Challenges of agricultural digitalization in the Guatemalan western highlands

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1 Introduction

Guatemala is a country located in the Central American isthmus, within a region known as the Northern Triangle. This region, consisting of Guatemala, El Salvador, and Honduras, has historically been characterized by agricultural export production, challenging political processes—including internal and cross-border conflicts—vulnerability to climate change and natural disasters (WorldRiskReport2022, 2023), and the displacement of rural populations seeking improved work opportunities and living conditions. Migration from Guatemala primarily flows to the United States, contributing ∼20% of Guatemala's Gross Domestic Product (GDP), according to the Ministry of Finance (Ministry of Finance of Guatemala, 2024).

The agricultural productivity challenges faced by Guatemala are part of a global issue. Worldwide, rural communities often struggle to integrate into the global economy due to insufficient technological infrastructure, limited access to capital, and the erosion of traditional farming practices. The ongoing digital transformation in agriculture presents great potential but also highlights significant disparities between regions with robust infrastructure and areas like Guatemala's western highlands, where digital solutions remain largely inaccessible. In this context, the conversation shifts from mere technological innovation to the adaptation of tools that align with the specific social and cultural realities of these agricultural communities (Rogers, 2003).

One of the primary drivers of migration is the low productivity of small-scale farmers compared to large-scale producers. Contributing factors include land fragmentation through inheritance, traditional agricultural methods that do not always align with land suitability, and resistance to adopting new practices. Additionally, current marketing systems offer small-scale producers limited access to higher-paying markets and credit, placing them at a disadvantage. As a result, they often become reliant on a distribution system controlled by intermediaries who dominate both the supply chain and its financing.

This situation creates conditions of food insecurity, leading to both chronic and acute malnutrition, as observed by the author during her research and work in these rural areas. Compounding this issue, a significant portion of the population is of Mayan origin and faces limited access to education and credit, with added barriers due to social, cultural, and language differences.

While migration and economic challenges persist, there is a growing recognition of the potential role of digital technologies in transforming Guatemala's agricultural sector. In the context of a global shift toward digital economies, adopting digital agriculture could help address some of the root causes of migration and poverty by modernizing farming practices, increasing market access, and providing farmers with real-time critical information.

In response to these challenges, various international cooperation agencies have initiated projects with mixed results. One such effort is a public-private

partnership between the U.S. government's Feed the Future initiative, an international program aimed at combating hunger and poverty (Feed the Future, 2024), and Popoyán, a Guatemalan agricultural company committed to the concept of impact-driven business. This partnership, supported by USAID (the U.S. Agency for International Development), seeks to foster economic growth while prioritizing community sustainability and innovation (Agropecuaria Popoyan, 2024). The initiative, launched in the western highlands of Guatemala, spans five departments: Huehuetenango, Quetzaltenango, San Marcos, Totonicapán, and Quiché.

2 About the change of the traditional model

The Feed the Future-Popoyán alliance, established in August 2017, launched a program called ProInnova, which stands for the Project of Innovative Solutions for Agricultural Value Chains (ProInnova Project, 2024). The project aims to address malnutrition and poverty by enhancing productivity across the agricultural sector. Key components of the initiative include CAMPO (Agricultural Innovation Centers), which offer educational spaces for farmers, demonstration plots for practicing new technologies, and access to crop varieties with higher market value. In addition, financial support lines were established to strengthen value chains and assist with home improvements, while training is provided in better food preparation practices. Agricultural technicians are also deployed to support farmers directly in the field.

The program emphasizes institutional integration, but this article will focus on the viability of establishing a digital ecosystem centered on AGRICONECTA, a mobile platform that integrates e-commerce, remote digital education, and technical support through audio and video messaging services, as well as a call center and commercial support services—all in a single platform. AGRICONECTA aims to transform both the productive and social environment, delivering real-time products and services to farmers and their families. Additionally, this model introduces a shift in the approach to cooperative intervention, as the digital ecosystem is designed to promote the program's sustainability by providing a dual marketing platform, a credit facilitation space, and a means of payment.

Preliminary feedback from farmers participating in the AGRICONECTA pilot project has shown improvements in tracking crop yields and accessing real-time market price data, enabling some to negotiate better prices. However, long-term data on productivity gains and broader socio-economic impacts are still needed to fully evaluate the platform's effectiveness. A print out of the mobile app dashboard is shown hereby in Figure 1.

3 About the challenges of AGRICONECTA

The question of digital intervention in the agricultural sector centers on its short-term viability, long-term sustainability, and real impact on the community, as well as identifying entry barriers and
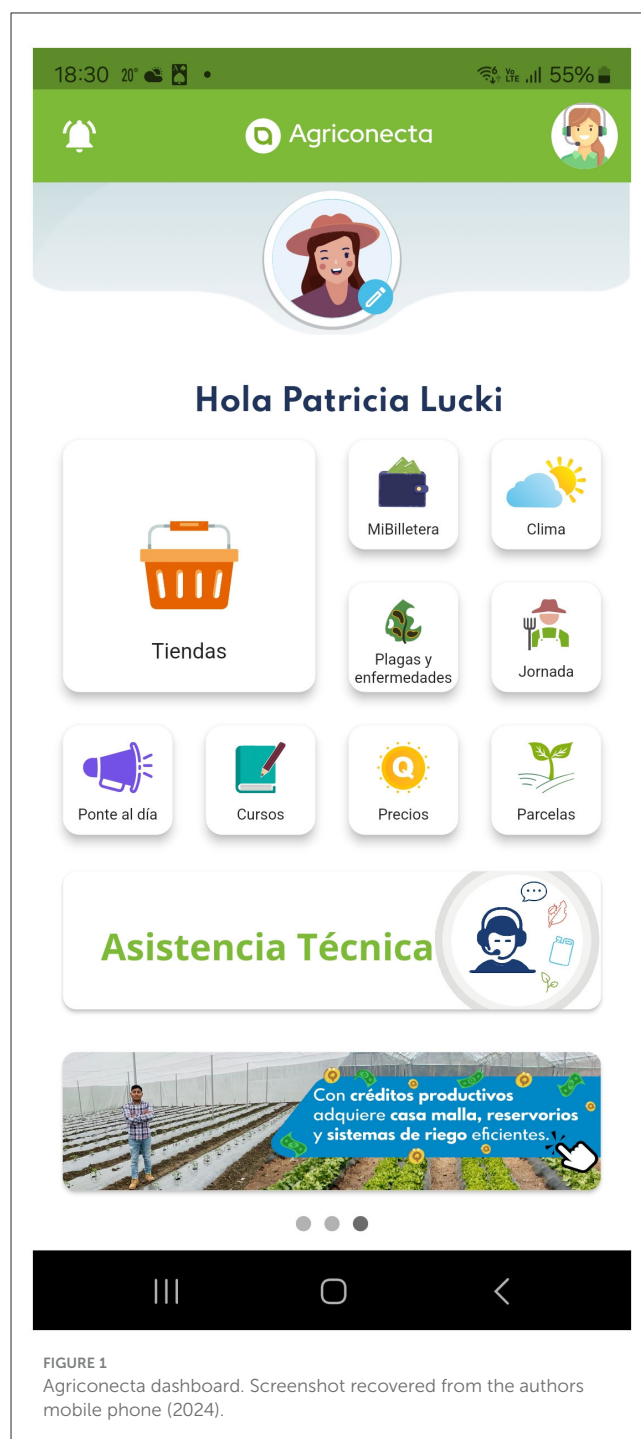

FIGURE 1
Agriconecta dashboard. Screenshot recovered from the authors mobile phone (2024).

potential solutions. Generally, shifts in adoption models align with unmet needs and the pursuit of innovative, feasible, and profitable solutions. Across sectors worldwide—commerce, industry, public administration, health, and education—there is a shift toward omnichannel models, evolving from unidirectional approaches to multidirectional systems that offer comprehensive 360-degree contact strategies. Users, whether in the private or public sectors, increasingly expect consistent, frictionless interactions with entities and services across all channels, both in person and virtually.

As Lehrer and Trenz (2022) note, the broad adoption of digital technologies and evolving user behaviors have facilitated the rise of omnichannel models, where businesses leverage integrated

processes and information systems to deliver a seamless, consistent experience across numerous digital and physical touchpoints. Although this trend is increasingly recognized in business, it has not yet been fully explored in other areas, presenting new opportunities for integrating various activities as long as the ultimate objectives are well-defined and accurately implemented.

4 The experience and challenges

However, convenience alone does not automatically foster a sense of belonging. Theoretically, providing farmers with services that maximize benefits—by improving access to goods and services in more convenient, timely, and cost-effective ways within an ethical framework—is a sound idea that should gain universal acceptance. From a multichannel perspective, an approach that integrates in-person services through agricultural advisors, events at CAMPO centers, and resources within allied associations and community spaces, alongside an app that provides emergency support, market prices, technical assistance, an online store, online courses, and other valuable content, includes all the elements necessary to drive positive change in the targeted communities.

However, there are barriers that still need to be addressed. During visits to the communities and field observations conducted in early 2024, it was noted that beyond the aspects of service provision, there are additional areas for improvement and opportunities to explore:

Barriers to overcome:

- Limited internet and telephone coverage in the target departments
- Low levels of digital literacy, particularly among adults in the target population
- High costs of mobile and internet services, which are often unaffordable for this population
- Cultural resistance and mistrust of new technologies, especially among older adults
- Strong preference for interpersonal, face-to-face interactions
- Language barriers in regions where Mayan languages are predominantly spoken
- Limited banking access and credit services that are challenging to qualify for
- Resistance from certain community leaders who feel their influence may be diminished
- Potential competition from established, traditional service channels
- Underdeveloped logistics networks in the target areas
- High initial investment required for technological resources with delayed returns

Despite mobile phone usage rates of 82.4% among men and 72.8% among women (National Institute of Statistics, 2023), affordability remains an issue. The average monthly income for small farmers is GTQ 2,877.00, while mobile internet packages cost GTQ 199.00 (Tigo, 2024) and Starlink residential packages begin at GTQ 375 per month (Starlink, 2024). With the basic food basket costing GTQ 3,904.98, internet expenses can represent up to 6.9% of their monthly income.

On the other hand, the opportunities offered by this type of development go beyond the supply

- Greater scope of technical content that is available 24/7
- Permanent and convenient educational offer
- Improve the offer of products and prices in two ways, lower the costs of inputs for agriculture and increase the price of fresh produce in the market
- Make market processes transparent by presenting price and quality comparisons from reliable information channels.
- Offer financing options transparently
- Provide greater security in collections and payments through electronic wallet
- Allow comparison of prices of inputs and technologies
- Greater control of tracking and tracing of product flow
- Immediate user feedback
- Improved pest control
- Promote the inclusion of displaced or poorly visible groups
- The young producer seeks novelty and productive improvement

5 Discussion

Introducing digital media to strengthen the agricultural value chain is challenging yet filled with potential. The main obstacles include weak phone signal coverage, the need for culturally and socially relevant digital technology, and the high costs of mobile and internet services. Immediate results may be limited, but digitalization offers a path to amplifying benefits once user adoption reaches critical levels.

Similar digital platforms have shown promising results in other regions. For instance, in Sub-Saharan Africa, mobile platforms like iCow have empowered smallholder farmers with best practices for livestock management, improving yields and food security (van der Velde et al., 2020). Key lessons from these initiatives include the importance of continuous community engagement and adapting technology to local needs.

AGRICONECTA's omnichannel approach provides long-term advantages in both sustainability and adaptability. One major hurdle for digitalization in rural agricultural areas is the socio-economic and cultural divide between technology creators and the users who most need these solutions. Digital tools are generally designed by urban professionals who, often unfamiliar with rural realities, may design with urban, literate users in mind. This gap underscores the need for localized digital education initiatives that do more than introduce technology—they must help communities understand, trust, and find value in these tools. Only when this is achieved can digitalization be embraced as an asset rather than viewed as an imposition (Foster and Heeks, 2013).

While the path to full digitalization in Guatemala's western highlands faces challenges, the potential long-term benefits are substantial. Tools like AGRICONECTA aim not only to improve efficiency but also to transform the socio-economic landscape of these communities by providing access to information, markets, and educational opportunities that were previously out of reach. Success hinges not only on implementing these tools but also on ensuring they are culturally relevant, accessible, and sustainable. As technology evolves, our approach to agricultural innovation must

also advance, rooted in community Needs, co-created solutions, and long-term engagement (van der Velde et al., 2020).

Although AGRICONECTA is a digital tool, face-to-face engagement with local opinion leaders in native languages is recommended to foster a two-way process that adapts the platform to different communities. Additionally, lobbying with telecom providers to improve coverage and offer affordable pricing will be essential to support this initiative.

Author contributions

PL: Conceptualization, Formal analysis, Investigation, Writing – original draft, Writing – review & editing.

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