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## Assessing Agricultural Extension Agent Digital Readiness in Rwanda

Kristin Davis, Gracie Rosenbach, David J. Spielman, Simrin Makhija and Lucy Mwangi

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## ABSTRACT

Effective agricultural extension and advisory services are a key component of efforts to achieve sustainable agricultural production, resilient livelihoods, and inclusive economic growth. These are all necessary elements for accelerating Rwanda's agricultural transformation. Both extension and information and communication technologies (ICT) are important elements in Rwanda's Strategic Plan for Agriculture Transformation. This paper examines the capacities of public and private agricultural extension agents in Rwanda and their readiness to use ICT in their work—that is, to be digitally equipped—and provides recommendations for enhancing agricultural extension capacities through expanding and effectively using ICT.

To examine capacities and readiness, we use a representative survey of 500 public and private extension agents in Rwanda, augmented by qualitative data from a literature review and key informant interviews. To assess agents' 'digital readiness,' we create two indices focused on their digital experiences and attitudes toward digital modernization.

We find notable differences between public and private sector extension agents in terms of age, sex, educational background, workload, and digital assets. Most frontline extension staff, including farmer promoters and farmer field school facilitators, do not have access to digital assets and do not use any digital tools in their professional or personal lives. However, other public sector and private sector agricultural extension agents not working directly with farmers have much more digital experience.

We find that many factors are associated with a readiness to employ digital tools in extension, including age, sex, sector, education, digital asset access, and number of trainings received. These findings suggest that increasing the availability of digital tools among extension agents and continuing to provide technical, functional, and digital tool-centered training will facilitate the integration of such tools into extension work.

The results show that technical and functional trainings increase the likelihood of extension staff being ready to integrate digital tools in their work. Thus, keeping staff engaged and informed on the best agricultural extension practices, in general, can also promote digital readiness. Additional focus should be placed on providing community-level workers with the digital assets (e.g., smartphones), other tools, and knowledge to succeed in their work, given that they now do not have much access to these important technologies and information.

Overall, we find that different digital tools are already being used by public and private sector extension agents in their work. This suggests that they could be open to new applications or types of tools being integrated into the extension services they provide farmers.

# 1 INTRODUCTION AND BACKGROUND

Agricultural extension and advisory services, both public and private, include the “entire set of organizations that support and facilitate people engaged in agricultural production to solve problems and obtain information, skills, and technologies to improve their lives and well-being” (Birner et al. 2009, 342). Extension and advisory services are thus key to sustainable agricultural production, resilient livelihoods, and inclusive economic growth.

Scholars have called for “the new extensionist” (Davis and Sulaiman 2014), emphasizing the functional competencies of extension staff, such as communication, which are needed on top of technical skills and the right mindset to help farmers cope with complex challenges to their livelihoods and welfare, such as climate change and food and nutrition security. Functional capacities have not been well documented in the academic literature on agricultural extension, especially with respect to the use of digital information and communication technology (ICT) tools (Strong et al. 2014).

Digitalization for agriculture and digital tools are considered a game changer for the transformation of African agriculture (CTA 2019). This is because a large amount of data can be captured and tailored cost-effectively for presentation to individual farmers using special applications and tools (CTA 2019). “E-extension” is the use of electronic tools to enhance traditional extension methods (James and Raj 2021). Digital extension services offer many benefits, including wider reach, customization, and two-way communication (James 2023). However, more efforts are needed to equip public and private agricultural extension staff and other actors to use digital tools in achieving solutions to agricultural development challenges (CTA 2019).

It is important to distinguish between the wider area of “digital extension,” which is rather holistic and considers other actors and the policy environment, from the basic use of ICT services and tools by extension officers to support their communication with farmers. Following Spielman et al. (2021, 3), we define ICTs somewhat narrowly as “technologies related to mobile phones, services, and networks; portable devices; web-based portals, tools, and applications; and the data and information shared through these products and services via technologies as varied as interactive voice response (IVR) systems and satellite imagery.”

ICTs are also important for the implementation of the fourth Strategic Plan for Agriculture Transformation (PSTA IV) of the Government of Rwanda. This plan emphasizes extension and advisory services as its first priority area and states that ICTs are necessary to increase the impact of those services on agricultural transformation (MINAGRI 2018).

In support of PSTA IV, the Ministry of Agriculture and Animal Resources (MINAGRI) has sought to enhance extension and advisory services in Rwanda by introducing the Customized Agriculture Extension System (CAES) (MINAGRI 2020).<sup>1</sup> CAES calls for, among other features, ICT-supported extension services. It states that “ICT can revolutionize agriculture in Rwanda” (MINAGRI 2020: 34), highlighting that ICTs can make important contributions to several components of CAES, particularly service delivery, capacity strengthening, and coordination, monitoring, and reporting.

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<sup>1</sup> Preliminary discussions surrounding the forthcoming PSTA V, to be launched in July 2024, also highlighted the importance of CAES and the expansion of ICT-supported agricultural extension services to achieving the new plan’s objectives.

Despite an enabling policy environment and Rwanda's embracing of ICTs, the country's agricultural extension services have generally not taken advantage of the potential of these tools to the benefit of farmers (MINAGRI 2020). Reforming these services to effectively employ such digital tools will require considerable investment in modifying agricultural extension training curricula and making learning modules on the tools widely available—ideally through online portals and platforms. Multiple digital extension approaches, methods, and tools will need to be leveraged to augment and strengthen the current extension system. For CAES to succeed at scale, higher quality training and capacity building efforts around digital extension will be needed for all extension agents in Rwanda to effectively make use of these new tools. Pluralism in extension delivery with the private sector playing a significant role in meeting several of the multiple needs of farmers is also a key ingredient for the success of a digital agricultural extension strategy in the country.

This paper looks at the capacities of agricultural extension staff in Rwanda and their readiness to use ICTs in their work—that is, to be digitally equipped. The International Food Policy Research Institute (IFPRI) conducted a capacity needs assessment of agricultural extension staff as part of the Feed the Future Developing Local Extension Capacity (DLEC) project in Rwanda. Using a telephone survey of both public and private extension agents, IFPRI collected information from them to use in assessing which of their capacities needed to be expanded or modified to enable them to use digital approaches and tools in providing advisory services to farmers more effectively.

Other studies have examined the use of ICT and attitudes toward the use of digital ICT tools in extension in developing countries. Birke and colleagues (2018) developed a conceptual framework identifying factors that contribute to the uptake of ICTs in extension activities. These factors include characteristics of the individual extension agent, such as age and attitude; organizational characteristics of the extension service, such as management structure and infrastructure; and the contextual environment, including working norms and content availability. Birke et al. use the theory of planned behavior (Ajzen 1991) to describe the process through which these factors contribute to an increased recognition of the value of ICTs, leading to their adoption.

Birke and colleagues (2018) also introduce an intermediate step in the process of shaping the individual behavior of extension agents with regards to ICTs. This step accounts for the perceived environment—that is, individual attitudes and social norms. For example, young male extension staff with a university education were found to be the most likely to use ICTs in their work, reflecting their training and attitudes.

Strong and colleagues (2014), working in the Caribbean, found that extension staff tended to use ICTs for personal reasons and professional productivity, but used more traditional methods to interact with farmers. However, they also found that higher education levels of staff led to an increase in ICT use.

Our study adds to this literature by expanding on the tools developed by Strong et al. (2014) to assess 'digital readiness' among extension agents. We draw on survey instruments developed by Venkatesh and Bala (2012) for the conduct of research on interorganizational business and information systems.

## 2 METHODOLOGY

We used a combination of qualitative and quantitative methods for this study:

- A review of the existing literature on agricultural extension in Rwanda, drawing on multiple sources. These included, but were not limited to, project reports, grey literature, academic research, and government documents. This literature was examined to obtain analytical insights on the overall objectives of agricultural extension efforts in the country, the capabilities and skills of extension staff, the curricula used to train extension officers, including any digital approaches, and other related topics.
- Key informant interviews were conducted with 42 experts on agricultural extension in Rwanda. A semi-structured interview guide was used to obtain insights from these experts on the current skills of agricultural extension staff and gaps in those skills.
- An analysis of primary data drawn from a telephone survey of 500 public and private extension agents on the capabilities, practices, and needs of extension and advisory service professionals. The survey was conducted in 2021. Due to COVID-19 considerations, the survey was deployed as a phone survey rather than in-person.

### 2.1 Qualitative Approach

Our qualitative approaches consisted of the literature review and key informant interviews. An inductive approach was used for qualitative data analysis with the data collected being used to form the structure of the analysis without following a predetermined framework. Data were processed manually using thematic content analysis based on a *focus-by-question* approach. The approach analyzed responses to individual items in the interview guide, identified themes in the responses, and explored consistencies and differences in those themes. The responses were then summarized and parallels drawn.

We carried out a literature review of the existing information on agricultural extension in Rwanda to better understand the current context and the best recommended practices for agricultural extension training, the role of youth, and the level of integration of digital technologies in extension service provision. This literature included strategy documents for various sectors, government and project reports, and research literature.

For the key informant interviews, a semi-structured interview guide of 16 questions was reviewed by a panel of experts for focus and content validity. This was administered to 42 key informants through face-to-face or online interviews. To identify key informants, purposive sampling was initially used. Snowball sampling then was employed whereby the key informants first interviewed were asked to recommend additional knowledgeable individuals the research team might interview. The key informants came from public institutions that provide extension services (6), nongovernmental organizations (11), educational institutions (4), local civil society organizations (6), financial institutions (4), private extension service providers (3), digital extension providers (3), and private companies (5). Each interview took approximately 30 minutes to complete.

### 2.2 Survey Data and Characteristics of Extension Staff

The telephone survey of 500 agricultural extension agents (EAs) was conducted in February and March 2021 across all districts of Rwanda. 'Agricultural extension agents' were defined

as all individuals who work as agronomists, agricultural extension agents, crop advisers, livestock advisers, and any other individuals who inform and promote good agricultural practices in the public, private, and non-profit sectors in Rwanda. The survey questionnaire contained modules on demographics, workload and time use, training and integration of functional skills, training of technical skills, extension activities, attitudes on technology, information and communication technologies and extension, and salary and benefits.

The literature review and key informant interviews suggested that public sector EAs, who are comprised mostly of farmer promoters (FP) and farmer field school facilitators (FFSF), differ notably from EAs working in the private sector or with civil society organizations, all of whom are referred to hereafter as 'Private sector EAs.' For this reason, the sample was stratified by the two sectors, with two-thirds of the sample comprised of public sector EAs (n=333) and one-third of Private sector EAs (n=167).

However, among public sector EAs, considerable variation in EA roles exists. Eighty-six percent of EAs sampled from the public sector were FPs, who are volunteer community leaders who received training to serve as farmer-to-farmer extension agents in their own villages, or FFSFs, who facilitate group-based learning (RAB 2021). The other public EAs work in much different roles, including as cell development officers, district veterinarians, and sector agronomists. Given this variability among public EAs, we disaggregated public sector EAs into sub-groups—FPs and FFSFs, and Other public sector EAs. Descriptive statistics show that age, sex, educational attainment, years of employment, and workload differ between the three EA groups (Table 2.1).

**Table 2.1 Characteristics of extension agents, by agricultural extension group**

|                                                                      | FPs and FFSFs | Other public sector EAs | Private sector EAs |
|----------------------------------------------------------------------|---------------|-------------------------|--------------------|
| Age, years                                                           | 49            | 40                      | 38                 |
| Female, percent                                                      | 16            | 29                      | 44                 |
| Highest education level completed, percent                           |               |                         |                    |
| Less than primary                                                    | 12            | 0                       | 1                  |
| Primary                                                              | 80            | 10                      | 39                 |
| Secondary                                                            | 6             | 29                      | 40                 |
| Post-secondary                                                       | 2             | 60                      | 21                 |
| Employment as extension agent, years                                 | 7             | 8                       | 5                  |
| Days worked per season                                               | 22            | 49                      | 76                 |
| Technical training topics received in last 2 years (max 9), number   | 6             | 6                       | 5                  |
| Functional training topics received in last 2 years (max 14), number | 9             | 9                       | 8                  |

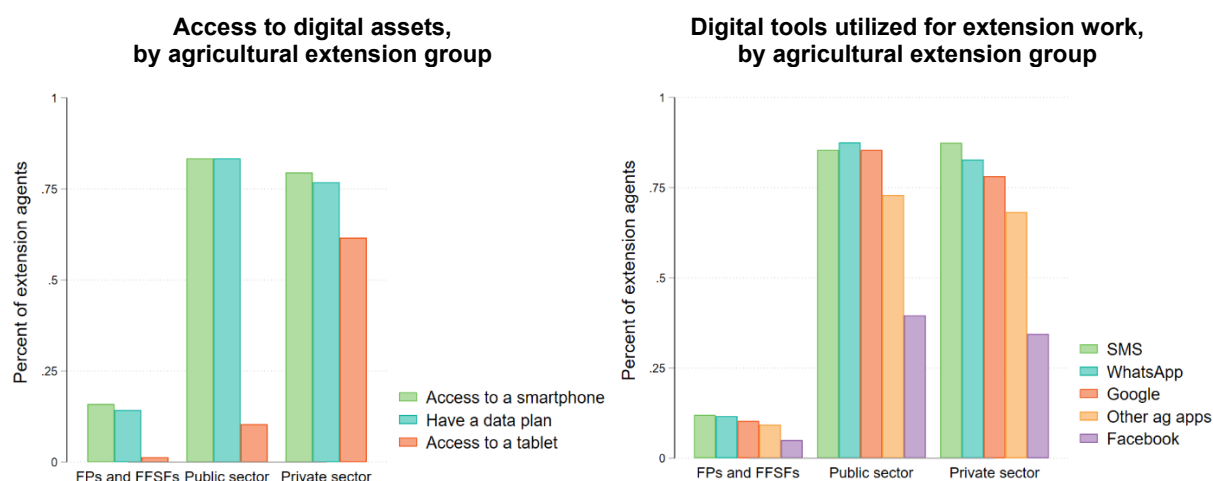
Source: Authors' calculations using the IFPRI Rwanda Agricultural Extension Agents Phone Survey, 2021.

Note: FP = "farmer promoters"; FFSF = "farmer field school facilitators"; EA = "extension agent".

The average age of EAs in the private sector is much younger than among FPs and FFSFs. The private sector is much more likely to have female extension agents. Private sector and Other public sectors EAs are likely to have received considerably more education than FPs and FFSFs—notably at the secondary level and above. Positively correlated with age, years of employment as an EA is lower in the private sector relative to the public sector. Finally, the number of topics that the EAs received training on in the last two years, both on technical skills, such as plot preparation, fertilizer application, and the like, and on functional skills, such as organizing farmer groups or establishing a demonstration plot, are similar across all three groups.

The access of EAs to digital tools and applications and the use of these resources for extension work also varied across the three groups of EAs (Figure 2.1). The figures show similarly high levels of digital accessibility and usage by EAs in the Other public sector and Private sector EA groups, but extremely low levels for FPs and FFSFs. More than three-quarters of EAs in the Other public sector and Private sector EA groups have access to a smartphone and a data plan. However, less than one-quarter of FPs and FFSFs do. Similarly, while more than three-quarters of EAs in the Other public sector and Private sector EA groups use Short Message Services (SMS), WhatsApp, and Google regularly for their extension work, less than one-quarter of FPs and FFSFs use these or any other digital tools. Encouragingly, among EAs in the Other public sector and Private sector groups, other agriculture digital applications are quite popular, with almost three-quarters of EAs in these groups using such applications. Unfortunately, no additional information was collected on what these ‘other agricultural applications’ entail. However, it is encouraging that many EAs are already using digital applications tailored to agriculture to provide advisory services to farmers.

**Figure 2.1: Extension agent access to digital assets and their use of digital tools, 2021**



Source: Authors' calculations using the IFPRI Rwanda Agricultural Extension Agents Phone Survey, 2021.

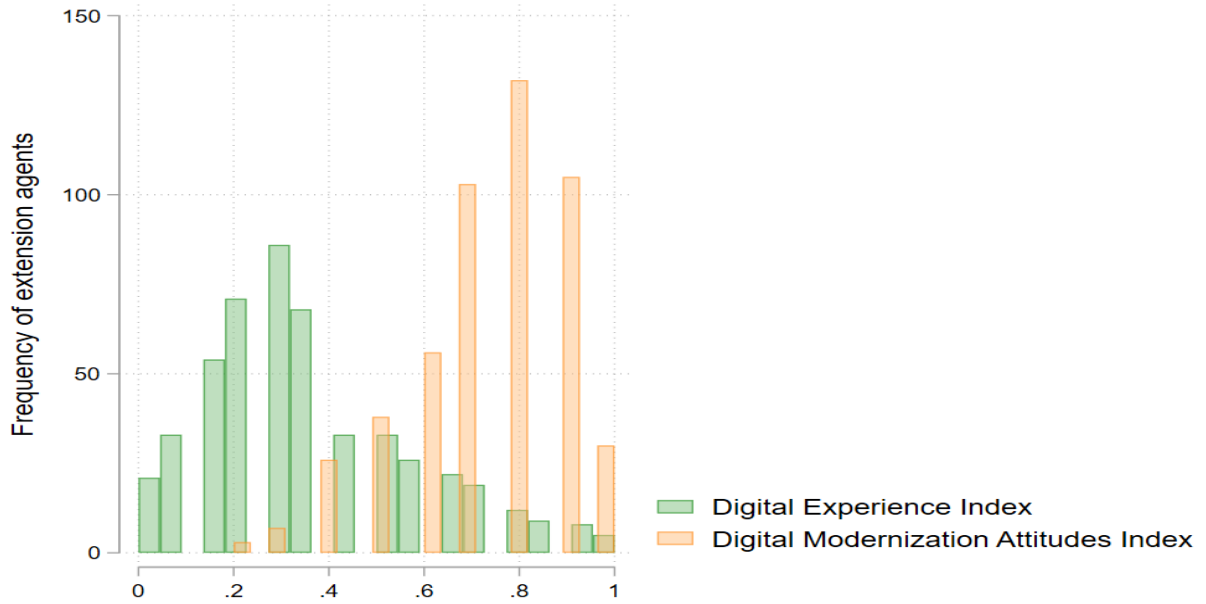
Note: FP = "farmer promoters", FFSF = "farmer field school facilitators".

For our investigation of 'digital readiness' among EAs, our methodology expands on research tools developed by Strong et al. (2014). Our survey instrument relied on an approach developed by Venkatesh and Bala (2012) for the conduct of research on interorganizational business and information systems. For our analysis, two indices were created that focused on the digital experiences and digital modernization attitudes of survey respondents.

The Digital Experience Index is comprised of 14 questions—eight ask whether the EA has taught various digital tools to others, and six ask whether the EA has recommended various digital tools to the farmers with which they work as a means of obtaining agricultural information (left panel in Annex Table 1). The Digital Modernization Attitudes Index is comprised of ten questions concerning the attitude of the EA to the use of new or digital technologies in their agricultural extension work (right panel in Annex Table 1). The two sets of questions are each used to create respective indices. Each response was weighted equally to compute the indices. For the analysis, the indices were normalized to range from zero to one. The distributions of the two indices are shown in Figure 2.2.



**Figure 2.2 Distribution of the two ‘digital readiness’ indices for agricultural extension agents in Rwanda**



Source: Authors' calculations using the IFPRI Rwanda Agricultural Extension Agents Phone Survey, 2021. Observations: 500.

The distributions of the indices vary notably. The majority of EAs scored lower on the Digital Experience Index, with more than three-quarters of EAs scoring below 0.5. In contrast, the EAs scored much higher on the Digital Modernization Attitudes Index, with more than three-quarters scoring above 0.5. The two indices are significantly positively correlated with one another, although the correlation coefficient is relatively weak ( $r=0.28$ ). This suggests some overlap in the attitudes of EAs toward digital modernization as a means to improve the effectiveness of their work, but that these are still distinct indices.

Our work expands beyond that of Strong and colleagues (2014) by exploring correlates of these indices. For each index, we regress a set of individual and institutional characteristics on each index value using tobit, or censored regression, models. Given that our dependent variable is an index, we censor possible estimates at zero at the lower bound and at one at the upper bound for more accurate estimates.<sup>2</sup> While this analysis is not causal, it does help to identify variables on which policy-relevant interventions can operate to effect change in EAs' attitudes and abilities toward the use of digital ITC tools in their agricultural extension work. Our estimation specification takes the following form:

$$y_i = \alpha + \beta_1(Age_i) + \beta_2(Sex_i) + \beta_3(Tenure_i) + \beta_4(Education_i) + \beta_5(Sector_i) + \beta_6(Device_i) + \varepsilon \quad (1)$$

where *Age* and *Sex* denote the age (years) and sex (female=1) of the  $i^{th}$  EA, respectively; *Tenure* denotes the  $i^{th}$  EA's number of years in service as an EA; *Education* denotes educational qualifications as a set of educational attainment categories, a binary category of having completed TVET, and an index of the number of technical and functional trainings the EA reported receiving; *Sector* denotes which EA group an EA is a member of—FP or FFSF, Other public sector, or Private sector; *Device* is a binary variable for whether an EA owns or has access to a smart device, like a smartphone, laptop, or tablet).  $\varepsilon$  is the independent and

<sup>2</sup> Analysis confirms that our Tobit estimates improve upon OLS estimates because the errors are more normally distributed, improving on efficiency and statistical inference.

identically distributed error term. The model is estimated with robust standard errors to account for heteroskedasticity in the error term.

## 3 RESULTS AND DISCUSSION

### 3.1 Literature review

The literature review made clear that both public and private EAs require a wide set of skills to be effective with the farmers they serve. While technical skills related to crops, livestock, and fisheries are critical, a broader skillset now includes marketing and building strong links to value chains, postharvest handling, agro-processing, gender considerations, and climate-smart approaches. The farmer field schools approach means that facilitation and group formation skills are also important. The use of ICTs was strongly emphasized in several strategies and reports examined in the literature review, including increasingly using digital materials for training of both extension staff and farmers. CAES, in particular, states that digital platforms for extension packages should be used for capacity building and should be made available to extension providers from all sectors. Engagement of youth was another important area mentioned, especially in extension services offered by the private sector. Digital tools were also thought to help interest young people in pursuing careers related to agriculture. The Ministry of Education's Technical and Vocational Education and Training (TVET) policy of 2015 noted that available skills in the agriculture sector do not match the sector's labor requirements (Ministry of Education 2015).

### 3.2 Key informant interviews

Qualitative responses from key informants mainly confirmed the findings from the literature review. Respondents generally perceived the need for additional training for agricultural extension staff, especially on newer topics such as entrepreneurship and climate change. While some staff were said to be using ICTs, many respondents noted the need for better digital literacy, especially among certain sub-groups of extension providers such as farmer promoters.

However, several informants highlighted that poor internet availability in rural areas and the high cost of certain ICTs may prove important barriers to EAs taking up digital tools for use in their work. Learning to use new ICT tools and the need for a mindset change to adopt ICTs more readily may present significant challenges. Some respondents suggested the need for incentives for EAs to encourage their digital learning.

While several informants mentioned the need for digitalizing curricula and other training materials, one noted that online training may not always be effective since there is limited supervision and many EAs will lack the skills to use online platforms effectively. Physical training was viewed as preferable for field-based staff, especially for hands-on training like the establishment of demonstration plots. Another bottleneck with digitalization is that, while many extension materials have been produced, few are in Kinyarwanda, so they will need to be translated and updated for the Rwandan context. Moreover, the range of learning materials from many sources means that information is often scattered, is not standardized, and may not have been subjected to any quality checks.

Several informants mentioned digital platforms as a promising means of linking all extension staff in the country to promote information sharing and to coordinate, standardize, and harmonize the messages that EAs convey to farmers. However, it also was observed that establishing a common platform for agricultural extension in Rwanda will not be easy, given the number of stakeholders involved.

Respondents also raised the issue of professionalization in areas such as certification, regulation, formalized extension education, career paths, and a professional association for extension staff. Using the right tools to do the job, including employing ICTs, forms a critical component in developing a professional agricultural extension service.

Finally, informants mentioned the need for greater engagement of youth and the private sector in agricultural extension. This is linked to the use of digital tools, as younger people and the private sector EAs were viewed as more likely to use ICTs than EAs in the public sector.

### **3.3 Analysis of agricultural extension agent survey data**

Using the agricultural extension agent survey data, a number of correlates were regressed against the two 'digital readiness' indices to see which demographic characteristics and work experiences are most associated with EAs being ready to digitally modernize how they work with farmers. We expected that age would likely be a main correlate of being ready to integrate digital tools into work, as younger individuals are more likely to own or use a digital device effectively. Based on previous research, we assumed that gender would also play a role. Since women tend to have less access to household assets, including digital technologies, we expect them to be less ready to integrate these tools into their extension work. We also hypothesized that EAs who have attained a higher level of education will feel more comfortable using technology, as they likely used or were exposed to digital tools in their later school years.

Years of employment and training background may also play a role in an EA's readiness to employ digital tools in their work. We hypothesize that having obtained more training, whether in the form of TVET, technical skill training sessions, or functional skill training sessions, and working as an EA for a longer time may help an EA to feel more comfortable and confident in their skills and position as an extension service provider and ready to integrate new tools into their work.

The various sectors in which EAs work will likely have different requirements for the integration of digital tools and processes into the workload of an EA. This may impact the digital readiness of EAs. Finally, an EA's ownership or access to digital tools will likely influence their willingness to integrate those tools into their work. We test all of these hypotheses in the regressions.

We do not include a location variable in our regressions because location is strongly correlated with public policies and civil society organization activities and, as such, is collinear with the EA group variable. In addition, the small sample size inhibits us from using location-based fixed effects in our regressions because of the loss of degrees of freedom. We also do not include the number of days EAs worked per season and the remuneration they received in our set of independent variables. These variables are highly correlated with the three EA groups—days worked per season has an  $r$  of 0.58, while remuneration received has an  $r$  of 0.46.

The tobit regression analysis of the two indices is shown in Table 3.1. Age, sex, educational attainment, training received, agricultural extension group, and technology access are associated with an EA's digital readiness to change. Scoring higher on both indices is negatively correlated with age, suggesting that younger EAs are more ready to modernize and incorporate digital tools into their work. The results also suggest that male EAs are more likely to be ready for digital integration than females. Both the age and sex variables are more significant and more strongly associated with the Digital Experience Index than with the Digital Modernization Attitudes Index. This contrast suggests that these characteristics are stronger indicators of the existing relationship of EAs with digital technology (which may be related to their job role and agricultural extension group) rather than to their overall attitudes toward digital modernization in conducting agricultural extension.

**Table 3.1 Correlates of 'digital readiness' indices, tobit regression results**

|                                                       | Digital Experience Index |                | Digital Modernization Attitudes Index |                |
|-------------------------------------------------------|--------------------------|----------------|---------------------------------------|----------------|
|                                                       | Coefficient              | Standard error | Coefficient                           | Standard error |
| Age, years                                            | −0.004***                | 0.0009         | −0.002*                               | 0.0008         |
| Female extension agent, 0/1                           | −0.049***                | 0.0182         | −0.030*                               | 0.0165         |
| Duration of employment as an extension agent, years   | −0.001                   | 0.0025         | 0.002                                 | 0.0023         |
| Primary school education attainment level, 0/1        | 0.001                    | 0.0186         | 0.041                                 | 0.0311         |
| Secondary school education attainment level, 0/1      | 0.096***                 | 0.0314         | 0.036                                 | 0.0372         |
| Post-secondary school education attainment level, 0/1 | 0.102**                  | 0.0412         | 0.034                                 | 0.0384         |
| Received TVET training, 0/1                           | 0.015                    | 0.0205         | −0.021                                | 0.0234         |
| Training index                                        | 0.282***                 | 0.0337         | 0.092***                              | 0.0293         |
| Other Public sector extension agent group, 0/1        | 0.038                    | 0.0406         | 0.010                                 | 0.0279         |
| Private sector extension agent group, 0/1             | 0.085***                 | 0.0292         | 0.062***                              | 0.0199         |
| Owns or has access to digital device, 0/1             | 0.151***                 | 0.0241         | 0.037**                               | 0.0184         |
| Constant                                              | 0.252***                 | 0.0537         | 0.671***                              | 0.0548         |
| var(e.Digital Experience Index)                       | 0.025***                 |                |                                       |                |
| var(e.Digital Modernization Attitudes Index)          |                          |                | 0.025***                              |                |
| F-statistic                                           | 27.0***                  |                | 6.7***                                |                |

Source: Authors' calculations using the IFPRI Rwanda Agricultural Extension Agents Phone Survey, 2021. Observations = 500. Note: The training index corresponds to the number of technical and functional skills trainings an extension agent has received in the last two years. It has a normalized distribution from 0 to 1. "Digital device" refers to a smartphone, laptop, or tablet. TVET = "Technical and Vocational Education and Training". FP = "farmer promoters"; FFSF = "farmer field school facilitators". The base category for educational attainment is 'Less than primary'. The base category for extension agent groups is 'FPs and FFSFs'.

Statistical significance levels: \*\*\* p<0.01, \*\* p<0.05, \* p<0.10.

Additionally, certain education and training opportunities are important correlates of an EA being ready to digitally modernize. Having a secondary or post-secondary education is associated with EAs scoring higher on the Digital Experience Index. Similarly, having received more technical and functional skills training in the past two years, as measured by the Training index variable, is positively associated with both indices. In contrast, the role of technical and vocational education and training (TVET) is not significant for either index. However, this result may reflect only 15 percent of EAs having obtained any TVET certification (Annex Table 2). Being a public sector employee, rather than working in the private sector or as an FP or FFSF, is not associated with an EA being 'digitally ready'. However, EAs in the private sector score significantly higher on both indices compared to FPs and FFSFs. Finally, owning or having access to a digital device, such as a smartphone,

laptop, or tablet, is correlated with a higher score on both indices. However, we find that the years of employment as an EA variable is not significantly correlated with either index.

## 4 CONCLUSIONS AND POLICY IMPLICATIONS

Several policy recommendations emerge from this analysis.

First, we find that the vast majority of FPs and FFSFs do not have access to any digital assets and do not use any digital tools in their personal or work lives. Though not surprising given the community-level role that FPs and FFSFs play, these results suggest that if the extension system seeks to digitally equip FPs and FFSFs, as well as the other public and private sector EAs, additional focus will need to be placed on providing these community-level workers with the digital assets (e.g., smartphones), tools, and knowledge to succeed in their work. The other public sector and private sector EAs are well positioned to provide digital training, given that our survey results indicate that their digital experience is much more extensive than that of FPs and FFSFs. However, the survey suggests that the confidence of EAs to teach others about digital tools varies and is not consistently strong across groups. Therefore, a “train-the-trainer” learning approach might be useful to better enable EAs in the Other public sector and Private sector EA groups to provide training on digital tools to FPs and FFSFs.

Facilitating peer learning and collaboration among EAs through digital platforms or online communities could be an effective way to share experiences, best practices, and insights on using digital tools effectively. Leveraging the underutilized TVET institutions in the country—very few EAs in either the public or private sector had received TVET training, according to our survey—may be one way to approach this.

It is also important to examine the types of digital tools already being used by the other public and private sector EAs in their work. SMS, WhatsApp, Google, and ‘other agricultural applications’ are the most popular digital tools used in their extension work by EAs in the Private sector and Other public sector groups. Unfortunately, we do not have information on what these ‘other agricultural applications’ entail, but it is encouraging to see that EAs are already using applications tailored to agriculture to provide advisory services to farmers. This suggests that they will be open to new applications or types of tools to be integrated into their extension services.

We also recommend the introduction of specialized training programs in digital literacy, focusing on fundamental digital tools, software, and applications relevant to agricultural extension work. These programs should be complemented with workshops and seminars on innovative digital tools and technologies, featuring hands-on training and demonstrations by experts. Additionally, EAs could be provided with access to online databases, research papers, educational materials, and collaborative learning events with technology providers, NGOs, and private sector companies so that they can contribute to the development of customized digital solutions to optimize their effectiveness further. The study underscores the need for ongoing support and technical assistance for EAs as they adopt new digital tools to facilitate a smooth transition and to address potential challenges as they emerge.

We found that female EAs are less likely than male EAs to be ready to use digital tools in their work. This could be due to a variety of factors, including restricted control of assets by women within their own households. This challenge could be overcome with comprehensive

digitalization training for all EAs. Lecoutere et al. (2019) find that such challenges often stem from information asymmetries between men and women in a household. Simply including women in training focused on agricultural extension and digitalization can help to overcome this gender gap.

Similarly, our results show that any trainings, whether technical or functional, increases the likelihood of an EA being ready to integrate digital tools into their work. Continuing to keep EAs engaged and informed on the best agricultural extension practices through regular training will also promote digital readiness.

In sum, this study provides an overview of the demographic, educational, and work backgrounds of public and private agricultural extension agents in Rwanda. We find notable differences between public and private sector EAs in terms of age, gender, educational background, workload, and digital assets. To assess the 'digital readiness' of EAs, we assess the impacts of various factors on an EA's digital experience and their attitudes toward digital modernization. We find that many factors are associated with an EA being ready to digitize, including age, sex, whether they work in the public or private sector, education, digital asset access, and how much training they receive. These findings suggest that increasing the availability of digital tools among EAs and continuing to regularly provide technical, functional, and, increasingly, digital training will help to facilitate the integration of new digital tools into their agricultural extension work.

# APPENDIX

**Annex Table 1 Survey questions used to compute the two ‘digital readiness’ indices**

| Digital Experience Index                                                                                                                                                                                                                       | Digital Modernization Attitudes Index                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Q1-8. Have you taught others to use the following?<br>1. Phone calls<br>2. SMS<br>3. WhatsApp<br>4. Facebook<br>5. Google search or other search engines<br>6. Checking email<br>7. Other agricultural information apps<br>8. Microsoft Office | I prefer <i>not</i> to use digital technologies to share information with farmers.<br>I find it easy to use digital technology for my day-to-day work.<br>I do not intend to use digital technology <i>more</i> to communicate with farmers.<br>I believe that when I use digital technologies it helps farmers to better understand the concepts I am explaining.<br>I do not believe that using digital technology makes it easier to do my work.                                                    |
| Q9-14. Have you recommended the following ICTs to farmers to get agricultural information?<br>9. Radio<br>10. TV<br>11. Video<br>12. Integrated Voice Response (via phone)<br>13. WhatsApp<br>14. Other agricultural information apps          | I believe that using digital technologies enhances the quality of my work.<br>I prefer to stick with the tools I already have to convey information to farmers.<br>I believe that farmers have information and knowledge that would be valuable to be shared with extension agents.<br>I believe farmers enjoy it when I use new digital technologies to share information with them.<br>I believe that extension tools and methods should not be changed too frequently because it creates confusion. |

Source: Authors.

**Annex Table 2 Descriptive statistics of dependent and independent variables for tobit regressions**

|                                                | Mean | Standard deviation | Minimum | Maximum |
|------------------------------------------------|------|--------------------|---------|---------|
| Digital Experience Index                       | 0.35 | 0.22               | 0       | 1       |
| Digital Modernization Attitudes Index          | 0.74 | 0.17               | 0.20    | 1       |
| Age, years                                     | 45   | 11                 | 25      | 79      |
| Female extension agents, percent               | 26   | 44                 | 0       | 1       |
| Length of employment as extension agent, years | 6    | 3                  | 1       | 18      |
| Highest education level completed, percent     |      |                    |         |         |
| Less than primary                              | 7    | 26                 | 0       | 1       |
| Primary                                        | 61   | 49                 | 0       | 1       |
| Secondary                                      | 19   | 39                 | 0       | 1       |
| Post-secondary                                 | 13   | 34                 | 0       | 1       |
| Completed TVET, percent                        | 15   | 35                 | 0       | 1       |
| Training Index                                 | 0.63 | 0.22               | 0       | 0.96    |
| Agricultural extension group, percent          |      |                    |         |         |
| FP or FFSF                                     | 60   | 49                 | 0       | 1       |
| Other public sector                            | 10   | 29                 | 0       | 1       |
| Private sector                                 | 30   | 46                 | 0       | 1       |
| Access to an internet enabled device, percent  | 46   | 50                 | 0       | 1       |

Source: Authors' calculations using the IFPRI Rwanda Agricultural Extension Agents Phone Survey, 2021. Observations: 500.  
Note: FP = "farmer promoters"; FFSF = "farmer field school facilitators"; EA = "extension agent".



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## ABOUT THE AUTHORS

**Kristin Davis** is a Senior Research Fellow with the Natural Resources and Resilience Unit at the International Food Policy Research Institute (IFPRI) and is based in South Africa.

**Gracie Rosenbach** was, at the time of writing, the Country Program Manager of the IFPRI Rwanda Strategy Support Program (Rwanda SSP).

**David J. Spielman** is the Director of the Innovation Policy and Scaling Unit at IFPRI and, was, at the time of writing, head of Rwanda SSP in Kigali, Rwanda.

**Simrin Makhija** was, at the time of writing, a Senior Program Manager at IFPRI in Washington DC.

**Lucy Mwangi** is a researcher with the High Lands Centre of Leadership for Development-Rwanda and an independent scholar based in Kigali.

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### INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE

1201 Eye St, NW | Washington, DC 20005 USA  
T. +1-202-862-5600 | F. +1-202-862-5606  
[ifpri@cgiar.org](mailto:ifpri@cgiar.org)  
[www.ifpri.org](http://www.ifpri.org) | [www.ifpri.info](http://www.ifpri.info)

### IFPRI-RWANDA

KG 563 Street #7, Kacyiru  
P.O. Box 1269 | Kigali, Rwanda  
[IFPRI-Rwanda@cgiar.org](mailto:IFPRI-Rwanda@cgiar.org)  
[www.rwanda.ifpri.info](http://www.rwanda.ifpri.info)



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