Open Access

J. Glob. Innov. Agric. Sci., 2025, 13(2):903-909
ISSN (Online): 2788-4546; ISSN (Print):2788-4538
DOI: https://doi.org/10.22194/JGIAS/25.1554
http://www.jgiass.com

Society for Innovative Agiculture

Smart-Tag Your Cows: A Lesson Learned from SIMAPI Adoption In A Farming Village In Central Java Indonesia

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The widespread use of the internet has accelerated digital technology adoption in almost all aspects of life in Indonesia, including the country's small-scale livestock industry. The shift from manual to digital databases is common in the current industrial 4.0 era. SIMAPI is a top-down web-based smart-tag innovation that brings physical livestock data to the digital realm. However, a primary issue affecting the implementation of this smart tag technology is the livestock farmers. Therefore, this article explores the adoption process of SIMAPI among 6,000 cattle in Boyolali Regency, the largest milk-producing area in Central Java Province, Indonesia. A total of 50 livestock farmers and seven other stakeholders participated in in-depth interviews for this research. The results revealed that several tiers in the SIMAPI adoption process were absent in the diffusion stage. Moreover, age, education, culture, opinion leaders, regulations, and infrastructure are essential factors for the success of SIMAPI adoption in Boyolali Regency.
Keywords: ICT Adoption, information technology, diffusion of innovation, livestock farmers.

INTRODUCTION

The dramatic changes in rural development over the past two to three decades have affected the adoption patterns of various innovations in rural areas and agriculture-related sectors. In the current industrial revolution 4.0 era, digital technology is commonly applied to increase production capacity, improve distribution opportunities, and shorten supply chains. Technology 4.0 helps automate the production process by using the Internet of Things (IoT), artificial intelligence (AI), human-machine interfaces, and robotic and sensory technology, thereby boosting productivity (*Suparno et al.,* 2019). These changes show that IT adoption can transform how humans interact and increase the production capacity of highly competitive products. Such improvements in production processes can be seen in smart factories, smart agriculture, and smart livestock farming.
Smart livestock farming has been widely applied and researched abroad. Indonesia has also begun to focus on researching and developing smart livestock farming. One of the pioneering studies on smart farming in Indonesia attempted to reconceptualize e-livestock by collecting literature and conducting a hermeneutic analysis (Ramadhan, *et al.,* 2012) Other studies about smart farming have mainly focused on informatics and on developing and testing software that could record cattle or poultry information without implementing them (Zulkarnain & Bakri, 2020; Sania *et al.*, 2020; Subowo & Saputra, 2019; Kumala *et al.,* 2018)
In Indonesia, there was no application or software-generated program that could be sustainably used by farmers or livestock communities to record complete and real-time livestock and farming data. Therefore, in 2018, the SIMAPI application was introduced by the local government of Boyolali Regency, the largest dairy-producing area in Central Java, Indonesia. This top-down program is considered a breakthrough in creating a solid and reliable regional livestock database. SIMAPI was created as the region's main database and was piloted to 6,000 dairy cattle in three villages in Boyolali Regency. However, no single study has evaluated the implementation, acceptance, and impact of SIMAPI's adoption.
To date, most beef and dairy products in Indonesia rely on small-scale farming in rural areas. For example, although Boyolali Regency is the largest dairy-producing area in Central Java, most of the region's dairy production is from small-scale home farming. Additionally, most farmers in

Amal, N.N., Subejo and Partini. 2025. Smart-Tag Your Cows: a lesson learned from simapi adoption in a farming village of central java indonesia. Journal of Global Innovations in Agricultural Sciences 13:903-909.
[Received 27 Oct 2024; Accepted 10 Mar 2025; Published 2 Apr 2025]

Indonesia are older adults who follow traditional methods and are generally of low education and socio-economic level (BPS Kabupaten Boyolali, 2021). Hence, despite ICT's development and adoption worldwide, Indonesian farmers have been unable to reap its benefits as it is unlikely that they own smartphones or can operate new technologies.

SIMAPI is a smart tag that can be accessed by smartphones. Once a cow is ear-tagged with SIMAPI, a veterinarian can input the cattle's data by scanning the barcode on the ear tag. Farmers can then access this data from their smartphones. However, SIMAPI's adoption and diffusion among farmers can be difficult and complex as they are unfamiliar with IT-based innovations.

The adoption of IT innovations is a multidimensional phenomenon. Aspects that affect the adoption may also vary from one community to another. In the livestock farming community in Boyolali, the success of SIMAPI's introduction and adoption as a digital monitoring system was determined by the local community's social life patterns and perspectives. According to Rogers (2003) the adoption of top-down innovation usually begins with the diffusion process, which is a communication process that involves interpersonal communication. In a top-down approach, the new way of thinking or information on the innovation is diffused from the main source to the first adopter. Thus, adoption is a process of mental change where an individual begins to seek information about the innovation. After the innovation is introduced and diffused, two possibilities may occur, i.e., adoption or rejection. These two possibilities highly depend on how the innovation's character matches the community's needs, such as its benefits, relevance, ease of use, trialability, and observability. Kumar (2015) also delved deeper into Rogers' work on the top-down innovation adoption approach. He found that variables such as social system, knowledge management, human resources, finance, technology inclusion, and technology transfer, are important aspects of the process.

These studies suggest that the diffusion stage of the adoption process involves many aspects. Thus, a successful top-down technology transfer requires the innovation to be relevant, suitable, and beneficial for its recipients. Moreover, the technology adoption process must be constantly cross-checked with the context and monitored for sustainability. However, it is also important to note that every technology diffusion-adoption process is unique and requires different attributes to make it work for the targeted community.

This article explores the SIMAPI application's diffusion-adoption process and identifies factors that support and inhibit SIMAPI's adoption. The SIMAPI application records information on each livestock, including its owner, location, heredity, birth, pregnancy, diseases, medical interventions performed, drugs administered, death, termination, or transfer through the buying and selling process. This basic cattle information is vital for the local government for monitoring purposes and farmers, buyers, brokers, veterinarians, and other relevant stakeholders such as insurance providers.

MATERIALS AND METHODS

This is a qualitative case study focusing on phenomenology. A case study is an approach that explores a real-life case or multiple cases through detailed and in-depth data collection and involves multiple information sources (Creswell, 2015). This approach also involves an in-depth analysis of an individual or group's program, event, activity, or process. This study focuses on the SIMAPI diffusion-adoption process. The researchers recruited the informants purposively to ensure they were eligible in terms of physical capability and knowledge so that they could answer each question well.

The SIMAPI application was piloted in three subdistricts: Ampel, Cepogo, and Mojosongo. However, as the characteristics of the population in Boyolali are considered homogenous regarding their exposure to ICT, this research collected data in only one of the villages in Boyolali, namely Singosari. Singosari was chosen because it has one of the largest number of livestock farmers in Boyolali, and it was the first village to be introduced to the SIMAPI application. A total of 57 informants were recruited and participated in the in-depth interview and focus group discussions. The details of this study's participants are as follows:

a. Three livestock community administrators from the village were recruited based on the following inclusion criteria: 1) actively handle the members' administrative needs and understand SIMAPI, and 2) actively follow the SIMAPI implementation process in their area.
b. 50 livestock farmers in Singosari village who met the following criteria: 1) live in the village, 2) exposed to SIMAPI information. The farmers were proportionally recruited based on age, education, and cattle ownership. Initially, the number of farmers could have been boosted to a larger number. However, data saturation was reached after collecting data from 50 livestock farmers.
c. 1 SIMAPI coordinator from the Disnakkan (Animal Husbandry and Fisheries Office) of Boyolali Regency who met the criteria of fully understanding the SIMAPI application.
d. 2 farmer extension workers from the Disnakkan of Boyolali Regency who met the following criteria: 1) were in charge in the villages implementing SIMAPI and 2) actively followed SIMAPI's implementation journey.
e. 1 veterinarian from the Veterinary Health Center (UPT Puskeswan) of Boyolali Regency, with the criteria that they understand how to use SIMAPI and follow along its implementation journey.

The data collected were then analyzed using the Miles and Huberman interactive model, as this case study focuses on phenomenology. Therefore, the richness and depth of the data are the vocal points of this research. This study did not attempt to seek a general conclusion. Instead, it aimed to describe all identified issues in detail.

RESEARCH FINDINGS

***Smart-Tag Diffusion-Adoption Process: Reality vs. Ideal Implementation*:** SIMAPI is a simple information technology innovation applied to the livestock industry in Boyolali Regency. The SIMAPI innovation includes a barcode tag pierced into the livestock's ear (Fig. 1).

Figure 1. SIMAPI Platform.

Officers would use the barcode on the tag to record the livestock's data. This data would then be uploaded to the central cattle database of Boyolali Regency, where it can be accessed and utilized by other relevant stakeholders. The information on the SIMAPI platform may be used for many purposes, such as buying and selling, medical interventions, disease and outbreak control, and more.

However, the adoption of a simple information technology innovation such as SIMAPI was not as simple as initially imagined. SIMAPI was applied in the livestock industry in Boyolali Regency, where farmers were the spearheads of its implementation. Although currently, Indonesia has a demographic bonus with a large number of the population being of productive age, the livestock farmers in Boyolali Regency are still dominated by older adults with low economic and educational levels. Therefore, the relevance of SIMAPI's target and goals was questionable.

SIMAPI was considered a local initiative. It was initially offered by the Department of Communication and Informatics (Kominfo) of Boyolali Regency to the Disnakkan of Boyolali Regency as a ready-to-use web-based application. The Disnakkan Officer stated that as soon as the SIMAPI tag was available, the SIMAPI coordinator immediately contacted several leaders of livestock farmers' associations to briefly inform farmers that officers were coming to tag their cattle.

Then, in the diffusion stage, the SIMAPI adoption process was simple and comprised only a few stages. Immediately after contacting the local livestock association, officers offered SIMAPI to the farmers – door-to-door. After the cattle owner consented to have their cattle pierced, the officers went to the shed and performed the tagging. At the final stage of SIMAPI's implementation, only a few farmers stated that they downloaded the SIMAPI application, and few have seen the information on the web version of SIMAPI.

The output stage revealed that SIMAPI collected the basic livestock data of approximately 6,000 cattle, including dairy and female beef cattle. However, the desired output has not been attained. The targeted output of the SIMAPI pilot project was a record of all cattle births, pregnancies, medical interventions, and terminations of cattle. However, after several years of SIMAPI's implementation, the recorded data is only limited to the owners' names, photos of the livestock, and shed location.

There was also a discrepancy between the number of cattle tagged (6000 cows) and the data listed on the SIMAPI website, which is 5868 (see Figure 2). This inconsistency indicates that the implementation of the SIMAPI pilot project was sub-optimal.

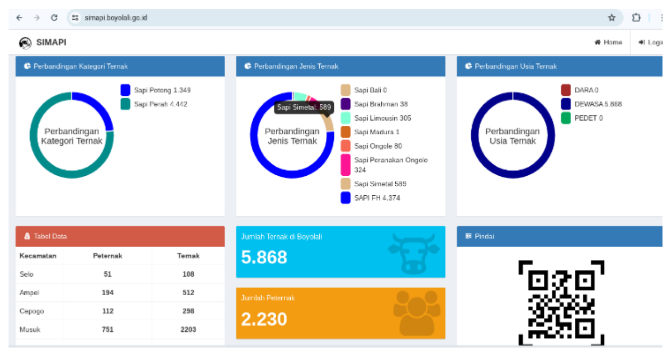

Figure 2. SIMAPI Data Summary – Web Page.

After analyzing the interview data and diffusion-adoption process proposed by Kumar (2015), a diffusion-adoption process was created for SIMAPI, as shown in Figure 3. The diffusion of a simple information technology innovation such as SIMAPI should, in theory, follow the same ideal process conveyed by experts (see Kumar (2015)). However, the SIMAPI diffusion process applied to the targeted community was highly simplified. Several elements that would typically occur in the process were missing, eliminated, overlooked, or intentionally skipped. It is assumed that these steps were missing because of the developer's beliefs (that SIMAPI is a super simple application and that everybody has a mobile phone).

SIMAPI is classified as a simple information technology innovation with the simple goal of collecting updated information about the livestock raised by the community. The supporting technology required to use SIMAPI, namely internet access, was also assumed to be widespread and accessible by almost everyone in Boyolali Regency. The main implementers, i.e., veterinarians and cattle health practitioners *(mantri sapi*), were assumed to have internet access. However, the opposite was found to be true. Almost all *matri sapi* have considerable knowledge about cattle farming, but they are older adults with limited – or no – internet or mobile phone access. Thus, the SIMAPI innovation diffusion process was inadequate and only briefly executed. Figure 3 exhibits that the critical aspects required for the success of the diffusion of an innovation are missing.

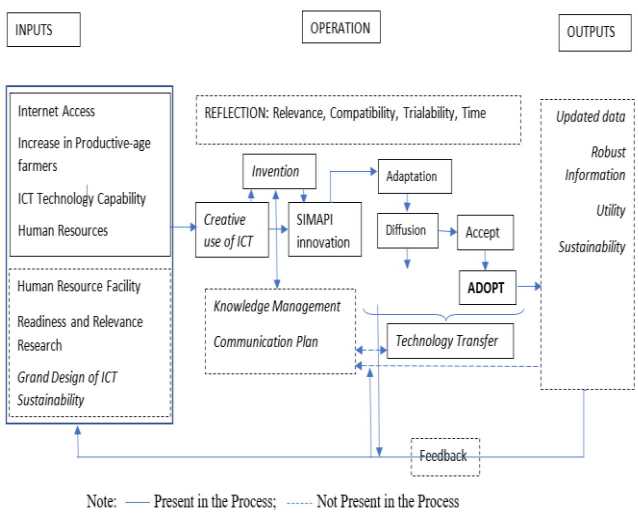

Figure 3. Diffusion – Adoption of SIMAPI.

The missing inputs included resource facilities, where officers who would be directly handling the operationalization of SIMAPI were not assessed to have their capabilities standardized. This standardization is essential to ensure that the officers meet SIMAPI's minimum operational standards. Next, this study only obtained the farmers' consent as cattle owners. Meanwhile, animal health care workers who would input daily cattle data, such as information on the cattle birth process, injections and medicines, types of diseases, vaccinations, and cattle termination or death, were overlooked and were not involved in the SIMAPI diffusion process.

Furthermore, essential stages at the operational stage were missing, such as determining the innovation's relevance, compatibility, trialability, and time. Relevance is important for the target recipients of innovation because it marks the beginning of the communication stage (Rogers, 2003). Relevance will ensure that the innovation offered meets the farmers' current needs and matches the minimum technical capability standards required to adopt the innovation. Second, properly evaluating the innovation's compatibility is essential for providing a definite picture of the number of farmers willing to adopt the innovation. Additionally, when compatibility is carefully measured, it can predict the extent to which the parties left behind can catch up within a specific period. This information is important because development must be inclusive, as explained in the SDGs. Nevertheless, development that involves technological skills may still potentially advance one party at the expense of the other parties.

The next stage is trialability. Innovations must be tested first, and trialability is important in translating technology into an innovation diffusion process. SIMAPI has met this trialability requirement as the program was introduced and tested in 2018. Approximately six thousand dairy and beef cattle have been smart-tagged. Thus, SIMAPI's operation has been tested and passed the trialability stage. However, trialability, referred to as conducting a trial with measures of predicted acceptance by stakeholders and the wider community, has not been implemented.

The final aspect is time. SIMAPI was initially designed to be applied to all dairy cattle in Boyolali Regency right after the pilot project of tagging 6000 cattle was completed. However, the COVID-19 pandemic has suspended the entire SIMAPI implementation budget until now.

SIMAPI was created based on a combination of a brief situational analysis regarding the availability of internet access throughout the country (i.e., internet access on mobile phones) and the creativity of application developers. In the piloting process, SIMAPI was successfully communicated and was tagged onto 6,000 cattle's ears. However, the knowledge management process was not properly implemented with SIMAPI.

Next, SIMAPI's development did not begin with adequate research for the foundation of their decision-making and other stages in the development and dissemination process, i.e., diffusion. Thus, when the diffusion stage occurred, the farmers' knowledge gain could not be optimally managed because the basic information and research were insufficient. Insufficient information has a domino effect on the next diffusion process as there was a lack of a communication plan. The haphazard communication conducted through several livestock association meetings was also imperfect, resulting in a lack of feedback from stakeholders. Meanwhile, feedback is important in every innovation diffusion process, especially with top-down approaches.

Moreover, in the desired outputs phase, the diffusion process for SIMAPI appeared to end shortly after completing the piloting process. Livestock data were not updated, the uploaded data was incomplete, the smart tags were no longer used, and many were torn apart. SIMAPI's goal of becoming a breakthrough in creating a sustainable digital livestock database was not achieved.

Supporting and Inhibiting Factors to the Successful Smart-Tag Adoption: Any top-down program or project that the government diffuses to its people cannot deviate from its shared development goals. Thus, any program provided for society must be people-centred to prevent disadvantaging other community members. Before displaying data on the supporting and inhibiting factors to successful SIMAPI adoption, it is crucial to understand the characteristics of the targeted farmers (Figure 4).

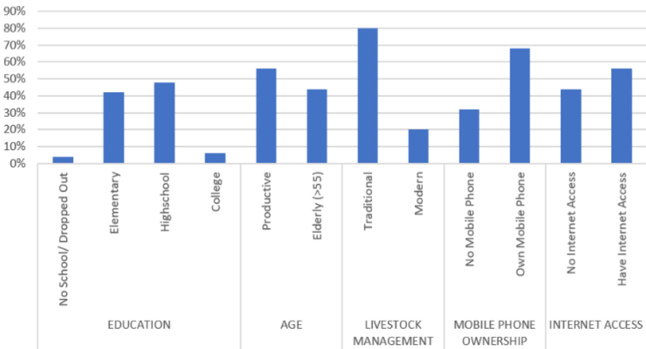

Figure 4. Characteristics of SIMAPI Targeted Farmers (n=50).

Figure 4 shows that almost half of SIMAPI's participants were older adults (age 55 or older) with a relatively low educational background (elementary school, no formal schooling, or dropped out of school). Most farmers also managed their cattle using traditional methods. Thus, they would manage their cattle according to the knowledge passed down from their parents. Additionally, almost half of the farmers have no mobile phone or internet access. Subsequently, there should have been more attention and study before technology diffusion, particularly for this group of people.

The SIMAPI pilot project in Boyolali showed that the general the livestock community in Boyolali Regency appeared to easily accept SIMAPI. However, some of them also rejected it, and some took it for granted, simply because the people they trusted adopted it, too.

Several reasons can explain SIMAPI's adoption and rejection. The cause behind its adoption by the livestock community in Boyolali villages is not as simple as due to its advantages and ease of use, as formulated by Vanketesh and Davis (2000), or because of the 5 conditions proposed by Rogers (2003) are met. This study's results show that the duality of acceptance and rejection of the top-down SIMAPI program is due to several attributes that have never been proposed by Vanketesh and Rogers, such as age, education, culture, opinion leaders, regulations, and infrastructure. These five factors simultaneously contributed to the acceptance of SIMAPI. The strength of these factors' supporting and inhibiting power describes the condition of livestock farmers in Boyolali Regency. It could also be used to predict the possibility of SIMAPI use in the future.

Several factors support and inhibit the adoption of SIMAPI. The SIMAPI application was introduced to traditional farmers, most of whom are older adults with low education and economic levels. Therefore, despite its simplicity, the SIMAPI application was still not fully embraced by all farmers due to age, culture, education, and economic level constraints. These factors are essential for accessing and understanding SIMAPI's technical aspects and realizing how important it is for their livestock development in the long term.

Tables 1 and 2 indicate that the diffusion of this innovation in the livestock farmer community is affected by five factors that determine adoption success: age, education, culture, opinion leaders, and regulations and infrastructure.

Table 1. Supporting Factors of SIMAPI Adoption.

Supporting Factors	Embedded Attributes	Supporting Power
Age (Productive)	Spirit of change Willingness to learn Operating Capability	✪✪✪✪✪✪
Education (Relatively high)	Ability to understand technicalities Logic and thinking capability	✪
Culture (open)	Openness to change and renewal	✪✪✪✪✪✪✪✪
Opinion Leader (the trusted one)	Confidence in decision making	✪✪✪✪✪✪✪
Regulation & infrastructure (strong and robust)	Sustainability assurance Bringing efforts closer to goals	✪

Table 2. Inhibiting Factors of SIMAPI Adoption.

Inhibiting Factors	Embedded Attributes	Inhibiting Power
Age (Elderly)	Low spirit of change Low willingness to learn Low operating capability	✪✪✪✪
Education (low)	Difficulties in understanding technical and operation	✪✪✪✪✪✪✪✪✪
Culture (traditional/ closed)	Closed to change and renewal	✪✪
Opinion Leader (Less trusted one)	Hesitation towards persuasion of opinion leader	✪✪✪
Regulation & infrastructure (weak)	Prone to failure	✪✪✪✪✪✪✪✪✪

Age is one of the most important factors contributing to the success of SIMAPI's adoption among livestock farmers in Boyolali. Although the number of older adult farmers currently outnumber the productive age farmers, there is a growing number of young farmers in the region. The success of SIMAPI's adoption relies on the age of the livestock farmers because this digital innovation requires knowledge of how to operate the latest technology. Generally, younger or productive-aged people still have a relatively high spirit toward change and enthusiasm for learning. They also tend to have a higher operational capacity than older adult farmers.

The next supporting factor is culture. Although a small part of the livestock community in Boyolali Regency maintains a

traditional way of life, they still have a relatively open culture regarding change and renewal. This tendency is relevant to SIMAPI, which requires users to be willing to learn and change for the innovation to be adopted properly.
The third supporting factor is the opinion leader's power. As a traditional society, livestock farmers in Boyolali still rely heavily on opinion leaders. Therefore, SIMAPI's adoption will also be determined by the opinion leaders' success or failure in convincing the livestock farmers to adopt the innovation (Marmoah *et al*., 2024; El Masri & Tarhini, 2017).

Conversely, education and regulation are the main inhibiting factors in SIMAPI's adoption among small-scale livestock farmers in Boyolali. Although the population of young farmers in Boyolali are increasing, they still have low levels of education. This condition prevents SIMAPI from being fully adopted because of the difficulty in understanding its technical and operational aspects. Other strong inhibiting factors are regulation and infrastructure. SIMAPI's adoption requires clear rules and regulations and monitoring from the government. Without robust regulation and adequate infrastructure maintenance and monitoring capabilities, the adoption of SIMAPI will not be sustainable. Most importantly, without strong regulations and infrastructure, people's trust in the effectiveness and sustainability of SIMAPI as a breakthrough innovation in small-scale livestock management will diminish.

Finally, although SIMAPI's ease of use and usefulness may promote its adoption, the targeted community's low level of readiness must be carefully studied and addressed. This aspect is critical for the successful adoption speed of SIMAPI and its use in the long run. Moreover, community development based on data and regular monitoring are prerequisites to inclusive development. Thus, such activities must also be conducted alongside the implementation of innovation to develop small communities in complex nations such as Indonesia.

Conclusion: The Indonesian small livestock industry is unique. A database of updated livestock data is vital to ensure the growth and development of the industry. It is also crucial for monitoring, problem-solving, and developing livestock programs. However, the farmers in mountainous-remote areas typically have low SES (social and economic status), low education level, and are older adults, making adoption difficult. Moreover, the SIMAPI platform requires access to the internet and for farmers to have the technical capability to use the application. Thus, adoption was far from success.

Furthermore, the SIMAPI diffusion process overlooked various aspects. Many steps in diffusion process were neglected. The absence of a preliminary study and monitoring systems regarding SIMAPI's use and purpose contributed to the devices' unsustainable usage in the small-scale livestock farm setting.

In addition, the lack of regulations and infrastructure to run SIMAPI in the long term has led to distrust in this digital innovation. Clear regulations and adequate infrastructure are prerequisites to communicating SIMAPI to its users. When this is achieved, the rest of the process will be relatively attainable. Next, communicating SIMAPI as a simple smart tag can easily be achieved by the role of a powerful opinion leader in the community.

Finally, as this study is qualitative, it is limited in exploring the complex problems during SIMAPI's adoption process. Thus, future research could conduct quantitative data analysis to explore other aspects of SIMAPI's or other similar digital livestock technology's adoption process.

Authors contributions statement**:** N.N. Amal designed, completed the research; Subejo, and Partini supervised the research project; Subejo reviewed and finalized the draft

Conflict of interest**:** The authors declare no conflict of interest.

Acknowledgement**:** Not applicable

Funding**:** *Private funding of main researcher***.**

Ethical statement: This article does not contain any studies regarding human or animal

Availability of data and material**:** We declare that the submitted manuscript is our work,

Informed Consent: N/A

Consent for publication**:** All authors submitted consent to publish this research article in JGIAS.

SDG's Addressed**:** Inclusive community development, Zero Hunger, Decent Work and Economic Growth,Industry, Innovation and Infrastructure,Responsible Consumption and Production.

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