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"Dear Brother Farmer": Gender-Responsive Digital Extension in Tunisia during the COVID-19 Pandemic

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Abstract: Providing farmers with essential agricultural information and training in the era of COVID-19 has been a challenge that has prompted a renewed interest in digital extension services. There is a distinct gender gap, however, between men's and women's access to, use of, and ability to benefit from information and communication technologies (ICTs). The overall purpose of this research is to examine how digital extension can address gender inequality in rural areas in the context of the COVID-19 crisis by designing and evaluating the gendered impacts of a digital extension intervention delivered to 624 farmers (363 men and 261 women) (which included phone distribution, radio and SMS messages, and sharing of information prompts) in northern Tunisia. In order to assess the effectiveness of gender-responsive digital extension that targets husband and wife pairs, as opposed to only men, we employed logistic regression and descriptive statistics to analyze a sample of 242 farmers (141 women and 141 men). We find that phone ownership facilitated women's access to their social network, as well as agricultural information and services, ultimately improving their participation in household decision making and agricultural production. We find that gender-responsive digital extension is effective for men and especially women in terms of usefulness, learning, and adoption. We identified education level and cooperative membership as important factors that determine the impact of digital extension services on farmers and demonstrate the positive impact of radio programming. We recommend strengthening phone access for women, targeting information (including through non-written ways) to both husbands and wives, using sharing prompts, and more rigorous extension for knowledge-intensive topics such as conservation agriculture and rural collectives.

Keywords: COVID-19 pandemic; digital extension; agricultural extension; phone ownership; gender equality; women's empowerment

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1. Introduction

Information and communication technology (ICT)-based extension, or digital extension, refers to the capturing, processing, display, and communication of agricultural information through ICTs, including radio programs, mobile phones, other portable devices, and web-based tools and applications, among others [1]. Given the existing gender gap in the access to, use of, and ability to benefit from ICTs, concerns have been raised about the inclusivity of digital extension, particularly since traditional agricultural extension programs have repeatedly marginalized women [2–5]. If implemented in a gender-responsive way, however, there is evidence, albeit limited, to suggest that ICT-based extension can contribute to better agricultural livelihoods for women [4]. Implementing gender-responsive digital extension has never been more important given that the COVID-19 crisis is disproportionately affecting women farmers who have had poorer access to extension services

during pandemic lockdowns [6–8]. The overall purpose of this research is to provide a timely contribution on how digital extension can address gender inequality in rural areas in the context of the COVID-19 crisis by designing and evaluating the gendered impacts of a digital extension intervention in the Kef, Baja, Zaghouan, and Siliana regions of northern Tunisia (Figure 1). Specifically, we aim to (1) assess whether the implemented digital extension services are useful for men and women farmers, and on which topics; (2) examine how digital extension has impacted men and women farmers learning and adoption of agricultural practices; (3) determine if radio extension improves usefulness, learning, and adoption; (4) determine whether prompting participants to share the extension information with others is effective; and (5) report on how and why women's phone ownership is important.

Figure 1. Study locations in northern Tunisia.

Our research has practical and theoretical contributions to the gender and extension literature. Research on gender and digital extension remain limited especially for the MENA countries [6,9–12]. As the COVID-19 pandemic places additional pressure on women farmers while also interfering with traditional extension services, the need to address the issue of gender in digital extension is pressing. It is also an opportunity to address gender gaps in access to information. This is precisely the aim of this study, wherein we examine the effects of phone ownership for women, the impact of digital extension (radio and SMS) on gendered learning and adoption of practices/technologies, and the success of various gendered approaches to delivering extension services. We go beyond information acquisition and adoption to document impacts related to decision making and networking. Often, the non-learning outcomes of digital extension are lumped together and referred to as women's "empowerment", meaning one's agency or the ability to act within constraints and exert control over one's own life, as well as one's capacity, or ability to gain skills and capabilities, increase self-confidence, and develop self-reliance [13–16]. Rather than referring to empowerment in our paper, we more specifically identify and define the benefits of ICTs for women in different contexts when both referring to the literature and in describing our specific study findings from Tunisia.

1.1. The Digital Gender Divide and Women's Empowerment

The "digital gender divide" refers to gender-based digital exclusion, notably the gap between women's and men's access to, use of, and ability to benefit from digital technologies, often because of social and economic disadvantage [17,18] (p. 13). Worldwide, roughly 327 million fewer women than men have a smartphone and can access mobile internet, and in low and middle income countries (LMICs), the gap is not only greater but is widening [17,19–21]. For decades, organizations including the United Nations and World Bank have observed that gender disparities persist despite rapid changes to ICT and an international recognition of the benefits of technologies for everyone [22].

Women's disadvantage not only encompasses physical barriers to access but also social and cultural barriers, which are shaped by gendered social norms and constitute significant contributors to the digital gender divide [22–24]. Indeed, despite nearly all countries in the world seeing improvements to their ICT penetration [25], improved physical access has not necessarily translated into increased usage and benefits, such as economic growth or women's wellbeing [26–29]. The ways in which sociocultural norms contribute to the digital gender divide are more complex and place specific [27,30].

For example, societal conditions in Rwanda encourage women to be technophobic, which presents a barrier to women's access alongside women's heavy domestic responsibilities, time poverty, and lack of education regarding the use of computers and the internet [30]. Barriers to access are also spatially determined, and the gender gap in access to and use of ICTs such as mobile phones remains largest in rural areas (2). Moreover, the perception that ICTs are "a man's domain" is particularly prevalent in rural areas, which has impacted the gendered distribution of technologies and resulted in gender-biased and gender-blind ICT-based programs [2]. Other sociocultural attitudes that limit mobile phone access include the perception that women may use phones to facilitate undesirable behavior, such as meeting men, which are justifications reportedly used in places such as Egypt, Jordan, Niger, and India in order to limit young girls' and married women's access to mobile phones [27].

Women's equal access to digital technologies is an issue of women's rights, as access to ICTs is crucial for participating in the economy, connecting to social networks, and accessing resources, support, and information. These considerations are important in light of sustained focus on digital extension in the face of the COVID-19 pandemic [5]. The importance of a rights-based approach to ICTs has now been widely recognized, as evidenced by the UN General Assembly's 2016 declaration that internet access is a human right. There are many examples of how ICTs can contribute to women's agency, sense of control, and decision making power.

Firstly, women's agency can be improved through better access to support networks, facilitated through ICT. For example, women have found that access to technologies such as mobile money in rural Kenya can improve households' vulnerability to economic shocks by allowing women to create and maintain kinship networks that provide resources and support [31]. Similarly, in Sri Lanka, access to mobile phones has allowed women to strengthen and expand their social circles and support networks [32]. Though access to mobile phones for women in Sri Lanka did not fundamentally shift household power dynamics, their use mitigated women's loneliness, boredom, and stress by facilitating a more frequent connectivity with kinship networks [32]. Access to mobile phones has also been shown to materially expand Indian women's agency by allowing domestic workers to control their daily schedule, workload, and sense of safety in public places [16]. More broadly, women's capacity to navigate the social, cultural, and economic constraints they face as domestic workers was improved [16]. Women may also gain agency and a sense of control as they learn new terminologies and technologies and are able to access public services such as sexual and reproductive health services, administrative offices of local governance, and employment opportunities, despite shouldering heavy domestic workloads that prohibit them from leaving the home [32]. Finally, women's economic positions and power over

household decision making can also be improved, as women beneficiaries of Grameen's micro-credit telephone program have reported in Bangladesh [33].

In addition to improving women's agency and sense of control over their own lives, a growing body of evidence shows that equitable access to digital technology is important for women's health, specifically insofar as accessing health care and information on sexual and reproductive health and rights [34–38]. Access to ICTs is also critical for women's education and training, particularly for the most marginalized and isolated girls and women [39–42]. Finally, women may be able to utilize ICTs to organize collective political action [43]. Evidence shows that women have used digital technologies as a tool to document discrimination and the violation of rights, such as exposing forced abortion in China and documenting violence against women in Turkey [43]. Other activist applications include the ability to influence public opinion and policy, as did an Iraqi women's campaign to stop female genital mutilation [43].

Given its potential for improving the lives of women, digital technology has often been presented as a "silver bullet" solution to international development challenges such as gender and inclusion [23,44]. Research has shown, however, that digital technology can also be exclusionary if not applied in a critical way, particularly when access is conceptualized shallowly and does not consider women's ability to use and benefit from ICTs [16,45]. Technology alone cannot change the social status quo by transforming gendered power relations or resolving existing inequalities, but it can reinforce existing social stratifications through maintaining gender stereotypes and reifying exclusionary boundaries to the access and use of technologies along gender lines. Yet, in development policy and practice, many assume that increasing women's access is enough to close the digital gender gap. Without transforming the broader conditions that have led to women's marginalization, however, ICT-based development projects will continue to "add women and stir" [46,47]. Digital technologies, which are increasingly an integral part of development agendas and initiatives due to COVID-19 [5,48], cannot be gender blind and/or separate from the overall structural inequality that marginalizes women. Access to ICTs cannot fundamentally improve women's social positions, as they are embedded in broader social, cultural, and economic structures and processes [16]. With respect to ICT policy, gender also remains a blind spot because of institutional failures that identify the need to address gender equality but fail to actually implement strategies to do so [49].

1.2. Agricultural Extension and the Digital Gender Divide with a Focus on the MENA Region: Status and Gaps

Though it is widely recognized that women throughout the world play significant roles in the production and management of crops, women farmers tend to have less access to agricultural information and training than men [50,51], as agricultural extension has historically marginalized women [1–4]. The MENA region is no exception to the pattern of women's exclusion from agricultural extension; however, this exclusion occurs in subtle ways [52]. Unlike in sub-Saharan Africa, women in the MENA region tend to work largely on farms owned or managed by their male kin, which means they have very limited financial independence, decision making power, and visibility as farmers, despite their increasing roles in farming and livestock management [52–54]. Concurrently, women continue to face barriers in their access to, use of, and ability to benefit from ICTs, which has resulted in Arab countries lagging with respect to narrowing the digital gender divide. The digital gender divide is substantial in the MENA region, with enduring gender gaps in access to and use of internet and mobile phones [55,56]. Between 2017 and 2020, the gender gap in mobile phone ownership actually increased from 8% to 9%, and the gender gap in mobile internet use only decreased from 18% to 17% [57]. There is great heterogeneity between countries in this region. For example, the gender gap in internet use is most substantial in Iraq, Algeria, Tunisia, and Egypt, whereas the gap is lowest in the United Arab Emirates [58].

This disadvantage has been further compounded by the COVID-19 pandemic, as evidence emerges that lockdowns are negatively impacting women farmers' access to information through extension services, resulting in decreased farm productivity [6]. Digital extension has been presented as a solution to this urgent problem, given its affordability and ability to be delivered remotely [6]. However, Badran [56] explains that women living in the MENA region lack decision making power over finances and are subject to social and cultural norms that restrict their physical mobility, in turn limiting access to public spaces with ICT facilities, such as cyber-cafes. Thus, women in MENA are likely to experience dual exclusion where digital extension is concerned, both because they have often been ignored or excluded from traditional extension services and because they have poorer access to and ability to use and benefit from ICTs. Yet, when implemented properly, digital extension has the potential to address the information gap between men and women farmers, as access to ICTs can improve women's ability to share information through informal networks, improve their access to financial or credit services, and allow women to become more informed, potentially improving their participation in household decision making related to food and farming [1]. In India and Bangladesh, for example, gender-responsive digital extension has been shown to increase women's agricultural knowledge, improve their roles in agricultural decision making, and increase their interest in and ability to adopt new techniques and inputs [59,60]. If extension technologies center the most marginalized farmer subgroups typically excluded from digital extension (e.g., women users with little or no literacy), ICT-based extension can become much more inclusive [61]. Radio extension services also have great potential for inclusivity, as radio is the lowest cost, most familiar, and most readily available ICT tool available to most women [2]. Moreover, the affordability of digital extension may encourage organizations and governments to widen the scope of extension services, thereby improving access for women in remote areas [1].

Notwithstanding a growing body of work on gender and digital extension, the literature is limited in systematically explaining what gender-responsive digital extension entails. While some studies identify inclusive access to ICTs through blended approaches and timing of information delivery [5,7], other literature identifies the identity of the extension agent [10] and language [2,4,10,58] as important factors. Moreover, the impacts of providing both men and women with information and the subsequent impacts on adoption are rarely documented [see 4 and 10 for an exception] as well as the means to achieve them (e.g., the potential of sharing prompts, to our knowledge, is undocumented). Steinke et al. [10] and Lecoutere et al. [4] have shown that providing information to both husbands and wives and using roles models (with similar language and behavior) increased adoption of technologies. There is also limited research on how factors such as the type of extension information and cooperative membership status influences learning and adoption. Taken together, such studies are important for providing necessary evidence and affecting policy change in extension programs. Our study offers a modest contribution to addressing these gaps.

2. Materials and Methods

2.1. Study Design and Sampling

We used a multi-stage design beginning with the selection of study participants (Table 1). Selection criteria included women and men involved in agriculture, either as individuals or through rural collectives, aged 18–100 years, equally distributed as much as possible between the Beja, Kef, Zaghouan, and Siliana regions of Tunisia. We had a roster of cell phone numbers for farmers and local leaders (from prior surveys), listing approximately 200 cell phone numbers. We aimed at delivering digital extension to 750 farmers across the 4 regions. We recruited more farmers through local leaders (4 women and 4 men leaders who belonged to different organizations, local extension units, or agricultural development groups or mutual agricultural services societies) who recommended additional names for participants meeting the selection criteria. We ended up short 126 beneficiaries from the aspired target of 750, but due to time limitations we had to start our interventions.

Table 1. Participant categories.

Participant Category	Number of Beneficiaries	Number of Survey Respondents
Category 1: Men (not prompted to share)	116	41
Category 2: Men (prompted to share with their spouses)	118	40
Category 3: Women (prompted to share with other household members)	132	41
Category 4: Husbands and wives both targeted	129 women and 129 men	80 (40 men and 40 women)
Women mobile phone recipients (included in Categories 3 or 4)	150	40 (20 from Category 3 and 20 from Category 4)
Total	624 (363 men and 261 women)	242 (121 men and 121 women)

We conducted two rounds of interviews. All interviews were conducted over the phone due to recurring lockdowns, interregional boarder closures, and social distancing measures. Four women enumerators were hired, as it is not culturally appropriate for men to call women who are not family members. In the first round, we interviewed 38 respondents (19 men and 19 women) across the 4 locations to identify their information needs. This survey was also used to test the phrasing of questions on beneficiaries' characteristics (age, education, membership status, etc.) and access to phones, extension, and preferred methods for receiving information.

We picked information needs which were aligned with our project entitled "Use of conservation agriculture in crop-livestock systems (CLCA) in the drylands for enhanced water use efficiency, soil fertility and productivity in NEN and LAC countries". These topics included animal health, conservation agriculture, animal feeding, and rural organizations. Veterinary advice and feed production were chosen as topics for agricultural extension given that the disruption of vaccination programs and restricted veterinary service from the COVID-19 pandemic will likely to lead to disease outbreaks in livestock. This has implications for women's health and economic vulnerability, as women tend to take on a much bigger role than men in milking, stall-feeding, and attending to sick animals [62,63].

Subsequently, we designed the interventions which were delivered to 624 farmers (363 men and 261 women). The sample was divided into 4 groups (see Table 1): men who were not prompted to share extension information, men who were prompted to share with their spouses, women who were prompted to share with their spouses, and husband and wife pairs who were both sent the SMS messages. As the FAO [5] recommends for gender-responsive digital extension, we adopted a blended approach combining the SMS messages with invitations to listen to radio programming. Close attention was paid to language used to deliver the information. Previous digital extension in the region, such as the "Mind the Gap" project undertaken by Germany's Federal Ministry for Economic Cooperation and Development (BMZ), which spanned 2017–2019, included gendered language. Communications began with "dear brother" in Arabic, wording that suggests that (1) a farmer is a man, and (2) that the message is directed to a man. This study, which was conducted in the same area, found high illiteracy rates, particularly among women, (43% men vs. 73% women), meaning voice messages or radio programs would have been more effective in reaching women. However, we were unable to find voice-based messaging services in Tunisia. Based on these gaps, radio communications were delivered on an existing agricultural show called *seasons* (run by the training arm of the Ministry of Agriculture) in addition to SMS messages. The gendered language addressing male farmers in each message which started with "Dear brother farmer" was removed.

The BMZ study also revealed that fewer women (48%) surveyed than men (92%) own cell phones. Because far fewer women owned phones than men, we provided 150 women with phones, sim cards, and time charge cards along with training on how to use the phones. The current approach for using digital extension in Tunisia entails sending messages to one household member, often a man, assuming that they will share the information with other household members. This approach, however, has been criticized in the gender and

extension literature [2,3]. To understand if indeed spouses share extension information, we reproduced the status quo approach in Category 1, but prompted participants in Categories 2 and 3 to share information by sending an additional text reading, "a basket is carried by two, share the SMS information with your spouse so the benefits accrue for two".

For all 4 categories, digital extension consisted of SMS content, specifically 4 messages on a weekly basis, on each topic along with an additional message inviting them to listen to the radio program addressing the following themes: (1) organizational training, (2) animal health, (3) feeding, (4) conservation agriculture, and (5) an invitation to listen to radio transmissions. Themes 1 through 4 were communicated orally using the local dialect, darija. Further details regarding the extension content are presented in Table 2 below. The radio show lasted 1 min and was delivered once a week by a combination of men and women experts. Efforts were made to ensure that women experts also participated in recording the radio messages to reinforce the idea that women can also be "experts" [1,4].

Table 2. SMS content by topic.

Organizations	49 SMS on professional agricultural organizations: • The different types of professional organizations and associated activities and objectives • Creating or joining a professional structure: the difficulties that small farmers face and what these organizations can offer • The steps to find an organization • The roles and different ways of functioning of various rural organizations • Rights and duties of members and management • The benefits of organizaitons for farmers
Animal health	58 SMS on animal health: • Encouragment to vaccinate livestock and consult veterinarians • Types of disease and bacterial infections, symptoms, risks for contamination, with a focus on prevention and treatment • Tips and recommendations for keeping livestock healthy • Reminders about a disease during its peak period • Reminders about livestock fattening periods
Conservation agriculture	46 SMS on conservation agriculture: • Introduction to CA • Agricultural, economic, and environmental benefits of CA • CA farming techniques, e.g., farming to reduce erosion, maintain soil fertility, and reduce the effects of climate change • Parasitic weed control • Successful fertilization with chemical fertilizers
Animal feeding	50 SMS on animal feeding: • Importance of a balanced diet: recommendations and tips • The forage calendar • Benefits of using a mechanical chopper • Improving the quality and intensification of green fodder • Valuation of agricultural by-products and their use in ruminant feed • Introduction and use of new feeding technologies • Importance of fodder, diversification, and intensification of fodder crops • Silage, fodder conservation, and storage
Sharinginformation	Participant Categories 2 and 3 were sent additional sharing prompts each time an SMS was sent reading: • "A basket is carried by two, share the SMS information with your spouse so the benefits accrue for two"

After 8 months of digital extension, we administered a survey evaluating the extension approach to a random subset of the beneficiaries (Table 1). Four women enumerators were trained on the survey instrument through a virtual workshop to ensure common understanding and avoid misunderstandings, as well as sharpen the survey questions. The

total surveyed sample included 121 women and 121 men, belonging to 4 differently targeted groups (as shown in Table 1). Approximately half of the total sample were members of a cooperative (n = 114), and the other half individual farmers (n = 128). Further participant characteristics are provided in Table 3. The survey included questions assessing the utility of the extension services, what participants learned, which practices were adopted, and, when relevant, how mobile phone ownership impacted women. Questions also assessed whether information was shared with other members in the household.

Table 3. Sample characteristics.

	Gender		Total
	Men	Women	
Cooperative member	51 (42.1%)	63 (52.1%)	114 (47.1%)
Education level			
Illiterate	9 (7.5%)	34 (28.6%)	43 (18%)
Primary only	54 (45.0%)	39 (32.8%)	93 (38.9%)
More than primary	57 (47.5%)	46 (38.7%)	103 (43.1%)
Region of residence			
Kef	42 (34.7%)	34 (28.1%)	76 (31.4%)
Beja	56 (46.3%)	36 (29.8%)	92 (38.0%)
Zaghouan	11 (9.1%)	28 (23.1%)	39 (16.1%)
Siliana	12 (9.9%)	23 (19.0%)	35 (14.5%)

2.2. Data Analysis

The data are comprised of written notes taken by enumerators during interviews which were recorded verbatim as much as possible. The researchers conducting the interviews had over 3 years of training on note-taking for open-ended questionnaires (focus groups and interviews) at the time of data collection. The data from the interviews were coded in Excel under broader themes and sub-themes in the literature and then analyzed in SPSS. We employed logistic regression to examine the various factors that impact information sharing, enhance the usefulness of digital extension, and to determine which factors (e.g., gender, education level, cooperative membership) impact the learning, sharing, and adoption of technologies and practices. The analysis for usefulness and extent of learning differentiates between four major thematic areas: organizations, animal health, conservation agriculture, and animal nutrition/feeding. We differentiate between each of these categories as gender roles and needs in this context differ between each aspect of farming. Table 4 presents the explanatory variables used in the analysis.

Table 4. Variables used in the logistic regression models.

Acronym	Description	Type of Measure
Gender_Male	Respondent is male	Dummy (1 if yes, 0 if no)
Men_only *	The respondent is part of men only group	Dummy (1 if yes, 0 if no)
HusbandWives	The respondent is part of husbands and wives group	Dummy (1 if yes, 0 if no)
Men_ToShare	The respondent is part of men asked to share information group	Dummy (1 if yes, 0 if no)
Women_ToShare	The respondent is part of women asked to share information group	Dummy (1 if yes, 0 if no)
Illiterate	The respondent's level of education is less than primary	Dummy (1 if yes, 0 if no)
Primary **	The respondent's level of education is primary	Dummy (1 if yes, 0 if no)
MorePrimary	The respondent's level of education is more than primary	Dummy (1 if yes, 0 if no)
Siliana	The respondent is from governorate of Siliana	Dummy (1 if yes, 0 if no)
Kef	The respondent is from governorate of Kef	Dummy (1 if yes, 0 if no)
Zaghouan	The respondent is from governorate of Zaghouan	Dummy (1 if yes, 0 if no)
Beja	The respondent is from governorate of Beja	Dummy (1 if yes, 0 if no)
GroupMember	The respondent is a member of a group	Dummy (1 if yes, 0 if no)
Radio_learn	The respondent reported learning from radio spots	Dummy (1 if yes, 0 if no)

* Men only is the control group for this regression model. ** Primary denotes 6 years of schooling.

3. Results

The following section begins with the presentation of descriptive findings with respect to the importance of women's phone ownership, which is a necessary precondition for receiving extension information firsthand. Subsequently, we present the findings of four logistic regressions, assessing the effectiveness of sharing prompts, the usefulness of gender-responsive digital extension, and the impact of extension on learning and adoption. Subsequently, we summarize the barriers to adoption reported by participants. We conclude this section by presenting several areas for the improvement of digital extension programming, as reported by our study participants.

3.1. Women Phone Owners

Among women who received phones and participated in this survey, 57.5% of women (n = 40) used the phones for agricultural activities, livestock related responsibilities, ordering feed from suppliers, contacting the veterinarian, and contacting drivers from the milk complex. Additional uses included contacting workers in the agricultural sector, contacting the cooperative, and contacting the livestock breeding office. In addition to agricultural activities, women reported using their phones for personal use. Most women (87.5%, n = 40) use their phones for communicating with their husband, family, and relatives due to the social distancing measures imposed by COVID-19. Listening to the radio (2.5%, n = 40), communicating with doctors (2.5%, n = 40), and using the phone as an alarm clock (2.5%, n = 40) were other important personal uses women identified.

Overall, 75% of women (n = 40) reported benefitting from phone ownership. Most women reported benefitting by receiving agricultural extension information and tips, particularly relating to animal vaccination, disease, medicine, and livestock breeding. Women also cited communication as a major benefit of phone ownership.

The majority of women reported being the sole users of their phones (80%, n = 40); however, some women's husbands (7.5%, n = 40) and children (7.5%, n = 40) used their phones. One woman reported that her brother (n = 40) used the phone, as did another who reported that her mother-in-law (n = 40) used the phone.

Few women reported consistently (often or always) using their phones to listen to the radio extension services (17.5%, n = 40). Most women listened only sometimes (47.5%, n = 40), either because they were not interested or because they felt they had many other competing responsibilities and preoccupations. Over a third of women (35.0%, n = 40) reported not listening to the radio extension messages at all.

All women reported that phone ownership facilitated working with others, though the ways in which this occurred varied by type and degree. Specifically, women's phone ownership facilitated their working relationship with veterinarians (40.0%, n = 40), milk complexes (10.0%, n = 40), feed suppliers (35.0%, n = 40), the owners of harvesters or tractors (7.5%, n = 40), and the middlemen for hiring agricultural laborers (10.0%, n = 40). Other areas where collaboration was facilitated include working with livestock breeders and exchanging information with women involved in cooperatives (5.0%, n = 40). Communication was reported as the primary means (25.0%, n = 40) by which collaborative work was facilitated. Nearly a third of women (27.5%, n = 40) reported that phone ownership only made a small difference to their working relationships with others, either because they already owned a phone or because their agricultural activities are limited and they have little interaction with others.

Overall, most women felt that owning a phone was helpful, largely because of the agricultural extension services they received via SMS (60.0%, n = 40). Communication (32.5%, n = 40), exchange of information (2.5%, n = 40), remote access to information (17.5%, n = 40), and portability (2.5%, n = 40) were cited as additional benefits. Only one woman (n = 40) felt that phone ownership was not helpful, whereas four women (10.0%, n = 40) reported a neutral experience given that they already owned phones.

When asked why phone ownership was important to them, the majority of women (57.5%, n = 40) reported that ownership allows them to easily fulfill their work responsibili-

ties without having to travel. Specifically, 20% of women (n = 40) noted that ownership allows them to contact machine owners and ask about materials needed for cultivation, and 17.5% (n = 40) cited their ability to contact the veterinarian. Additionally, 15% of women (n = 40) identified that receiving agricultural guidance is an important benefit of phone ownership. Beyond agricultural benefits, women expressed that phone ownership improves communication generally (37.5%, n = 40), reportedly breaking the isolation that women feel in remote rural areas where there is no transportation (2.5%, n = 40). Finally, one woman (n = 40) reported that phone ownership is important because it improves her access to medical care by facilitating contact with her family doctor. Only one woman found the phone not useful (n = 40).

In addition to emphasizing that women need to own mobile phones (35%, n = 40), our participants noted that women's access could be improved through educational initiatives offered via cooperatives and other local organizations. Approximately one-third of women (35.0%, n = 40) had no recommendations.

3.2. Effectiveness of Sharing Prompts

Table 5 presents the findings of a logistic regression identifying which factors influence the likelihood that participants share the extension information with other members of their household. We find that sharing prompts are effective, as men and women prompted to share information with their spouses are more likely to share ($p < 0.1$) than when both husbands and wives receive the prompts. More educated participants, specifically those with more than primary education, are also more likely ($p < 0.05$) to share information. Participants residing in Siliana are more likely ($p < 0.05$) to share information than their counterparts in Zaghouan, indicating that there is some regional variation. Finally, participants who reported learning from the radio programming are significantly more likely ($p < 0.05$) to share the extension information with others.

Table 5. Logistic regression predicting sharing of digital extension content.

	Sharing
	Coefficient (Std. Error)
Gender_Male	−0.28 (0.510)
HusbandWives †	
Men_only	0.51 (0.578)
Men_ToShare	1.24 * (0.678)
Women_ToShare	1.02 * (0.537)
Illiterate	
Primary	0.40 (0.480)
MorePrimary	1.10 ** (0.514)
Zaghouan	
Kef	−0.30 (0.596)
Siliana	−1.38 ** (0.613)
Beja	−0.42 (0.566)
Interviewee_Group	−0.01 (0.376)
Radio_learn	2.34 ** (1.070)
Constant	0.89 *** (0.794)
Model Information	
Number of obs (n = 239)	239
LR Chi2(4)	28.81 ***
Pseudo R2	0.1246
Log likelihood	−101.2063

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. † The control group in this regression was the husbands and wives group as both received information.

3.3. Gendered Benefits of Digital Extension: Usefulness

Table 6 presents the findings of a logistic regression model predicting usefulness of digital extension content for each of the four categories covered by the digital extension: organizations, animal health, conservation agriculture (CA), and feeding. With respect to organizations, men who are prompted to share the extension information are more likely ($p < 0.05$) to find the information on organizations useful than their counterparts who are not prompted to share. The most educated participants are also more likely ($p < 0.05$) to report that the extension services relating to organizations were useful. Those who are already members of cooperatives are less likely ($p < 0.001$) to find the information useful than individual farmers who do not belong to organizations.

Table 6. Logistic regression predicting usefulness of digital extension content.

	Organizations (Y/N)	**Animal Health (Y/N)**	**Conservation Agriculture (Y/N)**	**Animal Feeding (Y/N)**
	Coefficient (Std. Error)	**Coefficient (Std. Error)**	**Coefficient (Std. Error)**	**Coefficient (Std. Error)**
Gender_Male	−0.61 (0.719)	−0.32 (0.491)	−0.44 (0.543)	−0.88 * (0.461)
Men_only †				
HusbandWives	1.18 (1.182)	0.16 (0.510)	0.31 (0.646)	0.58 (0.491)
Men_ToShare	2.38 ** (1.166)	−0.68 (0.477)	0.93 (0.621)	0.08 (0.481)
Women_ToShare	1.23 (1.315)	−0.26 (0.669)	0.44 (0.803)	−0.12 (0.635)
Illiterate				
Primary	0.69 (0.885)	1.05 ** (0.439)	2.63 ** (1.059)	0.78 * (0.433)
MorePrimary	2.02 ** (0.848)	1.36 *** (0.446)	2.77 *** (1.057)	1.29 *** (0.437)
Zaghouan				
Kef	−0.33 (0.678)	−0.80 (0.489)	0.48 (0.591)	−0.63 (0.455)
Siliana	−0.26 (0.771)	−0.70 (0.547)	0.63 (0.670)	−1.06 ** (0.522)
Beja	−0.94 (0.699)	−0.69 (0.467)	0.28 (0.588)	−0.33 (0.436)
GroupMember	−1.92 *** (0.549)	−0.52 * (0.315)	−0.84 ** (0.376)	−0.36 (0.307)
Radio_learn	0.42 (0.570)	2.84 *** (1.047)	−0.07 (0.486)	1.08 ** (0.498)
Constant	−1.37 (1.614)	1.01 (0.908)	−3.14 ** (1.421)	0.26 (0.870)
Model Information				
Number of obs (n = 239)	239	239	239	239
LR Chi2(4)	35.08 ***	46.53 ***	24.47 **	36.40 ***
Pseudo R2	0.2032	0.1461	0.1021	0.1099
Log likelihood	−68.7890	−136.0109	−107.6370	−147.4581

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. † Men only is the control group for this regression model.

With respect to the usefulness of digital extension content on animal health, participants with primary school education are more likely ($p < 0.05$) to find the information useful than their illiterate counterparts, as are those with more than primary level education ($p < 0.001$). Participants belonging to a cooperative are less likely ($p < 0.1$) to find the information useful than their unaffiliated counterparts. Those who reported learning from radio extension are also more likely ($p < 0.001$) to find the information on animal health useful.

Similar to the findings for animal health, participants with primary school education are more likely ($p < 0.05$) to find the information on CA useful, as are those with more than primary level education ($p < 0.001$). Participants belonging to a cooperative are less likely ($p < 0.05$) to find the information on CA useful.

Finally, with respect to animal feeding, we find that men are less likely ($p < 0.1$) than women to find the information on animal feeding useful. The most educated farmers are more likely ($p < 0.001$) to find the information useful than their illiterate counterparts, while participants with primary education are less likely ($p < 0.1$) to find the information useful. Participants who reported learning from radio programming are more likely ($p < 0.05$) to find the information on feeding useful. Participants residing in the Siliana region are also more likely ($p < 0.05$) to find the information on feeding more useful than those residing in Zaghouan.

Importantly, certain categories of extension content were more useful than others for the farmers in our study. The information provided on organizations was reportedly not very useful, with only 9.1% (11 out of 121) of men and 14.0% (17 out of 121) of women finding it useful. Similarly, only 19.0% (23 out of 121) of men and 20.7% (25 out of 121) of women report finding the information on CA useful. Conversely, with respect to animal health, 55.4% (67 out of 121) of men and 66.1% (80 out of 121) of women reported finding the extension services useful. The information on animal feeding was also useful, with 40.5% (49 out of 121) of men and 58.7% (71 out of 121) of women finding it useful.

It is noteworthy that the gender-responsive extension program was useful insofar as its contribution toward improving women's participation in decision making. Overall, 61.2% of women (73 out of 121) reported improved confidence in agricultural decision making as a result of receiving the digital extension services.

3.4. Gendered Benefits of Digital Extension: Impacts on Learning

Table 7 presents the findings of a logistic regression model predicting the impact of digital extension on learning for each of the following four topic areas: organizations, animal health, conservation agriculture (CA), and feeding. With respect to organizations, participants with more than primary education are more likely ($p < 0.001$) to report learning than their illiterate counterparts. Participants residing in the Beja region are more likely ($p < 0.001$) to report learning about organizations than their counterparts in Zaghouan. Cooperative members are less likely ($p < 0.001$) to report learning information about organizations than unaffiliated farmers. This finding is understandable as they may already be familiar with organizations and their day-to-day operations.

With respect to animal health, participants with primary school education are more likely ($p < 0.05$) to report learning, as are those with more than primary level education ($p < 0.001$). Participants who reported learning from the radio programming are also more likely ($p < 0.05$) to have learned about animal health. Similarly, participants with primary school education are more likely ($p < 0.001$) to report learning about CA, as are those with more than primary level education ($p < 0.001$). Husband and wife pairs ($p < 0.05$), as well as men ($p < 0.001$) and women ($p < 0.1$) prompted to share are also more likely to have reported learning about CA than men who were not prompted to share the extension information.

With respect to animal feeding, participants with primary school education are more likely ($p < 0.05$) to report learning, as are those with more than primary level education ($p < 0.001$). Men were less likely ($p < 0.1$) than women to report learning about animal feeding. Participants who reported learning from the radio programming are also more likely ($p < 0.05$) to have learned about animal feeding. Participants residing in Siliana ($p < 0.05$) and Kef ($p < 0.1$) are less likely to have reported learning about animal feeding than those in Zaghouan.

Notably, we find that the knowledge that participants gained about organizations was somewhat limited, as only 14% (17 out of 121) of men and 12.4% (15 out of 121) of women reported learning some information about organizations. Reported areas of learning include: participation in organizations, including the associated benefits and privileges; the establishment of organizations; financial management; and election processes within organizations. Participants reported more instances of learning about CA, with 22.3% (27 out of 121) of men and 23.1% (28 out of 121) of women learning something new. The greatest areas of learning about CA include preserving soil fertility, preventing soil erosion,

improving agricultural production, and the importance of forage crops in maintaining soil health. There was greater learning with regard to animal feeding, with 48.8% (59 out of 121) of men and 62% (75 out of 121) of women reporting learning new information, including: how to make fodder, proportional feeding, and feeding times for animals. The greatest area of learning was in animal health, with 66.9% (81 out of 121) of men and 71.1% (86 out of 121) of women reportedly learning new information. The areas of learning most reported by participants were animal vaccination; disease, including treatment and prevention; medication; and veterinary care.

Table 7. Logistic regression predicting learning.

	Organizations (Y/N)	**Animal Health (Y/N)**	**Conservation Agriculture (Y/N)**	**Animal Feeding (Y/N)**
	Coefficient (Std. Error)	**Coefficient (Std. Error)**	**Coefficient (Std. Error)**	**Coefficient (Std. Error)**
Gender_Male	0.01 (0.669)	−0.27 (0.507)	−0.08 (0.497)	−0.86 * (0.475)
Men_only †				
HusbandWives	0.11 (0.762)	0.23 (0.525)	1.46 ** (0.715)	0.41 (0.488)
Men_ToShare	0.90 (0.737)	0.19 (0.489)	1.83 *** (0.701)	0.28 (0.466)
Women_ToShare	0.30 (0.968)	−0.05 (0.686)	1.45 * (0.851)	−0.31 (0.641)
Illiterate				
Primary	0.88 (0.889)	0.99 ** (0.432)	2.78 *** (1.054)	1.02 ** (0.436)
MorePrimary	2.24 *** (0.865)	1.33 *** (0.441)	2.98 *** (1.052)	1.34 *** (0.439)
Zaghouan				
Kef	−0.81 (0.588)	−0.59 (0.506)	−0.06 (0.541)	−0.81 * (0.470)
Siliana	−1.19 (0.746)	−0.65 (0.562)	0.35 (0.617)	−1.31 ** (0.533)
Beja	−1.67 *** (0.637)	−0.63 (0.482)	0.16 (0.531)	−0.57 (0.451)
GroupMember	−1.45 *** (0.468)	−0.41 (0.326)	−0.41 (0.361)	−0.35 (0.308)
Radio_learn	−0.27 (0.619)	2.51 ** (1.048)	0.32 (0.464)	1.32 ** (0.549)
Constant	−0.61 (1.323)	0.94 (0.935)	−4.70 *** (1.448)	0.64 (0.880)
Model Information				
Number of obs (n = 239)	239	239	239	239
LR Chi2(4)	29.49 ***	30.65 ***	31.04 ***	35.75 ***
Pseudo R2	0.1567	0.1048	0.1204	0.1091
Log likelihood	−79.3539	−130.9264	−113.4040	−146.0253

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. † Men only is the control group for this regression model.

3.5. Gendered Benefits of Digital Extension: Impacts on Adoption

Table 8 presents the results of a logistic regression model predicting which factors influence the likelihood that participants adopt new agricultural techniques and/or practices as a result of participating in the extension program. Importantly, we find that men are less likely ($p < 0.1$) than women to adopt new practices. When compared to their illiterate counterparts, participants with primary school education are more likely ($p < 0.1$) to adopt, as are those with more than primary level education ($p < 0.05$). Cooperative members, on the other hand, are less likely ($p < 0.05$) to adopt new practices than non-cooperative members. Finally, participants who reported learning from the radio programming are also more likely ($p < 0.05$) to adopt new techniques or practices.

Table 8. Logistic regression predicting adoption.

	Adoption
	Coefficient (Std. Error)
Gender_Male	−0.77 * (0.461)
Men_only †	
HusbandWives	0.09 (0.483)
Men_ToShare	0.02 (0.467)
Women_ToShare	−0.41 (0.631)
Illiterate	
Primary	0.75 * (0.424)
MorePrimary	0.91 ** (0.425)
Zaghouan	
Kef	−0.39 (0.455)
Siliana	−0.65 (0.514)
Beja	−0.62 (0.437)
GroupMember	−0.64 ** (0.302)
Radio_learn	1.16 ** (0.538)
Constant	1.32 (0.869)
Model Information	
Number of obs (n = 239)	239
LR Chi2(4)	30.04 ***
Pseudo R2	0.0915
Log likelihood	−149.1124

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. † Men only is the control group for this regression model.

We find that many of the practices adopted are related to livestock feeding, including the 10.3% of men (n = 58) and 16.0% of women (n = 75) who adopted new practices mixing feed for livestock. A total of 22.4% of men (n = 58) and 29.3% of women (n = 75) adopted the practice of providing fodder in specified quantities using a scale. Women reported adopting several practices with respect to grazing, including 4.0% of women (n = 75) who began grazing their animal later in the day to avoid pests, and 6.7% (n = 75) who began feeding livestock with *qaret* (green straw) in the morning after grazing in the fields and taking out the sheep to graze in the evening. Several practices relating to animal health were also adopted. For example, 48.3% of men (n = 58) and 52.0% of women (n = 75) reported adopting new practices around livestock vaccination. A total of 13.8% of men (n = 58) and 30.7% of women (n = 75) also adopted the practice of monitoring animal health closely and giving appropriate medication. There were also a substantial number of agricultural practices that were adopted. For example, 20.7% of men (n = 58) and 9.3% of women (n = 75) reported adopting new practices with respect to the cultivation of fodder crops. A total of 5.3% of women (n = 75) adopted timed applications of fertilizer, and 6.9% (n = 58) of men began using pesticides to remove parasitic weeds.

Importantly, we noted the highest rate of adoption of new agricultural practices among the group of husbands and wives that both received the SMS. Among the 100 husbands and wives who received the SMS, 141 instances of adoption were reported. This amounts to an average of 1.41 practices adopted per individual compared to the much lower rate of 0.73 practices per individual among men who were not prompted to share the information. Interestingly, men prompted to share adopted an average of 0.68 practices per individual, while women prompted to share adopted an average of 1.18 practices.

3.6. Barriers to Adoption

Many men and women also reported facing barriers to the adoption of new agricultural practices and/or techniques, specifically 22.3% of men (27 out of 121) and 33.9% (41 out of 121) of women. Among those who faced barriers, cost was most often cited, with 33.3% of men (n = 27) and 17.1% of women (n = 41) citing financial capabilities as a barrier. An additional 3.7% of men (n = 27) and 4.9% of women reported that practices they wished to adopt are prohibitively expensive. Importantly, 7.4% of men (n = 27) and 9.8% of women (n = 41) reported that fear of adopting new innovations prevents them from adopting practices communicated through the extension program. Several farmers also cited logistical barriers, for example, 7.4% of men (n = 27) and 9.8% of women (n = 41) noted that it was too late in the season for them to adopt certain practices, and 7.4% of men (n = 27) and 7.3% of women (n = 41) explained that the Regional Commission for Agriculture has not distributed the seed or provided the information they need to plant certain crops. With respect to land, 3.7% of men (n = 27) reported that the soil is infertile and/or tough to cultivate. For women, access to land constituted a major barrier to adoption, with 17.1% (n = 41) reporting either that their plot of land is too small or that they do not own land at all. For both women (11.1%, n = 41) and men (22.0%, n = 27), lack of water resources also represents a barrier to the adoption of agricultural practices. Additional barriers include the unavailability of fodder seeds, machinery, and small livestock herds. Finally, 7.4% of men (n = 27) and 7.3% of women (n = 41) felt that they did not understand the SMS messages well or that the information provided was incomplete.

3.7. Farmer Recommendations for Improving Digital Extension

Importantly, several farmers, both men (34.7%, 42 out of 121) and women (28.9%, 35 out of 121), had suggestions to improve the delivery of SMS information, including sending more detailed messages, sending simplified messages for better information retention, and adding in links to internet resources or the contact information for relevant services. Several participants suggested including new topics, for example, three women (8.6%, n = 35) recommended including additional information on beekeeping, two women (5.7%, n = 35) recommended information on raising chickens and rabbits, and four men (9.5%, n = 42) and one woman (2.9%, n = 35) recommended information on planting olive and fruit trees. Conversely, other farmers recommended focusing more exclusively on cropping (three men, 7.1%, n = 42; one woman, 2.9%, n = 35) or livestock rearing (two men 4.8%, n = 42; six women, 17.1%, n = 35). Several farmers suggested including a discussion of the problems that farmers face such as the high cost of seed and fodder (two women, 5.7%, n = 35) and climate change (one man, 2.4%, n = 42). Importantly, 15 men (35.7%, n = 42) and 9 women (25.7%, n = 35) felt that extension must be accompanied by tangible assistance accompanying extension services, for example, through face-to-face extension or by connecting them with the relevant authorities that can help them. Similarly, several men (14.3%, n = 42) and women (5.7%, n = 35) suggested that training was needed in order to help them develop agricultural projects.

With respect to radio programming, only a few men (3.3%, 4 out of 121) and women (13.2%, 16 out of 121) had suggestions to improve the radio programing component of the extension services. Specifically, three men and one woman suggested that radio extension could do better to address farmers' problems, such as fatigue, the high cost of fodder, and climate change. One man and one woman also felt that certain topics of interest could have been better addressed or further clarified, including information relating to crops, plowing methods, fertilizers, and pesticides. Interestingly, one man and one woman (3.1%, n = 32) suggested that the radio program could be improved by letting farmers participate in choosing the topics covered and by increasing interaction with the listeners. Three women also noted that face-to-face meetings with farmers is preferable to radio programs, while six women wanted longer programming with reminder messages, albeit with different timings. Finally, two women requested additional information about straw and *qaret*, meaning green straw in spoken Arabic.

4. Discussion

This study reinforced some established findings about ICTs, gender, and extension, namely that women's access to ICTs enables them to connect with important services, expands their networks and thus agency, and increases their decision making power in their households [1,4,32,33,35–39]. We also present novel findings regarding the effectiveness of sharing prompts and sending information to both husbands and wives, and the implications of different types of information and group membership, that are not as well documented in the literature. The study also sheds light on the importance of phone ownership for women.

We find that women's phone ownership is beneficial in terms of agriculture, primarily with respect to facilitating work by allowing women to connect with important services without leaving their homes. This represents a wealth of information and services that otherwise may have been difficult for women to access [40–43]. This also has implications for women's time poverty given that improved remote access may reduce travel time and increase efficiency. For example, women's mobile phone ownership allows access to important public services, such as health care, which is particularly important in contexts like Tunisia where women shoulder heavy domestic workloads that prohibit them from leaving the home [32]. Conversely, improving women's ability to work from home does little to challenge gender norms in this region, wherein women remain largely relegated to the domestic sphere despite their increasing economic roles [64]. In this context, patriarchal cultural norms that uphold male authority over women are reproduced within the family, shaping women's day-to-day lives despite relatively progressive laws and policies with respect to women's rights and freedoms [64]. These findings are similar to those of Malhotra and Ling [16] in India, where access to mobile phones improved domestic worker women's agency by allowing them to manage work and balance their domestic responsibilities more effectively. The authors highlight, however, that women often use phone access to fulfill traditional gender roles, by balancing their domestic and work responsibilities [16]. We suggest similarly that while providing phones to women has a significant impact insofar as improving their ability to farm, it does not alter the sociocultural context that defines women's roles and responsibilities.

Phone ownership was also important for women's personal use, particularly in connecting with family, friends, and relatives due to COVID-19 isolation measures, which reportedly broke the isolation that women are experiencing in rural and remote areas. Similar findings have been documented in Sri Lanka, where access to mobile phones has been shown to strengthen and expand women's social and support networks, which mitigates women's loneliness, boredom, and stress by facilitating a more frequent connectivity with kinship networks [32]. The impact of such connectivity cannot be understated within the context of increased isolation that many women face as a result of COVID-19, particularly given women's reliance on informal networks to access agricultural information [1]. With respect to farming, Spielman et al. [1] explain that women's social networks may represent an important source of peer-to-peer learning, which is supported by recent evidence from India and Nepal confirming that women farmers have increasingly relied on friends and family as sources of agricultural information during COVID-19 lockdowns [6]. In our study, women, and in particular mobile phone owners, widely shared extension information with others, including fellow workers and cooperative members. These findings indicate that mobile phone ownership improves social connectivity, which is important for women's wellbeing and for their farming.

In terms of the impact of gender-responsive digital extension, the results show that targeting women, in addition to men, is effective. Importantly, we find that women are more likely than men to adopt new practices as a result of gender-responsive digital extension, highlighting women's interest in and need for extension services. This is particularly noteworthy given that women report facing many of the same barriers to adoption as men (financial constraints, fear, access to water) in addition to their competing responsibilities, lack of training, and poor access to land. These findings are likely reflective of women's typical exclusion from extension services and indicate women's eagerness to learn about

skills and participate in activities that have traditionally only been offered to men [65]. Men, on the other hand, were less likely to adopt new practices and did not learn from or find the extension content on animal feeding useful. Broadly, this reflects the traditional gendered division of labor in this context, where women are often responsible for feeding and milking livestock [66]. Women's increased engagement and adoption may also reflect the feminization of agriculture in the region, which has seen women's roles in farming expand due to both male outmigration and men's increasing engagement in off-farm employment [65,67]. While the changing division of labor can be burdensome for women, it can also increase the "flexibility and complexity" of the gender division of labor and may contribute to renegotiations of gender relations within the household that improve women's power and control [67] (p. 203). Therefore, we emphasize the importance of not only including women in extension services but providing additional support to ensure that women's labor burden does not become overwhelming.

Furthermore, our results demonstrate that gender-responsive digital extension can improve women's participation in agricultural decision making [4,59]. Our findings add to a growing body of literature, providing empirical evidence of the importance of gender-responsive digital extension services with respect to women's ability to learn from and adopt new agricultural practices, as well as the impact that this has on their participation in agricultural decision making within the household [4,56]. The success of the digital extension program for women in our study may indicate that the gender-sensitive methods of information delivery, for example, removing gendered language that favors men and including radio programming featuring women experts, were successful. Our findings emphasize that the best way to ensure women receive this information is to (1) provide women with mobile phones and (2) target both women and men living in the same household. The latter group reported the highest rate of practices adopted. Moreover, we find that learning for knowledge-intensive topics such as CA was higher among husband and wife pairs, as well and men and women prompted to share the extension information with their spouses. This suggests that extension content on knowledge-intensive topics can be more effectively delivered when information is shared and discussed between spouses. Given that there is low uptake of CA more broadly in the Middle East and North Africa (MENA) region [68], our findings suggest that more gender-inclusive digital extension, accompanied by sharing prompts, may help with the uptake of CA and other knowledge-intensive practices. Though it may seem unsurprising that agricultural extension is most effective when both women and men are targeted, in practice, extension services still often target men and/or heads of household [4,52,69]. The continued ubiquity of these approaches, despite longstanding critiques, stems from an enduring failure to recognize women farmers in their own right, as well as the assumption that household heads will share information with other household members [1,4,70,71]. Our findings confirm results from other contexts such as the Democratic Republic of Congo, where Lambrecht et al. [72] find that extension services have a greater impact on adoption when men and women in the same household are both targeted. We also find that sharing prompts were effective, which is important given that many women still do not have access to phones in this context. While we strongly advocate for improving women's access to and ownership of phones, sharing prompts may be an effective means of increasing women's access to extension information in the time being.

Consistently, we identify that farmers with higher levels of education found the extension services more useful, and that these groups were also more likely to learn from and adopt new practices. This may be because educated farmers are better able to perceive, interpret, and respond to new information more quickly than less educated farmers, influencing their engagement with extension services [73,74]. This suggests that SMS extension must still be improved in order to fully benefit illiterate farmers, many of whom are women. In this respect, our findings regarding radio programming are particularly salient. Participants who reported learning from the radio programming component of the extension services were likely to: share information with others, see the

programming as useful, report learning, and adopt new agricultural techniques and/or practices. This suggests that radio programming, often included in digital extension programs due to their great potential for inclusivity [2], can enhance the effectiveness of digital extension. There is also potential for the radio extension to be improved in collaboration with farmers who have suggested more participative or interactive elements would improve their engagement. Such participative approaches have been successful in contexts such as Malawi and India [75,76]. Additionally, participants' interest in extension services that more broadly address the challenging conditions that farmers are experiencing, for example, with respect to climate change, is notable. Their interest reflects the broader evolution of extension services toward addressing scale social and economic problems that affect farming at the community and household levels [1]. This may be a fertile area for the improvement of future digital extension programs.

Finally, we find that men and women who are members of a cooperative found the extension information to be less useful, were less likely to adopt new practices, and were less likely to report having learned about organizations. This may be because cooperative members are already familiar with organizations and their day-to-day operations. They may also have better access to extension services, information, and new technologies, meaning information may have been repetitive or that they may already employ similar practices to that which were shared [77,78].

5. Conclusions

Overall, our study highlights the importance of phone ownership to women farmers in Tunisia, with respect to participating in agricultural extension, connecting with essential services, and social networking. In facilitating women's access to agricultural extension, phone ownership improved their confidence and participation in household decision making, which has the potential to improve women's agency and contribute toward a more equal balance of power within the household. We have operationalized gender-response digital extension to include gender-inclusive language, sharing prompts, improving women's access to phones, and use of radio to compensate for high illiteracy levels, particularly among women. With this study, we have provided empirical evidence of the effectiveness of gender-responsive digital extension for men and especially women in terms of usefulness, learning, and adoption. We also identify education level and cooperative membership as important factors that determine the impact digital extension services have on farmers. The effect of education level on the impact of digital extension emphasizes the importance of more verbal and visual (non-written) extension practices, such as radio programming. While there are certainly contextual differences between countries, the disadvantages women face with respect to accessing digital extension services remains a common challenge. We have demonstrated in the discussion section above that certain aspects of these findings may be generalizable to other rural contexts in LMICs.

Digital extension has been identified as a cost-effective and efficient means of delivering information to farmers and is a method that shows promise in the face of COVID-19 lockdowns and social distancing measures that prevent the delivery of face-to-face extension services [6]. Indeed, in the face of the COVID-19 pandemic, digital extension in LMICs has gained prominence among researchers and practitioners alike [5,6,48,79–81]. This is because digital extension is a cost-effective way to improve the reach of extension programs, providing rural and remote farmers with important agricultural information and connecting them to supply chains, service providers, and markets [5,6]. With the increasing importance of digital extension in the era of COVID-19, we add to the growing body of evidence that gender-responsive digital extension can benefit women by narrowing the gendered information gap, increasing adoption, and improving women's decision making.

The salient message is that providing women with access to ICTs and extension information is a basic human right that also improves the adoption of agricultural practices, including knowledge-intensive ones. The fact that women are more likely to adopt new practices despite facing many of the same barriers to adoption as men (financial constraints,

fear, access to water), in addition to their competing responsibilities, lack of training, and poor access to land, most poignantly supports the importance of this conclusion.

There are several limitations to this study which point to the need for further research. While participants were asked whether or not they shared the extension information with others, there was no follow-up with spouses or other household members to determine whether or not the information was indeed shared with them. With respect to the phones distributed to women, sim cards were kept operational through credit renewal every 6 months. It is unclear how women's phones will be maintained after the completion of the project in 2023. Despite these limitations, this study presents important findings relevant to gender-responsive agricultural policy and practice.

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References

1. Spielman, D.; Lecoutere, E.; Makhija, S.; Van Campenhout, B. Information and Communications Technology (ICT) and Agricultural Extension in Developing Countries. *Annu. Rev. Resour. Econ.* **2021**, *13*, 177–201. [CrossRef]
2. Ragasa, C. Improving gender responsiveness of agricultural extension. In *Gender in Agriculture*; Springer: Berlin/Heidelberg, Germany, 2014; pp. 411–430.
3. Manfre, C.; Rubin, D.; Allen, A.; Summerfield, G.; Colverson, K.; Akeredolu, M. Reducing the gender gap in agricultural extension and advisory services: How to find the best fit for men and women farmers. *Meas Brief* **2013**, *2*, 1–10.
4. Lecoutere, E.; Spielman, D.J.; Van Campenhout, B. *Women's Empowerment, Agricultural Extension, and Digitalization: Disentangling Information and Role-Model Effects in Rural Uganda*; International Food Policy Research Institute: Washington, DC, USA, 2020.
5. FAO. Gender-Responsive Digitalization: A Critical Component of the COVID-19 Response in Africa Accra, Ghana. 2021. Available online: https://www.fao.org/documents/card/en/c/cb5055en/ (accessed on 15 March 2022).
6. Alvi, M.; Barooah, P.; Gupta, S.; Saini, S. Women's access to agriculture extension amidst COVID-19: Insights from Gujarat, India and Dang, Nepal. *Agric. Syst.* **2021**, *188*, 103035. [CrossRef]
7. Copley, A.; Decker, A.; Delavelle, F.; Goldstein, M.; O'Sullivan, M.; Papineni, S. COVID-19 Pandemic through a Gender Lens. Africa Gender Innovation Lab, World Bank, Washington DC. 2020. Available online: https://www.semanticscholar.org/paper/COVID-19-Pandemic-Through-a-Gender-Lens-Copley-Decker/740a6c56b63843ee1ad82288ad60945be0959e42 (accessed on 15 March 2022).
8. Puskur, R.; Mohan, R.R.; Gadeberg, M. COVID-19 Opens Unknown Chapter on Rural Women's Plight in India's Migration Saga. Gender Platform Blog Series. 2020. Available online: https://gender.cgiar.org/news-events/covid-19-opens-unknown-chapter-rural-womens-plight-indias-migration-saga (accessed on 15 March 2022).

9. Gates, M.F. Putting women and girls at the center of development. *Science* **2014**, *345*, 1273–1275. [CrossRef] [PubMed]
10. Steinke, J.; Achieng, J.O.; Hammond, J.; Kebede, S.S.; Mengistu, D.K.; Mgimiloko, M.G. Household-specific targeting of agricultural advice via mobile phones: Feasibility of a minimum data approach for smallholder context. *Comput. Electron. Agric.* **2019**, *162*, 991–1000. [CrossRef]
11. Technical Centre for Agricultural and Rural Cooperation (CTA). The Digitalization of African Agriculture Report 2018–2019. 2019. Available online: http://www.fao.org/family-farming/detail/en/c/1199305/ (accessed on 15 March 2022).
12. Van Campenhout, B.; Spielman, D.; Lecoutere, E. The role of gender in ICT-mediated agricultural information campaigns. In Proceedings of the 30th International Conference of Agricultural Economists, Vancouver, BC, Canada, 28 July–2 August 2018.
13. UN Women. The Women's Empowerment Principles–Equality Means Business Initiative. 2010. Available online: https://www.unwomen.org/en/digital-library/publications/2011/10/women-s-empowerment-principles-equality-means-business#view (accessed on 15 March 2022).
14. Sen, A. *Development as Freedom*; Oxford University Press: Oxford, UK, 1999.
15. Peter, F. Gender and the foundations of social choice: The role of situated agency. *Fem. Econ.* **2003**, *9*, 13–32. [CrossRef]
16. Malhotra, P.; Ling, R. Agency within contextual constraints: Mobile phone use among female live-out domestic workers in Delhi. *Inf. Technol. Int. Dev.* **2020**, *16*, 15.
17. OECD. Bridgin the Digital Gender Divide: Include, Upskill, Innovate. 2018. Available online: https://www.oecd.org/digital/bridging-the-digital-gender-divide.pdf (accessed on 15 March 2022).
18. Gill, K.; Brooks, K.; McDougall, I.; Patel, P.; Kes, A. Bridging the Gender Divide: How Technology Can Advance Women Economically Washington DC. 2010. Available online: https://cleancooking.org/binary-data/RESOURCE/file/000/000/294-2.pdf (accessed on 15 March 2022).
19. Singh, S. Bridging the gender digital divide in developing countries. *J. Child Media* **2017**, *11*, 245–247. [CrossRef]
20. Barboni, G.; Field, E.; Pande, R.; Rigol, N.; Schaner, S.; Moore, C.T. *A Tough Call: Understanding Barriers to and Impacts of Women's Mobile Phone Adoption in India*; Harvard Kennedy Sch.: Boston, MA, USA, 2018.
21. Pew Research Center. Internet Seen as Positive Influence on Education but Negative Influence on Morality in Emerging and Developing Nations Washington DC. 2015. Available online: https://www.pewresearch.org/wp-content/uploads/sites/2/2015/03/Pew-Research-Center-Technology-Report-FINAL-March-19-20151.pdf (accessed on 15 March 2022).
22. Moghaddam, G.G. Information technology and gender gap: Toward a global view. *Electron. Libr.* **2010**, *28*, 722–733. [CrossRef]
23. Wajcman, J. Feminist theories of technology. *Camb. J. Econ.* **2010**, *34*, 143–152. [CrossRef]
24. Gurumurthy, A. Gender Equality through ICT Access and Appropriation: Taking a Rights-Based Approach. Occasional Paper, IT for Change, Bangalore, India. 2008. Available online: https://www.researchgate.net/publication/242233922_Gender_Equality_through_ICT_Access_and_Appropriation_Taking_a_Rights-Based_Approach (accessed on 15 March 2022).
25. Herbert, S. *Digital Inclusion–Recent Trends and Messages*; Institute of Development Studies: Brighton, UK, 2017.
26. Alliance for Affordable Internet (A4AI). 2017 Affordability Report. 2017. Available online: https://1e8q3q16vyc81g8l3h3md6q5f5e-wpengine.netdna-ssl.com/wp-content/uploads/2017/02/A4AI-2017-Affordability-Report.pdf (accessed on 15 March 2022).
27. GSMA. Bridging the Gender Gap: Mobile Access and Usage in Low and Middle-Income Countries. 2015. Available online: https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2016/02/Connected-Women-Gender-Gap.pdf (accessed on 15 March 2022).
28. GSMA. Mobile Industry Impact Report: Sustainable Development Goals. 2017. Available online: https://www.gsma.com/betterfuture/wp-content/uploads/2020/05/2017-09-18-SDG-Impact-Report.pdf (accessed on 15 March 2022).
29. World Bank. Development Report 2016: Digital Dividends. 2016. Available online: http://documents.worldbank.org/curated/en/896971468194972881/pdf/102725-PUBReplacement-PUBLIC.pdf (accessed on 15 March 2022).
30. Mumporeze, N.; Prieler, M. Gender digital divide in Rwanda: A qualitative analysis of socioeconomic factors. *Telemat. Inform.* **2017**, *34*, 1285–1293. [CrossRef]
31. Kusimba, S.; Yang, Y.; Chawla, N. Hearthholds of mobile money in western Kenya. *Econ. Anthropol.* **2016**, *3*, 266–279. [CrossRef]
32. Handapangoda, W.S.; Kumara, A.S. The world at her fingertips? Examining the empowerment potential of mobile phones among poor housewives in Sri Lanka. *Gend. Technol. Dev.* **2013**, *17*, 361–385. [CrossRef]
33. Richardson, D.; Ramirez, R.; Haq, M. *Grameen Telecom's Village Phone Programme in Rural Bangladesh: A Multi-Media Case Study Final Report*; CIDA: Grand Rapids, MI, USA, 2000; pp. 1–104.
34. Sinha, C.; Schryer-Roy, A.-M. Digital health, gender and health equity: Invisible imperatives. *J. Public Health* **2018**, *40*, 1–5. [CrossRef] [PubMed]
35. Martínez-Fernández, A.; Lobos-Medina, I.; Díaz-Molina, C.A.; Chen-Cruz, M.F.; Prieto-Egido, I. TulaSalud: An m-health system for maternal and infant mortality reduction in Guatemala. *J. Telemed. Telecare* **2015**, *21*, 283–291. [CrossRef]
36. Burrowes, V.J. *Bangles, Breath, and Machines-Evaluation of Novel Personal Exposure Methods to Measure Household Air Pollution in Puno, Peru*; Johns Hopkins University: Baltimore, MD, USA, 2019.
37. Ashraf, M.; Hasin, M.; Salahuddin, A.B.E.; Ahmed, S.; Ro, S.-C.; Ray, P. The potential scope of m-health initiative into Grameen renewable energy in Bangladesh. *Mortality* **2000**, *3*, 5.
38. Starrs, A.M.; Ezeh, A.C.; Barker, G.; Basu, A.; Bertrand, J.T.; Blum, R. Accelerate progress—Sexual and reproductive health and rights for all: Report of the Guttmacher–Lancet Commission. *Lancet* **2018**, *391*, 2642–2692. [CrossRef]
39. Gorski, P. Education equity and the digital divide. *AACE Rev.* **2005**, *13*, 3–45.

40. Tyers, A. A Gender Digital Divide? Women Learning English through ICTs in Bangladesh. In *mLearn*; British Council Bangladesh: Dhaka, Bangladesh, 2012; pp. 94–100.
41. Khan, F.; Ghadially, R. Empowerment through ICT education, access and use: A gender analysis of Muslim youth in India. *J. Int. Dev.* **2010**, *22*, 659–673. [CrossRef]
42. Dahya, N.; Dryden-Peterson, S. Tracing pathways to higher education for refugees: The role of virtual support networks and mobile phones for women in refugee camps. *Comp. Educ.* **2017**, *53*, 284–301. [CrossRef]
43. Cummings, C.; O'Neil, T. Do Digital Information and Communications Technologies Increase the Voice and Influence of Women and Girls? London. 2015. Available online: https://odi.org/en/publications/do-digital-information-and-communications-technologies-increase-the-voice-and-influence-of-women-and-girls/ (accessed on 15 March 2022).
44. Hilbert, M. Digital gender divide or technologically empowered women in developing countries? A typical case of lies, damned lies, and statistics. *Womens Stud. Int. Forum* **2011**, *34*, 479–489. [CrossRef]
45. Wallis, C. Mobile phones without guarantees: The promises of technology and the contingencies of culture. *New Media Soc.* **2011**, *13*, 471–485. [CrossRef]
46. Jackson, M.H. Exploring Gender, Feminism and Technology from a Communication Perspective: An Introduction and Commentary. *Women's Stud. Commun.* **2007**, *30*, 149–156. [CrossRef]
47. Harding, S. Just add Women and Stir? In *Missing Links: Gender Equity in Science and Technology for Development*; IDRC: Ottawa, ON, Canada, 1995; pp. 295–308.
48. International Fund for Agricultural Development (IFAD). Digital Information Service Helps Small-Scale Farmers Respond to COVID-19. 2021. Available online: https://www.ifad.org/en/web/latest/-/digital-information-service-helps-small-scale-farmers-respond-to-covid-19?p_l_back_url=%2Fen%2Fweb%2Flatest%2Fgallery%3Fstart%3D2 (accessed on 15 March 2022).
49. Steeves, H.L.; Kwami, J.D. ICT4D, Gender Divides, and Development: The Case of Ghana. In *Development Communication in Directed Social Change: A Reappraisal of Theories and Approaches*; Asian Media Information and Communication Centre (AMIC): Singapore, 2012; pp. 199–217.
50. FAO. The State of Food and Agriculture 2010–2011: Women in Agriculture: Closing the Gender Gap for Development. 2011. Available online: https://www.unwomen.org/en/docs/2011/1/state-of-food-and-agriculture-2010-2011#view (accessed on 15 March 2022).
51. Action Aid. What Women Farmers Need: A Blueprint for Action. 2011. Available online: https://actionaid.org/publications/2011/what-women-farmers-need-blueprint-action (accessed on 15 March 2022).
52. Diaz, I.I.; Najjar, D. Gender and agricultural extension: Why a gender focus matters. *J. Gend. Agric. Food Secur.* **2019**, *4*, 1–10.
53. Galie, A. *The Empowerment of Women Farmers in the Context of Participatory Plant Breeding in Syria: Towards Equitable Development for Food Security*; Wageningen University: Wageningen, The Netherlands, 2013.
54. Najjar, D.; Abdallah, I.; Alma, E. *Gender Roles and Relations in the Wheat Production of Sudan: Strengthening the Participation of Women*; International Center for Agricultural Research in the Dry Areas (ICARDA): Aleppo, Syria, 2016.
55. Ameen, N.; Willis, R.; Shah, M.H. An examination of the gender gap in smartphone adoption and use in Arab countries: A cross-national study. *Comput. Hum. Behav.* **2018**, *89*, 148–162. [CrossRef]
56. Badran, M.F. Bridging the gender digital divide in the Arab Region. In *The Future of Work in the Global South*; IDRC: Ottawa, ON, Canada, 2018; pp. 34–39.
57. GSMA. Connected Women. The Mobile Gender Gap Report. 2021. Available online: https://www.gsma.com/r/wp-content/uploads/2021/07/The-Mobile-Gender-Gap-Report-2021.pdf (accessed on 15 March 2022).
58. International Telecommunication Union (ITU). Digital Trends in the Arab States Region 2021: Information and Communication Technology Trends and Developments in the Arab States Region, 2017–2020. Available online: https://arabdevelopmentportal.com/publication/digital-trends-arab-states-region-2021-information-and-communication-technology-trends (accessed on 15 March 2022).
59. Mittal, S. Role of Mobile Phone-enabled Climate Information Services in Gender-inclusive Agriculture. *Gend. Technol. Dev.* **2016**, *20*, 200–217. [CrossRef]
60. Chowdhury, A.H.; Van Mele, P.; Hauser, M. Contribution of Farmer-to-Farmer Video to Capital Assets Building: Evidence from Bangladesh. *J. Sustain. Agric.* **2011**, *35*, 408–435. [CrossRef]
61. Steinke, J.; van Etten, J.; Müller, A.; Ortiz-Crespo, B.; van de Gevel, J.; Silvestri, S.; Priebe, J. Tapping the full potential of the digital revolution for agricultural extension: An emerging innovation agenda. *Int. J. Agric. Sustain.* **2020**, *19*, 549–565. [CrossRef]
62. Najjar, D.; Baruah, B.; Al-Jawhari, N. Decision-Making Power of Women in Livestock and Dairy Production in Jordan Lebanon. 2019. Available online: https://repo.mel.cgiar.org/handle/20.500.11766/10882 (accessed on 15 March 2022).
63. Najjar, D.; Oueslati, D.; Benghanem, H.; Werner, J.; Baruah, B. Gender and Agriculture in Tunisia: A Brief Country Report. 2019. Available online: https://hdl.handle.net/20.500.11766/10506 (accessed on 15 March 2022).
64. Grami, A. Gender Equality in Tunisia. *Br. J. Middle East. Stud.* **2008**, *35*, 349–361. [CrossRef]
65. Najjar, D.; Baruah, B. Gender, Livestock Rearing, Rangeland Use, and Climate Change Adaptation in Tunisia. 2021. Available online: https://repo.mel.cgiar.org/handle/20.500.11766/66305 (accessed on 15 March 2022).
66. Latreille, M. Honor, the gender division of labor, and the status of women in rural Tunisia—A social organizational reading. *Int. J. Middle East Stud.* **2008**, *40*, 599–621. [CrossRef]

67. Gana, A. Processes of Liberalization and Family Farm Restructuring in Tunisia. In Proceedings of the 4th European IFSA Symposium: Farming and Rural Systems Research and Extension–Local Identities and Globalisation. International Farming Systems Association–Europe Group, Volos, Greece, 2–7 April 2000; pp. 198–207. Available online: http://ifsa.boku.ac.at/cms/index.php?id=73 (accessed on 15 March 2022).
68. Yigezu, Y.A.; El-Shater, T.; Boughlala, M.; Devkota, M.; Mrabet, R.; Moussadek, R. Can an incremental approach be a better option in the dissemination of conservation agriculture? Some socioeconomic justifications from the drylands of Morocco. *Soil Tillage Res.* **2021**, *212*, 105067. [CrossRef]
69. Ragasa, C.; Berhane, G.; Tadesse, F.; Taffesse, A.S. Gender Differences in Access to Extension Services and Agricultural Productivity. *J. Agric. Educ. Ext.* **2013**, *19*, 437–468. [CrossRef]
70. Meinzen-Dick, R.; Quisumbing, A.; Behrman, J.; Biermayr-Jenzano, P.; Wilde, V.; Noordeloos, M.; Ragasa, C.; Beintema, N. *Engendering Agricultural Research, Development and Extension*; International Food Policy Research Institute (IFPRI): Washington, DC, USA, 2011.
71. Fletschner, D.; Mesbah, D. Gender Disparity in Access to Information: Do Spouses Share What They Know? *World Dev.* **2011**, *39*, 1422–1433. [CrossRef]
72. Lambrecht, I.; Vanlauwe, B.; Maertens, M. Agricultural extension in Eastern Democratic Republic of Congo: Does gender matter? *Eur. Rev. Agric. Econ.* **2016**, *43*, 841–874. [CrossRef]
73. Suvedi, M.; Ghimire, R.; Kaplowitz, M. Farmers' participation in extension programs and technology adoption in rural Nepal: A logistic regression analysis. *J. Agric. Educ. Ext.* **2017**, *23*, 351–371. [CrossRef]
74. Mugonola, B.; Deckers, J.; Poesen, J.; Isabirye, M.; Mathijs, E. Adoption of soil and water conservation technologies in the Rwizi catchment of south western Uganda. *Int. J. Agric. Sustain.* **2013**, *11*, 264–281. [CrossRef]
75. Chapota, R.; Fatch, P.; Mthinda, C. The Role of Radio in Agricultural Extension and Advisory Services–Experiences and Lessons from Farm Radio Programming in Malawi–Volume 8, MEAS Case Study. 2014. Available online: https://farmradio.org/wp-content/uploads/2020/09/MEAS-CS-Malawi-Farm-Radio-Chapota-Fatch-Mthinda-Feb-2014-1.pdf (accessed on 15 March 2022).
76. Bishta, K.; Sahb, P.; Rautc, A.A. Radio: An effective tool in the present context to serve the rural farming community. *J. Agric. Biol. Environ. Sci.* **2014**, *1*, 18–21.
77. Abebaw, D.; Haile, M.G. The impact of cooperatives on agricultural technology adoption: Empirical evidence from Ethiopia. *Food Policy* **2013**, *38*, 82–91. [CrossRef]
78. Wossen, T.; Abdoulaye, T.; Alene, A.; Haile, M.G.; Feleke, S.; Olanrewaju, A.; Manyong, V. Impacts of extension access and cooperative membership on technology adoption and household welfare. *J. Rural Stud.* **2017**, *54*, 223–233. [CrossRef]
79. Amjath-Babu, T.S.; Krupnik, T.J.; Thilsted, S.H.; McDonald, A.J. Key indicators for monitoring food system disruptions caused by the COVID-19 pandemic: Insights from Bangladesh towards effective response. *Food Secur.* **2020**, *12*, 761–768. [CrossRef] [PubMed]
80. Dharmawan, L.; Muljono, P.; Hapsari, D.R.; Purwanto, B.P. Digital information development in agriculture extension in facing new normal era during COVID-19 pandemics. *J. Hunan Univ. Nat. Sci.* **2021**, *47*, 64–73.
81. Ramadhani, A.R.; Hartatri, D.F.S.; Akbar, S. Coffee and cocoa dissemination through information and communication technology (ICT) during the Covid-19 pandemic. *E3S Web Conf.* **2021**, *306*, 03018. [CrossRef]