MAY 2024

Bip Project

2024

Agriculture 1

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Resume:

TerraByte is a project undertaken by 6 students as part of intensive programs (BIP2024), which utilize innovative methods of learning and teaching, including online cooperation.

Our project focuses on using IoT technologies in areas like agriculture to increase agricultural productivity and sustainability.

After extensive research, the 2030 Agenda for Sustainable Development was adopted by all United Nations Member States in 2015. It represents an urgent call to action by all countries. They acknowledge that ending poverty and other deprivations must go hand-in-hand with strategies that improve health and education, reduce inequality, and spur economic growth. All while tackling climate change and working to preserve our oceans and forests.

The rise in food insecurity across the Africa continent is threatening the livelihoods of millions of people and making it hard to achieve the 2030 Agenda for Sustainable Development. We're a non-profit project with a mission to help this kind of countries reach the UN's objectives and leave a better world for this and next generations. It is designed for vulnerable populations in regions with high levels of food insecurity.

We are committed to developing innovative and customized solutions that will help more vulnerable countries access this type of technology. Our goal is to increase the value-added content of agricultural production while addressing critical issues in these countries, such as the food crisis.

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Terms and Abbreviations

TERM	DESCRIPTION
GUI	Graphical User Interface
BIP	Blended Intensive Project
UN	United Nations
EU	European Union
IoT	Internet od Things

Summary:

The TerraByte project proposes the development of a Supervision and Control System based on the Internet of Things (IoT) applied to agriculture. TerraByte is seeking a purpose to leverage the potential of Internet of Things (IoT) technology to add value to agriculture in a market that has already been extensively explored and has numerous players. This project was developed by a team of six students as part of the BIP2024 intensive program and includes innovative teaching and learning methods, including online engagement. TerraByte's main goal is to increase agricultural efficiency and productivity through a sophisticated supervision and control system that everyone can use.

This system uses IoT sensors to gather important information about the environment, like temperature, soil moisture, water levels, and information about farming. This data is entered into a dashboard that farmers can use to monitor conditions in real time and remotely manage their agricultural operations. TerraByte plans to use automation features like irrigation and fertilization to reduce operating costs.

The TerraByte project is focused on sustainability and our goals are aligned with the United Nations 2030 Agenda for Sustainable Development. Our main goal is to improve agricultural practices to help farmers increase their productivity. By doing so, we make a significant contribution to combating food insecurity, particularly in Africa, where it poses a significant threat to millions.TerraByte aims to empower economically vulnerable communities by providing technology that increases the value-added content of agricultural production and addresses critical issues like food shortages.

Through its combination of technology and social responsibility, the TerraByte project strives not only to promote agricultural practices, but also to leave a legacy for future generations. This makes it more than just a technological project. It is a beacon for progressive changes in the global economy and the imminent need to develop agriculture in these communities.

Key Features:

This project proposes the development of a Internet of Things (IoT) based Supervision and Control System for Agriculture. The main goal is to make farming better by letting farmers watch and control their fields from far away, use resources wisely, and make smart choices.

The system will use sensors to collect important data, such as temperature, soil moisture, water quality, weather conditions, and crop information. These data will be sent to our platform where they will be processed and presented in a way that farmers can easily understand.

Farmers will be able to use the platform to keep track of their crops and adjust cultivation operations as needed. Furthermore, the system can be connected to automatic systems like watering, fertilizing, and other things. This will save money and use resources more efficiently.

Objective:

Our proposal centers on the primary Sustainable Development Goals established by the United Nations to Agenda 2030. We aim to make a significant impact by focusing on sustainable agriculture, which offers a viable solution for countries and farmers with low incomes. To do this, our group decided to make a cheap solution that is connected to our website for free. We want to help increase agriculture in more vulnerable countries.

Mission:

Help developing countries and communities use IoT tools to make farming better and prevent food shortages.

Vison:

A world where smart agriculture is accessible to all kinds of people and promotes food security, environmental sustainability, and economic prosperity in vulnerable communities.

Value Proposition:

Promove (IoT) solutions for regions that are more vulnerable. Our integrated approach uses cutting-edge technology to increase crop productivity, quality and sustainability. By making it cheap and easy to get advanced technology tools, we help vulnerable communities overcome agricultural challenges and promote sustainable development.

Market analysis:

Future Expectations and Current Challenges.

In the 2030 Agenda for Sustainable Development, the United Nations and the international community established a target to eradicate hunger by 2030. Right now, the World Health Organization says that over 800 million people around the world don't have enough food.

Figura 1 - Challenges in sustainable future agriculture.

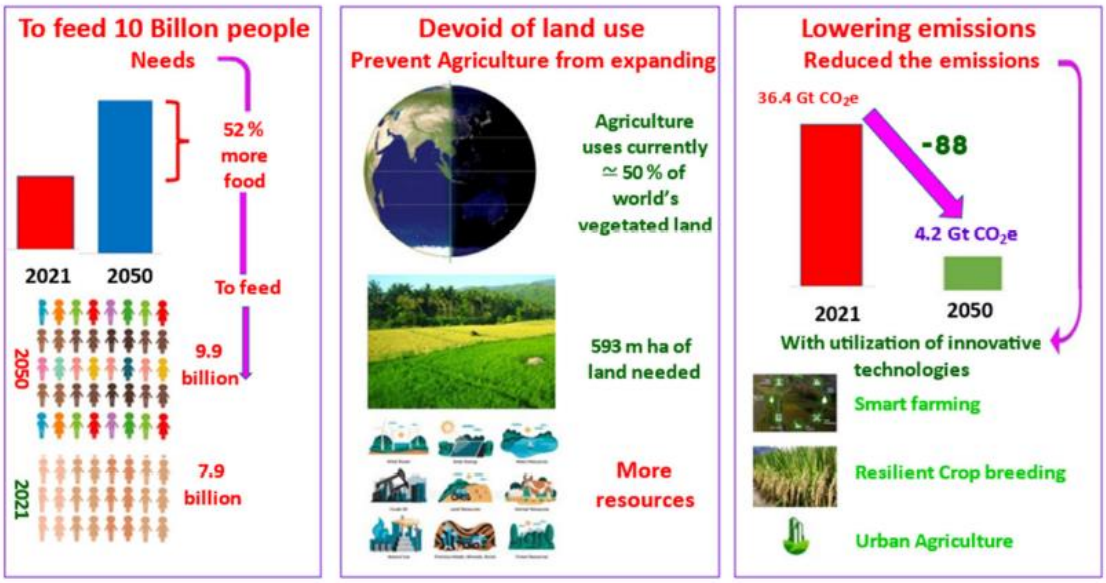


Figure shows the challenges agriculture will face in 2050. This illustration presents three significant challenges, namely: (1) **sustaining a population of 10 billion**, (2) **limiting the expansion of land**, and (3) **reducing the gross domestic product**. These challenges have led to new thinking about water scarcity, shrinking arable land, rural labor, climate conditions, and more.

Abrupt weather changes enhance the intensity of environmental issues, such as drought, groundwater depletion, and soil degradation, affecting crop production.

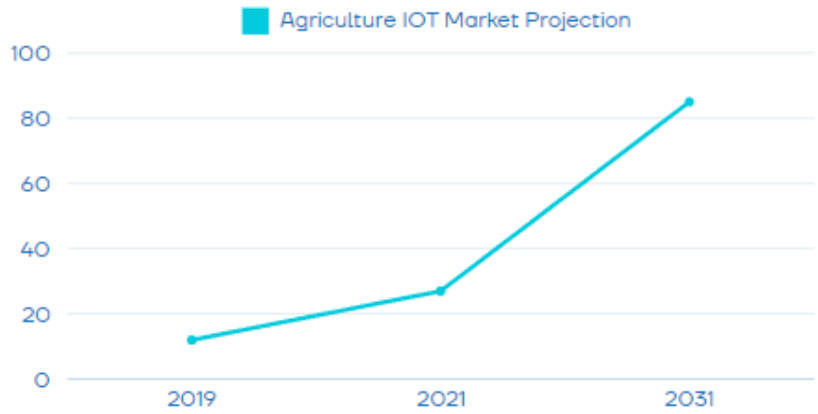
In developing countries, agricultural challenges include poor crop selection, poor soil testing, inefficient irrigation, poor weather forecasting, and poor animal husbandry practices.

Agriculture IoT Current situation:

The current situation of IoT in the agricultural market reflects an increasing adoption and promising future expectations. Using IoT tools in agriculture can make farming better, work better, and help the environment.

Projections show that the IoT market in agriculture is growing, driven by the need to meet challenges such as increased demand for food due to population growth, the need to increase the efficiency of agricultural resources, and the search for more sustainable agricultural practices.

Ilustração 1- Agriculture IOT Market Projection



Even though the market is growing, there are a few obstacles for new companies in the agricultural IoT space:

- **Technological Complexity:**

  To implement IoT solutions in agriculture requires a high level of knowledge and advanced technology expertise, such as sensors, communication networks, data analysis, and systems integration. It can be difficult for new companies that haven't done it before.

- **High Initial Costs:**

  IoT systems can be expensive, especially for small farmers and start-up companies. The cost of equipment, sensors, and technology infrastructure can make it hard to enter the market.

- **Integration and Adoption Challenges:**
  It is challenging to integrate IoT systems with existing agricultural practices and get farmers to adopt them. It's important to educate and train end users about the benefits of IoT technology.

The future of IoT in agriculture remains highly promising, despite the challenges. Technology will make it easier to use IoT, make it more efficient, and make it better fit the needs of the agricultural community. Technology companies, research institutions, and farmers are working together to create IoT solutions that are personalized and easy to use. Furthermore, government support and financing initiatives are essential to overcome initial barriers and encourage innovation in this sector.

As the market continues to evolve, the potential for IoT to significantly enhance operational sustainability and business effectiveness in agriculture is evident. But it's hard for new companies and investors to enter a big market with big companies in places like Asia, Europe, and the Americas. Despite these obstacles, strategic alignment with market needs and continued innovation are key to achieving success in the evolving agricultural IoT landscape.

Our market:

In our market analysis, we started with a survey to get to know our potential users and find out what the market needs, but even though we sent it to more than 200 emails, shared it in forums related to the topic, and sent it directly to companies, our sample was small. After that, we searched the Internet for information about the goals of the United Nations and how they relate to our project.

“The 2030 Agenda for Sustainable Development, adopted by all United Nations Member States in 2015, provides a shared blueprint for peace and prosperity for people and the planet, now and into the future. At its heart are the 17 Sustainable Development Goals (SDGs), which are an urgent call for action by all countries - developed and developing - in a global partnership.” (Nations, 2024).

The objectives and targets are integrated and can be put into practice by governments, civil society, the private sector, and every citizen who cares about future generations.

Figura 2 - UN The Global Goals

TerraByte wants to make farming better and use less resources. They want to reduce food waste and make it easier for people to get healthy food. We think that our project is relevant by helping the most vulnerable countries achieve the following SDG goals.

- With better agriculture, less food will be wasted and more people will be able to get healthy food.

- Sustainable agricultural practices include water management strategies to save water resources and encourage responsible use of water in agriculture.

- Our plan encourages using agricultural resources responsibly, reducing waste, and using methods that are environmentally friendly.

- Sustainable agriculture is about using resources more efficiently and being more resilient to climate change.

- Through sustainable farming practices, we help preserve terrestrial ecosystems, soil health, and biodiversity.

East of Africa:

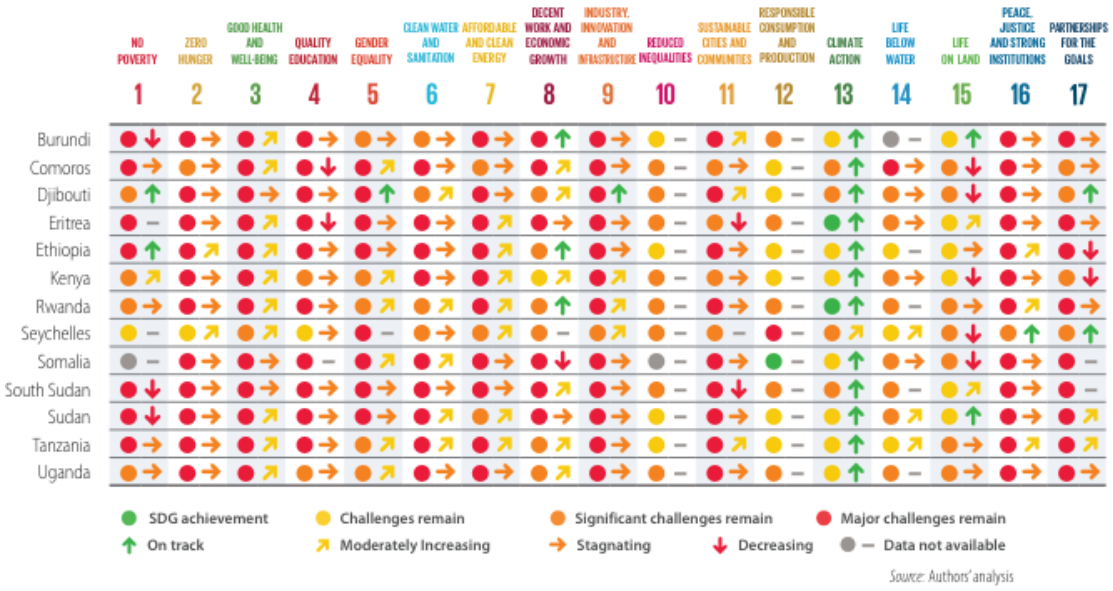
Agricultural production methods in Africa have been stagnant for decades. This has a direct impact not only on food security but also hinders economic and social advancement in these regions.

Stagnation is the most observed trend in this region, in 45% of the cases. The worst performing goals are SDG 2 (hunger and agriculture), which is stagnating for all except 2 countries, and SDG 4 with 92% of countries either regressing or stagnating.

Our project could benefit from the information provided by CAADP. Strategic alignment with CAADP objectives can help TerraByte be accepted and implemented, transforming the agricultural sector and contributing to sustainable development in Africa.

Figura 3 - East Africa SDG and Trends Dashboard (SDG Report)

Pest analysis:



The PEST analysis is a way to use tools to help companies make better decisions. It uses big-picture factors and relationships to gather and understand information about what might happen in the future. This technique also involves describing and analyzing important features of the market where the company is located and the product whose marketing strategy is being developed.

Political:

- The CAADP is a project started by African Ministers of Agriculture and worked with FAO and the NEPAD Steering Committee to emphasize the importance of strong agricultural policies and investing in new agricultural technologies.
- To make CAADP work, African governments need to be willing and keep helping. They also need to adopt good agricultural policies that encourage investment and new ideas in agriculture, like TerraByte.

Economic:

- Agriculture is an important part of the African economy. It employs around 60% of the workforce and contributes 17% of the GDP.
- CAADP will require significant investments to modernize and grow the agricultural sector. These investments can create opportunities for technologies like TerraByte, which can improve agricultural processes and increase efficiency.
- The proposed agricultural modernization under CAADP can help the economy by creating jobs in rural areas and helping to grow GDP. TerraByte can help the agricultural sector adopt technologies that improve efficiency and innovation.

Social:

- TerraByte can help reduce hunger and improve food security, which align with the programs social goals. Agriculture can help around 200 million people in Africa. It can create jobs and make rural areas less poor.
- TerraByte can help farms become more productive and sustainable by allowing new cheap technologies to be used in agriculture. This will help Africa grow economically and socially.
- The project can help rural communities by creating jobs and improving the quality of life in agricultural communities.

Technological:

- TerraByte will be successful if farmers use modern tools like water management and sustainable irrigation. Research and technological innovation like TerraByte can help CAADP objectives.
- Investing in agricultural research and using new technologies are important for making farms more productive and innovative.

Our Users:

Driving the adoption of IoT technologies and promoting sustainable agricultural practices for the most vulnerable countries, we thought about our project and that we can work with different types of users, such as:.

The target users of the "TerraByte" system are:

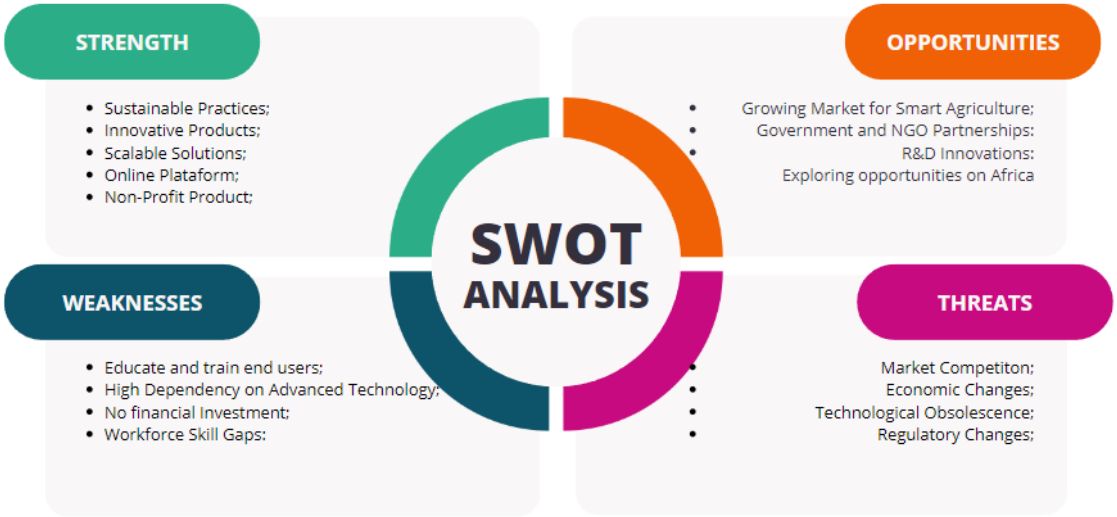
- Smallholder Farmers;
- Governments and policymakers;
- Non-Governmental Organizations (NGOs);
- Universities and Research Communities;
- Technology companies and the private sector with the same proposal of “TerraByte”;
- Local Communities and Civil Society Groups.

SWOT analysis:

Analyzing strengths, weaknesses, opportunities, and threats is a method for determining the most important internal and external factors for achieving objectives. Strengths and weaknesses are typically internal to the organization, and they either help or hinder the achievement of its objectives. Opportunities and threats, on the other hand, are external factors that the organization can capitalize on or needs to manage or mitigate.

For TerraByte, a company that is entering the field of IoT-based agriculture, a SWOT analysis is especially important. This analysis will enable TerraByte to accurately assess its position in the highly competitive marketplace of intelligent agricultural solutions. It will find out what TerraByte is good at and what it needs to improve, suggest ways to grow and work together, and warn about dangers for the environment and the market. The SWOT analysis not only provides TerraByte with strategic guidance, but also alerts it to market and environmental risks that require strategic management.

Figura 4 - Terrabyte SWOT Analysis



<table>
<tr>
<td rowspan="3">Key Partners
• Local government
• Non-governmental organizations (NGOs)
• Technology providers</td>
<td>Key Activities
• Training programs for farmers and local partners.
• Data collection and analysis to improve agricultural outcomes.
• Developing and refining IoT-based agricultural technologies.</td>
<td rowspan="2">Value Propositions
• IOT Agriculture solutions for developing countries.
• Easy integration of technology with existing agricultural practices.
• Real-time data monitoring and decision support to enhance productivity and sustainability.</td>
<td>Customer Relationships
• Community Building
• Training Programs</td>
<td rowspan="3">Customer Segments
• Collaborating with NGOs
• Government programs
Entities that can help introduce the technology
Organizations that can help develop countries.</td>
</tr>
<tr>
<td>Key Resources
• Technological Infrastructure;
• Human Capital;
• Intellectual Property
• Partnerships</td>
<td>Channels
• Smallholder Farmers
• Agricultural Cooperatives
• NGOs and Government
• Educational Institutions</td>
</tr>
<tr>
<td colspan="3">Cost Structure
• Research and Development (R&D);
• Manufacturing and Hardware;
• Software Development;
• Operational Costs;</td>
<td colspan="2">Revenue Streams
• Government and NGO Grants
• Donations</td>
</tr>
</table>

Canvas Business Model Explanation:

TerraByte is a non-profit project that focuses on sustainable agriculture through IoT solutions.

- **Key partners:**

  TerraByte can collaborates closely with:

  - **Local Governments:** To align projects with regional agricultural policies and gain support.
  - **Non-Governmental Organizations (NGOs):** To leverage their networks and expertise in community development.
  - **Technology Providers:** For access to cutting-edge IoT technologies tailored for agricultural use.

- **Key activities:**

  Our primary activities include:

  - **Training Programs:** We think that technology is not enough. We have to change people's minds and teach them how to use this type of technology.
  - **Data Collection and Analysis:** To maximize agricultural outcomes and enhance decision-making procedures..
  - **Development and Refinement our project:** Ensure that the solutions are both effective and appropriate to the specific challenges faced by farmers in developing regions.

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Smart Analysis:

The SMART analysis helps us achieve our objectives clearly and effectively. This method makes it possible to describe ideas in realistic and practical goals, making planning processes more concrete and oriented toward achievable results. By defining the SMART principles, it is possible to clearly delineate expectations, identify progress indicators, and establish concrete actions. The monitoring of processes and results-oriented planning in the developing TerraByte are facilitated by this methodology.

Illustration 2- Smart Analysis

S	• Develop IoT-based technologies to increase agricultural productivity and sustainability; • Make a low-budget solution available to all types of users; • Aligns the project with the UN 2030 goals; • Areas with high levels of food insecurity, especially in Africa; • Contribute to creating a better world for us and the future.
M	• Estimated project development and prototype presentation time is 3 months. • Reduce food waste and increase access to healthy food in certain communities; • Encourage farmers to adopt IoT solutions to improve their crop yields;
A	• The project will work physically and online; • After finishing the project, we can add things like irrigation systems to test.
R	• Conduct a study of the population of Africa; • How the project's funding can be secured after its completion; • Make sure the project meets deadlines and budget constraints; • Make sure it matches the goals of the 2030 Agenda in points 2, 6, 12, 13, and 15.
T	• We would need another year to finish the project, have a solid base for the sample, and then start the competition for funds and contacts with the target sectors; • We understand that the team need to have access to funds to test IoT solutions for 6 months and improve possible problems between the hardware, backend and front end. • We need to test the expansion parts in the field and work with farmers to try different ways of expanding over the next 3 years.

Project TerraByte:

The scope of this social project is to develop and implement innovative IoT solutions adapted to sustainable agriculture in vulnerable regions, with a focus on increasing productivity, reducing food waste, and improving access to nutritious food sources.

Objective:

- Create a modular prototype of IoT devices with the ability on the future to connect to soil sensors, irrigation control, and self-sustainable technologies.
- Create a cost-effective solution that is accessible to all types of users.
- Develop a web platform that can interface with our IoT devices and offer real-time data analysis.
- Data transmission capacity in locations with limited mobile network coverage.
- With the help of NGOs, conduct pilot tests of IoT solutions in vulnerable agricultural communities.
- Provide training and support materials to farmers about how to use and maintain IoT technologies.
- Help Africa reach its goals in the United Nations 2030 Agenda.

Functionalities and Features:

- **Web platform:** Web platform that can interface with our IoT devices and offer real-time data analysis.
- **Rainfall Data:** Rainfall is the primary source of water for crops in rain-fed agriculture, which is widespread in many parts of Africa. Understanding rainfall patterns helps you plan planting dates that coincide with the start of the rainy season and manage water resources more effectively.
- **Temperature:** Temperature affects the growth rate of crops and the length of the growing season. Some crops need specific temperatures to grow and develop. Knowing the temperature patterns helps choose the right crops and when to plant them to make sure that the crops can finish their growth cycle at the right temperature range.
- **Soil moisture:** Soil moisture has a direct influence on the availability of water to crops. It affects how seeds grow, how roots grow, and how healthy the plant is in

general. Monitoring soil moisture helps make informed irrigation decisions to prevent both water stress and waterlogging, which can harm the crops.

Logo:

Figura 5 - "TerraByte" logo

Our name and logo reflect the essence of our company and our vision for the market. "TerraByte" is a fusion of two words: "Terra", which signifies land in Portuguese, and "Byte," which refers to a unit of data that evokes innovation and technology. This combination shows our approach to providing advanced technological solutions for the agricultural sector. Our logo consists of elements that symbolize the connection between land and technology, representing our mission to promote sustainable and efficient agricultural practices.

Project Development:

Our Team:

- **Documentation:** Bruno Aguiar;
- **Hardware:** George Paschalis;
- **Back-End:** Abdulla Bagishev;
- **Front-end:** Seppe Faster;
- **Front-end:** John Van Muhler;
- **Documentation:** Mabula Thomas;

Prototype Description

The TerraByte prototype is a system that uses IoT technology to improve gricultural productivity and sustainability. It includes several key components:

Tabela 1 - Key Functions

	Function:	**Benefit:**
IoT Sensors:	Track temperature, soil moisture, water content, and other environmental variables in real time.	Provides precise monitoring of agricultural conditions.
Data Dashboard:	This tool aggregates and displays sensor data in an easy-to-understand format.	It helps farmers make informed decisions about irrigation, fertilization, and other critical farm activities.
Web Platform	Offers real-time data analysis, Weather predictions and remote control capabilities.	Allows farmers to manage their agricultural operations from anywhere.
Automated Systems:	Works with irrigation and fertilization systems to manage resources.	Reduces costs and optimizes resource use.
Training and Support:	Provides educational materials and technical support to farmers.	Ensures efficient application and upkeep of connected devices.

Component List:

Tabela 2- Component List

Resources	Amount
Baterias 18650	3
LILYGO TTGO T-CALL V1.3	1
Baterry Holder	3
Metalic Buttons	3
ESP32 S2 C1	1
ESP8266	1
Water Sensor	1

DHT22 Sensor	1
Sim card with data	1

Product Features

Include the list of product features using UML diagrams (Use cases)

Example:

IoT Sensors:

- **Environmental Monitoring:** Collects real-time data on temperature, soil moisture, water levels, weather conditions, and crop health.
- **Precision Agriculture:** Ensures accurate monitoring to optimize farming practices.

Data Dashboard:

- **User-Friendly Interface:** Displays sensor data in a clear, easily interpretable format.
- **Real-Time Alerts:** Sends notifications about critical changes or issues in the field, such as low soil moisture or extreme temperatures.

Automated Control Systems:

- **Smart Irrigation:** Automatically adjusts watering schedules based on soil moisture and weather forecasts.
- **Automated Fertilization:** Dispenses fertilizers precisely when needed, based on crop requirements.

Web Platform:

- **Remote Monitoring:** Allows farmers to oversee their agricultural operations from any location via an internet connection.
- **Data Analytics:** Provides comprehensive data analysis to help farmers make informed decisions and improve crop management strategies.

Integration Capabilities:

- **Compatibility:** Integrates with existing agricultural equipment and systems.
- **Scalability:** Can be scaled to accommodate farms of various sizes, from smallholders to large commercial operations.

Sustainability Features:

- **Resource Efficiency:** Optimizes the use of water, fertilizers, and other resources to minimize waste.
- **Environmental Impact:** Promotes sustainable farming practices that reduce environmental footprint and enhance biodiversity.

Support and Training:

- **Educational Resources:** Provides comprehensive training materials and user manuals to assist farmers in using the system effectively.
- **Technical Support:** Offers ongoing technical support to ensure smooth operation and maintenance of the IoT systems.

Cost-Effectiveness:

- **Affordable Solutions:** Designed to be cost-effective, making advanced agricultural technology accessible to farmers in developing regions.
- **Free Web Access:** Provides free access to the web platform to lower the entry barrier for economically disadvantaged farmers.

Technology Choice

Data Transmission

Data storage

User interface/Backend/API

Data processing

Hardware

Data accessible:

Prototypes Features

Example:

Conclusion:

The TerraByte BIP V6 project has successfully demonstrated a transformative leap in agricultural productivity and sustainability through its innovative Internet of Things (IoT) prototype. This low-cost, modular solution has been designed specifically to address the unique challenges faced by countries like Uganda and Tanzania, where agriculture forms a cornerstone of the economy and societal well-being.

Collaboration with major non-governmental organizations (NGOs) has been a pivotal element of this project, ensuring that the technology not only aligns with the specific needs of these regions but also complements ongoing efforts to enhance food security and economic development. By integrating advanced IoT technologies into everyday agricultural practices, TerraByte has empowered local farmers, allowing them to make data-driven decisions that increase crop yields, optimize resource use, and ultimately reduce costs.

This project exemplifies a scalable model of innovation that can be adapted across different regions to support the United Nations' Sustainable Development Goals. It underscores the potential of technological interventions in revolutionizing agriculture—making it more resilient, efficient, and sustainable.

As we move forward, the continued success of the TerraByte project will depend on expanding these partnerships, securing further funding, and iterating on the solution based on real-world feedback and technological advances. By staying committed to these principles, the TerraByte initiative is poised to leave a lasting impact on global agriculture, particularly in developing nations that stand to benefit the most from such groundbreaking technologies.

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