Agrotourism Gamification for Farmer Empowerment

Pedro Gonçalves
ESTGA and IT, Universidade de Aveiro
Aveiro, Portugal
e-mail: pasg@ua.pt

Pedro Azevedo, Ruben Lopes,
DETI and IT, Universidade de Aveiro;
Aveiro, Portugal
e-mail: {pgca, lopes.ruben}@ua.pt

***Abstract*—Rural depopulation has emerged as a pressing issue, driven primarily by the migration of younger generations to urban centers, thereby leaving behind ageing populations. This demographic shift undermines local productivity, leading to the abandonment of agricultural land and the progressive decline of rural economies. The agricultural sector, in particular, is adversely affected by labor shortages and diminished investment, posing significant risks to both food security and the preservation of rural cultural heritage. Addressing these challenges necessitates the implementation of sustainable and integrated policy frameworks aimed at revitalizing rural communities and safeguarding traditional agricultural practices. In this context, the intersection of agriculture and tourism presents promising opportunities. When effectively coordinated, these sectors can generate synergistic benefits that support mutual development. The GAIME project is designed to investigate and promote these synergies through the application of gamification strategies in the tourism sector. By fostering collaboration between tourism and agriculture, the initiative seeks to enhance the resilience of rural economies and ensure continued socio-economic vitality in agricultural regions.**

Keywords-Agrotourism; Gamification; Empowerment of farming sector.

I. INTRODUCTION

Rural depopulation, largely driven by the outmigration of younger generations in pursuit of improved economic prospects, has significantly accelerated the ageing of rural communities. This demographic trend is rooted in the absence of dynamic economic structures capable of offering adequate income levels and skilled employment opportunities to retain youth.

Consequently, agricultural enterprises face acute labor shortages, local businesses struggle to modernize, and fundamental public services, such as educational institutions and healthcare facilities, are forced to close due to declining population density and reduced tax revenues. This labor deficit severely undermines productivity and elevates operational costs [1], rendering agriculture, agro-processing, and small-scale enterprises increasingly unprofitable. The resulting decrease in profitability discourages both investment and innovation, thereby further contracting the local economic base and diminishing employment opportunities. This negative feedback loop reinforces the perceived unattractiveness of rural territories, accelerating youth outmigration and exacerbating socio-economic and demographic decline.

Breaking this self-reinforcing cycle [2], particularly in the Southern European context, necessitates targeted policy interventions that promote sustainable rural entrepreneurship, enhance digital infrastructure, and foster the development of high-value economic niches beyond traditional sectors, with the aim of retaining or repatriating younger populations. The case of Portugal is illustrative: the contribution of agriculture to national Gross Domestic Product (GDP) declined from 8.9% in 1980 to 1.6% in 2020, signaling the sector's inability to keep pace with broader economic value creation [3][4].

Nonetheless, rural decline has also opened avenues for innovation through the adaptive reuse of abandoned properties. Across the Iberian Peninsula, these spaces present unique opportunities for heritage tourism. In Spain's Castilla y León region, for instance, disused stone *cortijos* have been converted into boutique accommodations along cycling routes in the Duero Valley, combining architectural heritage with active tourism [5] [6]. In parallel, Portugal's Alentejo region has seen the transformation of former olive mills into cultural centers that preserve and showcase traditional *taipa* (rammed earth) construction techniques. These initiatives strategically employ abandonment as a storytelling medium, linking ecological restoration [7] with community-based tourism as a mechanism to revitalize depopulated areas.

Agritourism practices—such as olive oil tastings in Andalusia or cork oak forest tours in Alentejo—offer visitors authentic, educational experiences while simultaneously diversifying the income streams of smallholders. Rural accommodations (*casas rurales*) often make use of heritage architecture, and on-site sales of artisanal products like cheese, wine, or Iberian ham capture added value through direct-to-consumer channels. Interactive experiences such as harvest volunteering or shepherd-guided treks deepen visitors' cultural engagement, foster land stewardship, and contribute to the holistic strengthening of rural economies.

In these scenarios, agricultural activities are not only productive but also performative, enhancing the touristic appeal of rural destinations. By increasing visitors' length of stay and stimulating local consumption, they reinforce demand for regional goods. However, farmers often lack organizational structures and maintain historically limited engagement with end consumers, which inhibits their ability to form effective partnerships with the hospitality sector. The absence of reciprocal value in existing relationships between agriculture and tourism has led to the gradual dissolution of such collaborations—resulting in mutual economic losses and further decline in rural economic activity. To address this, the application of gamification in agritourism [8],[9] introduces a novel framework. By incorporating game design elements

such as points, challenges, and leaderboards into farm-based activities, previously mundane tasks—such as harvesting, animal care, or ecological exploration—are reimagined as interactive quests. This not only enhances visitor engagement, enjoyment, and educational outcomes, but also appeals to younger demographics, potentially increasing visitor loyalty and the duration of stays.

In response to these opportunities, the GAIME (Gamification of Agrotourism Industry to Maximize Efficiency) project [10] has developed a tourist-centric gamification model [11] aimed at fostering greater participation in agricultural activities, encouraging accommodation in rural areas, and monitoring the flow of locally produced goods. The project also integrates sensor-based technologies into selected agricultural processes, allowing real-time data to be shared via a user platform. This platform disseminates information on upcoming festivals, hospitality offers, and events linked to the agricultural calendar, thereby sustaining tourist engagement beyond the duration of the physical visit.

The remainder of this paper is organized as follows: Section II briefly overviews GAIME project and Section III presents the gamification strategy. Section IV concludes the paper.

II. PROJECT GAIME

The GAIME project constitutes a comprehensive strategy aimed at fostering economic diversification in rural territories by strategically integrating digital innovation with the agricultural and tourism sectors. Its principal objective is to harness technological tools to generate new revenue streams and bolster the resilience of these interdependent sectors through a series of interlinked interventions.

The first pillar of GAIME centers on the digitization of agricultural practices. By incorporating advanced technologies—including precision agriculture tools, Internet of Things (IoT) sensors, and data analytics—the project seeks to enhance the efficiency of crop and livestock management. The intended outcomes are increased productivity, optimized resource use, and improved profitability for farmers through evidence-based decision-making frameworks.

Secondly, the project explores the development of agritourism as a viable solution for rural revitalization. A key element involves the creation of an immersive digital platform that offers potential visitors an engaging preview of authentic agricultural experiences. This virtual interface functions as an essential promotional instrument, targeting urban audiences and highlighting the distinctive features and activities of participating farms.

Thirdly, GAIME adopts an innovative approach to user engagement through the gamification of the digital platform. By integrating elements such as achievement-based rewards, interactive challenges, and participatory features, the project aims to transform passive interest into active involvement. This gamified engagement strategy is particularly significant for cultivating sustained attention, encouraging emotional and experiential connection, and ultimately converting digital interaction into on-site visitation and local consumption.

Lastly, GAIME promotes capacity-building initiatives via a dedicated knowledge-sharing platform. This component is designed to support both established and emerging farmers by offering access to technical resources, best practices, and structured training modules.

Taken together, these strategic dimensions contribute to the creation of a more dynamic, resilient, and attractive rural economy—one that is responsive to technological transformation and capable of sustaining long-term socio-economic vitality.

III. GAMIFICATION STRATEGY

The project's gamification strategy illustrated in Figure 1, involves tourists, farmers, and hotel operators, establishing a set of mutual incentives so that collaboration between them can boost agritourism in sparsely populated regions.

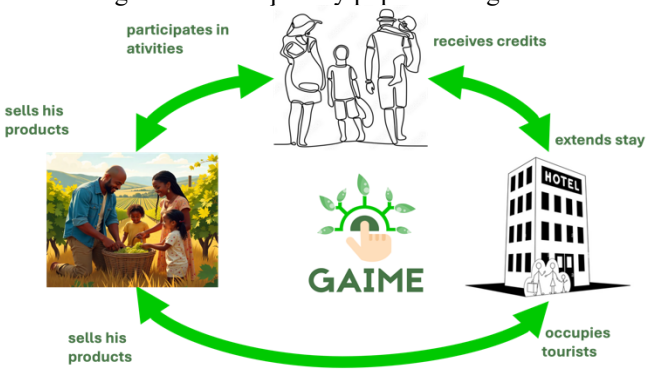

Figure 1 - GAIME approach

Within the GAIME framework, the gamified agritourism model relies on the interaction of three key stakeholders—farmers, hotels, and tourists—each fulfilling a distinct role and contributing to the functioning and sustainability of the ecosystem. TABLE 1 summarizes the respective contributions and benefits of each actor.

The farmer serves as the central producer and host, playing a pivotal role in enabling the agritourism experience. Their primary source of income derives from the direct sale of agricultural products to tourists and, in some cases, to partner establishments, such as hotels. Importantly, farmers host visitors on their land, offering a range of activities—including farm tours, tastings, and hands-on experiences—which constitute the core of the agritourism offering. To enhance visitor engagement and promote product sales, farmers may also provide complimentary samples or small gifts, thereby fostering goodwill, brand recognition, and loyalty. The farm itself acts as the essential infrastructural and experiential foundation upon which the entire tourism experience is built.

Hotels operate as crucial amplifiers of the local tourism economy. Through their established marketing channels and booking systems, they attract visitors to the region and contribute to longer tourist stays, thereby maximizing local

economic impact. In partnership with farmers, hotels may offer local agricultural products within their food services or retail spaces, promoting regional identity and sustainability. Additionally, hotels may procure agricultural goods directly from farms to supply their own operations, providing an important sales outlet for producers. Furthermore, hotels contribute financially by paying activity registration fees, which enable tourist participation in farm-based experiences and directly support those services.

Tourists are the primary consumers and drivers of the agritourism model. Their participation in recreational activities on farms constitutes the core demand, and their expenditures sustain the economic viability of both agricultural and hospitality stakeholders. Tourists purchase farm products, book accommodations, and may pay fees to participate in agricultural experiences. In return, they receive added value through incentives, such as discounts, vouchers, or complementary services—typically offered by farmers or hotel partners—as a means of enhancing their experience and encouraging future engagement. Ultimately, their presence and spending represent the driving force behind the entire collaborative ecosystem.

TABLE 1 - CROSS-BENEFITS AMONG GAIME ACTORS.

Actor	Contributions	Benefits
Farmer	Sells products	Receives tourists Offers samples/gifts
Hotel	Increases the number of tourists Enlarges tourist stays	Offers farm goods Consumes farm goods Pays activity inscription
Tourist	Participates in recreation activities Receives Discounts Receives Vouchers	Buys farm goods Pays hotel stay Pays activity inscription

The AgriturGAIME platform facilitates the monitoring of rural agricultural activities from urban locations. It achieves this by integrating real-time sensor data collected via the Internet and leveraging social media channels through dedicated project pilots. This integration serves dual purposes: enhancing tourist loyalty to rural experiences and attracting new urban audiences.

A. Gamification process

The platform's pilot implementations serve as pivotal nodes within the agritourism ecosystem, functioning as data aggregation and processing centers that monitor the use of various tourism and agricultural activities. This analytical capacity is enabled by the digitization of fundamental agricultural and livestock operations, achieved through the integration of advanced sensorisation, IoT technologies, and big data analytics. A defining feature of the platform is its capacity to actively disseminate sensor-derived data through web-based interfaces and social media channels. This strategic visibility fosters a tangible connection between rural activity and urban audiences, effectively narrowing the spatial and experiential divide. In this way, the AgriturGAIME platform serves as a technological conduit, facilitating meaningful interaction between rural producers, urban consumers, and tourists.

The gamification layer is operationalized through a digital platform that enumerates participating stakeholders—specifically farmers and hospitality providers—and guides tourists through the experience in an interactive, user-centric manner. The system continuously monitors tourist engagement and activity, while offering curated entertainment, accommodation options, and local agricultural products for purchase. The platform's technical architecture, as illustrated in Figure 2, comprises two principal components: a central server that stores system data, logs user interactions, and enables agricultural and tourism operators to create and manage their business profiles and service offerings; and a mobile application installed on the tourist's personal device, which functions as the primary interface for user interaction with the platform.

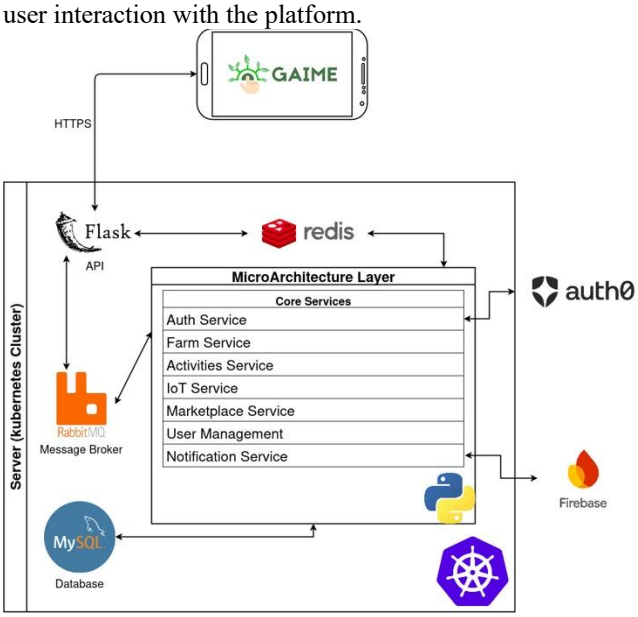

Figure 2 - GAIME platform.

The android app tracks the user's location and focuses on activity offerings, hotel offers, and agricultural products available for purchase based on the user's location. It also monitors tourist activity and records stays at accommodations and participation in recreational activities reading QR-Codes and Near Field Communication (NFC) tags, allowing agricultural and touristic operators to tailor their offerings based on the context: offering recreational activities and extending accommodation periods based on participation in recreational activities.

The platform includes a web interface so that those responsible for agricultural businesses and accommodations can edit information about their own businesses, upload photos, and manage their offerings, whether in terms of activities, product sales, or accommodations. Figure 3 illustrates an activity schedule management form to be used by the farmers.

B. Project Pilots

The project includes a set of four pilots where various agricultural processes were digitized, generating information used by the platform to extend the relationship between tourists and the activities in which they participated, even after returning home. In each of the pilots, agricultural activities that could establish greater empathy with tourists were identified and sensorized so that monitoring data could be published through the project platform.

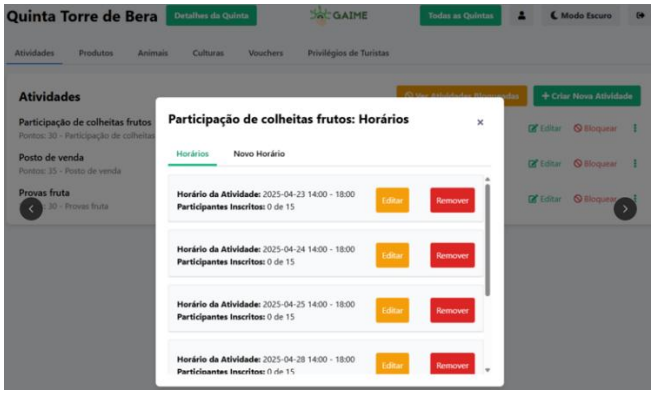

Figure 3 - Farm editing process.

In each pilot project, agricultural activities that could foster greater rapport with tourists were identified and sensorized so that monitoring data could be published through the project platform. Among the livestock activities, sheep and cow herds were monitored, with their location and accelerations continuously recorded. Processing this monitoring data allows the platform to display the animals' activity in real time and track their location.

Among agricultural activities, the condition of cultures is monitored, with continuous image capture and air temperature and humidity measure5ments. This information is disseminated through the platform, allowing users to track the phenological status of the plants visited.

The pilots also contain a set of devices designed to streamline tourist activities, such as audio guides that share interesting facts about activities in the region. In one case, audio guides are used to explain the various steps of the Serra cheese production process in several languages during a cheesemaking activity at a traditional cheese factory in the Guarda region.

IV. CONCLUSION AND FUTURE WORK

Rural depopulation, driven by youth migration due to limited economic opportunities, creates a self-reinforcing cycle of decline: labor shortages reduce productivity and investment, further diminishing attractiveness. While heritage tourism repurposes abandoned assets, traditional agritourism often struggles with fragmented sectoral collaboration.

The GAIME project addresses this by deploying a synergistic gamification platform that digitally bridges farmers, hotels, and tourists. Through sensorized agriculture (livestock/crop monitoring), real-time data sharing, and incentivized activities (discounts, vouchers), GAIME deepens tourist engagement, extends rural stays, and fosters direct economic links.

This model is based on the expectation that digitally mediated partnerships—transforming working farms into interactive destinations—can revitalize rural economies by aligning tourism appeal with agricultural authenticity and community resilience. Disseminating the project to stakeholders will help identify challenges in adoption, as well as problems with farmer involvement.

ACKNOWLEDGMENT

This work is supported by the European Union / Next Generation EU, through Programa de Recuperação e Resiliência (PRR) [Project Nr. PRR-C05-i03-I-000235-LA7.2 /PRR-C05-i03-I-000235-LA7.5 /PRR-C05-i03-I-000235-LA7.6: GAIME (17/C05-i03/2022.PPRR-C05-i03-I-000235-LA7.2 / LA7.5 / LA7.6)].

REFERENCES

[1] D. Strijker, “Agriculture in Transition. A Neo-Institutional Analysis - By PIERLUIGI MILONE”, *Tijdschrift voor economische en sociale geografie* 2011, *102*, 119–120, doi:10.1111/J.1467-9663.2010.00639.X.

[2] W. Chen, D. Han, Y. Zhan, and B. Chen, “The Impact of Rural Population Decline on the Economic Efficiency of Agricultural Carbon Emissions: A Case Study of the Contiguous Karst Areas in Yunnan–Guizhou Provinces, China”, Agriculture 2025, Vol. 15, Page 1081 2025, 15, 1081, doi:10.3390/AGRICULTURE15101081.

[3] Portal Do INE Available online: https://www.ine.pt/xportal/xmain?xpid=INE&xpgid=ine_unid_territorial&menuBOUI=13707095&contexto=ut&selTab=tab3, retrieved: July, 2025.

[4] Agricultura, F. e P. os subtemas Dados Das Explorações Agrícolas Em Portugal - Pordata Available online: https://www.pordata.pt/subtema/portugal/exploracoes+agricolas+e+superficie-421, retrieved: July, 2025.

[5] Upcycling Abandoned Houses – Smart Rural Areas Available online: https://www.smartrural21.eu/smart-solution/upcycling-houses/, retrieved: July, 2025.

[6] Heritage and Culture | Portal de Turismo de Castilla y León Available online: https://www.turismocastillayleon.com/en/heritage-culture, retrieved: July, 2025.

[7] J. F. M. Duque, J. Pedraza, A. Díez, M. A. Sanz, and R. M. Carrasco, “A Geomorphological Design for the Rehabilitation of an Abandoned Sand Quarry in Central Spain”, Landsc. Urban Plan 1998, 42, pp. 1–14, doi:10.1016/S0169-2046(98)00070-X.

[8] Z. Ju, Z. Y. Li, X. D. Cheng, and W. X. Wang, “Design and Research on the Integration of Gamification Design and Agricultural Harvesting”, Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics) 2024, 14716 LNCS, 104–116, doi:10.1007/978-3-031-61362-3_8.

[9] J. Garzón, J. Acevedo, J. Pavón, and S. Baldiris, “Promoting Eco-Agritourism Using an Augmented Reality-Based

Educational Resource: A Case Study of Aquaponics Interactive Learning Environments 2020", doi:10.1080/10494820.2020.1712429/ASSET/A86CC06F-3EE9-41EF-BD83-EB80C500C69A/ASSETS/IMAGES/NILE_A_1712429_F0005_OC.JPG.

[10] Project GAIME, Available online: http://agrogaime.com/, retrieved: July, 2025.

[11] P. Gonçalves, D. Corujo, and L. Coelho, "Gamification of Agrotourism Industry to Maximize Efficiency". Proceedings of the 11th International Conference on Information and Communication Technologies in Agriculture, Food and Environment, vol. 117, pp. 26, 2025, doi:10.3390/PROCEEDINGS2025117026.