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Digitizing Extension Services: Evidence from a Two-Sided Randomized Experiment in Indonesia

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Digitizing Extension Services: Evidence from a Two-Sided Randomized Experiment in Indonesia*

Abstract

We conducted a cluster randomized controlled trial to evaluate a platform-based training intervention designed to integrate digital technologies into agricultural extension services and aimed to reduce information delivery costs while improving the efficiency of extension systems. The intervention targeted both extension workers and farmers and combined a digital literacy module to address barriers to platform adoption with modules on digital agribusiness practices. We compared fully online delivery with a blended format combining online and in-person instruction, examining effects on platform adoption, digital literacy, and the use of digital agribusiness practices, as well as the cost-effectiveness of each modality. Both delivery modalities increased knowledge and adoption of the digital platform among extension workers and farmers and reduced digital literacy constraints among farmers, suggesting that digital platforms can facilitate information diffusion in agricultural extension systems. The intervention also increased the integration of digital agribusiness practices by extension workers into their activities, with evidence of adoption of some practices among farmers. Both interventions were relatively inexpensive compared to conventional extension training programs. The blended format was more cost-effective for extension workers due to the larger estimated impacts, whereas lower compliance among farmers reduced the effectiveness of the blended modality, making the fully online format the more cost-effective approach.

JEL classification

C93, O12, O13, O33, Q12, Q16

Keywords

digital platforms, digital innovations, agricultural extension, millennial farmers, digital literacy, technology adoption, sustainable farming, Indonesia

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1 Introduction

Agricultural extension services are a key policy instrument for promoting the adoption of innovative farming practices among small-scale farmers. By facilitating the diffusion of new knowledge and technologies, these services can increase agricultural productivity and contribute to achieve policy objectives such as reducing hunger, promoting sustainable production, and strengthening climate resilience. Yet, providing conventional extension services is costly, particularly in settings where extension workers serve geographically dispersed farming communities. Digital platforms may offer a low-cost alternative for delivering information and training (Aker et al., 2016; Aker and Blumenstock, 2015). However, the effectiveness of digital delivery depends on whether intended users can access and navigate these platforms and translate the information they provide into practice. This raises two related questions: can extension workers integrate a digital training platform into existing extension systems, and can farmers increase agricultural knowledge and adoption of practices at a cost that makes them a viable alternative to conventional delivery?

To shed light on these questions, we offer extension workers (EWs) and young farmers, referred to as Millennial Farmers (MFs), a free self-paced online training on the digital platform Lentera DESA (LD). The content of the self-paced course covers digital literacy and agribusiness practices, including farm management, financial record keeping, and marketing. To address potential severe digital literacy constraints, we compare two delivery modalities. In the fully online modality, participants attend an introductory session via *Zoom* before completing the online course. In the blended modality, the introductory session is delivered in person, while the remaining training is identical. We compare these two delivery modalities by examining their effects on platform knowledge, adoption, and engagement, digital literacy, extension workers' service delivery (performance and geographical and farmers' outreach), and farmers' knowledge, adoption of recommended agribusiness practices, and production. Finally, because the fully online format is less costly to implement, we compare the cost-effectiveness of the two delivery modalities.

We evaluate the intervention using a cluster-randomized controlled trial in the Special Region of Yogyakarta, Indonesia. Subdistricts were randomly assigned to receive fully online training, blended training, or no training. To measure impacts, we interviewed a random sample of 166 extension workers and 745 Millennial Farmers before the intervention and approximately eight to nine months after its start. Since not all participants attended the training, we estimate both intention-to-treat effects (ITT) and local average treatment effects (LATE) using randomized assignment as an instrument.

Our findings indicate that both training modalities substantially increase the knowledge and adoption of the digital platform among extension workers and young farmers. Among extension workers, blended training leads to larger increases in platform use and engagement than fully online training, with high participation in both modalities. We find no evidence that digital literacy is a major constraint for extension workers' use of the platform. Treated extension workers adopt the platform more often, yet without showing measurable improvements in extension service performance, such as the number of extension activities, area covered, or numbers of farmers' reached (geographical and farmers' outreach). However, we find suggestive evidence that treated extension workers are more likely to incorporate agribusiness management practices into their advisory services, especially one-to-one in-person activities.

Among treated Millennial Farmers, participation is lower than among treated extension workers but consistently higher in the fully online modality. Both training modalities substantially increase platform adoption and engagement, and improve farmers' digital literacy. We also find suggestive evidence of gains in farmers' knowledge and adoption of recommended agribusiness practices. However, these improvements do not yet translate into significant improvement in agricultural production and sales during the study period. Overall, our findings suggest that digital platforms can successfully promote the adoption of digital extension services among both extension workers and farmers, although improvements in knowledge and platform use do not necessarily translate into measurable production gains in the short-run.

We contribute to the literature in three respects. First, we add to the growing literature on digital agricultural extension and platform-based service delivery in developing countries. Existing studies have primarily evaluated digital advisory services delivered through SMS, phone calls, audio or video messages, or applications tailored to specific crops or farming systems (Arouna et al., 2021; Beach et al., 2025; Casaburi et al., 2019; Cole and Fernando, 2021; Cole et al., 2025; Fabregas et al., 2019; Larochelle et al., 2019; Campenhout, 2017). We provide evidence on a mobile-friendly digital

platform that delivers advisory services across multiple agricultural subsectors and simultaneously targets extension workers and farmers.

Second, our paper contributes to the literature on the barriers to adopting digital agricultural services. While digital technologies have the potential to expand access to extension at relatively low cost, their effectiveness depends on infrastructure, smartphone availability, and users' digital literacy, i.e., the ability to access and navigate digital tools. (Aker et al., 2016; Baumüller, 2022; Deichmann et al., 2016; Suri, 2011). To our knowledge, only Abdelaziz and Abay (2026) explicitly incorporates digital literacy training into the design of a 'digital' agricultural intervention. Unlike that study, which focuses on the use of specific agricultural platforms, our intervention develops broader digital competencies that can be applied across different digital environments while evaluating whether relaxing digital literacy constraints facilitates engagement with platform-based extension services.

Third, we contribute to the literature on agricultural training for both farmers and extension workers. Previous studies have shown that digital extension can improve access to information, knowledge, and the adoption of recommended practices, while evidence on agricultural production remains mixed (Beach et al., 2025; Casaburi et al., 2019; Cole and Fernando, 2021; Cole et al., 2025; Fabregas et al., 2019; Larochelle et al., 2019; Van Campenhout et al., 2021). Much of this evidence comes from Sub-Saharan Africa and South Asia, with comparatively little evidence from Southeast Asia. Related work finds that training extension workers can increase awareness and use of digital tools (Abdelaziz and Abay, 2026; Enwelu et al., 2017; Tata and Mcnamara, 2017; Campenhout, 2017). We extend this literature by evaluating a two-sided intervention that simultaneously trains extension workers and farmers in Indonesia and by comparing a fully online and a blended delivery modality, allowing us to assess both effectiveness and cost-effectiveness.

The remainder of the paper is organized as follows. Section 2 describes the Indonesian context, the platform used, and the intervention. Section 3 describes the sample selection, the treatment randomization procedure, and baseline characteristics including balance tests. Section 4 provides theoretical considerations regarding the mechanisms relating training and outcomes. Section 5 describes the follow-up survey and studies attrition, and outlines the estimation strategy. Section 6 presents the results along with robustness checks. Section 8 provides a cost-benefit analysis. Section 9 concludes.

2 Context and intervention

2.1 Country context and the Lentera DESA platform

Our study is set in Indonesia, where the agricultural sector faces important structural challenges. Value added per agricultural worker has declined in recent years (World Bank, 2023), partly due to an aging agricultural workforce (BPS - Statistics Indonesia, 2023) and the long-term consequences of the Green Revolution (Grimm and Luck, 2023). Therefore, attracting younger generations to agriculture and supporting their adoption of modern, sustainable farming practices have become important policy objectives.

The Indonesian government has implemented several initiatives to encourage youth participation in agriculture. One such initiative is the Youth Entrepreneurship and Employment Support Services (YESS) program, implemented in collaboration with IFAD, which provides support to young individuals entering agriculture and identifies *Millennial Farmers*, defined as farmers between 19 and 39 years old. Although the YESS program was implemented only in selected regions, it encouraged regional Ministries of Agriculture to compile lists of young farmers receiving support through government extension services. However, agriculture is still often perceived as an unattractive career opportunity among younger generations.

Extension workers (EWs) play a central role in promoting the adoption of improved agricultural and business practices. Their ability to fulfill this role may, however, be constrained by limited digital skills among both extension workers and farmers, potentially limiting the effectiveness of digital tools to engage younger farmers and disseminate information. While in Indonesia there is widespread access to digital technologies and high smartphone penetration (International Telecommunication Union, 2025), this does not necessarily translate into effective use of digital services, and limited digital literacy may constrain the adoption of digital technologies in agriculture.

The Indonesian government has invested in digital tools to support agricultural extension. However, the provision of digital extension services remains fragmented, partly because agricultural extension

has been decentralized since the early 2000s.[1] Each region is responsible for organizing and coordinating extension activities within its territory, with implementation delegated to subdistrict offices. This fragmentation and the limited digital literacy make it unclear whether digital platforms can be effectively integrated into existing extension systems.

In this context, we study the integration of the digital learning platform *Lentera DESA* into agricultural extension services in the Special Region of Yogyakarta, where the YESS program has not been implemented. Lentera DESA is a mobile-friendly web application managed by the Faculty of Agricultural Extension and Communication at Universitas Gadjah Mada (UGM).[2] The platform provides agricultural information about practices, facilitates interaction among users, and offers self-paced courses designed to improve knowledge and skills related to agricultural practices. The Lentera DESA platform provides content across several agricultural subsectors, including crop cultivation, livestock, forestry, and fisheries. It also includes a farm record feature to account for financial movements and agribusiness management. Courses and information materials are developed by UGM and its network of agricultural experts. Users can access articles, participate in discussions, and complete self-paced courses for free. In this study, we focus on the platform's learning component and its potential to support the delivery of agricultural extension services.

2.2 The training interventions

The intervention invited extension workers and Millennial Farmers in treated subdistricts to attend a free training on digital literacy and the use of Lentera DESA. The training combined an introductory session with a self-paced course accessible through the platform. The introductory session was delivered either in person or online through Zoom (depending on the treatment group) and introduced participants to digital transformation in agriculture, the creation of an Lentera DESA account, the use of the platform features including the use of the farm record feature, *Buku Tani*, and financial record keeping.

Following the introductory session, participants were invited to complete a self-paced course consisting of four modules. The first two modules covered digital literacy and digitization in agriculture. These modules were identical for extension workers and farmers. The remaining modules were tailored to the respective roles of participants. For extension workers, the training focused on digital marketing, agribusiness management, financial record keeping, and the use of social media to engage with farmers. For Millennial Farmers, the training covered digital marketing, e-commerce, agribusiness management, financial literacy, and financial record keeping, with a particular emphasis on the *Buku Tani* feature.

The intervention also included two online monitoring sessions intended to support participants' engagement with the training and provide opportunities to demonstrate their learning. The first session, conducted approximately 10 days after the information session, allowed participants to receive a knowledge achievement certificate, while the second (two months after) included an online presentation through which participants could obtain a digital literacy competency certificate. These certificates were intended to provide participants with evidence of acquired skills. Farmers were also informed that they could use their *Buku Tani* financial reports to support any loan applications. The intervention, including the monitoring sessions, was implemented between May and August 2025.

To facilitate participation, individuals attending the in-person session received reimbursement for travel expenses, while participants attending the online session received compensation for mobile internet data (related to the Zoom session only). These arrangements were intended to reduce the direct costs of attending the introductory session under each delivery modality.

3 Theoretical considerations and rationale of the intervention design

Imperfect information about the benefits of new technology is a long-established constraint on technology diffusion in agriculture (Suri and Udry, 2022). Traditionally, extension workers play a crucial

[1] At the end of February 2025, the National government decided to restructure its agricultural efforts and centralize the department's organization once again.

[2] Lentera DESA is part of the DESA platform ecosystem which includes also the DESA App (mobile app); and Bincang DESA (a webinar platform), all managed by UGM. LD is linked to the mobile application, which offers information on weather conditions and prices, and to the webinar events, which are recorded and posted on YouTube.

role in addressing this constraint by transferring information from research and experts to farmers and supporting the adoption of improved agricultural practices (Anderson and Feder, 2004; Magruder, 2018). However, this information-transmission chain may fail to lead to adoption of recommended practices at multiple stages. On one hand, extension workers must be able to access and integrate relevant information into their activities, on the other, farmers must be able to understand, assess, and apply the information they receive. Our intervention addresses these two potential bottlenecks in a single information-transmission chain by training trainers (extension workers) and farmers simultaneously. Rather than focusing on delivering information exclusively to farmers, it gives extension workers the means to reinforce information transmission. Similar to previous studies in the literature, many testing contact farmer approaches, we focus on the entire pipeline and test where the bottleneck actually is (Beaman et al., 2021; Behaghel et al., 2026; Hörner et al., 2022; Kondylis et al., 2017).

Our outcomes of interest span along the entire extension cascade: training compliance, extension workers' performance, platform knowledge, adoption, and engagement, integration of the recommended practices as topics within extension activities, and ultimately farmers' adoption of these practices. Digital literacy is a potential enabling condition at EW and MF levels: even when relevant information is available, users may be unable to access it effectively or incorporate it into their activities and practices. The training therefore includes modules intended to strengthen participants' digital literacy.

Our intervention design allows us to test how information is transferred at each node of the "extension pipeline". Moreover, it compares two different delivery modalities: an online introductory session and an in-person introductory session, with the remaining training components held constant, the fully online and blended training, respectively. The online introduction has the potential to reduce delivery costs on the supply side, while the in-person modality offers more interaction. The comparison therefore concerns not only the cost of delivering training, but also whether the mode of delivery of the introductory session affects participation, learning, and subsequent use of the platform.

As last-mile intermediaries, extension workers can integrate a digital platform into existing extension activities, only if they have the capacity, the motivation, and the trust to do so. Digital tools are frequently piloted but fail to become embedded actual workflows of extension agents due to low digital confidence, workload, or unclear incentives to change established practice (Fabregas et al., 2019). Hence, under which conditions does training convert into integration is a non-trivial question and worth testing with an RCT.

According to technology acceptance theory (Davis, 1989; Venkatesh and Davis, 2000; Venkatesh et al., 2003), perceived usefulness, perceived ease of use, and self-efficacy of extension workers as the first-line technology user may determine whether an agent voluntarily incorporates a new digital tool into routine practice, versus reverting to old methods. Hence, the modality of training (fully-online vs. blended) might matter specifically at this node, as self-directed online training presupposes exactly the digital confidence that can be the bottleneck for older or less tech-familiar extension staff.

On the farmer side, access to digital information is not sufficient to change agricultural practices (Aker et al., 2016; Fabregas et al., 2019). Our experiment allows us to test not only whether access to digital information increases platform adoption, but also how the information is actually used. An open question is how to deliver more sophisticated advice and how to make such advice locally relevant and to ensure that farmers actually engage with it. Our intervention starts from the assumption that technology-enhanced extension effects run through digital literacy rather than being automatic. And again, we compare two training modalities to address it.

The modality can be seen as a treatment on the learning production function, not just the delivery cost. If we assume effective information transmitted to a farmer being a function of (i) platform content quality, (ii) extension worker's integration capacity θ_{EW}, and (iii) farmer's effective-use capacity θ_{MF}, then training raises θ_{EW} and θ_{MF}, but how it raises them depends on the modality: fully online training relies more on self-directed learning and pre-existing digital literacy, while blended training adds facilitated and social learning components (peer support, hands-on troubleshooting, trust-building) that plausibly matter more for low-baseline-literacy populations. Cost differs sharply by modality, so the central tension we address is a learning-effectiveness vs. cost trade-off: blended may raise θ_{EW} and θ_{MF} more, but online is cheaper to scale.

To summarize, our intervention design assumes that knowledge moves from the platform through the extension agent's integration capacity (θ_{EW}) to the farmer's effective-use capacity (θ_{MF}) and on to outcomes, with our two-sided training treatment raising both capacities, and modality (online vs. blended) as the delivery choice determining how effectively the training itself raises θ_{EW} and θ_{MF}.

The two-sided intervention may address both, complementarities and coordination failures. If the two inputs are complements — an agent's promotion is only useful if farmers can act on it, and farmer skill is only useful if there is content to act on — the marginal return to training farmers is higher when agents are also trained, and vice versa. Coordination-failure might be relevant if the incentive to invest effort in the platform depends on extension workers' and farmers' belief about whether the other side will also invest. An extension worker may be reluctant to pushing an unfamiliar digital tool if they expect farmers will not engage with it; a farmer may have little incentive in learning how to use it if they do not expect the extension worker to keep supporting it. Multiple equilibria can exist (mutual disengagement vs. mutual engagement), and a simultaneous, two-sided intervention can shift both parties to the better equilibrium in a way that a one-sided training cannot. However, our research design does not allow us to distinguish whether complementarities or coordination failures are more relevant or whether both matter equally.

4 Sample selection, treatment randomization and baseline characteristics

4.1 Sample selection

The sampling frame consists of governmental extension workers and registered Millennial Farmers identified from administrative data collected by the agriculture and food security training office of the Special Region of Yogyakarta.[3] The sampling frame covered 51 subdistricts corresponding to agricultural extension service areas, each with one office.[4] Five offices were excluded because they served no more than two Millennial Farmers.

Within each of the 51 subdistricts, we randomly selected half of the registered extension workers and Millennial Farmers. This procedure resulted in an initial target sample of 171 extension workers and 839 Millennial Farmers from a population of 303 extension workers and 1,624 Millennial Farmers. If the selected respondents were not reachable after three attempts, refused, or were not practicing agriculture any longer, we instructed the enumerator to select a replacement from a randomly ordered list of the remaining eligible individuals in the same subdistrict. Replacement continued as needed until the list was exhausted.

4.2 Treatment randomization

We implemented a stratified cluster-randomized controlled trial in which the 51 agricultural extension offices in the Special Region of Yogyakarta were randomly assigned to one of three groups: a fully online training offer (treatment 1 - T1), a blended training offer (treatment 2 - T2), or a control group that received no training. Treatment randomization was conducted at the extension office level to minimize spillovers between participants within the same service area. We stratified the randomization based on whether the number of registered extension workers in each office was above or below the median, ensuring a balanced distribution of office size across the three groups.

4.3 Baseline characteristics and balance

A baseline survey was conducted between January and March 2025. Two separate survey instruments were administered by trained enumerators, one to extension workers and one to Millennial Farmers. The baseline survey interviewed 170 extension workers and 784 Millennial Farmers. The surveys collected demographics and information related to three groups of outcomes: (i) knowledge and adoption of the Lentera DESA platform; (ii) digital literacy; and (iii) downstream outcomes related to

[3]The primary source was the *Unit Pelaksana Teknis Daerah (UPTD) Balai Pengembangan Sumber Daya Manusia Pertanian (BPSDMP) Dinas Pertanian dan Ketahanan Pangan DIY* that is the Regional Technical Implementation Unit (UPTD) of the Agricultural Human Resources Development Center (BPSDMP) of the Agriculture and Food Security Office of the special region of Yogyakarta (DIY). For Millennial Farmers we supplemented the initial registry with administrative data from the local agricultural extension department (DINAS), as the original registry contained numerous individuals who were minimally or no longer actively engaged in agricultural activities and were therefore outside the target population for this study.

[4]The boundaries of these service areas generally corresponds to administrative subdistricts, except for the regency of Sleman, where the administrative subdistricts are grouped into eight offices.

participants' activities. For extension workers, these outcomes include extension performance, capabilities, technology acceptance, and innovation-related measures. For Millennial Farmers, the surveys cover knowledge and adoption of agricultural and business practices, agricultural and non-agricultural income, formalization, access to credit, and ability measures.

Table 1: Summary Statistics for extension workers (N=170) at baseline

	Mean	SD	Min	Max
Age (years)	44.54	7.03	27.00	58.00
Female (=1)	0.40	0.49	0.00	1.00
Knowledge of LD (=1)[a)]	0.31	0.46	0.00	1.00
Use of LD (=1)	0.01	0.11	0.00	1.00
Digital Literacy index (0-3)	1.97	0.36	0.95	3.00
The EW does remote activities (=1)	0.73	0.44	0.00	1.00
# of in person one-to-one act.	379.51	364.62	0	2,880
# of remote one-to-one act.	204.27	321.53	0	2,352
# of group act. in class	109.21	90.35	0	480
# of group act. in the field	156.64	180.48	0	1,344
# of remote group act.	58.96	131.92	0	1,008
Area covered (ha)	499.85	522.75	0.03	2,344
Number of total farmers served (last 12 months)	1,275.34	1,327.46	155	12,604
Number of MFs served (last 12 months)	21.47	22.76	0	130

Notes: [a)] The question about Lentera DESA use was asked only to those respondents reporting to know about the platform.

Table 1 describes the characteristichs of the extension workers' sample at baseline. Extension workers are, on average, 44.5 years old, and 40% are female. Approximately 30% of extension workers report knowing the Lentera DESA platform, but only 1% reports having used it. They have a medium-to-high level of digital literacy measured in a scale from 0 to 3, with an average index value close to 2. Most extension workers (72%) already conduct remote activities involving digital devices, primarily through WhatsApp.

Extension workers provide a wide range of extension services. The most common services are individual advice provided either in person or remotely, with average annual frequencies of 380 and about 200 activities per EW, respectively. Group-based activities are also common, although conducted less frequently, with approximately 110 in-person classroom activities, 160 field activities, and almost 60 remote activities per year. On average, extension workers cover approximately 500 hectares through their extension activities. They serve almost 1,300 farmers on average, although only around 20 of these farmers are Millennial Farmers.

Table 2 presents the characteristics of the MF sample. Millennial Farmers are, on average, 33.6 years old, and 25% are female. Although eligibility was based on being between 19 and 39 years old in the year before the survey, we included a few older respondents in the analysis because they were classified as Millennial Farmers within the local registry. At baseline, awareness and use of Lentera DESA among Millennial Farmers were limited: fewer than 7% reported knowing the platform, and almost none reported using it. Millennial Farmers have low-to-intermediate cognitive ability scores based on a digit span test. Most Millennial Farmers belong to a farmer group (70%) and are active in crop cultivation and livestock production, with fewer than 3% operating exclusively outside these two subsectors. During the 12 months preceding the baseline survey, Millennial Farmers reported average agricultural output valued at approximately 81 million Indonesian Rupiah (around USD 4,865).

Tables A.1 and A.2 in the Online Appendix report balance tests for extension workers and Millennial Farmers, respectively. For the EW sample, we do not find statistically significant differences across treatment groups. For the MF sample, however, some baseline characteristics differ across groups. In particular, both treatment groups differ from the control group in terms of gender composition, with a higher share of males in the control group. The blended training group also differs from the control group in terms of marital status, and the two treatment groups differ in household size. While the farmers involved in crop cultivation are evenly distributed, there are less farmers working with livestock and fishery in the control group, and the blended training modality has significantly more farmers

Table 2: Summary Statistics for MFs (N=784) at baseline

	Mean	SD	Min	Max
Age (years)	33.63	5.52	19.00	42.00
Female (=1)	0.25	0.43	0.00	1.00
Knowledge of LD (=1)[a)]	0.07	0.26	0.00	1.00
Use of LD (=1)	0.00	0.05	0.00	1.00
Digital Literacy index (0-3)	1.69	0.50	0.21	2.98
Ability (out of 10)[b)]	5.88	1.48	3.00	10.00
Farmer group member (=1)	0.70	0.46	0.00	1.00
Crop cultivation (=1)	0.86	0.35	0.00	1.00
Livestock (=1)	0.51	0.50	0.00	1.00
Fishery (=1)	0.08	0.27	0.00	1.00
Forestry (=1)	0.10	0.30	0.00	1.00
Agricultural processing (=1)	0.04	0.19	0.00	1.00
Value of total agricultural production (1,000 Rupees)	81,545.62	404,521.66	9.03	7,785,000.00

Notes: [a)] The question about Lentera DESA use was asked only to those respondents reporting to know about the platform. [b)] Nine missing values for the ability measure.

involved in agricultural processing. In addition, groups differ in the number of registered extension workers above the median, which was the variable used for stratification. Overall, joint orthogonality tests reject balance for some comparisons. We therefore control for unbalanced characteristics in our empirical specifications.

5 Follow-up survey, attrition, and estimation approach

5.1 Follow up survey and attrition

A follow-up survey was conducted, between January and March 2026, using roughly the same questionnaires and targeting the same respondents as baseline. The questionnaires collected the same information collected at baseline, as well as information on compliance with treatment assignment and platform engagement for both respondent types. The MF questionnaire included survey items to construct the reduced Coping Strategy Index, a composite indicator of implemented coping strategies to face lack of food or money to buy it.

Attrition was limited over the course of the study. In the follow-up, we successfully re-interviewed 166 extension workers and 745 Millennial Farmers, corresponding to attrition rates of 2.35% and 4.87%, respectively. Table C.1 in the Appendix reports regressions of attrition on treatment assignment and baseline characteristics. We find no evidence that attrition is systematically related to the treatment status. Reported reasons for attrition include changes in agricultural activity, relocation, pregnancy-related constraints, and death.

5.2 Estimation approach

We estimate the effects of being offered the full training package under each of the two delivery modalities: fully online and blended training. We estimate intention-to-treat (ITT) effects, as treatment assignment captures whether respondents were offered the opportunity to participate in the intervention rather than whether they actually attended the training. We estimate treatment effects using OLS and, where baseline outcomes are available, an ANCOVA specification. ANCOVA models can provide greater statistical power than difference-in-differences estimators when outcomes are only weakly correlated over time McKenzie (2012). The specification can be written as follows:

$$Y_{ist} = \beta_0 + \beta_1 Online_s + \beta_2 Blended_s + \beta_3 Y_{is0} + X'_{is0}\gamma + \epsilon_{ist}, \quad (1)$$

where Y_{ist} is the post-treatment outcome for respondent i in subdistrict s at time t. $Online_s$ is the treatment indicator equal to 1 if a subdistrict s received the fully online training. Similarly,

$Blended_s$ is the treatment indicator equal to 1 if a subdistrict s received the blended training. β_1 and β_2 are the ITT effects of being in a district assigned to the respective training modality relative to the control group. Therefore, a subdistrict is 'treated' whenever its extension workers and Millennial Farmers were encouraged to attend the training, not the actual attendance of it. Y_{is0} denotes the corresponding baseline outcome, and X_{is0} includes baseline characteristics. These controls include socio-economic characteristics including age, gender, education, marital status, household size, work experience, and contract type for extension workers, and household assets, additional income sources, entrepreneurial ability, farmer organization membership, and subsector fixed effects (crop cultivation, livestock, fishery, forestry, agro-processing) for Millennial Farmers. Including these covariates allows us to account for minor baseline imbalances and to improve the precision of our estimates.

We also estimate heterogeneous effects by gender, age, education, baseline digital literacy, and agricultural subsector (for Millennial Farmers).

6 Results

6.1 Treatment compliance

Table 3: Compliance with treatment assignment, self-reported (treatment groups only)

	Mean	SD
Extension Workers (N=111)		
Attended no session (share)	0.10	0.30
Attended Zoom or in-person introductory session (share)	0.86	0.34
Participation to self-paced course on LD (share)	0.58	0.50
First monitoring session attendance (share)	0.59	0.49
Second monitoring session attendance (share)	0.50	0.50
	Mean	SD
Millennial Farmers (N=483)		
Attended no session (share)	0.51	0.50
Attended Zoom or in-person introductory session (share)	0.46	0.50
Participation to self-paced course on LD (share)	0.29	0.46
First monitoring session attendance (share)	0.34	0.47
Second monitoring session attendance (share)	0.27	0.44

Notes: Out of the 114 extension workers assigned to any treatment, only 111 were interviewed at endline, due to attrition. Out of the 509 Millennial farmers assigned to any treatment, only 483 were interviewed at endline, due to attrition.

Table 3 reports compliance with the intervention based on endline data. The first panel presents compliance among extension workers. Out of the 114 extension workers assigned to the treatment groups, 111 responded to our survey at endline. Overall, only 10% of invited extension workers did not participate in any component of the intervention. Among those invited, 96 attended at least one introductory session, corresponding to 86% compliance. Almost 60% of extension workers subsequently participated in the self-paced course on Lentera DESA covering digital literacy and digitization in agriculture. Participation in the first monitoring session, conducted approximately ten days after the introductory session, was similar, while around half of invited extension workers participated in the second monitoring session.

The second panel of Table 3 presents compliance among Millennial Farmers. Among the 509 Millennial Farmers assigned to treatment, 483 responded to our survey at endline. About 50% of the Millennial Farmers assigned to any treatment participated to any of the activity offered. Among those who replied at endline, 223 attended an introductory session, corresponding to 46% of the Millennial Farmers. Participation in the self-paced Lentera DESA course was lower, with about 30% of Millennial Farmers joining. Participation in the two monitoring sessions was also limited, with 34% attending the first session and 27% attending the second.

Tables D.1.1 and D.2.1 in the Online Appendix show how treatment assignment is related to course attendance.

6.2 Platform knowledge, adoption, and engagement

We first check whether the intervention increased knowledge and use of the Lentera DESA platform. This is a key outcome, as the effectiveness of a digital extension system depends on whether extension workers and farmers are able to access and engage with the platform.

Table 4 reports treatment effects for extension workers. Assignment to the blended training modality significantly increased awareness of the Lentera DESA platform. It is interesting to note that awareness increased also substantially in the control group, from 31% at baseline to almost 95% at endline. A plausible explanation is that extension workers became aware of Lentera DESA through the baseline survey itself, during which they were asked questions about the platform. A similar pattern emerges for platform use. While usage increased from 1% at baseline to 41.8% at endline among control-group extension workers, the increase was significantly larger among treated respondents. Relative to the control group, assignment to the fully online and blended training modalities increased platform use by 33.7 and 42.3 percentage points, respectively.

Beyond course participation, we also examine whether respondents used other Lentera DESA features. Both treatment modalities increased broader platform engagement relative to the control group. The estimated effect is larger for extension workers assigned to the blended training modality, and the difference between the two treatment effects is statistically significant (p-value = 0.035). This suggests that the additional in-person interaction may have strengthened engagement with the platform beyond the initial training component.

Table 4: Treatment effects on platform knowledge, adoption, and engagement (ITT), EWs

	(1) Knows LD (=1)	(2) Used LD (=1)	(3) Other LD features (=1)
T1: Fully online	0.057	0.337***	0.197***
	(0.039)	(0.092)	(0.073)
T2: Blended	0.071**	0.423***	0.407***
	(0.033)	(0.089)	(0.088)
Baseline level coeff.	0.010	0.381*	
	(0.025)	(0.192)	
Observations	166	166	166
Adjusted R^2	0.02	0.11	0.21
Control Mean	0.945	0.418	0.055
Control SD	0.229	0.498	0.229
p-value T1-T2	0.536	0.381	0.035

Notes: Standard errors in parentheses clustered at subdistrict level. All regressions control for respondent characteristics (education, age, marital status, household size, type of work contract, and experience).

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 5 presents the corresponding results for Millennial Farmers. As for extension workers, awareness and use of Lentera DESA also increased among control-group respondents. Among control-group Millennial Farmers, knowledge of the platform increased from 7% at baseline to 32% at endline, while platform use increased from almost zero to 7.4%. Yet, the intervention led to large and statistically significant effects on both outcomes. Assignment to either training modality increased the probability of knowing the platform by about another 40 percentage points and increased platform use by 30 to

Table 5: Treatment effects on platform knowledge, adoption, and engagement (ITT), MFs

	(1) Knows LD (=1)	(2) Used LD (=1)	(3) Other LD features (=1)
T1: Fully online	0.442***	0.303***	0.280***
	(0.058)	(0.046)	(0.031)
T2: Blended	0.401***	0.311***	0.298***
	(0.057)	(0.050)	(0.046)
Baseline level coeff.	0.265***	0.251	
	(0.052)	(0.397)	
Observations	736	736	736
Adjusted R^2	0.19	0.13	0.12
Control Mean	0.316	0.074	0.012
Control SD	0.466	0.263	0.108
p-value T1-T2	0.572	0.900	0.739

Notes: Standard errors in parentheses clustered at subdistrict level. All regressions control for respondent characteristics (education, marital, household size, ability, membership to a farmer group). When controlling for the ability measure, we lose 9 observation due to lack of data.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

31 percentage points relative to the control group. We do not find statistically significant differences between the fully online and blended modalities for either platform knowledge or adoption (p-values = 0.572 and 0.900, respectively).

Treatment assignment also increased the likelihood that Millennial Farmers used additional Lentera DESA features beyond the self-paced course by approximately 30 percentage points. Overall, the results indicate that both training modalities successfully promoted adoption of the digital platform among farmers and extension workers.

6.3 Digital literacy

For extension workers we do not find statistically significant treatment effects of either training modality on the aggregate digital literacy index or on any of its individual components. This may reflect the relatively high level of digital literacy among extension workers already present at baseline. The control group mean exceeds 2 on a 0–3 scale, suggesting limited scope for further improvements within the study period. This is interesting as beforehand many extension workers flagged limited financial literacy among extension workers as a main constraint of adopting platform services. Our estimates suggest that extension workers underestimate the knowledge of their peers. The detailed results are shown in Table E.2.1 in the Online Appendix.

Figure 1 reports the corresponding results for Millennial Farmers. In contrast to extension workers, the intervention increased digital literacy among farmers. Assignment to the fully online training modality increased the aggregate digital literacy index by 0.075 points relative to the control group, corresponding to 0.12 standard deviations. This effect is mainly driven by improvements in the dimensions of 'communication and collaboration', and 'digital safety'. The estimated effect of the blended training modality on the overall index is also positive, but not statistically significant.

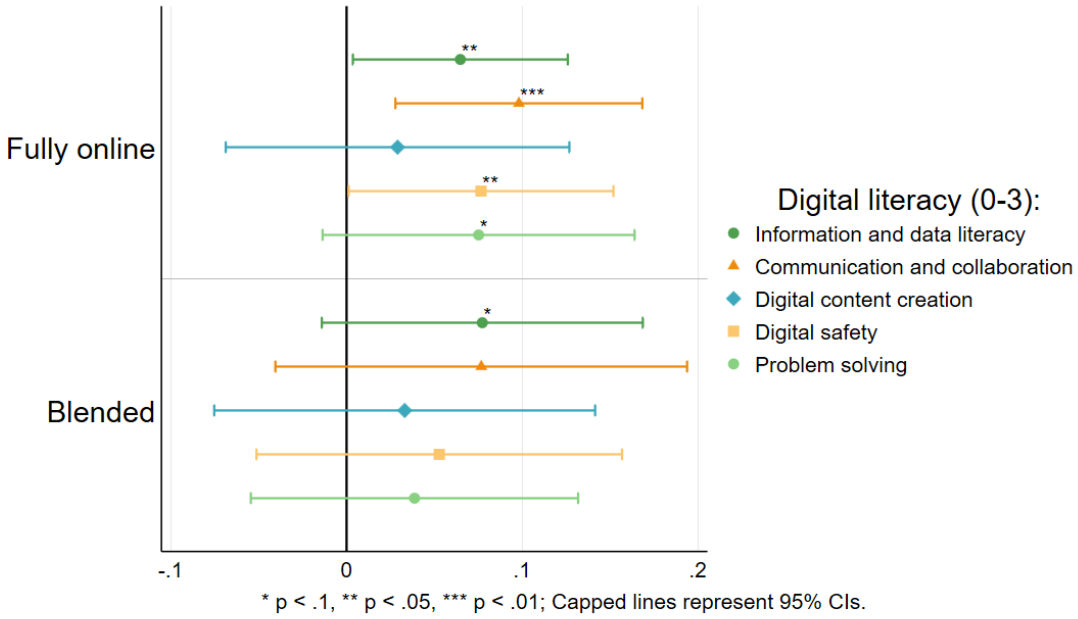


Figure 1: Treatment effects on different dimensions of digital literacy (all measured on a scale from 0 to 3) (ITT), MFs

6.4 Downstream outcomes

6.4.1 Changes in activities by extension workers

A key question is whether the training motivated and enabled extension workers to integrate new topics into their extension work. We focus on three topics — agribusiness management, financial record keeping, and marketing — and four training modes: one-to-one in person, one-to-one remote, group in-person, and group remote.[5] We find that extension workers seems to integrate the recommended topics especially within in-person one-to one activities (see Figure 2 below). Relative to the control group, extension workers assigned to either treatment modality were 13.6 to 16.5 percentage points more likely to include agribusiness management topics in one-to-one in-person activities (control mean: 20%). They were also 5.3 to 13.4 percentage points more likely to discuss marketing-related topics in these activities (control mean: 31%). These effects are statistically significant at the 10% level. We do not find statistically significant differences between the fully online and blended training modalities. We also do not find significant changes in terms of topics covered for the other training modes. Table E.3.2 in the Online Appendix shows the results for other extension worker activities.

We also checked whether treated extension workers increased the number and frequency of extension activities conducted during the 12 months preceding the endline survey, and whether they expanded their outreach in terms of number of farmers trained and the geographic area covered, however we did not find any significant changes. We think that the absence of any significant changes reflects that extension workers had already a relatively high level of activity at baseline, leaving them not much room to increase their offer further. For details, see Table E.3.1 in the Online Appendix.

Overall, the results suggest that while the intervention did not change the quantity of extension services provided, it influenced the type of information delivered. The effects are concentrated in one-to-one in-person interactions, suggesting that extension workers primarily used the digital training as a complement to their existing face-to-face advisory activities.

[5] We exclude field-based group activities from this analysis because they are less suited for delivering the agribusiness topics emphasized during the training.

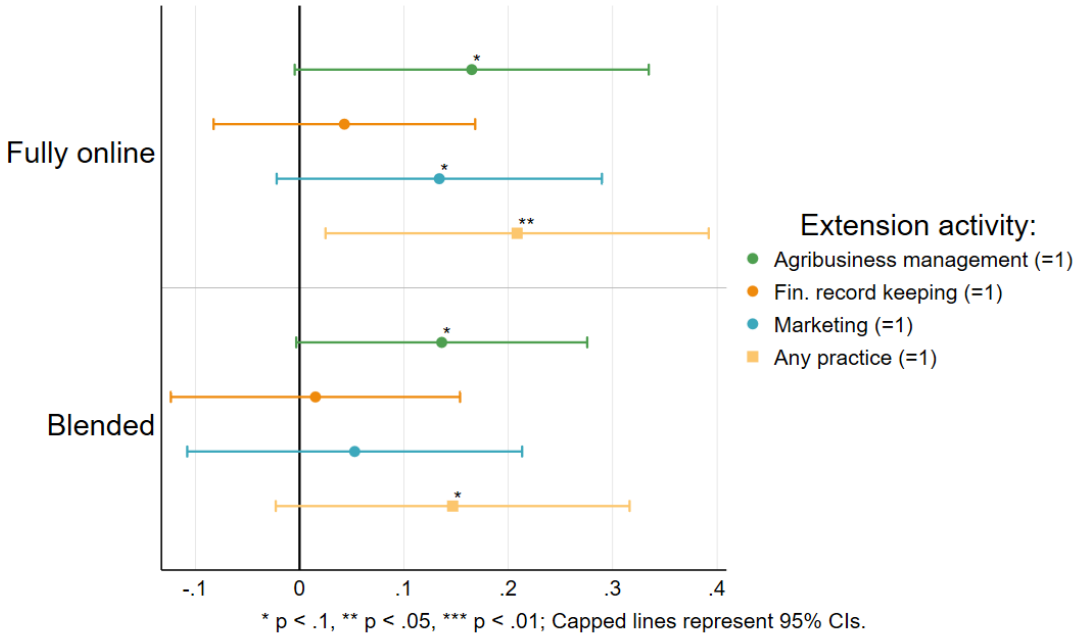


Figure 2: Treatment effects on integration of recommended practices in one-to-one in person activities (ITT), EWs

6.4.2 Changes in practices used by Millennial Farmers, production and welfare effects

Figure 3 shows the treatment effects on Millennial Farmers' knowledge and adoption of agribusiness practices. As for extension workers, we distinguish between three topics covered during the training: agribusiness management, financial record-keeping, and marketing. We find positive and statistically significant effects of the blended training on two of the three topics. Relative to the control group, Millennial Farmers assigned to the blended training were 20 percentage points more likely to report knowledge of agribusiness management practices and 13.7 percentage points more likely to report knowledge of financial record-keeping practices. Both effects are statistically significant at the 5% level. The corresponding coefficients for the fully online treatment are also positive, but smaller in size and less precisely estimated. The effects of both treatments are statistically not significantly different from each other. The treatment effects associated with knowledge of marketing practices are also positive but statistically not significant.

A similar pattern emerges when considering the use of agribusiness practices. Millennial Farmers assigned to the blended treatment were 12.8 percentage points more likely to adopt agribusiness management practices and 9.8 percentage points more likely to keep financial records compared to the control group. Both effects are statistically significant at the 5% level. The corresponding point estimates for the fully online treatment are also positive, but smaller and statistically insignificant. Nevertheless, we cannot reject equality between the two treatment effects. For marketing practices, we find a positive and statistically significant effect for the fully online training, which is much larger than the effect associated with the blended training. For details, see Table E.4.1 in the Online Appendix.

Given the positive effects on knowledge and adoption, at least for some of the business practices, we also check whether there are already some changes in terms of agricultural production, and resilience even if the time that has elapsed since the training is probably too short that such effects can materialize. We estimate treatment effects for agricultural household income, agricultural production, agricultural sales, and crop and livestock production in quantities and values per hectare of land. We also consider changes in the coping strategy index. To reduce the influence of extreme values, we winsorized all variables at the 1st and 99th percentiles.

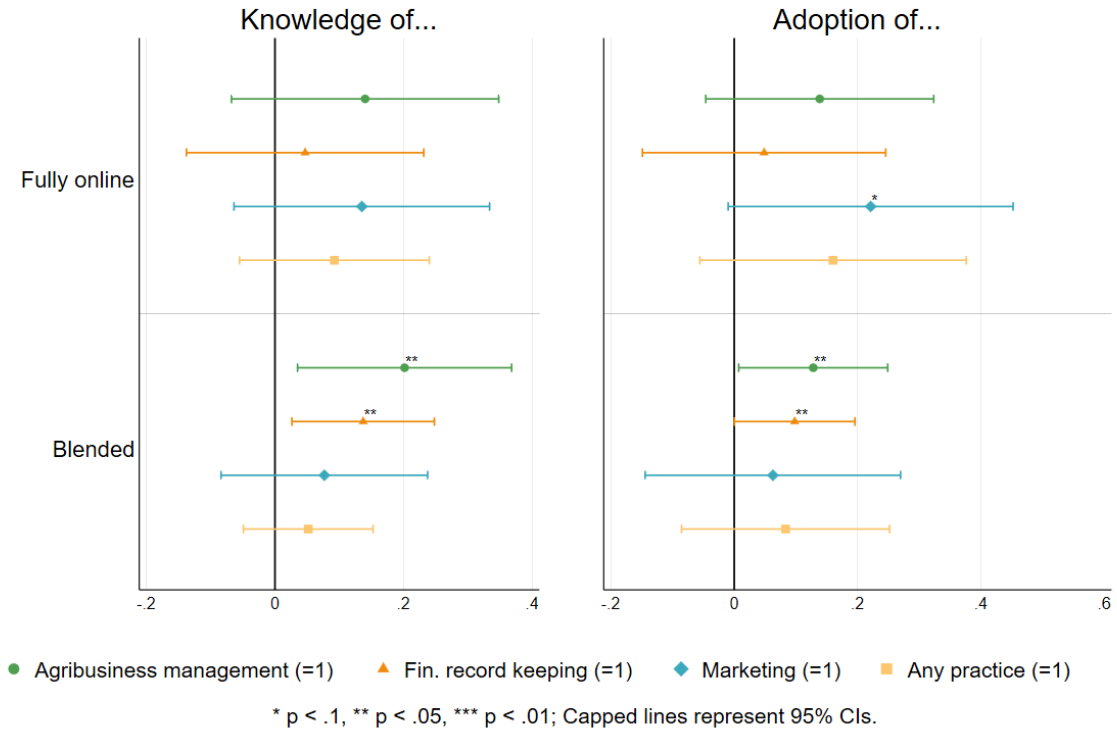


Figure 3: Treatment effects on knowledge and adoption of recommended practices (ITT), MFs

As expected, we do not find any evidence for broader improvements in income and productivity measures. Two out of the 16 treatment effects are even negative, but all other coefficients are simply very small and insignificant. The coping strategy index resonates positively to both training types, but only the one associated with the fully online training is statistically significant. For details, see Table E.4.2 in the Online Appendix.

6.5 Heterogeneous effects

In this section, we explore heterogeneous effects by gender, age, education, baseline digital literacy, and agricultural subsector (for Millennial Farmers). We estimate heterogeneous effects by introducing these traits as linear terms and by interacting them with both treatment arms, again separately for extension workers and Millennial Farmers. We limit this analysis to the following outcomes: training attendance, knowledge, adoption, other platform features used, digital literacy, and outreach to Millennial farmer by extension workers. Given the small sample size by sub-groups limits the power and hence precision of our estimates, hence the results need to be interpreted carefully. We report the results in detail in the Online Appendix and focus here on the main insights.

Heterogeneity by gender. We note a slightly higher training attendance for female extension workers compared to male extension workers, especially in the fully online training. As a result, we also find for the group of female extension workers assigned to the fully online training somewhat higher usage of Lentera DESA and its features. However, we do not find any differences between treated male and female extension workers with respect to digital literacy and outreach. Among Millennial Farmers, we find little evidence for heterogeneous effects across gender. If anything we find a somewhat higher attendance of women assigned to the blended training, and consequently for women who were assigned to the fully online training, we find lower knowledge of Lentera DESA, lower use, but again no effects on digital literacy.

Heterogeneity by age. Older extension workers in the fully online modality, are less likely to attend any session offered, with no clear effect in terms of knowledge, use, engagement with the platform, and outreach of Millennial Farmers. We do find that older extension workers in the fully online training

increase their digital literacy significantly more than their younger colleagues. Older Millennial Farmers in the blended modality are more likely to attend training sessions than those in the fully online one. They also have significantly higher adoption of the platform than the one in the control group. They do not seem to have differential effects on digital literacy, which is expected given that they are a homogeneous cohort by design (i.e., Millennial Farmers, belong to the same generation).

Heterogeneity by education. We find that highly educated extension workers in the blended training offer are more likely to attend a training session (at a 10% significance level), but this does not translate into higher knowledge, usage of the platform, nor digital literacy. Highly educated extension workers have higher benefits from the fully online training, but this is not the case for the blended format where the interaction term is negative and significant at 10% level. Highly educated farmers are more likely to attend a session in both treatments, without any additional effect by education level on platform knowledge and use, and digital literacy.

Heterogeneity by baseline digital literacy. Among extension workers, we find little evidence of systematic heterogeneity by baseline digital literacy, apart from somewhat higher attendance by extension workers with higher digital literacy in the introductory session of in the fully online arm. Millennial Farmers with higher digital literacy at baseline are more likely to attend any session, which translates into higher adoption and engagement with the platform. The effects are stronger and significant for the fully online training.

Heterogeneity by main agricultural activity (Millennial Farmers only). We find no difference in attendance depending on the main agricultural activity. Our estimates show a lower adoption and engagement with the platform by Millennial Farmers primarily engaged with crop cultivation, compared to those working with livestock. No other differential effect is significant.

For details, see Tables F.1.1 to F.2.1 in the Online Appendix.

6.6 LATE estimates

Since a significant share of the invited extension workers and Millennial Farmers did not attend any training session (10% and 51% respectively), we also estimated LATE effects in addition to the ITT effects presented above. Although these effects are only valid for the compliers, they are very relevant for any upscaling and hence most interesting for policy makers.

With respect to knowledge, adoption and engagement of extension workers the LATE effects are 30% to 40% higher than the ITT effects, especially, for those extension workers assigned to the fully online training. Not surprisingly, for Millennial Farmers the LATE are even more than double the size of the ITT effects, including the effects on digital literacy. With respect to the other outcomes, the LATE effects are across the board also somewhat larger than the ITT effects, but in many cases insignificant.

Section G in the Online Appendix report the details of the LATE effects on platform knowledge, adoption, and engagement and digital literacy.

6.7 Spillover effects

Above, we document increases in platform knowledge over time in the control group. This pattern raises the possibility that exposure to treated participants may have generated spillover effects. To check whether this is the case, we estimate spillover effects for selected outcomes: knowledge, adoption, and engagement with the platform Lentera DESA, and digital literacy. We measure local exposure as the number of treated respondents of the same type within 1, 3, or 5 km of the interview's location. We then linearly interact the treatment variables with the exposure measure to assess whether outcomes vary with the local presence of treated participants separately for extension workers and Millennial Farmers.

Spillover effects for extension workers. Overall, we do not find significant spillover effects on untreated extension workers depending on their exposure to treated colleagues. Although we find positive treatment effects for platform knowledge that are declining in the distance to treated extension workers, these effects are statistically all insignificant. We also find suggestive evidence that greater exposure to treated extension workers within one km increases the likelihood that the control group extension workers engage with other platform features, but this effect is also insignifcant and completely disappears as we increase the distance. Moreover, we find no statistically significant evidence of spillovers on digital literacy.

Spillover effects for Millennial Farmers. In contrast to the patterns for extension workers, the estimates for Millennial Farmers suggest negative spillovers on platform knowledge and use among control-group participants. Moreover, we find that local exposure to treated Millennial Farmers within 1 km positively affect digital literacy among control-group farmers. These findings are difficult to reconcile and do not establish a clear mechanism.

See Table H.1.1 and H.2.1 in the Online Appendix for further details.

To summarize, we find little evidence for spill-overs from treated to untreated extension workers and farmers. Yet, we also lack power to estimate such effects very precisely, but if anything spill-overs rather seem to be positive, which would imply that our treatment effects are rather lower bounds of the 'true' effects.

7 Cost-effectiveness

The total cost of the intervention can be divided into three components. First, fixed implementation costs which amounted to USD 5,460. These costs include the training of trainers and the monitoring activities. Second, costs for the blended training of USD 5,834, mainly related to venue rental, trainers' honoraria, and the reimbursements of travel costs for participants. Third, costs for the fully online training of USD 1,690, including trainers' honoraria and the costs of the working space used to deliver the online sessions.

Table 6: Cost effectiveness analysis (in USD)

Cost per...	**T1: Light Treatment**		**T2: Intensive Treatment**		**Multiplier**	
	Var. Cost	Tot. Cost	Var. Cost	Tot. Cost	Var. Cost	Tot. Cost
... expected participant	\$5.45	\$14.21	\$18.70	\$27.46	3.43	1.93
... reported receiving the invitation	\$6.23	\$16.14	\$20.91	\$30.82	3.36	1.91
... reported attending any introductory session	\$10.52	\$27.64	\$36.92	\$54.04	3.51	1,96
... reported attending the course	\$35.29	\$79.32	\$76.76	\$120.79	2.18	1.52

Notes: The table presents the cost per person participating in the different training interventions (fully online and blended). The cost are divided in variable and total costs for each treatment arm. The last two columns show the proportional cost increase for the blended training (cost-intensive) when compared to the fully online (light-cost) training. The calculations are based on the survey and project monitoring data.

Based on the expected number of participants, the cost per invited participant amounts to USD 14.21 for the fully online training and USD 27.48 for the blended training. Using the realized attendance at the introductory session, the corresponding costs per participant increase — given that most of the costs are fixed costs — to USD 27.64 and USD 54.04, respectively. Hence, the fully online training is considerably less costly to implement than the blended training. For details, see Table 6 in the Online Appendix.

Although only few studies report on implementation costs those studies that do suggest that the cost per farmer trained by an extension worker ranges between USD 65 and USD 84 Franzel et al. (2018); Muilerman et al. (2018), which is substantially higher than the costs incurred in our intervention. Although it is not yet possible to conduct a cost-benefit analysis, as impacts on agricultural productivity are expected to materialize only over a longer period, the intervention has also generated improvements in digital literacy. These benefits are likely to extend beyond agricultural extension by facilitating the use of digital technologies also in other domains.

8 Conclusion

In this paper, we used a clustered randomized control trial to test whether a two-sided training intervention targeted at extension workers and farmers can enable extension workers to integrate a digital training platform into their extension activities and farmers to make efficient use of it. If successful, more information could be transmitted to farmers at a lower overall cost. For both sides — extension

workers and farmers — we tested two modalities to deliver the training: fully online, and a mix of online and offline modules.

In general, we find that our training increases knowledge, adoption, and engagement with the digital platform, among both, extension workers and farmers. Digital literacy does not seem to be a constraint for extension workers, but for farmers, and the training is able to relax that constraint to a large extent. Extension workers also introduce the recommended practices, especially more business related information, including management, financial record keeping, and marketing, and farmers have started to adopt these practices. Even if this has not yet resulted in any significant changes in productivity — it may even reduce productivity in the short-term —, an increase could materialize in the longer-term if farmers engage over a longer period and more deeply with the new practices.

Regarding the training modalities, it does not make a significant difference, which one is offered, but it seems the blended training delivery worked better for the extension workers, and the fully online training for the farmers. Given that for many farmers agriculture is only a secondary activity, the flexibility that the online training offers seems to make participation easier.

So, overall our experiment suggests that access to the digital training platform can make extension services more efficient. Extension workers can integrate it into their training routines and provide more and higher-quality information. Farmers in turn can, according to their own pace, access additional information, consult training videos, and integrate modern business practices into their activities. The platform also allows farmers to connect among each other, which can reinforce social learning beyond what happens in the usual farmer group meetings. Given the low cost of the training we offered and the low cost of the provision of the platform services, there is a very high chance that this is a cost-effective reform of traditional extension services.

In the longer-term, the improved digital literacy among farmers and their engagement with the platform may pave the way for a transition towards smart agriculture. This transition will be key to make the agricultural system in Indonesia sustainable from an environmental perspective. There is also a good chance that the digitization of agriculture renders farming more attractive for younger farmers, such as our Millennial Farmers, and hence helps to rejuvenate the sector. Both, turning agriculture digital and counteracting an aging agricultural sector are key strategic objectives of the Indonesian Government.

We believe that our intervention could also be successfully implemented in other regional and country contexts with a tradition of extension services, decent mobile connectivity, and high penetration of digital mobile devices.

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A Balance tables

While for the sample of extension workers, there is no statistically significant difference to report,[6], for the sample of Millennial Farmers we note small differences. With respect to gender, both treatment groups differ from the control group at the 1% significance level. The treatment group offering the blended format has also significantly more married respondents than the control group (statistically significant at the 5% level). Moreover, there is a significant difference between the treatment groups in household size ($\alpha = 0.05$). In addition, there are significant differences across groups in the number of registered extension workers (variable used for stratification, see subsection 4.2. The differences across groups are jointly significant for each comparison. To redress these imbalances we include in all regressions that we use to estimate impacts the relevant controls.

Table A.1: Balance tests, EWs

Variable	(1) Control Mean/(SE)	(2) Fully online Mean/(SE)	(3) Blended Mean/(SE)	(1)-(2) Mean difference	(1)-(3) Pairwise t-test Mean difference	(2)-(3) Mean difference
Age (years)	44.65	44.11	44.84	0.54	-0.19	-0.73
	(0.85)	(1.01)	(0.98)			
Female (=1)	0.40	0.44	0.35	-0.04	0.05	0.09
	(0.07)	(0.07)	(0.06)			
Married (=1)	0.89	0.85	0.95	0.04	-0.06	-0.10*
	(0.04)	(0.05)	(0.03)			
Experience (years)	14.71	12.87	13.26	1.84	1.45	-0.39
	(0.78)	(0.90)	(0.88)			
EW Organization	0.33	0.33	0.33	-0.01	-0.01	0.00
	(0.06)	(0.06)	(0.06)			
Number of total farmers served (last 12 months)	1,370.22	1,214.76	1,241.19	155.46	129.03	-26.43
	(221.90)	(179.34)	(127.27)			
Number of MFs served (last 12 months)	21.78	20.37	22.21	1.41	-0.43	-1.84
	(2.82)	(3.57)	(2.82)			
The EW does remote activities (=1)	0.76	0.78	0.67	-0.01	0.10	0.11
	(0.06)	(0.06)	(0.06)			
Above median registered EWs (=1)	0.62	0.50	0.54	0.12	0.07	-0.04
	(0.07)	(0.07)	(0.07)			
F-test of joint significance (p-value)				0.71	0.53	0.77
Number of observations	55	54	57	109	112	111

Notes: If the table includes missing values (.n, .o, .v etc.) see the Missing values section in the help file for the Stata command iebaltab for definitions of these values.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

[6]Note that the frequencies of each activity type have not been included in the table as the low number of observations for some variables makes it impossible to compute the F-test.

Table A.2: Balance tests, MFs

Variable	(1) Control Mean/(SE)	(2) Fully online Mean/(SE)	(3) Blended Mean/(SE)	(1)-(2) Mean difference	(1)-(3) Pairwise t-test Mean difference	(2)-(3) Mean difference
Age (years)	33.22	33.77	33.93	-0.55	-0.72	-0.17
	(0.34)	(0.35)	(0.36)			
Female (=1)	0.15	0.29	0.31	-0.13***	-0.16***	-0.02
	(0.02)	(0.03)	(0.03)			
Married (=1)	0.71	0.75	0.82	-0.04	-0.11***	-0.07*
	(0.03)	(0.03)	(0.02)			
Total household size	4.32	4.49	4.26	-0.17	0.07	0.23*
	(0.09)	(0.10)	(0.09)			
Farmer group member (=1)	0.72	0.72	0.67	0.00	0.04	0.04
	(0.03)	(0.03)	(0.03)			
Crop cultivation (=1)	0.87	0.84	0.87	0.03	0.00	-0.03
	(0.02)	(0.02)	(0.02)			
Livestock (=1)	0.45	0.56	0.52	-0.11**	-0.07	0.03
	(0.03)	(0.03)	(0.03)			
Fishery (=1)	0.05	0.10	0.10	-0.05**	-0.05**	0.01
	(0.01)	(0.02)	(0.02)			
Forestry (=1)	0.10	0.12	0.07	-0.02	0.03	0.06**
	(0.02)	(0.02)	(0.02)			
Agricultural processing (=1)	0.02	0.03	0.07	-0.01	-0.04**	-0.04**
	(0.01)	(0.01)	(0.02)			
Value of total agricultural production (1,000 Rupees)	105,488.48	75,192.27	61,784.91	30,296.22	43,703.57	13,407.35
	(36,891.08)	(18,324.71)	(12,237.59)			
Household Income (1,000 IDR)	79,795,294.56	83,061,681.21	83,988,245.14	-3,266,386.66	-4,192,950.58	-926,563.92
	(4,557,227.51)	(7,127,137.77)	(4,668,127.79)			
Asset value (1,000 IDR)	438,215.58	569,491.76	259,887.03	-131,276.18	178,328.55	309,604.73
	(118,145.24)	(233,854.80)	(53,175.08)			
Above median registered EWs (=1)	0.60	0.43	0.82	0.17***	-0.22***	-0.39***
	(0.03)	(0.03)	(0.02)			
F-test of joint significance (p-value)				0.00***	0.00***	0.00***
Number of observations	262	244	239	506	501	483

Notes: If the table includes missing values (.n, .o, .v etc.) see the Missing values section in the help file for the Stata command iebaltab for definitions of these values.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

B Training content

Table B.1: Information on Extension Worker Training Content

Module	**Sub-module**
1. Urgency of digital literacy	MOD 1.1 Info Digital Literacy MOD 1.2 Google Contribution MOD 1.3 Digital Safety
2. Digital literacy in agriculture	MOD 2.1 Info search: Smart Farming MOD 2.2 Prototype Smart Farming MOD 2.3 Digital Tools
3. Digital marketing and management in agriculture	MOD 3.1 E-banking MOD 3.2 Product Promotion MOD 3.3 Agribusiness Management MOD 3.4 Definitions for Agribusiness records MOD 3.5 How to use Buku Tani
4. Digital content creation	MOD 4.1 Ethics of Digital Extension MOD 4.2 Digital Technology MOD 4.3 Social Media (part 1) MOD 4.4 Social Media (part 2)

Source: Own creation.

Table B.2: Information on Millennial Farmer Training Content

Module	**Sub-module**
1. Urgency of digital literacy	MOD 1.1 Info Digital Literacy MOD 1.2 Google Contribution MOD 1.3 Digital Safety
2. Digital literacy in agriculture	MOD 2.1 Info search: Smart Farming MOD 2.2 Prototype Smart Farming MOD 2.3 Digital Tools
3. Digital marketing, e-commerce, and e-banking	MOD 3.1 Product Promotion MOD 3.2 Online Customer Strategy MOD 3.3 Online Store Utilization MOD 3.4 E-banking
4. Financial literacy and agribusiness management	MOD 4.1 Definitions for Agribusiness records MOD 4.2 Learning Agribusiness SOM MOD 4.3 Farmer Business Record MOD 4.4 How to use Buku Tani

Source: Own creation.

C Attrition

Table C.1: Attrition

	Attrition EWs (=1)	Attrition MFs (=1)
T1: Treatment fully online	0.02	0.00
	(0.03)	(0.02)
T2: Treatment blended format	0.02	0.01
	(0.02)	(0.02)
Female (=1)	-0.02	-0.01
	(0.02)	(0.02)
Constant	0.33*	0.14*
	(0.19)	(0.07)
Observations	170	784
Adjusted R^2	0.09	0.05

Notes: Standard errors in parentheses clustered at subdistrict level. School categorical variables, age, marriage, household size, and base levels not shown. Other covariates added depending on respondent type as in the other regressions. With the exception of the ability measure for MFs, which is missing for 9 observations. Including it and dropping the nine observations does not change the results.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

D Compliance

D.1 Compliance: Extension workers

Table D.1.1: Compliance, EWs

	(1) Attend none	(2) Attend any intro	(3) Attend LD course	(4) Attend 1st monitoring	(5) Attend 2nd monitoring
Fully online	-0.829***	0.757***	0.542***	0.494***	0.435***
	(0.061)	(0.063)	(0.071)	(0.054)	(0.062)
Blended	-0.907***	0.913***	0.617***	0.637***	0.560***
	(0.047)	(0.047)	(0.073)	(0.088)	(0.080)
Female (=1)	-0.017	-0.016	0.043	0.000	-0.012
	(0.040)	(0.049)	(0.069)	(0.058)	(0.071)
Constant	0.640**	0.424	0.216	0.491	0.397
	(0.264)	(0.261)	(0.317)	(0.300)	(0.305)
Observations	166	166	166	166	166
Adjusted R^2	0.70	0.64	0.29	0.33	0.27
p-value T1-T2	0.291	0.036	0.456	0.130	0.183

Notes: Standard errors in parentheses clustered at subdistrict level. All regressions control for respondent characteristics (education, age, marital status, household size, type of work contract, and experience).

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

D.2 Compliance: Millennial Farmers

Table D.2.1: Compliance, MFs

	(1) Attend none	(2) Attend any intro	(3) Attend LD course	(4) Attend 1st monitoring	(5) Attend 2nd monitoring
T1: Treatment fully online	-0.557***	0.519***	0.288***	0.390***	0.313***
	(0.023)	(0.027)	(0.046)	(0.033)	(0.031)
T2: Treatment blended format	-0.450***	0.434***	0.289***	0.298***	0.216***
	(0.037)	(0.038)	(0.040)	(0.028)	(0.038)
Female (=1)	0.052	-0.052	0.010	0.012	-0.005
	(0.035)	(0.035)	(0.032)	(0.035)	(0.029)
Constant	1.749***	-0.654***	-0.376***	-0.534***	-0.405***
	(0.119)	(0.122)	(0.119)	(0.122)	(0.138)
Observations	736	736	736	736	736
Adjusted R^2	0.27	0.26	0.13	0.17	0.12
p-value T1-T2	0.015	0.082	0.977	0.025	0.046

Notes: Standard errors in parentheses clustered at subdistrict level. All regressions control for school categorical variables, age, marriage, female indicator, household size, ability, and membership to a farmer group.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

E Additional results

E.1 Treatment effects on platform engagement

Table E.1.1: Use of other platform features (ITT), extension workers

	(1) Used LD beyond the course (=1)	(2) Other courses (=1)	(3) Information (=1)	(4) Comment post (=1)	(5) Farmer records (=1)
T1: Fully online	0.197***	0.133**	0.283***	-0.003	0.070*
	(0.073)	(0.062)	(0.101)	(0.026)	(0.041)
		[0.059]	[0.031]	[0.300]	[0.080]
T2: Blended	0.407***	0.102	0.383***	-0.007	0.395***
	(0.088)	(0.063)	(0.095)	(0.026)	(0.088)
		[0.083]	[0.001]	[0.244]	[0.001]
Observations	166	166	166	166	166
Adjusted R^2	0.21	0.05	0.07	-0.03	0.22
Control Mean	0.055	0.055	0.418	0.018	0.000
Control SD	0.229	0.229	0.498	0.135	0.000
p-value T1-T2	0.035	0.697	0.327	0.859	0.001

Notes: Standard errors in parentheses clustered at subdistrict level. All regressions control for respondent characteristics (education, age, marital status, household size, type of work contract, and experience).

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table E.1.2: Use of other platform features (ITT), MFs

	(1) Used LD beyond the course (=1)	(2) Other courses (=1)	(3) Information (=1)	(4) Comment post (=1)	(5) Farmer records (=1)
T1: Fully online	0.280***	0.211***	0.239***	0.057***	0.219***
	(0.031)	(0.032)	(0.047)	(0.016)	(0.032)
		[0.001]	[0.001]	[0.001]	[0.001]
T2: Blended	0.298***	0.200***	0.249***	0.127***	0.241***
	(0.046)	(0.051)	(0.047)	(0.035)	(0.045)
		[0.001]	[0.001]	[0.001]	[0.001]
Observations	736	736	736	736	736
Adjusted R^2	0.12	0.09	0.10	0.06	0.10
Control Mean	0.012	0.000	0.062	0.000	0.004
Control SD	0.108	0.000	0.243	0.000	0.062
p-value T1-T2	0.739	0.851	0.870	0.083	0.685

Notes: Standard errors in parentheses clustered at subdistrict level. All regressions control for respondent characteristics (education, marital, household size, ability, membership to a farmer group). When controlling for the ability measure, we lose 9 observation due to lack of data.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

E.2 Treatment effects on different dimensions of digital literacy (all measured on a scale from 0 to 3), EWs

Table E.2.1: Impact on Digital Literacy dimensions (0-3) for EWs (ITT).

	(1) Digital Literacy Index	(2) Information and data lit.	(3) Communic. and collab.	(4) Digital content creation	(5) Digital safety	(6) Problem solving
T1: Fully online	-0.047	-0.091	-0.024	-0.037	-0.049	-0.042
	(0.060)	(0.068)	(0.068)	(0.072)	(0.070)	(0.065)
T2: Blended	0.014	0.009	0.001	0.063	-0.003	0.007
	(0.058)	(0.072)	(0.063)	(0.071)	(0.074)	(0.058)
Baseline level coeff.	0.288***	0.250***	0.214**	0.274***	0.284***	0.299***
	(0.098)	(0.083)	(0.097)	(0.091)	(0.086)	(0.095)
Observations	166	166	166	166	166	166
Adjusted R^2	0.21	0.17	0.17	0.28	0.17	0.12
Control Mean	2.263	2.304	2.375	2.126	2.277	2.189
Control SD	0.399	0.401	0.418	0.506	0.451	0.397
p-value T1-T2	0.322	0.175	0.711	0.218	0.491	0.473

Notes: Standard errors in parentheses clustered at subdistrict level. School categorical variables, female, marriage, household size, contract type, experience, and base levels not shown.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

E.3 Treatment effects on downstream outcomes, EWs

Table E.3.1: Treatment effects on performance and capabilities (ITT), EWs

	(1) Total # of activities	(2) Farmer Reach	(3) MFs Reach	(4) Area covered (Ha)
T1: Fully online	-21.232	277.121	8.327	105.032
	(187.630)	(338.253)	(11.560)	(359.671)
T2: Blended	18.644	52.879	1.155	2059.192
	(210.496)	(124.670)	(4.069)	(1967.042)
Baseline level coeff.	0.147	0.443**	0.836***	2.142
	(0.127)	(0.213)	(0.248)	(1.354)
Female (=1)	-234.816	-97.980	3.980	-1196.301
	(225.147)	(118.448)	(10.123)	(1267.033)
Observations	166	166	166	166
Adjusted R^2	-0.03	0.19	0.13	-0.02
Control Mean	1098.982	1108.200	24.127	408.806
Control SD	848.082	509.876	23.722	435.560
p-value T1-T2	0.849	0.491	0.547	0.302

Notes: Standard errors in parentheses clustered at subdistrict level. All regressions control for education, gender, age, marital status, household size, type of work contract, and experience.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table E.3.2: Treatment effects on extension activities (recommended practices integrated) (ITT), EWs

	(1) Any activity on...	(2) In person one-to-one activity on...	(3) Remote one-to-one activity on...	(4) Group in class activity on...	(5) Remote group activity on...
Panel A: Any recommended practice					
T1: Fully online	-0.009	0.208**	-0.052	-0.051	-0.025
	(0.076)	(0.091)	(0.078)	(0.115)	(0.081)
	[1.000]	[0.156]	[1.000]	[1.000]	[1.000]
T2: Blended	0.028	0.147*	-0.011	0.159	0.044
	(0.078)	(0.084)	(0.089)	(0.113)	(0.076)
	[1.000]	[0.708]	[1.000]	[0.708]	[1.000]
Baseline level coeff.	0.025	-0.040	0.169	0.085	0.004
	(0.072)	(0.072)	(0.101)	(0.078)	(0.084)
Control Mean	0.727	0.345	0.309	0.491	0.164
Control SD	0.449	0.480	0.466	0.505	0.373
p-value T1-T2	0.681	0.536	0.645	0.059	0.382
Panel B: Agribusiness Management					
T1: Fully online	0.026	0.165*	-0.123	-0.076	-0.003
	(0.104)	(0.084)	(0.075)	(0.081)	(0.076)
	[1.000]	[0.364]	[0.364]	[0.547]	[1.000]
T2: Blended	0.040	0.136*	-0.028	0.070	0.021
	(0.095)	(0.069)	(0.081)	(0.091)	(0.072)
	[1.000]	[0.382]	[1.000]	[1.000]	[1.000]
Baseline level coeff.	-0.047	-0.060	0.086	-0.006	-0.017
	(0.083)	(0.080)	(0.089)	(0.081)	(0.113)
Control Mean	0.418	0.200	0.218	0.309	0.145
Control SD	0.498	0.404	0.417	0.466	0.356
p-value T1-T2	0.888	0.727	0.211	0.080	0.746
Panel C: Financial Record Keeping					
T1: Fully online	0.050	0.043	0.019	-0.013	0.013
	(0.095)	(0.062)	(0.047)	(0.085)	(0.047)
	[1.000]	[1.000]	[1.000]	[1.000]	[1.000]
T2: Blended	0.093	0.015	0.021	0.066	0.023
	(0.086)	(0.069)	(0.050)	(0.083)	(0.054)
	[1.000]	[1.000]	[1.000]	[1.000]	[1.000]
Baseline level coeff.	-0.104	-0.154***	-0.066*	-0.112	0.233
	(0.077)	(0.047)	(0.035)	(0.077)	(0.184)
Control Mean	0.345	0.145	0.055	0.273	0.055
Control SD	0.480	0.356	0.229	0.449	0.229
p-value T1-T2	0.660	0.679	0.972	0.356	0.844
Panel D: Marketing					
T1: Fully online	0.125	0.134*	0.020	0.008	-0.015
	(0.092)	(0.078)	(0.063)	(0.113)	(0.073)
	[0.819]	[0.819]	[1.000]	[1.000]	[1.000]
T2: Blended	0.031	0.053	0.067	0.097	0.015
	(0.098)	(0.080)	(0.071)	(0.113)	(0.065)
	[1.000]	[1.000]	[1.000]	[1.000]	[1.000]
Baseline level coeff.	0.132*	0.032	0.068	0.187**	0.031
	(0.078)	(0.074)	(0.094)	(0.080)	(0.094)
Observations	166	166	166	166	166
Control Mean	0.582	0.309	0.127	0.400	0.127
Control SD	0.498	0.466	0.336	0.494	0.336
p-value T1-T2	0.352	0.329	0.455	0.398	0.695

Notes: Standard errors in parentheses clustered at subdistrict level. FDR sharpened q-values accounting for the testing of multiple hypotheses in brackets. All regressions control for education, female indicator, age, marital status, household size, type of work contract, and experience.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

E.4 Treatment effects on downstream outcomes, MFs

Table E.4.1: Treatment effects on knowledge and adoption of recommended practices (ITT), MFs

	(1) Agribusiness Management (=1)	(2) Finan. Record Keeping (=1)	(3) Marketing (=1)
Panel A: Knowledge of practices			
T1: Fully online	0.140	0.047	0.135
	(0.103)	(0.092)	(0.099)
T2: Blended	0.201**	0.137**	0.077
	(0.083)	(0.055)	(0.080)
Baseline level coeff.	0.242***	0.300***	0.165***
	(0.039)	(0.030)	(0.056)
Observations	736	736	736
Adjusted R^2	0.14	0.15	0.09
Control Mean	0.387	0.598	0.711
Control SD	0.488	0.491	0.454
p-value T1-T2	0.561	0.356	0.446
Panel B: Use of practices			
T1: Fully online	0.139	0.048	0.221*
	(0.092)	(0.098)	(0.115)
T2: Blended	0.128**	0.098**	0.063
	(0.060)	(0.049)	(0.103)
Baseline level coeff.	0.231***	0.263***	0.112*
	(0.048)	(0.038)	(0.064)
Observations	736	736	736
Adjusted R^2	0.16	0.11	0.10
Control Mean	0.203	0.387	0.527
Control SD	0.403	0.488	0.500
p-value T1-T2	0.905	0.643	0.069

Notes: Standard errors in parentheses clustered at subdistrict level. All regressions control for school categorical variables, age, marriage, female indicator, household size, ability, and membership to a farmer group. When controlling for the ability measure, we lose 9 observation due to lack of data.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table E.4.2: Treatment effects on production, sales, productivity, and resilience (ITT), MFs

	(1) HH Income (Log)	(2) Agr. Production (Log)	(3) Agr. Sales (Log)	(4) Crop Prod. Log(IDR/Ha)	(5) Liv. Prod, Log(IDR/Ha)	(6) Crop Prod. Log(kg/Ha)	(7) Liv. Prod. Log(kg/Ha)	(8) Coping Strategy Index
T1: Fully online	-0.133	-0.194	-0.099	-0.455*	-0.020	-0.258	0.157	0.739*
	(0.147)	(0.146)	(0.152)	(0.228)	(0.269)	(0.206)	(0.171)	(0.426)
T2: Blended	0.037	-0.467***	-0.268	-0.227	-0.115	0.005	-0.037	0.372
	(0.103)	(0.169)	(0.179)	(0.262)	(0.277)	(0.207)	(0.236)	(0.337)
Baseline level coeff.	0.523***	0.590***	0.548***					
	(0.080)	(0.054)	(0.036)					
Female (=1)	-0.176**	-0.472***	-0.600***	0.183	-0.475**	0.165	-0.236	-0.028
	(0.070)	(0.137)	(0.170)	(0.188)	(0.223)	(0.148)	(0.192)	(0.391)
Observations	734	726	630	629	319	635	338	736
Adjusted R^2	0.29	0.46	0.43	0.05	0.01	0.03	0.07	0.18
Control Mean	18.101	9.956	9.781	9.808	12.897	0.544	2.671	0.309
Control SD	0.867	1.752	1.694	1.489	1.661	1.399	1.358	1.537
p-value T1-T2	0.171	0.088	0.340	0.382	0.652	0.256	0.395	0.446

Notes: Standard errors in parentheses clustered at subdistrict level. All regressions control for school categorical variables, age, marriage, gender, household size, ability, and membership to a farmer group. Note that the regressions that have production as dependent variable are computed across sectors while the productivity related regressions are estimated only for those working in the respective sector. Therefore, the latter regressions do not include agricultural subsector dummies. Moreover, the regressions related to productivity and coping strategies are simple OLS specifications without controlling for baseline outcomes.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

F Heterogeneous effects

F.1 Heterogeneous effects, EWs

Table F.1.1: Heterogeneous effects by gender, age, education, and baseline digital literacy for EWs

	(1) Attend any session (=1)	(2) Attend any intro session (=1)	(3) Knows LD (=1)	(4) Uses LD (=1)	(5) Other LD use(=1)	(6) Dig. Lit. (0-3)	(7) # MFs reached
By gender (ref. male)							
T1: Fully online	0.747***	0.716***	0.048	0.202	-0.055	0.031	3.305
	(0.093)	(0.092)	(0.051)	(0.149)	(0.088)	(0.078)	(9.136)
T1*Female	0.192*	0.098	0.021	0.301	0.585***	-0.182	11.155
	(0.105)	(0.139)	(0.066)	(0.219)	(0.111)	(0.146)	(31.900)
F-test (p-value all coef. above)	0.000	0.000	0.333	0.000	0.000	0.416	0.758
T2: Blended	0.874***	0.885***	0.078*	0.482***	0.333***	0.053	3.914
	(0.067)	(0.067)	(0.043)	(0.124)	(0.099)	(0.076)	(5.053)
T2*Female	0.076	0.068	-0.019	-0.179	0.161	-0.093	-8.165
	(0.077)	(0.079)	(0.072)	(0.195)	(0.132)	(0.150)	(10.287)
F-test (p-value all coef. above)	0.000	0.000	0.112	0.000	0.000	0.768	0.675
By age (ref. below median)							
T1: Fully online	0.902***	0.816***	0.059	0.376***	0.188*	-0.180*	7.912
	(0.052)	(0.067)	(0.047)	(0.105)	(0.099)	(0.101)	(19.709)
T1*Older	-0.174*	-0.143	-0.017	-0.100	0.028	0.316**	0.810
	(0.088)	(0.110)	(0.073)	(0.198)	(0.168)	(0.143)	(26.015)
F-test (p-value all coef. above)	0.000	0.000	0.408	0.001	0.034	0.099	0.698
T2: Blended	0.965***	0.974***	0.055	0.435***	0.439***	-0.035	3.881
	(0.045)	(0.045)	(0.047)	(0.108)	(0.097)	(0.092)	(7.717)
T2*Older	-0.135	-0.139	0.026	-0.052	-0.059	0.109	-4.732
	(0.089)	(0.092)	(0.067)	(0.200)	(0.142)	(0.147)	(10.803)
F-test (p-value all coef. above)	0.000	0.000	0.127	0.000	0.000	0.721	0.881
By education (ref. low)							
T1: Fully online	0.837***	0.758***	0.047	0.319***	0.210***	-0.095	9.580
	(0.067)	(0.068)	(0.040)	(0.096)	(0.070)	(0.064)	(12.083)
T1*High educ.	-0.023	0.093	-0.006	0.024	0.037	0.517***	-12.148
	(0.202)	(0.196)	(0.040)	(0.303)	(0.287)	(0.176)	(11.110)
F-test (p-value all coef. above)	0.000	0.000	0.273	0.005	0.012	0.019	0.513
T2: Blended	0.887***	0.884***	0.066**	0.409***	0.449***	0.039	1.464
	(0.046)	(0.047)	(0.033)	(0.096)	(0.093)	(0.059)	(4.222)
T2*High educ.	0.124*	0.151**	-0.034	0.171	-0.286	-0.344*	-1.303
	(0.069)	(0.075)	(0.039)	(0.229)	(0.233)	(0.189)	(17.008)
F-test (p-value all coef. above)	0.000	0.000	0.124	0.000	0.000	0.201	0.941
By dig. literacy (ref. low)							
T1: Fully online	0.780***	0.652***	0.044	0.424**	0.209*	0.051	4.237
	(0.103)	(0.095)	(0.076)	(0.163)	(0.112)	(0.099)	(10.655)
T1*High dig. literacy	0.101	0.211*	0.002	-0.178	0.021	-0.146	7.330
	(0.118)	(0.116)	(0.084)	(0.210)	(0.142)	(0.143)	(25.914)
F-test (p-value all coef. above)	0.000	0.000	0.219	0.004	0.003	0.541	0.757
T2: Blended	0.863***	0.848***	0.090	0.562***	0.420***	-0.014	3.189
	(0.072)	(0.071)	(0.061)	(0.136)	(0.114)	(0.102)	(5.325)
T2*High dig. literacy	0.067	0.099	-0.057	-0.245	0.045	0.118	-5.415
	(0.094)	(0.095)	(0.064)	(0.193)	(0.145)	(0.143)	(7.657)
F-test (p-value all coef. above)	0.000	0.000	0.142	0.000	0.000	0.472	0.770

Notes: The heterogeneity analysis by age, education, and baseline level of digital literacy are based on indicators on whether the respondent is above the median level of the respective variable under consideration. Standard errors in parentheses clustered at subdistrict level. All regressions control for education, gender, age, marital status, household size, type of work contract, and experience.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

F.2 Heterogeneous effects, MFs

Table F.2.1: Heterogeneous effects by gender, age, education, and baseline digital literacy for MFs

	(1) Attend any session (=1)	(2) Attend any intro session (=1)	(3) Knows LD (=1)	(4) Uses LD (=1)	(5) Other LD use(=1)	(6) Dig. Lit. (0-3)
By gender (ref. male)						
T1: Fully online	0.586***	0.547***	0.475***	0.345***	0.309***	0.101***
	(0.030)	(0.025)	(0.068)	(0.043)	(0.034)	(0.034)
T1*Female	-0.126	-0.121	-0.148	-0.173**	-0.116***	-0.040
	(0.082)	(0.081)	(0.114)	(0.069)	(0.040)	(0.063)
F-test (p-value all coef. above)	0.000	0.000	0.000	0.000	0.000	0.011
T2: Blended	0.439***	0.422***	0.395***	0.287***	0.277***	0.046
	(0.039)	(0.041)	(0.064)	(0.049)	(0.049)	(0.049)
T2*Female	0.023	0.026	-0.002	0.068	0.071	0.071
	(0.045)	(0.042)	(0.105)	(0.076)	(0.052)	(0.061)
F-test (p-value all coef. above)	0.000	0.000	0.000	0.000	0.000	0.361
By age (ref. below median)						
T1: Fully online	0.582***	0.546***	0.390***	0.336***	0.291***	0.058
	(0.034)	(0.036)	(0.081)	(0.047)	(0.035)	(0.043)
T1*Older	-0.060	-0.064	0.127	-0.078	-0.027	0.075
	(0.042)	(0.040)	(0.079)	(0.064)	(0.053)	(0.067)
F-test (p-value all coef. above)	0.000	0.000	0.000	0.000	0.000	0.037
T2: Blended	0.420***	0.400***	0.346***	0.304***	0.286***	0.043
	(0.037)	(0.041)	(0.062)	(0.054)	(0.046)	(0.048)
T2*Older	0.067	0.073	0.129**	0.012	0.027	0.050
	(0.057)	(0.052)	(0.061)	(0.055)	(0.054)	(0.054)
F-test (p-value all coef. above)	0.000	0.000	0.000	0.000	0.000	0.386
By education (ref. low)						
T1: Fully online	0.487***	0.442***	0.441***	0.301***	0.279***	0.108***
	(0.024)	(0.024)	(0.061)	(0.036)	(0.030)	(0.038)
T1*High educ.	0.183**	0.207***	-0.046	-0.048	-0.053	-0.067
	(0.076)	(0.073)	(0.082)	(0.113)	(0.068)	(0.054)
F-test (p-value all coef. above)	0.000	0.000	0.000	0.000	0.000	0.024
T2: Blended	0.392***	0.375***	0.418***	0.297***	0.266***	0.086
	(0.046)	(0.048)	(0.065)	(0.052)	(0.052)	(0.054)
T2*High educ.	0.173**	0.169**	-0.094	0.001	0.089	-0.070
	(0.079)	(0.077)	(0.084)	(0.086)	(0.078)	(0.052)
F-test (p-value all coef. above)	0.000	0.000	0.000	0.000	0.000	0.198
By dig. literacy (ref. low)						
T1: Fully online	0.410***	0.375***	0.443***	0.200***	0.172***	0.145**
	(0.037)	(0.035)	(0.066)	(0.045)	(0.035)	(0.059)
T1*High dig. literacy	0.273***	0.265***	-0.006	0.193***	0.199***	-0.105
	(0.053)	(0.047)	(0.079)	(0.061)	(0.057)	(0.066)
F-test (p-value all coef. above)	0.000	0.000	0.000	0.000	0.000	0.042
T2: Blended	0.384***	0.355***	0.412***	0.252***	0.249***	0.113
	(0.057)	(0.056)	(0.067)	(0.064)	(0.070)	(0.081)
T2*High dig. literacy	0.110	0.128**	-0.046	0.081	0.079	-0.090
	(0.071)	(0.063)	(0.083)	(0.082)	(0.068)	(0.085)
F-test (p-value all coef. above)	0.000	0.000	0.000	0.000	0.000	0.378
By main agr. activity (ref. livestock)						
T1: Fully online	0.561***	0.516***	0.439***	0.342***	0.338***	0.073
	(0.043)	(0.049)	(0.056)	(0.056)	(0.042)	(0.045)
T1*Crop	-0.038	-0.029	-0.047	-0.085*	-0.141***	0.011
	(0.067)	(0.058)	(0.074)	(0.050)	(0.046)	(0.065)
F-test (p-value all coef. above)	0.000	0.000	0.000	0.000	0.000	0.084
T2: Blended	0.429***	0.406***	0.357***	0.307***	0.311***	0.100*
	(0.056)	(0.057)	(0.076)	(0.059)	(0.049)	(0.057)
T2*Crop	0.045	0.050	0.076	-0.011	-0.031	-0.077
	(0.058)	(0.057)	(0.070)	(0.041)	(0.047)	(0.071)
F-test (p-value all coef. above)	0.000	0.000	0.000	0.000	0.000	0.223

Notes: The heterogeneity analysis by age, education, and baseline level of digital literacy are based on indicators on whether the respondent is above the median level of the respective variable under consideration. The heterogeneity analysis by main agricultural activity, is based only on crop cultivation and livestock, as only 19 Millennial farmers are not doing crop cultivation or livestock as main agricultural activity, so they are excluded from the sample). Standard errors in parentheses clustered at subdistrict level. All regressions control for education, age, marriage, gender, household size, ability, and membership to a farmer group.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

G LATE estimates

G.1 Treatment effects on platform knowledge, adoption, and engagement (LATE)

Table G.1.1: Treatment effects on platform knowledge, adoption, and engagement, EWs (LATE)

	(1) Knows LD	(2) Used LD	(3) Other LD features
T1: Treatment fully online	0.076	0.446***	0.264***
	(0.048)	(0.113)	(0.094)
T2: Treatment blended format	0.078**	0.463***	0.451***
	(0.034)	(0.095)	(0.098)
Baseline	0.009	0.357*	
	(0.023)	(0.206)	
Female (=1)	0.024	0.103	0.151**
	(0.022)	(0.085)	(0.070)
Observations	166	166	166
Adjusted R^2	0.00	0.10	0.16
1st-Stage F-test T1	68.655	70.042	71.280
1st-Stage F-test T2	240.398	230.687	231.016
p-value T1-T2	0.933	0.874	0.102

Notes: Standard errors in parentheses clustered at subdistrict level. All regressions control for education, gender, age, marital status, household size, type of work contract, and experience.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table G.1.2: Treatment effects on platform knowledge, adoption, and engagement, MFs (LATE)

	(1) Knows LD	(2) Used LD	(3) Other LD features
T1: Treatment fully online	0.847***	0.573***	0.528***
	(0.138)	(0.081)	(0.053)
T2: Treatment blended format	0.926***	0.724***	0.695***
	(0.144)	(0.111)	(0.098)
Baseline	0.176**	0.417	
	(0.070)	(0.296)	
Female (=1)	0.041	0.024	-0.015
	(0.037)	(0.030)	(0.023)
Observations	736	736	736
Adjusted R^2	0.17	0.43	0.43
1st-Stage F-test T1	139.893	145.482	141.244
1st-Stage F-test T2	89.288	89.770	89.897
p-value T1-T2	0.683	0.196	0.135

Notes: Standard errors in parentheses clustered at subdistrict level. All regressions control for school categorical variables, age, marriage, gender, household size, ability, and membership to a farmer group. When controlling for the ability measure, we lose nine observation due to missings.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

G.2 Treatment effects on platform engagement (LATE)

Table G.2.1: Treatment effects on platform engagement, EWs (LATE)

	(1) Used LD beyond the course	(2) Other courses	(3) Information	(4) Comment post	(5) Farmer records
T1: Treatment fully online	0.264***	0.174**	0.375***	-0.004	0.100**
	(0.094)	(0.078)	(0.123)	(0.033)	(0.050)
T2: Treatment blended format	0.451***	0.110	0.421***	-0.008	0.443***
	(0.098)	(0.067)	(0.100)	(0.027)	(0.103)
Female (=1)	0.151**	0.075	0.121	-0.008	0.117**
	(0.070)	(0.073)	(0.089)	(0.025)	(0.051)
Observations	166	166	166	166	166
Adjusted R^2	0.16	0.02	0.08	-0.05	0.19
1st-Stage F-test T1	71.280	71.280	71.280	71.280	71.280
1st-Stage F-test T2	231.016	231.016	231.016	231.016	231.016
p-value T1-T2	0.102	0.486	0.686	0.883	0.001

Notes: Standard errors in parentheses clustered at subdistrict level. All regressions control for education, gender, age, marital status, household size, type of work contract, and experience.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table G.2.2: Treatment effects on platform engagement, MFs (LATE)

	(1) Used LD beyond the course	(2) Other courses	(3) Information	(4) Comment post	(5) Farmer records
T1: Treatment fully online	0.528***	0.401***	0.452***	0.094***	0.411***
	(0.053)	(0.063)	(0.084)	(0.031)	(0.055)
T2: Treatment blended format	0.695***	0.463***	0.579***	0.303***	0.563***
	(0.098)	(0.098)	(0.094)	(0.071)	(0.100)
Female (=1)	-0.015	0.011	0.025	-0.001	-0.016
	(0.023)	(0.023)	(0.030)	(0.017)	(0.023)
Observations	736	736	736	736	736
Adjusted R^2	0.43	0.31	0.33	0.18	0.36
1st-Stage F-test T1	141.244	141.244	141.244	141.244	141.244
1st-Stage F-test T2	89.897	89.897	89.897	89.897	89.897
p-value T1-T2	0.135	0.595	0.229	0.013	0.195

Notes: Standard errors in parentheses clustered at subdistrict level. All regressions control for school categorical variables, age, marriage, gender, household size, ability, and membership to a farmer group. When controlling for the ability measure, we lose nine observation due to missings.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

G.3 Treatment effects on digital literacy (LATE)

Table G.3.1: Treatment effects on digital literacy (0-3), knowledge and usage of LD, EWs (LATE)

	(1) Digital Literacy Index	(2) Information and data lit.	(3) Communic. and collab.	(4) Digital content creation	(5) Digital safety	(6) Problem solving
T1: Treatment fully online	-0.061	-0.118	-0.031	-0.047	-0.064	-0.054
	(0.075)	(0.084)	(0.085)	(0.091)	(0.088)	(0.081)
T2: Treatment blended format	0.017	0.014	0.002	0.072	-0.001	0.010
	(0.060)	(0.076)	(0.066)	(0.074)	(0.076)	(0.060)
Baseline	0.297***	0.265***	0.217**	0.280***	0.290***	0.306***
	(0.094)	(0.081)	(0.093)	(0.087)	(0.082)	(0.091)
Female (=1)	0.062	0.007	0.087	0.076	0.078	0.050
	(0.058)	(0.063)	(0.064)	(0.070)	(0.066)	(0.069)
Observations	166	166	166	166	166	166
Adjusted R^2	0.17	0.13	0.12	0.23	0.14	0.08
1st-Stage F-test T1	70.407	72.019	70.043	70.503	70.430	71.331
1st-Stage F-test T2	229.727	230.981	228.955	223.352	231.807	238.233
p-value T1-T2	0.278	0.123	0.678	0.208	0.417	0.428

Notes: Standard errors in parentheses clustered at subdistrict level. All regressions control for education, gender, age, marital status, household size, type of work contract, and experience.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table G.3.2: Treatment effects on digital literacy (0-3), knowledge and usage of LD, MFs (LATE)

	(1) Digital Literacy Index	(2) Information and data lit.	(3) Communic. and collab.	(4) Digital content creation	(5) Digital safety	(6) Problem solving
T1: Treatment fully online	0.146**	0.120**	0.190***	0.054	0.150**	0.149*
	(0.063)	(0.059)	(0.067)	(0.095)	(0.073)	(0.086)
T2: Treatment blended format	0.130	0.180*	0.177	0.078	0.122	0.087
	(0.111)	(0.105)	(0.135)	(0.125)	(0.121)	(0.107)
Baseline	0.780***	0.622***	0.715***	0.729***	0.683***	0.696***
	(0.041)	(0.040)	(0.046)	(0.037)	(0.038)	(0.038)
Female (=1)	-0.011	-0.056*	0.006	-0.021	-0.015	-0.014
	(0.027)	(0.030)	(0.032)	(0.037)	(0.028)	(0.031)
Observations	736	736	736	736	736	736
Adjusted R^2	0.64	0.48	0.57	0.55	0.55	0.52
1st-Stage F-test T1	138.600	136.638	137.763	139.243	139.700	139.640
1st-Stage F-test T2	88.651	92.111	91.400	87.329	87.506	88.067
p-value T1-T2	0.877	0.570	0.921	0.850	0.816	0.525

Notes: Standard errors in parentheses clustered at subdistrict level. All regressions control for school categorical variables, age, marriage, female indicator, household size, ability, and membership to a farmer group. When controlling for the ability measure, we lose nine observation due to missings.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

H Spillover effects

H.1 Spillover effects, EWs

Table H.1.1: Spillover effects, EWs

	(1) Knows LD (=1)	(2) Uses LD (=1)	(3) Other LD use(=1)	(4) Dig. Lit. (0-3))
1km # treated EWs: mean 0.06				
T1: Fully online	0.105*	0.271	0.078	0.022
	(0.061)	(0.182)	(0.137)	(0.127)
T1 * # treated EWs	-0.083	0.099	0.045	-0.099
	(0.064)	(0.168)	(0.157)	(0.139)
T2: Blended	0.099*	0.359*	0.286*	-0.140
	(0.056)	(0.180)	(0.168)	(0.114)
T2 * # treated EWs	-0.096	0.079	-0.045	0.002
	(0.069)	(0.144)	(0.139)	(0.127)
# treated EWs	0.107	0.024	0.185*	0.146
	(0.069)	(0.107)	(0.093)	(0.094)
F-test (p-value all coef. above)	0.535	0.000	0.000	0.006
3km # treated EWs: mean 0.65				
T1: Fully online	0.151*	0.211	0.141	0.067
	(0.078)	(0.166)	(0.110)	(0.116)
T1 * # treated EWs	-0.043	0.158**	0.100*	-0.026
	(0.028)	(0.076)	(0.054)	(0.066)
T2: Blended	0.119*	0.479***	0.348**	0.046
	(0.061)	(0.128)	(0.138)	(0.109)
T2 * # treated EWs	-0.037*	0.071	0.062	-0.012
	(0.021)	(0.066)	(0.045)	(0.065)
# treated EWs	0.047*	-0.081	-0.002	0.036
	(0.025)	(0.061)	(0.031)	(0.052)
F-test (p-value all coef. above)	0.499	0.000	0.000	0.673
5km # treated EWs: mean 1.53				
T1: Fully online	0.142*	0.220	0.160	0.080
	(0.084)	(0.176)	(0.118)	(0.119)
T1 * # treated EWs	-0.014	0.066	0.046*	-0.015
	(0.019)	(0.045)	(0.026)	(0.036)
T2: Blended	0.110*	0.525***	0.364**	0.056
	(0.062)	(0.131)	(0.138)	(0.109)
T2 * # treated EWs	-0.010	0.004	0.036	-0.004
	(0.015)	(0.044)	(0.031)	(0.035)
# treated EWs	0.017	-0.016	-0.006	0.016
	(0.019)	(0.037)	(0.017)	(0.030)
F-test (p-value all coef. above)	0.559	0.000	0.000	0.860

Notes: Standard errors in parentheses clustered at subdistrict level. All regressions control for education, gender, age, marital status, household size, type of work contract, and experience.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

H.2 Spillover effects, MFs

Table H.2.1: Spillover effects, MFs

	(1) Knows LD (=1)	(2) Uses LD (=1)	(3) Other LD use(=1)	(4) Dig. Lit. (0-3))
1km # treated MFs: mean 0.15				
T1: Fully online	0.510***	0.371***	0.364***	0.075*
	(0.082)	(0.055)	(0.040)	(0.041)
T1 * # treated MFs	-0.002	-0.035	-0.025**	-0.045**
	(0.044)	(0.033)	(0.012)	(0.021)
T2: Blended	0.476***	0.414***	0.392***	0.060
	(0.050)	(0.070)	(0.072)	(0.066)
T2 * # treated MFs	0.005	-0.037	-0.018	-0.045**
	(0.037)	(0.031)	(0.012)	(0.018)
# treated MFs	-0.024	0.013	-0.008	0.043**
	(0.035)	(0.029)	(0.007)	(0.016)
F-test (p-value all coef. above)	0.000	0.000	0.000	0.092
3km # treated MFs: mean 1.83				
T1: Fully online	0.508***	0.350***	0.329***	0.063
	(0.059)	(0.058)	(0.054)	(0.044)
T1 * # treated MFs	0.004	-0.003	-0.004	-0.004
	(0.008)	(0.005)	(0.004)	(0.006)
T2: Blended	0.477***	0.394***	0.348***	0.025
	(0.060)	(0.078)	(0.079)	(0.071)
T2 * # treated MFs	0.004	-0.005	-0.004	-0.002
	(0.006)	(0.007)	(0.006)	(0.006)
# treated MFs	-0.011**	-0.001	0.000	0.005
	(0.005)	(0.004)	(0.002)	(0.005)
F-test (p-value all coef. above)	0.000	0.000	0.000	0.213
5km # treated MFs: mean 8.19				
T1: Fully online	0.420***	0.370***	0.388***	0.064
	(0.071)	(0.064)	(0.053)	(0.051)
T1 * # treated MFs	0.006	-0.000	-0.004**	-0.002
	(0.004)	(0.002)	(0.002)	(0.002)
T2: Blended	0.426***	0.372***	0.318***	0.016
	(0.064)	(0.095)	(0.109)	(0.085)
T2 * # treated MFs	0.004	0.000	-0.001	-0.001
	(0.003)	(0.003)	(0.004)	(0.003)
# treated MFs	-0.007***	-0.003*	0.000	0.003
	(0.002)	(0.002)	(0.001)	(0.002)
F-test (p-value all coef. above)	0.000	0.000	0.000	0.161

Notes: Standard errors in parentheses clustered at subdistrict level. All regressions control for education, gender, age, marital status, household size, type of work contract, and experience.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$