animal life, and keep the land fertile. It's also a means to help accomplish things like ending world hunger and achieving the Sustainable Development Goals. Greater biodiversity is supported, energy usage is reduced by up to 56% per unit of food production, and greenhouse gas emissions are reduced by up to 64% per hectare when compared to traditional farming practices [2]. There is a knowledge gap on how agriculture, the environment, and human health are all connected. Pollution and other forms of environmental deterioration are often not protected by law because policymakers do not see nature as a kind of capital [3]. Yet many people still don't connect the dots between what they eat and the health of the planet or even their own bodies. Producers have little reason to alter their method unless they are required to by law or there is significant customer interest. Eat a wider variety of foods and prepare more of your meals at home. Increase your intake of plant-based proteins by feasting on pulses, peas, beans, and chickpeas [4]. Eat what is in season where you are. Learn more about sustainable agricultural techniques and food labeling, and make purchases of sustainably produced goods. Excessive packing that ends up in a landfill should be avoided at all costs. Don't throw away perfectly good food; doing so might cut world carbon emissions by 8-10%. Grow a garden, even if it's

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only a potted herb collection, in your kitchen. Back initiatives, policies, and programme that work toward creating more long-term, secure food supplies. Moreover, talk about the value of sustainable and healthful food with the people who create it, sell it, and make decisions about it in your life[5]. Farmers lack the financial power to bargain for lower prices for inputs and crops due to the growing concentration of food producers, food marketers, and agricultural input suppliers. As a result, many farmers find their profit margins shrinking, leaving them with less money to invest in bettering their communities and the environment. Cooperatives can be formed for the purpose of production, processing, or marketing, all of which can improve farmers' economic situation. If farmers do things like process their goods on the farm before selling them, cultivate higher-value specialty crops, develop direct marketing opportunities that cut out middlemen, and seek out niche markets, they might possibly earn a larger share of their products' economic value. Policies that limit mergers and acquisitions may help ensure the safety of farmers with long-term interests [6]. Due to the economic hardships farmers are experiencing, many rural areas have seen a decline in their standard of living as farms and other related agricultural businesses have closed.

3. Objectives

The study is to make aware among the community about the sustainability and its impacted areas. The study envisages the various area where technology adoption is essential and use of their various use cases pertaining to the sustainability development. The objective of study is to study adoption of technology in sustainability development. This study finds various business use case in multiple technology area to implement the sustainability development. The study also found the barrier to implement technology in sustainable development. The study is to understand the technology used in sustainable agriculture and then the bottleneck to implement it. The study also find various business and marketing applications though the use of technology and its major role in sustainability development in agriculture.

4. Research Methodology

This study used an exploratory research technique approach since it sought to answer issues that had not been investigated before. In exploratory research, the researcher sets out to answer a question on a topic that has not yet been fully articulated. Research using this strategy does not provide results that provide definitive answers to the study's central question. To study research topics that have not been well described or understood, researchers often use an exploratory research strategy. For researchers to decide whether a subject is worth exploring, they must first have a firm grasp on their research challenge. This research conducted by analyzing top 10 technology companies and their solution to agriculture sustainability. In turn to enhance farmers growth and profitability. The study is purely secondary research based on the claim by various technology companies on the internet.

5. Influences on sustainable agriculture through Big Data:

Sustainability Getting a deeper comprehension of your buying cycles, brand performances by category, effective supply chain management, analysis, and consumer behaviour is made possible by farming intelligence solutions.

Over the past few years, the volumes of data generated by the internet have been increasing at a massive rate – this is the most significant example of big data. Big data is a generic term for

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datasets whose size exceeds the capacity of typical computer systems and therefore very different technical solutions are required in order to access, manage and analyze these sources. Looking beyond the internet, big data are continuously being generated in every industry where sensors, embedded microprocessors and other devices are being used to monitor behavior. Some instances of online and offline sources of big data are given in below table together with examples of their business applications. Bill Franks (2012) discusses the many opportunities that advanced analytics of big data can bring. This strategy will strengthen credibility with stakeholders by producing measurable business outcomes, including enhancements in certain areas of marketing performance.

Examples of big-data sources and their business applications

Source	Example application
Precision Farming	Drip Irrigation
Snapshot of insecticide areas – capturing vehicle journey information	UAV – Drone Technology
Market Linkages, Promotions	Social Sites, SEO
Online product searches and browsing	Targeting online advertising
Online abandoned shopping baskets	Targeting offers to complete purchases
Postings on social media websites	Early identification of product problems/faults
Text data from consumer comments	Measuring consumer sentiment about a company or product
Make use of Renewable Energy Sources	Cleaner energy generation using renewable resources including solar panels, hydroelectric dams, and windmills. With solar panels, farmers may collect and store energy from the sun for later use.
Prices on supermarket web sites	Collecting prices for calculating consumer price indices
Crop Rotation	Crop pattern Analysis
RFID[a] data in retail and manufacturing	Tracking items through the retail supply chain; stock control
Social network data in mobile phone industry	Identifying influential customers with high numbers of connections
Permaculture	Smart farming to reduce waste

For example, big data could identify the customer's interest in a product, internal sources could quantify their ability to purchase, and demographics could describe their circumstances. Then a more tailored offer could be made to the prospective buyer. This will require an integration of big-data systems with conventional database technology, which the solution providers are well placed to provide.

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6. Influences on Sustainability Agriculture through Predictive Analysis

A predictive model is designed with a particular outcome in mind, in order to predict that target variable for each customer. This type of model is sometimes also known as directed. The campaign response model is one example of a predictive model. The following examples or situations where predictive model can be implemented.

Marketing application	Business question
Customer recruitment from a prospect database	Which one of prospects is most likely to buy a good or service?
Cross-sell/up-sell campaign	In other words, which customers of Product X are most likely to buy Product Y? Which current buyers are most likely to make additional purchases of Product Z?
Next-best offer	Which product/service is each customer likely to purchase next?
Customer retention	Which customers are most likely to lapse or attrite?
Customer lifecycle management	How long before each customer becomes likely to lapse or attrite?
Win-back campaign	Who of your former clients might be open to a win-back offer?
Customer future value or lifetime value	In other words, how much money, or profit contributions, do you expect each client to make in the future?

7. Influences on sustainable farming through New Technology and Tool

Since the emergence of cloud, IOT and AI technology, a lot of farms begin to expand their business to digital farming. Cloud computing can also benefit organizations, industries, and economies by:

a) Due to the increased transparency into the food manufacturing process made possible by block chain technology, there is now an opportunity for customers to engage with producers. It reinforces customers' trust and confidence in food safety by lowering barriers to the interchange of commodities, which strengthens their relationships. Regulatory agencies may conduct efficient and effective supervision using the reliable and accurate data made available by blockchain.(Zhou et al., 2016; Chen, 2018).

b) IoT and blockchain technologies have led to the emergence of new agricultural techniques. For instance, "a lightweight block chain-based architecture for smart greenhouse farms" is presented by Patil et al. in 2017. Greenhouse Internet of Things (IoT) sensors function as a private, locally maintained block chain controlled from a central location. A smart agricultural system based on the blockchain and the Internet of Things is proposed by Lin et al. (2018).

c) Improved food safety is made possible by the use of block chain technology, which allows for the tracking of data across the food supply chain. It offers a reliable data management and storage system, which is necessary for innovations based on data like "smart farming" and "smart index-based agricultural insurance."

d) With the technology adoption the Campaign & Lead Management, Product Management and Pricing Changes, Forecasting of Revenue, Knowledge Management, Collaboration among various Communities (Buyer and Seller) are becoming easy to achieve the sales and service goals.

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Top 10 Agritech and their sustainability agriculture solution:

Sl. No	Company Name	Revenue (million)	Technology	Outcomes
1	Ninjacart	$164.2	B2B	To resolve supply chain problem for farmers and retailer
2	WayCool	$60.8	B2B	Last mile distribution using various distribution channel
3	AgroStar	$42	Online Marketplace	Real time advice from expert advice to manager crops and boost yield
4	DeHaat	$19.3	Apps	Low-priced Seeds and Fertilizers, Soil Testing, and a Current Weather Report
5	Stellapps		Apps, IOT solutions	Digitizing and optimizing Milk procurement Milk procurement and cold chain management
6	Bijak	$14.3	Apps	Assist retailers and distributors in locating new vendors, managing accounts, and processing payments,
7	CropIn Technology	-	Apps using SAAS solutions	Real time weather updates and predict crop yields
8	EM3 AgriServices	-		Rent Agri equipment to boost productivity
9	Intello Labs	-	Apps	Computer Vision and deep learning to assess quality
10	Aibono	$3.5	Apps	In order to increase agricultural output, farmers may now utilize data gathered from soil sensors, internet-of-things devices, and imaging drones uploaded to their cloud platform and analyzed using predictive analytic.

* Source: https://www.prakati.in/top-10-agritech-startups-helping-indian-farmers/Recent revenue

8. Barriers to uptake of Technologies

Some of the obstacles to the widespread use of sustainable agricultural methods are:

- The technology's potential for financial gain.
- Limits on farmers' ability to borrow money and other financial issues.
- The farmer's level of technological literacy, expertise, and schooling.
- Uncertainty about international commodity pricing and government initiatives that aid farmers.
- Farmers' and local governments' conservative outlooks (which might hinder adoption);
- Factors unique to the area/site in question.

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- Structural variables, such as the size of the farm (precision farming is advantageous for big farms, but prohibitively expensive for small farms, that would do better with semi-precision farming);
- The high initial investment required for farmers to take advantage of cutting-edge innovations.
- The technology's scale of production: Products made in small numbers have trouble entering markets.

9. Conclusions

A truly sustainable agriculture must include social, economic, and environmental sustainability, all of which are inextricably intertwined. In order to make ends meet, impoverished farmers often turn to destructive environmental practices, such as the extraction of natural resources like soil fertility. Promotion of sustainable agriculture systems requires legislation that balances these three competing interests. There is a need for everyone to consider how they might remain "sustainable" in a world where change occurs rapidly and profoundly. Both farmers and governments need to assess the "sustainability" of their businesses and practices. In order to protect small-scale agriculture, wildlife hedges, aesthetically pleasing landscapes, etc., governments must not only express an interest in doing so but also provide the necessary policy framework and funding. This is the exact reverse of what would happen if market forces are liberalized. Only if agriculture can continually rejuvenate itself by inspiring a new generation of farmers to enter the field will it be viable over the long term. To maintain a stable financial agricultural sector and a thriving rural economy, it is necessary to adopt proper incentives and a suitable legislative framework, in addition to implementing appropriate technology for sustainable agricultural systems. In our collective endeavour to create a sustainable future, proactive risk mitigation is essential. It is not necessary for potentially dangerous occurrences to develop into full-fledged catastrophes, nor should dangers become overwhelming. Despite inherent vulnerability and impending threats, catastrophe effect is ultimately dependent on communities' readiness to predict, deal with, resist, and recover from shocks. It is essential, therefore, that contemporary agri-food systems include strategies for resilience and catastrophe risk reduction.

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