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AgroTech village hub: conceptual framework for digital innovation to reduce economic disparities and support food security in Sukosari Village

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Abstract

Sukosari Village faces significant economic disparities, characterized by a high poverty rate of 42.03% of a total of 1,230 families, low coverage of social assistance, and inequality in housing quality. Meanwhile, this village has great agrarian potential with 2,150 hectares of agricultural land and 1,191 farming families that have not been optimized. This study aims to analyze the economic gap and local agricultural potential of Sukosari Village, as well as formulate the concept of AgroTech Village Hub as an innovative conceptual framework solution based on digital technology to reduce inequality and sustainably strengthen food security. The research uses a conceptual-innovative approach supported by secondary data analysis from village monographs and relevant scientific literature reviews. Primary data was obtained through field observation to verify the actual condition of the village, while secondary data was sourced from the Sukosari Village Profile and Monograph in 2024. The results of the analysis show that Sukosari Village has great agrarian potential but has not been optimally utilized due to limited access to technology and information. In response, the concept of the AgroTech Village Hub was formulated, which includes five main components: Smart Farming Center, E-Commerce Production House, Digital Creative Studio & Co-Working Space, Virtual Reality AgroEduTour, and Renewable Energy & Sustainability Unit. This concept offers an integrated technology ecosystem that has the potential to increase agricultural productivity, expand access to the digital economy, and strengthen village food security.

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Introduction

Economic inequality is a structural challenge that reflects an unequal distribution of income and impacts on disparities in welfare and access to resources between social groups (Putradi & Lestari, 2024). Indonesia's Gini ratio of 0.388 shows that economic inequality is still quite high and requires collaborative handling so as not to widen the gap in people's welfare (Central Statistics Agency, 2023). This uneven economic development directly affects the quality of life of people, especially in rural areas that are generally dependent on the agricultural sector (Putradi & Lestari, 2024). The agricultural sector has a strategic role in the national economy, contributing to GDP by 13.5% and absorbing about 29% of Indonesia's workforce (Food and Agriculture Organization of the United Nations, 2023). However, this great potential has not been utilized optimally due to the limitations of technology, infrastructure, and market access, which are still the main obstacles for farmers in rural areas (Ginting et al., 2025).

The adoption of digital agriculture technology in developing countries has been shown to significantly increase farmers' incomes, with an average increase in income of 25–30% through expanding market access and production efficiency (Luo et al., 2023). Meanwhile, the application of the Internet of Things (IoT) in precision agriculture can increase resource use efficiency by up to 25% (Mansoor et al., 2025). At the national level, the Smart Village program launched by the Indonesian government through various village technology policies aims to encourage digital transformation in the rural agriculture sector (Hombone, 2025). rovinsi Lampung itself has shown positive development through the Smart Village Towards a Successful Village program, which has implemented agricultural technology in several pilot areas.

Although the potential for agricultural digital transformation is huge, its implementation at the village level still faces various structural obstacles. Most digital agriculture innovations are sectoral and partial, yet to integrate aspects of production, distribution, marketing, education, and energy sustainability in a single village ecosystem (Lyu et al., 2025; Nasution et al., 2025; Pimenow et al., 2025). This gap is even more pronounced in Sukosari Village, Kalirejo District, Central Lampung Regency, which is geographically located at the coordinates 05°10'40"–05°11'20" S and 104°59'30"–105°30'68" E. Based on village monograph data in 2024, there are 517 heads of families (42.03%) who are classified as poor and 38 heads of families (3.09%) who are classified as very poor and almost poor — a condition that is far above the national average of 9.57% (Central Statistics Agency, 2023). This inequality is exacerbated by the lack of access to modern agricultural technology, limited marketing networks, and low digital literacy among farmers (Sucosari Village Government, 2024).

Ironically, Sukosari Village has enormous agrarian potential but has not been utilized optimally. Most of the population makes a living as farmers, with a total of 1,191 farming families, of which 981 families own their own land. The total area of agricultural land reaches 2,150 hectares with fertile soil conditions and a supportive agroclimate (Sucosari Village Government, 2024). This gap between the great potential and the dire economic conditions suggests that a comprehensive and integrated solution is needed, not just the partial intervention that has been implemented so far.

Aspects of human resource development (HR) and digital education for farmers have also begun to be studied separately in several recent studies. Agribusiness management education programs and the application of agricultural technology have been proven to significantly improve farmers' skills in facing the agricultural era (Anwar et al., 2025). However, the implementation of the program is still sporadic and not integrated with the village's digital production and marketing system, so its impact has not been able to encourage the overall transformation of the village economy. Furthermore, digital agriculture optimization is not only a technical issue, but also concerns aspects of human resources, institutions, infrastructure, and policies that must be managed in an integrated manner (Harahap et al., 2026). These recommendations have not been realized in a concrete ecosystem model that can be implemented directly at the village level, especially in agrarian villages that face the problem of economic inequality.

A review of the existing literature reveals a critical research gap: until now there has been no integrated innovation model based on digital technology that holistically integrates aspects of agricultural production, digital marketing, human resource development, education, and energy sustainability in one village ecosystem that can be implemented. This condition further strengthens the urgency of this research. Therefore, this study aims to: (1) analyze the economic gap and local agricultural potential of Sukosari Village based on secondary data from the village monograph in 2024; and (2) formulate the concept of the AgroTech Village Hub as a contextual and integrated village digital ecosystem framework, which can be a replicable model for similar agrarian villages in Indonesia.

Method

Research Approach

This research uses a conceptual-innovative approach, designed to develop new theoretical or practical frameworks based on the synthesis of empirical data and existing literature (Imenda, 2014; Jaakkola, 2020; Rocco & Plakhotnik, 2009). This approach is appropriately used when the purpose of the research is not to test hypotheses empirically, but rather to build a conceptual model that is rooted in real evidence in the field and supported by existing knowledge sets. The research process takes place through two main stages of analysis: (1) qualitative descriptive analysis of the socio-economic conditions and agrarian potential of Sukosari Village; and (2) a conceptual synthesis that integrates empirical findings with literature review to formulate the framework of the AgroTech Village Hub. The overall research flow is illustrated in Fig 1.

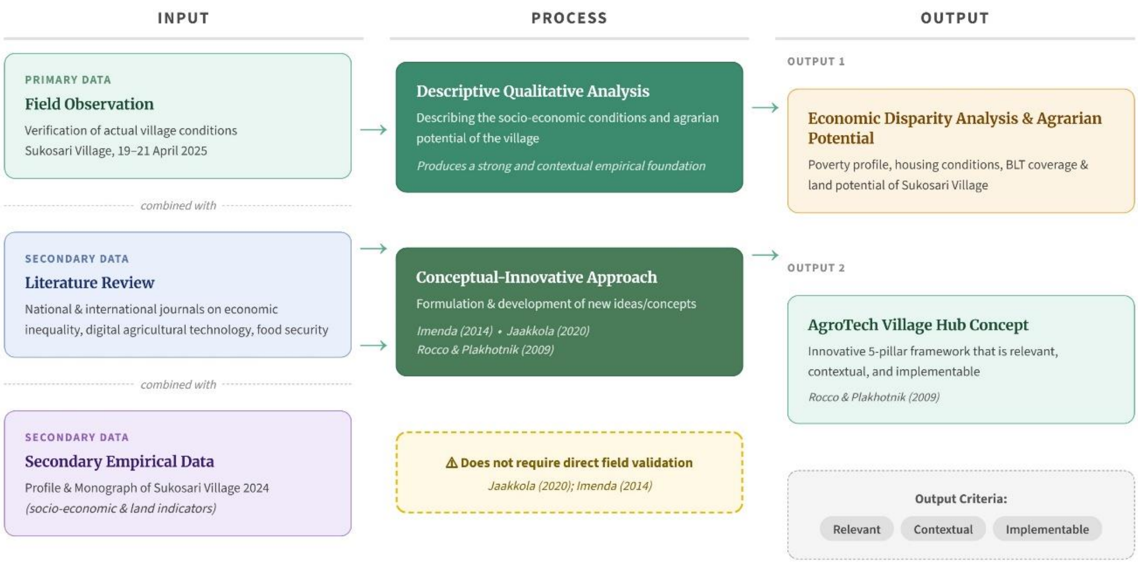

Fig 1. Conceptual-Innovative Approach Flowchart

Data Collection

As shown in Fig 1, the research began with the identification of problems, namely economic disparities and untapped agrarian potential in Sukosari Village. This stage is followed by the collection of data from various sources, which is then analyzed in a qualitative descriptive manner. The findings of this analysis, combined with insights from the literature review, were synthesized to produce the conceptual framework of the AgroTech Village Hub. The final stage includes the formulation of implementation recommendations and directions for further empirical research.

Data was collected through three complementary sources to ensure triangulation and validity of the findings. Direct observation was carried out in Sukosari Village to verify and validate the actual socio-economic and physical conditions of the village. Observations were focused on land use conditions, agricultural infrastructure, access to technology, and general living conditions of farmers' households. This data source serves as a means of *ground-truthing* for secondary data.

The main empirical data source of this research is the Profile and Monograph of Sukosari Village in 2024 (Sukosari Village Government, 2024). This document contains comprehensive data on: (a) demographic categories and family welfare based on poverty classification per household; (b) land use and agricultural land area; (c) the livelihood structure of the population; (d) the scope of social assistance, including Direct Cash Assistance (BLT); and (e) data on housing conditions. All the quantitative figures presented in the Results section — including the poverty rate of 42.03%, the area of agricultural land of 2,150 hectares, and 1,191 farming families — are obtained directly from this monograph.

A review of relevant national and international scientific literature was conducted to: (a) contextualize empirical findings in a broader body of knowledge on rural poverty, digital agriculture, and village development; and (b) identify components and best practices that informed the design of the AgroTech Village Hub concept. The literature is sourced from *peer-reviewed* scientific journals accessed through Google Scholar and other academic databases, with a focus on publications from 2018 to 2026 related to smart agriculture, e-commerce in agriculture, digital village development, and food security.

Data Analysis

The data is analyzed through two stages. First, a qualitative descriptive analysis of village monographic data to describe the socio-economic conditions and agrarian potential of Sukosari Village, with the data from field observations used as triangulation to verify the findings of secondary data. Second, a conceptual synthesis that integrates empirical findings with evidence from literature review through the following procedures: (1) identification of village-specific deficits based on empirical data; (2) the search for evidence-based solutions from the literature for each deficit identified; and (3) integration of these solutions into a coherent ecosystem framework. The resulting framework was then evaluated using four criteria: *novelty*, *Parsimony*, *Consistency*, and *Utility* (Jaakkola, 2020).

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Study Areas

The research was conducted in Sukosari Village, Kalirejo District, Central Lampung Regency (05°10'40"–05°11'20" S and 104°59'30"–105°30'68" E). The village has an area of 2,150 hectares of agricultural land, with the majority of the population making a living as farmers, consisting of 1,230 heads of families and a total population of 3,914 people. Research Location shown in Fig 2.

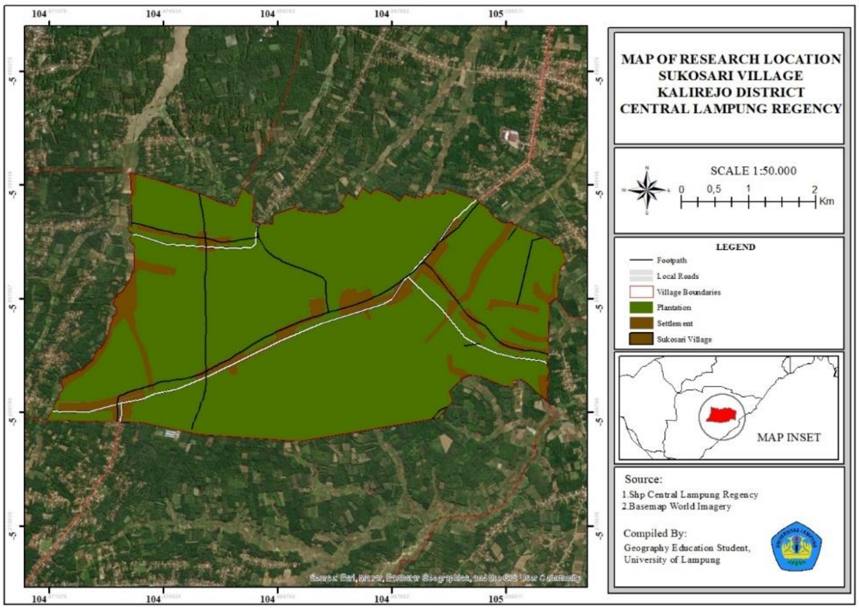

Fig 2. Research Location

Population and Social Conditions. Sukosari Village has a total population of 3,914 people spread across 1,230 households (KK). The population is dominated by those engaged in the agricultural sector, with 1,191 families (96.9% of the total households) dependent on their livelihood as farmers. Of these, 981 families have their own farmland, while the rest work as cultivators or farm laborers (Sucosari Village Government, 2024). The village is administratively divided into several hamlets, with most of the population living in rural settlement clusters surrounded by farmland.

Kalirejo sub-district has a wet tropical climate that is influenced by Asian monsoon winds (Smith & Ferguson Type A). Annual rainfall ranges from 2,431 mm/year, with air temperatures ranging from 23°C to 32°C and average air humidity of 80–88% (Lampungtengahkab.bps.go.id, n.d.). The Kalirejo region is an area with rainfall below the district average, so agriculture in this village is relatively dependent on seasonal rainfall distribution.

In the Kalirejo District area, there are Tasobosan rocks, Kapen Granite, and Sakis Metamorphic rocks of Pretertiary age, with the potential for limestone excavation materials (Lampungtengahkab.bps.go.id, n.d.). The rock deposits in this region are dominated by tuffs with pumiceous and coarse-grained clastic tuffaceous, which are part of the Lampung Formation.

The topography of Kalirejo District is in the category of undulating to undulating with slopes between 8%–15% and the height of residential areas ranges from 89 to 132 meters above sea level (Lampungtengahkab.bps.go.id, n.d.).

Hydrologically, Kalirejo District is located in the Way Seputih watershed area, which is one of the main watersheds in Lampung Province, with a length of 249 km (Lampungtengahkab.bps.go.id, n.d.). Agriculture in Sukosari Village mainly relies on rain-fed agriculture, so agricultural productivity is vulnerable to seasonal rainfall variability.

Results

Economic Disparity in Sukosari Village

Based on the analysis of Sukosari Village Profile data in 2024, the poverty rate in Sukosari Village is relatively high and far exceeds the national average of 9.57% (Central Statistics Agency, 2023). Of the total 1,230 families, 517 families (42.03%) belong to the poor category, 27 families (2.20%) are almost poor, and 11 families (0.89%) are very poor. Only 673 households (54.72%) are classified as prosperous, and 10 households (0.81%) are very prosperous, as presented in Table 1 and Fig 3. This inequality in the distribution of welfare reflects a condition of structural poverty that requires holistic and sustainable treatment (Dimas, 2025; Imran et al., 2025).

Table 1. Sukosari Village Poverty Category in 2024

Categories	Quantity (KK)	Percentage (%)
Very Bad	11	0,89
Almost Poor	27	2,20
Poor	517	42,03
Stuart T	673	54,72
Very Rich	10	0,81
Quantity	1.230	100,00

Source: (Processing profile data for Sukosari Village, 2024)

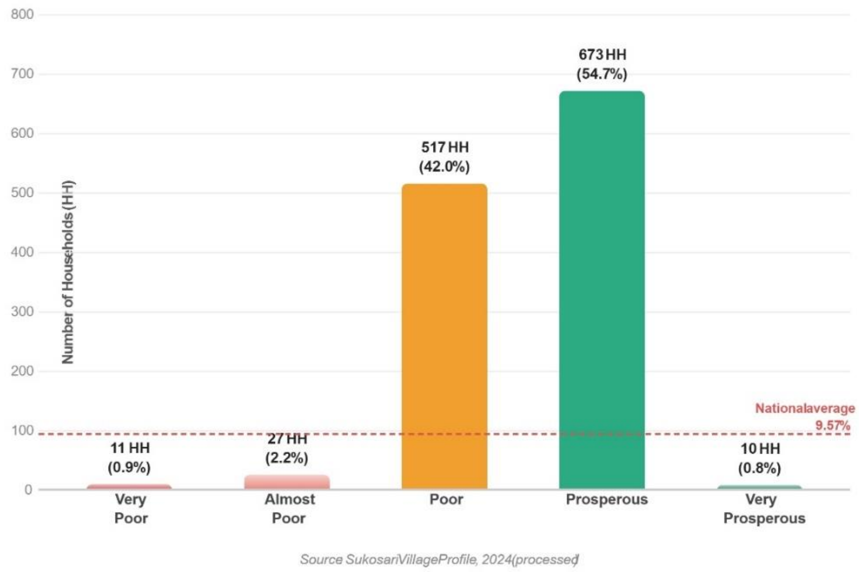

Fig 3. Distribution of Poverty Categories in Sukosari Village in 2024

Housing conditions reflect the same inequalities. Of the 1,225 housing units, 25 units (2.04%) are classified as uninhabitable, as shown in Fig 4. Although the percentage is small, the existence of uninhabitable houses reflects the socio-economic vulnerability of the poorest groups, which has the potential to negatively impact the health and quality of life of its residents (Prison, 2025).

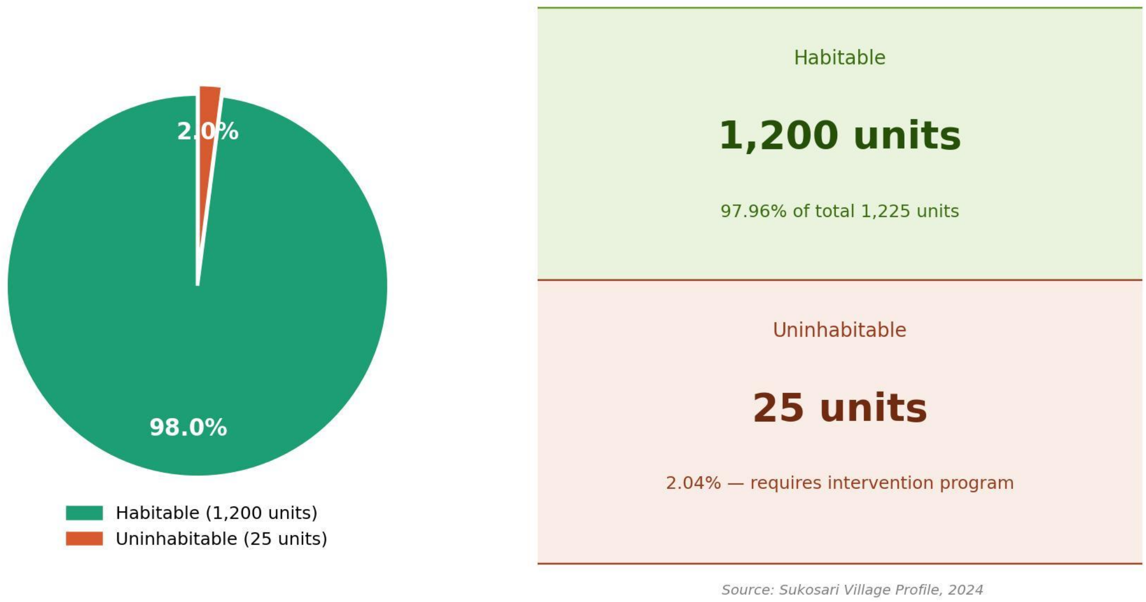

Fig 4. Proportion of Housing Conditions in Sukosari Village in 2024

Meanwhile, the coverage of Direct Cash Assistance (BLT) only reaches 80 people or around 2.04% of the total 3,914 people — far below the proportion of poor people who reach more than 40% (Sukosari Village Government, 2024). This striking gap between BLT coverage and actual poverty levels indicates serious problems in the accuracy of data collection and the effectiveness of social assistance distribution, which need to be evaluated regularly to make aid more targeted (Febriyanti & Pratama, 2025; Gracenda Febina Br Purba et al., 2025).

Agrarian Potential of Sukosari Village

On the other hand, Sukosari Village has enormous agrarian potential. The total agricultural land reached 2,150 hectares, dominated by moors/fields of 81% (1,742 ha), followed by plantations of 14% (300 ha), as presented in Table 2 and Fig 5.

Table 2. Distribution of Agricultural Land Utilization in Sukosari Village in 2024

Soil Type	Area (ha)	Percentage (%)
Farming/Farming	1.742	81,0
Plantations	300	14,0
Settlement	65	3,0
Page	30	1,4
Rice Fields/Others	13	0,6
Quantity	2.150	100,0

Source: (Processing profile data for Sukosari Village, 2024)

A total of 1,191 families (96.9% of the total households) earn a living as farmers, with 981 of them owning their own land (Sukosari Village Government, 2024). Ultisol soil type with rainfall of 491 mm/year, average temperature of 25°C, and 75% humidity supports the productivity of various agricultural commodities. However, the productivity of farmers in Sukosari Village is still below its potential due to the absence of modern agricultural technology, limited access to agricultural extension services, and weak market linkages. This gap between physical potential and productivity empirically emphasizes the urgency of the adoption of digital technology in the agricultural sector, which has been proven to have a significant positive impact on increasing farmers' incomes. (Getahun et al., 2024).

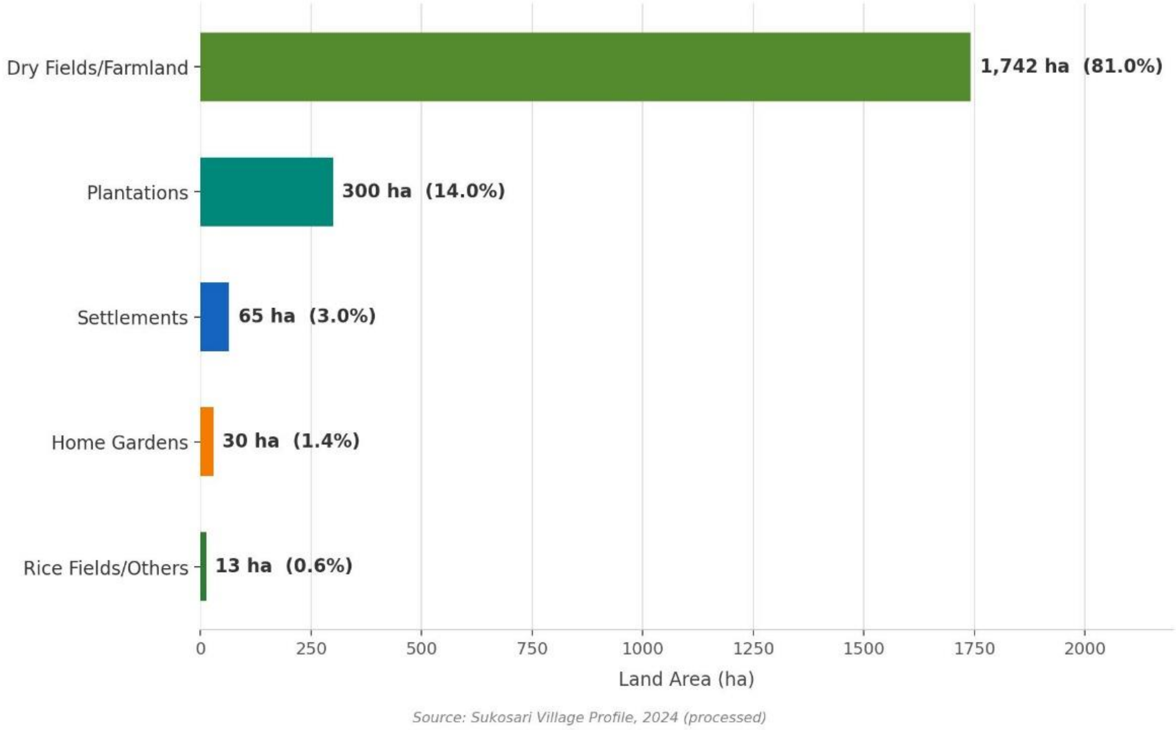

Fig 5. Distribution of Agricultural Land Use in Sukosari Village

AgroTech Village Hub Concept

In response to the gap between agrarian potential and the dire economic conditions documented above, this study formulates the concept of the AgroTech Village Hub as an integrated village digital ecosystem consisting of five pillars, as presented in Fig 6. The formulation of these five pillars is rooted in the specific conditions of Sukosari Village: the dominance of dryland agriculture is the background for the establishment of the Smart Farming Center; weak market linkages and dependence on middlemen underpinning E-Commerce Production House; low digital literacy among the younger generation is the reason for the establishment of the Digital Creative Studio; agricultural landscapes that have the potential to be the foundation of the VR AgroEduTour; and the absence of modern energy infrastructure justified the establishment of the Renewable Energy & Sustainability Unit. This integrated ecosystem concept emphasizes the integration of Cyber-Physical Systems (CPS) and Industrial Internet of Things (IIoT) through inter-entity connectivity, interoperability, and data-driven decision-making as the foundation of digital transformation (Pivoto et al., 2021).

Smart Farming Center is a core pillar that integrates soil sensors, weather sensors, drone cameras, AI analytics, and automated irrigation to improve agricultural production efficiency in real-time (Fig 7). This pillar directly addresses the hydrological constraints identified in the research area, namely the absence of modern irrigation, by enabling precision-based water management. The application of this system is relevant to the findings Mansoor et al.(2025), which examines the role of smart sensors and IoT integration in precision agriculture to optimize the efficient and sustainable use of resources, and Lloret et al. (2021), which confirms the effectiveness of the wireless soil sensor network in supporting real-time soil moisture monitoring for irrigation schedule optimization.

Fig 6. AgroTech Village Hub Ecosystem

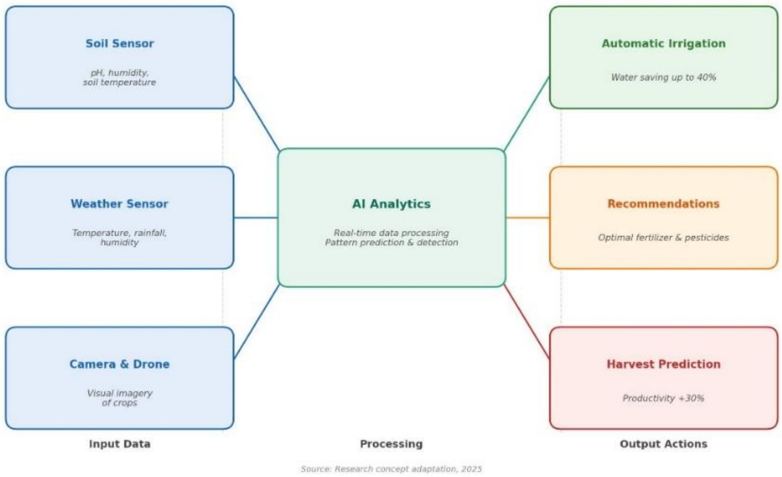

Fig 7. Smart Agriculture Center Workflow Diagram

The E-Commerce Production House connects the entire agricultural value chain from production to digital marketing through marketplaces and social media, as illustrated in Fig 8. This pillar directly responds to the finding that BLT coverage only reaches 2.04% of the population, which shows that village households must be able to generate their own income stream, rather than relying on social assistance. This model is in line with the findings of Morepje et al.(2024), which shows that e-commerce platforms significantly increase market access and selling value of smallholder agricultural products by reducing dependence on intermediaries, as well as Kong et al, 2024. empirically proves that e-commerce encourages farmers to acces the market more wildely and increase the portion of the final value of the products.

Fig 8. Production House E-Commerce Value Chain

The Digital Creative Studio & Co-Working Space provides a space for digital literacy development for village youth, in line with the findings Lioutas & Charatsari, (2020), which emphasizes that smart farming requires a supporting ecosystem that includes the capacity of local actors to effectively manage digital technologies. AgroEduTour Virtual Reality develops immersive technology-based educational tourism as an alternative source of income relevant to the concept of agrotourism. The Renewable Energy & Sustainability Unit leverages solar and wind energy to support the operation of the entire ecosystem, potentially reducing energy costs. The implementation of this concept is planned in three strategic phases, as shown in Figure 8.

Virtual Reality AgroEduTour develops immersive technology-based educational tourism as an alternative source of income, thereby diversifying the village's economic base beyond primary agricultural commodities. This approach is relevant to the agrotourism typology put forward by Phillip et al. (2010), which identifies the dimensions of education and experience as key components of successful agrotourism development.

The Renewable Energy & Sustainability Unit leverages solar and wind energy to support the operations of the entire ecosystem, potentially reducing energy costs and ensuring the long-term sustainability of the hub's operations. The implementation of this concept is planned in three strategic phases, as shown in Fig 9.

Discussion

Economic Disparities as a Structural Problem

The poverty rate of Sukosari Village of 42.03% far exceeds the national average of 9.57% (Central Statistics Agency, 2023), showing structural inequality that cannot be resolved through a partial approach. indicates a condition of structural inequality that cannot be resolved through a partial or short-term approach. The structural nature of poverty is evident from various overlapping dimensions: low household income, poor housing quality, limited access to social protection, and weak integration with the wider market. Structural poverty is different from temporary poverty (*transient poverty*) because it is persistent and inherited between generations due to the lack of access to adequate human capital, physical capital, and social capital (Dimas, 2025; Imran et al., 2025).

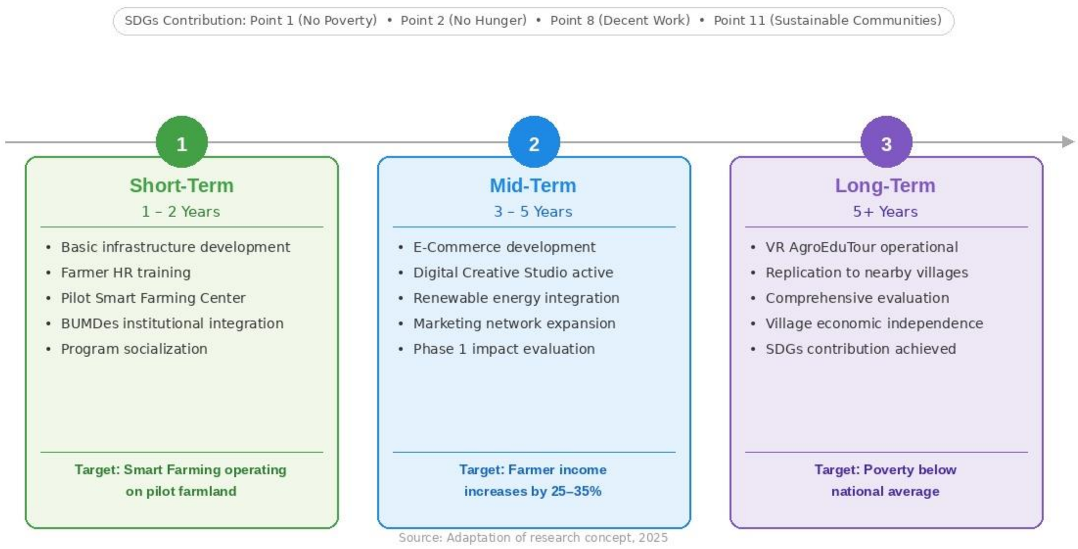

Fig 9. AgroTech Village Hub Implementation Roadmap — Three Strategic Phases

Fiszbein et al. (2014) assert that even with the best targeting efficiency, social protection programs alone are not enough to address the poverty gap without adequate funding and structural and sustainable policies. This finding is particularly relevant to the condition of Sukosari Village, where the low coverage of BLT, which only reaches 2.04% of the population, while the poverty rate exceeds 40%, not only reflects budget limitations, but also fundamental problems in data accuracy and targeting mechanisms.

The housing dimension also reflects the depth of existing structural poverty. The existence of 25 units of uninhabitable houses (2.04% of the total 1,225 units), although the percentage seems small, reflects the socio-economic vulnerability of the poorest group that requires special intervention. Poor housing conditions are directly correlated with the quality of health, work productivity, and long-term well-being of household members, so they need to be seen as an integral part of poverty alleviation strategies, rather than separate issues. Overall, these findings suggest that Sukosari Village's economic challenges require solutions that go beyond social assistance—especially solutions that structurally increase productive capacity and market integration of farmer households, as offered by the AgroTech Village Hub concept.

Agricultural Potential That Is Not Optimal

The 2,150 hectares of agricultural land supported by 1,191 farming families and the supporting agroclimatic conditions are significant productive assets but have not been fully mobilized. The 81% (1,742 ha) moorland dominance reflects a strong orientation towards dryland agriculture, which typically faces greater productivity challenges than technical irrigated rice fields due to dependence on rainfall and lack of technological inputs. Ultisol soils in the region, although naturally low in fertility due to intensive washing in humid tropical environments, can be significantly improved through precision fertilization and the addition of organic matter—interventions that are efficiently possible through precision digital agriculture.

Lei & Yang, (2024) empirically prove that the adoption of digital technology in agriculture has a significant positive impact on increasing farmers' income, both in production and marketing activities, while Chen, (2025) shows that GPS, drones, and IoT-based precision agriculture can increase yields by 20–30% while substantially reducing the wastage of inputs such as fertilizers and pesticides. Applied to the context of Sukosari Village, even a conservative increase in agricultural productivity of 20% on 1,742 hectares of moorland alone will represent a transformative increase in production and income for 981 farmer families who own land. This increase will also have a direct impact on food security at the household level, considering that most of the commodities produced, especially cassava and corn, are the main source of food and income for farming families.

However, this agrarian potential also faces threats in terms of sustainability. Intensive dryland farming practices without good soil fertility management have the potential to lead to long-term land degradation, which will ultimately exacerbate existing conditions of structural poverty. The adoption of precision agriculture technology not only increases short-term productivity but also contributes to long-term ecological sustainability through the reduction of overuse of inputs and real-time monitoring of soil conditions. Therefore, agricultural modernization in Sukosari Village should ideally be not only oriented towards increasing production, but also on the ecological sustainability of the land — a consideration that is explicitly accommodated in the Renewable Energy & Sustainability Unit pillar of the AgroTech Village Hub concept. This analysis confirms that the gap between the great agrarian potential and the dire economic conditions is not the result of a scarcity of resources, but rather a deficit of access to technology, markets, and knowledge, exactly the kind of gap that the AgroTech Village Hub concept is designed to address.

AgroTech Village Hub as an Innovative Solution

The AgroTech Village Hub concept offers significant progress compared to the partial approach that has been applied in Indonesia's digital village development program. Unlike previous smart agriculture implementations that generally only touch on the production aspect, the AgroTech Village Hub integrates the entire agricultural value chain — from upstream production to marketing, HR education, agro-tourism, and downstream energy sustainability — in a single digital ecosystem rooted in a local context. This is in line with the Agriculture 4.0 framework, which emphasizes the application of digital technology throughout the entire agricultural supply chain (Zambon et al., 2019).

The Smart Farming Center pillar directly responds to two main deficits identified from Sukosari Village data: the absence of modern irrigation and the low productivity of the moorland. Through the integration of soil sensors, weather sensors, drones, artificial intelligence (AI) analytics, and automated irrigation systems, this pillar enables farmers to make data-driven decisions in real-time—a fundamental transformation from subsistence farming patterns that have relied on traditional empirical experience. Mansoor et al. (2025) comprehensively examine the role of smart sensors and IoT integration in precision agriculture, proving that these systems are able to significantly optimize the use of water resources and soil nutrients. Lloret et al.(2021) further confirm the effectiveness of the wireless soil sensor network in supporting real-time soil moisture monitoring, which is directly relevant to the conditions of rainfed agriculture in Sukosari Village, which is highly dependent on seasonal rainfall distribution. Squirrels & Squirrels (2018) He added that the integration of deep learning in precision farming systems can detect plant diseases with high accuracy, so that it can prevent crop losses, which have been one of the sources of uncertainty for farmers' incomes.

The E-Commerce Production House pillar responded directly to the finding that BLT coverage only reaches 2.04% of the population, which indicates that village households must be able to generate independent income channels through wider market integration. The dependence of farmers in Sukosari Village on middlemen as the only product marketing channel is one of the main factors that suppresses selling prices and narrows farmers' profit margins. Morepje et al.(2024) suggest that e-commerce platforms significantly improve market access and the selling value of smallholder agricultural products in Sub-Saharan Africa through a reduction in dependence on intermediaries — a finding that has high relevance to the context of Sukosari Village. Yin et al. (2025), explaining which proves that farmers' participation in e-commerce significantly increases income through the expansion of sales channels and increased product value, and is supported by empirical studies showing that the disintermediation effect of e-commerce allows farmers to obtain a larger portion of the final value of agricultural products directly.

Ilar Digital Creative Studio & Co-Working Space responds to the constraints of low digital literacy, which is one of the main obstacles to technology adoption in Sukosari Village. Charatsari et al (2023) emphasized that successful agricultural digital transformation requires the comprehensive and sustainable development of human resource digital competencies; it is not enough to just provide technological infrastructure without building human capacity to operate and optimize it. Lioutas & Charatsari (2020) added that smart agriculture requires a supporting ecosystem that includes the capacity of local actors to effectively manage digital technologies, which shows that investment in digital human resources is just as important as investment in physical infrastructure. This pillar specifically targets the young generation of villages who have the potential to be agents of digital transformation, but so far do not have adequate space and facilities to develop digital skills that are relevant to the needs of agriculture and the village economy.

The AgroEduTour Virtual Reality Pillar contributes to the diversification of the village's economic base through the development of agrotourism based on immersive technology. Income diversification is a crucial *economic resilience* strategy for farming households that are vulnerable to commodity price volatility and crop failure due to climate change. Phillip et al. (2010) identified the dimensions of education and experience as key components of successful agrotourism development, while the integration of VR technology adds significant differentiation value over conventional agrotourism. The development of VR AgroEduTour also has the potential to build urban awareness and appreciation of the agricultural sector, which can indirectly strengthen the demand for quality local agricultural products marketed through the E-Commerce Production House — creating synergies between pillars that strengthen the entire ecosystem.

The Renewable Energy & Sustainability Unit pillar ensures the operational sustainability of the entire ecosystem through the use of renewable energy. Dependence on fossil energy not only incurs high operational costs but also creates vulnerability to energy price fluctuations that can threaten the sustainability of the program. By integrating solar panels and small-scale wind turbines, this pillar positions the AgroTech Village Hub as an *energy-independent ecosystem*, while contributing to the reduction of carbon emissions at the village level.

Contribution to Food Security and Poverty Alleviation

Overall, the integration of the five pillars of the AgroTech Village Hub has the potential to create *a layered impact* on food security and poverty reduction in Sukosari Village. In the first layer, the Smart Farming Center improves the productivity and stability of food production through technological precision, which directly strengthens food security at the household level. In the second layer, the E-Commerce Production House increases farmers' income through expanding market access and eliminating intermediaries, which strengthens household purchasing power and investment ability in quality agricultural inputs. In the third layer, the Digital Creative Studio creates new economic opportunities outside the primary agricultural sector for the younger generation, which reduces demographic pressure on agricultural land and diversifies the economic structure of the village. In the fourth layer, VR AgroEduTour generates income from the complementary tourism sector, while in the fifth layer, the Renewable Energy Unit ensures that the entire system operates efficiently and sustainably in the long term.

Kuntjorowati et al. (2024) demonstrate that multisectoral collaboration has proven effective in reducing poverty in rural communities, emphasizing the importance of synergistic involvement of village governments, BUMDes, farmer groups, the private sector, and educational institutions. This multisectoral collaboration framework is a prerequisite for the successful implementation of the AgroTech Village Hub, given the complexity of the proposed ecosystem that requires institutional, technical, and financial capacity that goes beyond the capabilities of a single actor. The University of Lampung, as the nearest higher education institution, has a strategic role as a technical companion and research partner, while the local government acts as a facilitator of regulation and access to financing through the Village Fund program and other financing schemes.

The three-phase implementation roadmap formulated in this study is designed to ensure that the concept of the AgroTech Village Hub can be realistically realized within the institutional and financial constraints of rural villages. The first phase focuses on building the foundation of digital infrastructure and building the capacity of human resources, the second phase on the development of digital production and marketing platforms, and the third phase on the full integration of ecosystems, including agrotourism and renewable energy. This phased approach follows the principle *of minimum viable ecosystems* — starting with the components that provide the highest impact in the shortest amount of time, then gradually building towards full ecosystem integration. Thus, the AgroTech Village Hub is not only a visionary concept, but an actionable and measurable roadmap for digital-based village economic transformation.

Conclusion

This research successfully answered two main objectives: analyzing the economic gap and agrarian potential of Sukosari Village, and formulating the concept of AgroTech Village Hub as a contextual digital innovation framework. The findings confirm that Sukosari Village faces serious structural inequality, with 42.03% of households classified as poor — far exceeding the national average of 9.57% — exacerbated by a critical mismatch between BLT coverage of only 2.04% and an actual poverty rate of more than 40%. At the same time, the village has substantial agrarian assets of 2,150 hectares of agricultural land, 1,191 farming families, and favorable climatic conditions that remain untapped due to the deficit of technological and market access.

The novelty of this research lies in the conceptualization of the AgroTech Village Hub as a village digital ecosystem that holistically integrates five pillars — Smart Farming Center, E-Commerce Production House, Digital Creative Studio & Co-Working Space, Virtual Reality AgroEduTour, and Renewable Energy & Sustainability Unit — each of which is rooted in the specific conditions and needs of Sukosari Village and supported by empirical evidence from the scientific literature. This integrated approach distinguishes the AgroTech Village Hub from previous partial interventions in the development of digital villages in Indonesia.

This study acknowledges its main limitations: the AgroTech Village Hub is still in the conceptual stage and has not undergone field implementation or empirical validation. The theoretical contribution of this research lies in the provision of a context-rooted and evidence-based framework, which can guide future implementation. Therefore, it is recommended that the Sukosari Village government, in collaboration with the University of Lampung and relevant local government agencies, carry out pilot implementation on the highest priority pillars — specifically the Smart Farming Center and E-Commerce Production House — on a limited scale as a first step. Further research should focus on measuring the real impact of each pillar on household income, agricultural productivity, and poverty rates, as well as the development of standardized impact evaluation instruments to support the replication of this model in other agrarian villages with similar characteristics.

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Author's Contributions

Conceptualization, MH and NMW; methodology, MH; formal analysis, MH and FA; research, M.H., F.A., N.F., and B.A.; writing—preparation of original drafts, M.H.; writing—reviewing and editing, M.H., N.M.W., F.A., N.F., and B.A.; visualization, FA and NF; project administration, NMW and BA. All authors have read and approved the published version of the manuscript.

Data Availabilty

All data generated or analyzed during this study are presented in the tables and figures within this article

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Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have influenced the work reported in this pape

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