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Pilot study of a digital literacy-based intervention to confront concomitant crises amongst key food system actors in Chile

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Introduction: The fragility of food systems in Chile has been exposed through concomitant crises, from a social crisis in 2019 to the COVID-19 pandemic, and ongoing climate change. There is an increased dependence on information and communication technologies (ICTs) to produce, sell, and consume food and the digital divide has increased. The lack of digital literacy in Chile has not been evaluated or considered within comprehensive interventions.

Methods: To examine how local food systems can be strengthened, we conducted a pilot study of a digital literacy-based intervention with smallholder farmers, vendors, and consumers ($n = 96$) of different age groups (25–45 y, and 46–65 y) from adjacent urban and rural regions in Chile. Telephone surveys were carried out on the use of ICTs, access to the food environment, and agricultural practices during crises. A 5-week digital literacy intervention was carried out on digital confidence, the use of ICTs to generate networks, networks, the use of apps to sell or buy food, banking operations, and communication with state agencies. We also planned a virtual conversation about the food system and nutrition in Chile.

Results: All participants knew how to read and send WhatsApp messages but >50% of farmers and vendors reported cell signal problems. Between the 2019 social crisis and the COVID-19 pandemic, supermarkets as the main source of food decreased from 79 to 57%, and delivery increased from 2 to 17%. In total, 92% of the participants received the intervention, and 52% expressed satisfaction. Across participants, the average implementation score was 61%. Only one person connected to the virtual conversation.

Discussion: Crises have impacted how the Chilean population in both urban and rural regions navigate their food environment for their household as well as small-scale agricultural production in these areas; elucidating a greater dependency on ICTs amongst small-scale farmers, vendors, and consumers in Chile to buy and/or sell food. We also conclude that it is feasible to implement a digital literacy intervention for key food system actors in urban and rural settings in Chile. Future studies will contribute to the evidence base about the feasibility and impact of similar digital literacy interventions; an area of increasing importance given the rising prevalence of the digital food environment worldwide.

KEYWORDS

food systems, digital literacy, concomitant crises, Chile, COVID-19, climate change

Introduction

Ongoing climate change together with the COVID-19 pandemic have exposed vulnerabilities in both local and global food systems (FAO, IFAD, UNICEF, WFP, and WHO, 2022). In the case of Chile, a social crisis that started in October 2019 led to the damage of many supermarkets, some of which remained closed during the COVID-19 pandemic. This, together with ongoing climate change, has had an impact on the Chilean food system, making its fragility visible (Kanter and Boza, 2020). These concomitant crises are superimposed on the existing challenges of obesity, undernutrition, and climate change; referred to as the global syndemic (Swinburn et al., 2019). The COVID-19 pandemic highlighted the importance of the digital food environment, or the digital aspects of food environments that include both digital sectors (e.g., digital food sales) and actors (e.g., public and private entitles) that interact in digital settings (e.g., smartphone applications, social media) (Granheim, 2019). The digital food environment, in Chile and globally, has exacerbated the digital divide by pushing many to depend on information and communications technologies (ICTs) to produce, sell, and eat their food and excluding those that lack digital literacy or ICT access. The UN Educational, Scientific and Cultural Organization (UNESCO) defines digital literacy as "a set of basic skills which include the use and production of digital media, information processing and retrieval, participation in social networks for creation and sharing of knowledge, and a wide range of professional computing skills" (Karpati, 2011, p. 1). Digital tools, or ICT, can strengthen local food systems by (1) informing consumers about healthy and sustainable diets to motivate behavior change and; (2) facilitating linkages between food demand and supply (Todorovic et al., 2018). However, how to improve digital literacy for agriculture and food systems actors is largely ignored (World Bank, 2017; Trendov et al., 2019). The impact of digital literacy on strengthening food systems has not yet been evaluated in Chile, nor have comprehensive interventions been proposed in this regard.

In Chile, smartphone use became common in the general population relatively early compared to other Latin American countries, such that by 2010 there was on average more than one mobile cellular subscription per inhabitant (World Bank, 2022). Studies prior to the COVID-19 pandemic suggest that small-scale producers did not use online services for business-related purposes, such as online banking, sales, purchase of inputs, or carrying out administrative procedures with public institutions (Boza et al., 2018, 2019). The strict COVID-19 lockdown measures in Chile, which led to farmers market closures, prompted an increased demand for the delivery of fresh products (Boza and Kanter, 2021). The global impact of COVID-19 exacerbated the dependence on the digital food environment in Latin America and elsewhere, even with great diversity in the makeup of local food systems within and between countries (O'Meara et al., 2022). Commonalities have been observed in the way that food systems of different countries dealt with COVID-19, both in its impacts and in its adaptation and resilience strategies, which suggests that this pilot study may be useful for other countries.

Leading up to the COVID-19 pandemic, small-scale producers in Chile were not taking advantage of how digital tools could help them in their value chain (Klerkx et al., 2019). The subsequent ramifications of this limited the promise of small-scale producers in Chile to contribute to the expanding digital food environment through greater sales of fresh products. A better understanding of digital literacy amongst key food system actors in Chile will provide insights as to how to strengthen food systems through digital means. Therefore, from 2022 to 2023, we conducted a virtual study to pilot a digital literacy intervention amongst key food systems actors in the adjacent Metropolitan and O'Higgins regions of Chile, where there is a high adult obesity prevalence and where fresh food provision, especially fruits and vegetables, is concentrated (Boza et al., 2020). This approach addresses the limitations of previous studies that have not specifically examined digital literacy amongst food system actors for the purpose of food systems strengthening.

The primary aim of the pilot study was to assess the feasibility of implementing a digital literacy intervention amongst three key actors from Chilean food systems: small-scale farmers, farmers market vendors, and consumers. The secondary aim of the pilot study was to identify how the fragility of food systems in Chile has manifested itself during concomitant crises (social, COVID-19, climate change) and elucidate trends in the usage of information and communication technologies (ICTs) to produce, sell and consume food. Thus, the purposes of this article are: (i) to present how key food systems actors in Chile have utilized ICTs between 2019 and 2021; (ii) to present the core components of the digital literacy intervention; (iii) to present strategies used in its pilot implementation; and (iv) to discuss lessons learned during the implementation and evaluation of the pilot study, and share implications for subsequent digital literacy interventions globally. The present study is unique in that its focus is on digital literacy, rather than ICT utilization, and the importance of tailoring a digital literacy intervention based on food system actor group and area (urban/rural); enabling a better understanding of how to implement digital literacy interventions for local food systems strengthening.

Evidence before this study on the role of ICT and food systems

We searched PubMed for any study published up until 28 July 2023 using the search terms "ICT" or "Information and Communication Technologies" and "food systems" which yielded six results; of which three were relevant to this study. Samoggia et al. have conducted a systematic review of "digital technologies in the agro-food sector" in which they concluded that "Apps" are the most prevalent digital technology within the agro-food chain, especially within the production, distribution, and consumption sectors (Samoggia et al., 2021). In China, in response to the COVID-19 pandemic, Zhan and Chen highlight the important role that ICTs played in keeping the food supply chains operating as normally as possible, from virtual technical support to agricultural producers, to virtual events to connect all the actors in the food supply chains, and digital applications for e-commerce that included contactless delivery services (Zhan and Chen, 2021). In the third paper, MacKenzie and Davies describe the co-design of an online sustainability impact assessment (SIA) framework called SHARE IT with the purpose of disseminating "ICT-mediated food sharing initiatives" and their subsequent impacts on urban food systems, especially in terms of its contribution to the sustainability of said systems (Mackenzie and Davies, 2019). In this context, food sharing is defined as activities around food that are not limited to eating or drinking together, such as community gardens, community kitchens, and redistributing food

products to those in need; of which websites, apps, and social media platforms are becoming the common means to promote food sharing initiatives (Mackenzie and Davies, 2019). On the Share City website, one can search a database of such initiatives and register a food-sharing initiative, and undertake a related sustainability assessment if desired (ShareCity, 2023). All three of these studies highlight the myriad positive contributions ICT has brought to food systems that can be applied to different contexts globally. However, none of these three articles mentioned digital literacy and thus, presume that the users and beneficiaries of said ICTs within food systems have the level of digital literacy necessary and sufficient to utilize the given ICT.

A second PubMed search for "digital literacy" and "food systems" resulted in only one new (2023) study on the multi-faceted role that Facebook has played in strengthening how small farmers in Myanmar do business (Faxon, 2023). While this work was funded through a grant from "Facebook Research on digital literacy, demographics and misinformation in Myanmar," digital literacy, or literacy alone, is not mentioned in the body of the text itself (Faxon, 2023). These studies suggest that food systems actors can benefit from ICT use through online videos, apps, and different social media platforms that greater digital literacy can help facilitate. Digital literacy is not limited to solely the literal use of ICT nor its production (e.g., the Share City website) as both the user and the beneficiary process its respective information, and in the case of social media, participate in social networks to both create and share knowledge (Reddy et al., 2020). Thus, a greater focus on education around digital literacy competencies is warranted to ensure that the maximum positive benefit and reach of ICTs within food systems is achieved and that they do not exacerbate the current digital divide that still exists in many countries (Reddy et al., 2023). Taken together, digital literacy is important because it improves the utilization of ICTs which in turn can help strengthen food systems through different impacts throughout the agri-food chain.

Methods

Study setting and sample

The study was conducted in two adjacent regions in the center of Chile: the more urban Metropolitan Region where over half of the Chilean population resides and the capital, Santiago, is located, and the rural Region of O'Higgins. The region of O'Higgins has one of the largest rural populations in Chile and an economy heavily dependent on agriculture that together offers important socio-demographical contrasts compared to the Metropolitan region (Rengifo et al., 2022). While both regions have a high prevalence of adult obesity, more school-age children are obese in rural areas than those in urban areas (JUNAEB -Ministerio de Educación, 2023). The region of O'Higgins has one of the greatest proportions of employed men and women in the agricultural sector (21.4%) of Chile's 16 regions, while the Metropolitan region has one of the lowest (1.8%) (ODEPA, 2023). However, the predominance of seasonal agricultural work in the O'Higgins region has led to one of the country's highest unemployment rates for contract (non-salary) workers. Thus, O'Higgins is one of two regions in which, independent of an average educational completion of 12 years, the majority of employed people are located in vulnerable areas and with an average income that does not exceed 1.5 times the minimum wage (Municipalidad Rancagua, 2018). While the Ministry of Agriculture has designated many places within both regions as agricultural emergency areas due to drought, extreme weather events have a greater impact on the O'Higgins region related to the aforementioned characteristics (MINAGRI, 2023). Given these socio-demographical contrasts between the O'Higgins and Metropolitan regions, the proximity between the two in turn motivated the selection of these two regions for the study setting. The study sample was designed to include 96 participants stratified by region (n = 48), by actor (small farmer, vendors, and consumers), and by age group (25 to 45 years and 46 to 65 years) and sex to provide a pilot size sample sufficient to assess the feasibility and acceptability of a digital literacy intervention. Overall, for each category of region, actor, age group, and sex four participants were included if they reported residing in the specified region, defined themselves as being a small farmer, food seller, or consumer, and was between the ages of 25 and 65. Participants were recruited through word of mouth and invitations to participate that were also published on social media.

Baseline data collection

Knowledge of participants' baseline levels of digital literacy and use (or lack thereof) of different digital platforms was essential for the design of the digital literacy intervention described below. Therefore, we collected survey data from all participants on socio-demographic characteristics, use of information and communication technologies (e.g., cellular phones), food environment access, and food insecurity, specifically the Spanish version of the food insecurity experience scale (FIES) for COVID-19 household reference version (FAO, 2020). The food environment access survey included 14 questions about how all participants accessed food for their household during three different time periods: (i) before the social crisis in October 2019, (ii) during the social crisis, and (iii) during the COVID-19 pandemic, with specific questions about their local farmers market and the use of social media to obtain foods during the COVID-19 pandemic. From the participants who self-identified as small-scale producers (i.e., farmers) we also collected survey data on agricultural practices during these same three time periods. Many of the 23 survey questions were categorical and asked about their agricultural production and related costs, interaction with intermediaries, and needs for technical assistance. Due to the digital objective of this study, all surveys were designed to be implemented through a conversation via cellular phone. A trained research assistant in public health nutrition conducted all surveys in Spanish between March and October 2022. All survey instruments have been previously validated in Chile (Boza et al., 2019) or in Latin America (Kanter et al., 2014; Rubinstein et al., 2016; FAO, 2020).

Digital literacy intervention design

Based on how digital tools might benefit a food system actor differently, the digital literacy intervention was designed separately for small-scale producers, vendors, and consumers. To design the digital literacy intervention, five key competencies were defined based on the statistical analysis of the telephone survey data described below and previous studies related to digital literacy, especially in Latin America,

which considered the COVID-19 pandemic (Ministerio de Educación y Cultura and Centro MEC, 2010; Hargittai and Dobransky, 2017; Letelier Loyola, 2019; Sunkel and Ullmann, 2019; NU. CEPAL, 2020; OEA and Twitter, 2021). The first key competency was digital trust (i.e., virtual connectivity, data protections, and digital identity) with a sub-competency of being able to use ICTs to search for information. The second key competency was the frequent use of information technologies for communication and networking (e.g., through WhatsApp, email, Facebook, Instagram, other social media platforms and Zoom) with a sub-competency specifically about how to use Zoom. The third key competency for the small-scale producers and vendors was sales networking using WhatsApp communities and a sub-competency on "WhatsApp Business." For consumers, the third key competency was on how to use applications to purchase food (e.g., Uber Eats, Cornershop). The fourth key competency was about how to do banking operations using ICTs (e.g., viewing monthly statements, bank transfers, communicating with the bank, etc.). The fifth key competency was how to use ICTs to communicate with state entities (e.g., the Institute of Agricultural Development of the Ministry of Agriculture (INDAP) – for farmers, how to emit an electronic receipt for vendors, and the National Consumer Protection Agency (SERNAC) – for consumers). For each competency, five literacy levels were identified: basic, fundamental, intermediate, advanced, and expert (Table 1) based on the necessary skills of digital literacy (use, communication/interaction, analysis, and creation) as Lee suggests (Lee, 2014). To design the digital literacy intervention, we utilized the study variables collected in the surveys to determine what baseline level of digital literacy each participant had within each key competency. This is described in detail in the following subsection. Each participant received material for the level ahead of their baseline level. For example, if a participant had a baseline level 1 then they received the material that targeted level 2 of the same competency. Because small farmers/vendors had statistically significant differences from consumers related to ICT use, the digital literacy intervention was designed separately for small-scale producers/vendors and consumers, and the materials were tailored to these two groups. Whereby, for each key competency and literacy level, visual materials were separately designed for small-scale producers/vendors and consumers.

Digital literacy intervention

The digital literacy intervention took place between November and December 2022. At the beginning of each week, each participant was sent via WhatsApp the digital visual materials that corresponded to their actor group and key competency for that week. All participants included in the telephone surveys were offered the 5-week digital intervention program The study procedures and timeline are presented in Figure 1.

Definitions of each key competency level based on the study variables for the digital literacy intervention

Low or no digital trust was defined for farmers and vendors as no digital sales and not using WhatsApp for work purposes or not using electronic banking whereas no specific variables were used to determine low or no digital trust for consumers. The use of ICTs to search for information was defined for all as those who reported using their phone to browse the internet. The frequent use of ICTs for communication and networking differed between farmers/vendors and consumers. The farmers and vendors with no or low use of ICTs for communication and networking either did not know how to read WhatsApp or use their cell phone to chat or knew how to use their cell phone for WhatsApp, but did not use their cell phone for social media purposes. For farmers and vendors, respectively, frequent use of ICTs for communication and networking was defined as having made digital sales through WhatsApp or having utilized WhatsApp for work or using their cellphone for both WhatsApp and social media while those with more advanced use and skill have utilized any social media platform for digital sales. The consumers with frequent use of ICTs for communication and networking was defined as those who used their cellphone for both WhatsApp and social media compared to those who only used their cellphone for WhatsApp (low communication and networking skills) and those who did not even use their cell phone for WhatsApp (no ICT use for communication and networking). Amongst all participants, because only one person reported using Zoom as a means of using ICTs for communication and networking, it was assumed that all other participants did not know how to use Zoom, especially on a cell phone. For farmers and vendors, we defined sales networking as those that reported using digital platforms, especially WhatsApp, for business purposes, specifically digital sales. Consumers who had reported using apps during the COVID-19 pandemic to purchase food for their household were defined as those with advanced use of these apps, while those that have only had experience using social media platforms to do so (i.e., Facebook, WhatsApp, or Instagram) were defined as intermediate users. Consumers who had not reported using their cell phones to buy food for their household during the COVID-19 pandemic but reported knowing how to use social media platforms were defined as having a basic level of being able to use apps to purchase food compared to those who did not use their cell phone for any social media. Online banking literacy was defined as intermediate where participants had reported using online banking as well as online Bill Pay; as low, when they only used online banking but not online Bill Pay; or none, when they reported neither of these actions. For all participants, ICT use to communicate with state entities was defined either as low if someone reported using email or none for those who did not use email.

Food system dialogue

After the conclusion of the digital literacy intervention, we invited via a WhatsApp graphical invitation all the participants who completed the intervention to participate in a virtual food systems dialogue (FSD), over the Zoom platform, about food and the food system in Chile. The FSD method is a globally validated methodology designed to (a) engage groups who would not normally work together, (b) foster greater agreement and ambition among them, and (c) encourage greater alignment and

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TABLE 1 Intervention content and level by food system actor group.

1A: Farmers and vendors					
	Level				
Competencies	Without skills	Basic	Intermediate	Advanced	Expert
1a. Digital trust (connectivity, data protection, digital identity)	Fear and insecurity of technology	Ability to recognize fraud or virtual risks (e.g., scams, malicious emails or links, etc.)	Know and apply protection measures such as double encryption. Know and apply steps to distinguish fake news, malicious sites, etc.	Knowledge of and ability to access information spaces and communication media in virtual format (e.g., electronic newspapers, television channels, others)	Knowledge of and ability to access training and education programs on topics of interest from reliable sources (e.g., Coursera)
Baseline (*n*)	27	37	0	0	0
1b. Continuous and extensive use of ICTs to search for information	Does not use the Internet to search for information	Knows how to open web pages and enter Google to perform searches	Ability to navigate the Internet and search in search engines	Advanced web searches, with the ability to distinguish safe sites and trusted sources	Expert management of advanced searches in internet search engines
Baseline (*n*)	20	44	0	0	0
2a. Continuous and extensive use of ICTs to communicate and generate networks (Whatsapp, Facebook, Instagram, etc.)	Does not know how to use apps	Can download social media apps and create a name. Can create an email account	Basic social media app management: can recognize the icon, can enter, navigate. For Whatsapp, ability to send a text and audio message, send videos	Advanced management of the app, interaction with users and publication of content. In the case of WhatsApp, the ability to make video calls	Expert management of social media apps. Interaction with users, publication of content, knows how to report inappropriate content, search for content of interest, others
Baseline (*n*)	4	15	37	8	0
2b. Use of zoom	Does not know how to use Zoom	Can recognize the Zoom icon, can join and leave a meeting	Can change their name in Zoom, open and close the microphone/camera, send messages to the chat, read chat messages	Can create meetings in Zoom, send an invitation, join groups, and others	Can record and save recording in Zoom, do surveys, and other advanced Zoom functions
Baseline (*n*)	62	0	2	0	0
3a. Sales networking: Whatsapp communities	Does not know how to use Whatsapp communities	Can download Whatsapp, create a profile and learn the basic uses (add contacts, open a conversation, create a community)	Knows how to configure Whatsapp for administrators and add or remove members. Knows how to deactivate a community and how to add a group to a community.	Knows how to establish security criteria and recommendations for good practices for the community, generates interactions with the members of the community	Knows how to send broadcast messages and organize conversations with labels
Baseline (*n*)	64	0	0	0	0
3b. Sales networking: Whatsapp business	Does not know how to use Whatsapp business	Knows the costs and benefits of using Whatsapp business	Download Whatsapp Business, create a profile and learn the basic uses (add contacts, open a conversation, send individual messages)	For WhatsApp Business, knows how to apply security measures, end-to-end encryption and others, can send automated messages, generate automatic responses and other similar interactions	Can generate a business profile with relevant information, create a catalog, delete products, generate welcome messages, automatic responses, and others
Baseline (*n*)	50	0	14	0	0
4. Digital banking (payment and account statement review, use of financial services, transfers, contacting the bank, etc.)	No experience with digital banking	Can enter the bank's website or use the app, with username and password, contact the bank	Can handle basic online banking operations such as knowing account status, balances, etc. Has passwords that allows online procedures	Ability to make transfers, simulate credits, contact an executive	Trust in digital banking, ability to carry out different procedures, communicate with the bank online, etc.

(Continued)

TABLE 1 (Continued)

1A: Farmers and vendors					
	Level				
Baseline (*n*)	26	7	31	0	0
5. Communication with state-based organizations	Does not have a unique password nor does it use government digital platforms	Manages to provide itself with a unique government password and can use it to access to government services	Has a unique government password, can search the web for government organizations	Can download/request forms, claims or inquiries, carry out simple procedures (e.g., background certificate, etc)	Can download/request forms, claims or inquiries, online tax payments or other similar online interactions (e.g., internal tax services)
Baseline (*n*)	12	52	0	0	0

1B: Consumers					
	Level				
Competencies	Basic	Skilled	Intermediate	Advanced	Expert
1a. Digital trust (connectivity, data protection, digital identity)	Apply data protection measures such as double encryption and secure locks	Know and apply steps to distinguish fake news, malicious sites, etc.	Learn to select validated sources of information, assuming a critical attitude towards the content that is available on the web	Report malicious sites, fraud, etc.	Use of tools such as antivirus, knows how to use VPN, etc.
Baseline (*n*)	32	0	0	0	0
1b. Continuous and extensive use of ICTs to search for information	Knows how to open web pages and enter Google to perform searches	Ability to navigate the internet and search in search engines	Advanced web searches, with the ability to distinguish safe sites and trusted sources such as recognition of https and lock symbol as safe	Ability to identify, locate, retrieve, store, organize and analyze the digital information collected in search engines.	Ability to communicate in digital environments, share resources through online tools, connect and collaborate with others through digital tools, interact and participate in communities and networks (for example through platforms such as Google Drive, Dropbox, others)
Baseline (*n*)	6	26	0	0	0
2a. Continuous and extensive use of ICTs to communicate and generate networks (WhatsApp, Facebook, Instagram, etc.)	Can download apps from social media and create a username	Knows how to use the app and can interact with other users / send and receive emails; interaction via texts and audios	Management of the app, interaction with users, extensive interactions (texts, audio, images, stories, others) and sharing content	Ability to create groups in WhatsApp and other ways to generate networks in social media platforms that are more advanced	Expert management of social media apps. Interaction with users, content publication, critical reflection and ability to report inappropriate content, search for content of interest, ability to create digital content
Baseline (*n*)	1	5	18	8	0
2b. Use of zoom	Does not know how to use Zoom	Can recognize the Zoom icon, can join and leave a meeting	Can change their name in Zoom, open and close the microphone/camera, send messages to the chat, read chat messages	Can create meetings in Zoom, send an invitation, join groups, and others.	Can record and save recording in Zoom, do surveys, and other advanced Zoom functions
Baseline (*n*)	31	0	1	0	0

(Continued)

TABLE 1 (Continued)

1B: Consumers					
	Level				
3. Continuous and extensive use of apps to buy food (e.g., UberEats)	Download apps, create username and search for food	Knows how to use the app, pays with cash, knows how to perform a search to order food, direct contact with vendors (e.g., Facebook Marketplace)	Knows how to use the app, knows and uses different payment methods such as cash and credit/debit cards, etc.	Advanced management of the app as a consumer, manage simple purchases through delivery apps, such as the ability to place an order from 1 supplier	Advanced management of the app as a consumer, manage various purchases through apps, ability to make purchases in various items (not exclusively food, for example pharmacies or others)
Baseline (*n*)	1	5	18	8	0
4. Digital banking (payment and account statement review, use of financial services, transfers, contacting the bank, etc.)	Handles basic operations such as checking account status, balances, etc.	Has a card or another that allows secure online procedures (Digipass, transfer card, etc.)	Ability to make transfers, simulate credits, contact an executive	Confidence in digital banking identity, ability to carry out different procedures, communicate with the bank, others	Link the bank account with other apps, automate bill payments, synchronization with other apps, etc.
Baseline (*n*)	3	1	28	0	0
5. Communication with state-based organizations	It does not have a unique password and uses government digital platforms without the need for a unique password	It manages to provide a unique password and access to government services that require a password	Download/request forms, claims or inquiries, carry out simple procedures (eg background certificate, others)	Download/request forms, claims or inquiries, online tax payments or other similar (e.g., Internal Revenue Service)	Advanced knowledge of the possibilities of carrying out procedures and procedures with government agencies (for example, IRS, apply for government funding, enrollment in courses, etc.)
Baseline (*n*)	2	30	0	0	0

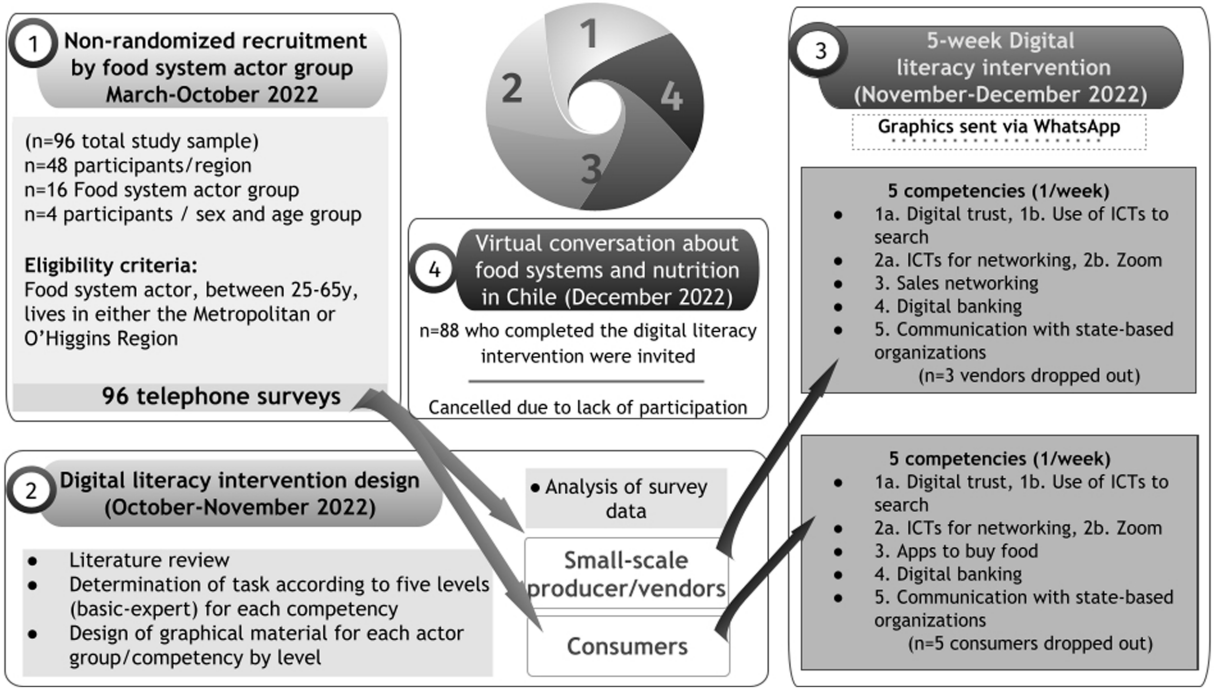

FIGURE 1
Pilot study timeline and procedures.

more intensive action" (Food Systems Dialogues, 2019). The purposes of the FSD were to convene the food system actors to engage in an interactive dialogue, including about the digital literacy intervention for improving Chilean food systems and nutrition, to close out the project, and to assess inherent digital literacy levels through one's capacity to use Zoom.

Intervention process indicators

Multiple process indicators were defined to assess the implementation of the intervention and if it was successful. Reach was defined as those with a valid cell phone number as well as with WhatsApp during the first week of the intervention based on the premise that if a participant could be sent the digital intervention materials during the first week, they would be able to receive intervention materials during the four subsequent intervention weeks; and the average reach was determined based on these two indicators. Dose delivered was defined as the percentage of participants that received all of the digital intervention materials as indicated by the WhatsApp double check mark system that indicates that a user has received the message and did not include participants lost to follow up. Dose received was defined as two different aspects of participant engagement: receptive to materials and satisfaction. Dose received related to the receptivity of materials was defined as the percentage of participants that viewed all of the digital intervention materials according to the WhatsApp blue check mark system that indicates when a user has viewed the message. Dose received related to satisfaction was defined as any time a participant responded positively to the intervention materials, such as through messages sent in response or emoticons; that also reflected the absence of participant discontent or desire to abandon the study (Ishaq Bhatti et al., 2014; Georgsson and Staggers, 2016). The average dose received was based on both indicators of dose received. To determine an overall implementation score we utilized the multiplicative approach based on the following equation: average reach multiplied by dose delivered multiplied by average dose received multiplied by average fidelity (Steckler and Linnan, 2002). Given that the intervention was designed and sent on schedule as planned we assumed a fidelity of 100%.

Statistical analysis

Descriptive statistics were used to illustrate both the baseline characteristics and the outcome variables related to the digital literacy intervention of all participants initially enrolled in the study stratified by actor group (small-scale farmer, vendor, and consumer) and region (Metropolitan and O'Higgins). Many of the baseline characteristics entailed categorical variables for which proportions were calculated. While means were calculated for the continuous variables. For the questions with a categorical response that were asked in the context of three different time periods (i.e., before the social crisis, during the social crisis, and during the COVID-19 pandemic), as well as the distance one reported from a farmers market, the chi-squared test was used to determine if the distribution of these variables was statistically significantly different across each actor-region group. Chi-squared tests were also used to determine if statistically significant differences existed between baseline characteristics related to digital literacy and by actor group. For example, whether having internet at home or a preferred means of communication was statistically significantly different between small-scale farmers, vendors, and consumers. For each chi-squared test that was performed, statistical significance was set at $p < 0.05$. All statistical analyses were conducted using STATA 17.0/SE (StataCorp, 2021).

Ethical considerations

The study was approved by the ethics committee of the University of Chile. Verbal informed consent was obtained from all participants after the study protocol had been explained to them over the telephone in Spanish.

Results

Sociodemographic characteristics and ICT use

Nearly a third (28%) of participants expressed that they or their household had experienced some form of food insecurity between 2021 and 2022; 96% of which was attributed to the COVID-19 pandemic (Table 2). Almost all participants reported having received some form of State support due to the COVID-19 pandemic, mainly emergency family income payments for income relief during COVID-19 to economically vulnerable households. Across regions, vendors reported greater overweight or obesity, type 2 diabetes, and COVID-19 compared to farmers and consumers (Table 2). Most consumers had completed higher education and reported that someone in the household was teleworking due to the COVID-19 pandemic. Most of both vendors and consumers reported that someone teleworking in the household due to the COVID-19 pandemic affected mealtimes. Farmers and vendors in both regions reported either sometimes or always having cell signal problems while over half of consumers in both regions reported never having cell signal problems. Having both internet and a computer at home was >60% across all actor groups, except rural farmers in which only 38% had internet at home and 50% reported having a computer at home. Most urban consumers reported knowing how to use a computer (88%), compared to 69% of rural consumers, 50% of urban vendors, approximately 40% of all farmers, and only 38% of rural vendors. More farmers in urban areas (37%) preferred television as a form of mass communication compared to farmers in rural areas who preferred internet web pages (44%). Television was the preferred form of mass media across vendors. Consumers were split in their preferred form of communication between television and internet web pages. In both regions, many participants used their cell phones to make and receive calls, use the internet, chat (e.g., WhatsApp), and social media. Almost all participants reported that they knew how to read and send a WhatsApp message (99%) and how to use email (86%). Urban consumers (66%) and rural farmers (55%) were the only groups in which over half reported having a dedicated work email. Compared to consumers and farmers, fewer vendors reported using online banking, and only half of rural vendors reported using online Bill Pay. However, 50% of rural vendors reported that they started an online business during the COVID-19 pandemic for more income, more

TABLE 2 Socio-demographic characteristics and information and communications technology (ICT) use by region Urban RM (Metropolitan Region) or Rural OH (O'Higgins Region) and actor group (Ag: small-scale producer, Ven: vendor, and Con: consumer).

	RM-Ag (*n* = 16)	OH-Ag (*n* = 16)	RM-Ven (*n* = 16)	OH-Ven (*n* = 16)	RM-Con (*n* = 16)	OH-Con (*n* = 16)	Total (*n* = 96)	*p* value (χ^2)
Age (y)	44	47	44	40	43	43	44	
Household members (*n*)	4	3	4	4	3	4	4	
During the past 12 months, did you or someone else in HH worry about not having enough food to eat due to lack of money or other resources? (%)	25	31	19	38	19	38	28	
Was HH food insecurity due to COVID-19? (%)	75	100	100	100	100	100	96	
Do you have Overweight/obesity? (%)	19	12	25	50	56	31	32	0.049*
Do you have CVD? (%)	0	0	0	6	6	6	3	NS
Do you have Hypertension? (%)	19	19	6	12	6	12	12	NS
Do you have T2D? (%)	0	19	25	19	0	6	11	NS
Do you have any cancer? (%)	0	6	6	0	0	6	3	NS
Do you have COVID-19? (%)	12	19	31	44	19	12	23	NS
HH member with any chronic condition above (%)	62	50	69	62	62	31	56	NS
Highest education completed (%)								NS
Primary	19	19	31	19	0	0	15	
Secondary	31	50	31	50	19	38	36	
Technical	25	12	12	12	12	12	15	
Higher education	25	19	25	19	69	50	34	
Anyone in HH teleworking due to COVID-19? (%)	31	25	40	25	81	62	44	0.004**
Did the teleworking affect meal times? (%)	40	25	67	75	62	90	64	NS
Anyone in HH without work due to COVID-19? (%)	19	19	31	38	31	44	30	NS
Did the above affect your ability to buy food? (%)	67	67	40	67	40	57	55	NS
Received state support due to COVID-19? (%)	94	88	100	100	81	100	94	NS
Do you use your cell phone? (%)	100	94	100	100	100	100	99	NS
How much do you spend a month on your cell phone? (%)								NS
Monthly cell phone costs (USD$1.30–6.30)	0	0	0	6	0	6	2	
Monthly cell phone costs (USD$6.30–12.30)	25	31	12	38	31	44	30	
Monthly cell phone costs (>USD$12.30)	75	62	75	50	69	50	64	
Do not know	0	6	12	6	0	0	4	
Normally how is your cell phone signal at home? (%)								NS
Never have cell signal problems	25	19	44	44	56	62	42	
Sometimes cell signal problems	44	44	44	25	38	25	36	
Always cell signal problems	31	38	12	31	6	12	22	
Internet at home (%)	62	38	94	75	94	94	76	<0.000*
Computer at home (%)	69	50	81	75	100	81	76	0.035*
Use a computer (%)	43	40	25	38	88	69	51	0.004**
What is your preferred means of communication? (%)								NS
Preferred communication-TV	38	19	50	38	31	38	35	
Preferred communication-Radio	12	6	0	12	19	12	10	
Preferred communication-Newspaper	0	0	6	0	6	0	2	

(Continued)

TABLE 2 (Continued)

	RM-Ag (n = 16)	OH-Ag (n = 16)	RM-Ven (n = 16)	OH-Ven (n = 16)	RM-Con (n = 16)	OH-Con (n = 16)	Total (n = 96)	p value (χ^2)
Preferred communication-Internet web pages	31	44	25	25	31	44	33	
Preferred Communication-Social Media	19	31	19	25	12	6	19	
Know how to open a text (SMS) message (%)	88	81	62	81	100	100	85	0.026*
What do you do when you receive a text (no WhatsApp) from someone known? (%)								NS
When receiving a text message from someone known-almost never read it	0	8	0	8	0	0	2	
When receiving a text message from someone known-sometimes read it	0	15	0	8	0	0	4	
When receiving a text message from someone known-almost always read it	14	0	20	15	6	25	13	
When receiving a text message from someone known-always read it	86	77	80	69	94	75	80	
Know how to read a WhatsApp message (%)	100	94	100	100	100	100	99	NS
Know how to send a WhatsApp message (%)	100	94	100	100	100	100	99	NS
Use email (%)	81	73	81	94	94	94	86	NS
Use a dedicated work email (%)	38	55	23	47	67	47	46	NS
Use online banking (personal and/or work) (%)	69	56	56	56	100	81	70	0.033*
Do online Bill Pay (%)	62	56	56	50	100	81	68	0.020*
During COVID-19, used social media to receive nutrition information and/or healthy eating tips (%)	50	38	38	31	75	62	49	NS
During COVID-19, have you started an online business for more income? (%)	44	38	38	50	31	19	36	NS
During COVID-19, have you started businesses like selling fruit/veg or foods from home to adapt your actual business? (%)	50	31	38	50	0	7	29	0.005**

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$;z NS, not significant.

than farmers and consumers, while 50% of urban farmers reported adapting their actual business during the COVID-19 pandemic, such as selling more fruits and vegetables from home, to complement their income. Also, during the COVID-19 pandemic, two-thirds of consumers in both regions accessed social media to receive nutrition information and/or healthy eating tips which was more than farmers and vendors, respectively.

Trends in the food environment across food system actors and crises

Most of the study participants reported being the primary food shopper for the household, except for rural vendors (Table 3), which, across groups, was statistically significantly different by sex ($p = 0.045$, data not shown). Before the Chilean social crisis in October 2019, across food system actor groups and regions, 79% of participants reported buying food for their household from supermarkets, this ranged from 94% of rural farmers to 62% of urban vendors. During the Chilean social crisis, however, 66% of participants reported buying food for their household from supermarkets, and the percentage of participants buying food from neighborhood stores increased from 3% before the Chilean social crisis to 11%. With the onset of the COVID-19 pandemic, the number of participants buying food from supermarkets declined even further to 57%, while delivery increased to 17% compared to only 2% before the Chilean social crisis, and was highest amongst urban farmers and vendors (p for trend = 0.011). While nearly all participants reported having access to a farmers market in their community, the distance to the farmers market varied widely and was statistically significantly different across actor-region groups ($p < 0.000$). Only 36% of participants had a farmers market within less than 1 kilometer from home, especially urban vendors and consumers. Approximately 40% had a farmers market more than 3 kilometers away, including 9 participants who reported a farmers market within 18–25 kilometers from home. Before the October 2019 social crisis, 60% of all participants reported going to the farmers market on a weekly basis. During both the social crisis and COVID-19 pandemic weekly attendance declined to 42 and 32%, respectively, and 60% of urban farmers reported never going to a farmers market during these time periods. Except for urban vendors, over a third of all participants reported that they or someone in their household has used social media to obtain food for the household, including 62% of urban consumers. Of these participants, 81% reported using WhatsApp to obtain food. Most urban consumers reported that their

TABLE 3 Food environment characteristics by region Urban RM (Metropolitan Region) or Rural OH (O'Higgins Region) and actor group (Ag: small-scale producer, Ven: vendor, and Con: consumer).

	RM-Ag (*n* = 16)	OH-Ag (*n* = 16)	RM-Ven (*n* = 16)	OH-Ven (*n* = 16)	RM-Con (*n* = 16)	OH-Con (*n* = 16)	Total (*n* = 96)	*p* value (χ2)
How many people have been eating regularly in your HH over the past 30 days? (*n*)	4	3	4	4	3	3	4	
Does the majority of food shopping for the HH (%)	69	69	88	56	62	81	71	
Before the social crisis, main place to buy food (%)								NS
Delivery	6	0	0	0	0	6	2	
Supermarkets	75	94	62	81	88	75	79	
Corner store/ minimarket	0	0	6	0	0	0	1	
Neighborhood store	6	0	6	0	0	6	3	
Produce shop	0	0	6	0	0	0	1	
Farmers market	6	6	19	19	12	12	12	
Other (Wholesale)	6	0	0	0	0	0	1	
During the social crisis, main place to buy food (%)								NS
Delivery	19	0	0	0	6	6	5	
Supermarkets	62	88	56	56	62	69	66	
Corner store/ minimarket	6	0	6	0	6	6	4	
Neighborhood store	6	12	6	25	12	6	11	
Produce shop	0	0	6	6	0	0	2	
Farmers market	0	0	25	12	12	12	10	
Other (Wholesale)	6	0	0	0	0	0	1	
During the COVID-19 pandemic, main place to buy food (%)								NS
Delivery	25	12	25	6	12	19	17	
Supermarkets	56	62	44	44	75	62	57	
Corner store/ minimarket	0	6	0	0	0	0	1	
Neighborhood store	6	6	0	19	12	6	8	
Produce shop	0	0	6	6	0	0	2	
Farmers market	6	12	25	25	0	12	14	
Other (Wholesale)	6	0	0	0	0	0	1	
p for trend across the three time periods								0.011*
Do you have access to a farmers market in your community? (%)	94	94	100	100	100	94	97	NS
Before the social crisis, how often went to farmers market (%)								0.001**
Never	40	7	6	0	19	13	14	
A few times a year	7	33	6	0	6	7	10	
Once a month	0	20	0	12	19	0	9	
Every 2 weeks	0	0	6	0	19	20	8	
Every week	53	40	81	88	38	60	60	
During the social crisis, how often went to farmers market (%)								<0.000***
Never	60	13	12	0	38	33	26	
A few times a year	0	27	0	0	6	7	6	
Once a month	7	27	0	19	31	7	15	

(Continued)

TABLE 3 (Continued)

	RM-Ag ($n = 16$)	OH-Ag ($n = 16$)	RM-Ven ($n = 16$)	OH-Ven ($n = 16$)	RM-Con ($n = 16$)	OH-Con ($n = 16$)	Total ($n = 96$)	p value ($\chi 2$)
Every 2 weeks	13	7	6	0	12	27	11	
Every week	20	27	81	81	12	27	42	
During the COVID-19 pandemic, how often went to farmers market (%)								0.001**
Never	60	33	25	12	44	33	34	
A few times a year	7	27	0	0	38	13	14	
Once a month	7	27	12	12	0	7	11	
Every 2 weeks	13	7	12	0	6	13	9	
Every week	13	7	50	75	12	33	32	
p for trend across the three time periods								0.007**
Distance to farmers market (%)								<0.000***
<1 KM	0	13	69	38	69	27	37	
1 KM	7	0	12	12	19	33	14	
>1–2 KM	20	0	6	6	12	20	11	
3–5 KM	27	20	0	6	0	20	12	
6–8 KM	13	7	0	12	0	0	5	
9–13 KM	20	33	6	12	0	0	12	
18–25 KM	13	27	6	12	0	0	10	
Since the COVID-19 pandemic, have you or anyone in HH used social media to obtain food for the HH? (%)	31	38	19	44	62	38	39	NS
Specifically via Whatsapp	60	100	67	86	90	67	81	NS
Specifically via Facebook	60	50	67	0	10	33	30	NS
Specifically via Instagram	60	17	33	14	60	50	41	NS
Specifically via other platforms	0	17	33	14	60	50	32	NS
Are you the main cook in your HH? (%)	44	56	62	38	50	56	51	
Since the COVID-19 pandemic, has delivery of prepared food increased in your HH? (%)	25	19	25	25	88	25	34	<0.000***
Before the social crisis, did the people in your HH eat together at the same table? (%)	69	100	75	62	73	69	74	NS
During the social crisis, did the people in your HH eat together at the same table? (%)	69	87	69	69	87	88	78	NS
Since the COVID-19 pandemic, did the people in your HH eat together at the same table? (%)	81	93	81	88	100	81	87	NS
p for trend across the three time periods								NS

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$; NS, not significant.

use of delivery to obtain prepared food increased in their household during the COVID-19 pandemic which was not the case for the other groups. Before the social crisis in October 2019, among all participants, 75% reported eating together at the same table in the household which increased to 87% during the COVID-19 pandemic.

Farmer characteristics related to crisis

Farmers in both study regions experienced changes related to their agricultural production during each of the three crises in Chile: the social crisis, the COVID-19 pandemic, and climate change (Table 4). While the number of people who worked on the farm did not change over the study period, approximately half of all farmers reported that it has been harder to find workers either due to the COVID-19 pandemic or due to climate change. Most of the farmers in both regions use drip irrigation and reported having to make changes in their agricultural production due to the drought. Approximately half of the farmers reported using fertilizers, pesticides, or herbicides. Independent of input type, half of the farmers also reported that how much they spend on inputs has changed with climate change and during the COVID-19 pandemic. Two-thirds of

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TABLE 4 Farmer characteristics by region Urban RM (Metropolitan Region) or Rural OH (O'Higgins Region).

	RM (*n* = 16)	OH (*n* = 16)	Total (*n* = 32)
Before the COVID-19 pandemic, how many people (inc. family) worked on the farm (*n*)	5	4	5
During the social crisis, how many people (inc. family) worked on the farm (*n*)	5	4	5
Since the COVID-19 pandemic, how many people (inc. family) worked on the farm (*n*)	5	4	4
During the social crisis, has it been harder to find workers? (%)	25	50	38
Since the COVID-19 pandemic, has it been harder to find workers? (%)	38	62	50
Due to climate change, has it been harder to find workers? (%)	31	62	47
What type of watering system do you use? (%)			
None	6	6	6
Irrigation by laying	6	6	6
Drip irrigation	69	44	56
Furrow irrigation	6	12	9
Other	12	31	22
Due to the drought, have you had to make changes in your agricultural production? (%)	62	69	66
What type of inputs do you use: None (%)	6	6	6
What type of inputs do you use: Fertilizers (%)	62	44	53
What type of inputs do you use: Pesticides (%)	50	44	47
What type of inputs do you use: Herbicides (%)	44	44	44
What type of inputs do you use: Other (%)	50	56	53
Has how much you spend on inputs changed with the social crisis? (%)	44	0	23
Has how much you spend on inputs changed with the COVID-19 pandemic? (%)	69	36	53
Has how much you spend on inputs changed with climate change? (%)	50	57	53
Do you use machines for production? (%)	75	75	75
Do you own these machines? (%)	58	50	54
Due to climate change, are you motivated to make changes in machine use or other changes to continue producing? (%)	33	42	38
Due to the COVID-19 pandemic, are you motivated to make changes in machine use or other changes to continue producing? (%)	17	0	8
Due to the social crisis, has the price of gas increased? (%)	8	0	4
Due to the COVID-19 pandemic, has the price of gas increased? (%)	50	67	58
Due to climate change, has the price of gas increased? (%)	67	83	75
Due to the COVID-19 pandemic, have you had to sell your products via digital platforms (%), if so which platform	50	50	50
Facebook (*n*)	0	1	1
Instagram (*n*)	0	1	1
Instagram, WhatsApp (*n*)	0	1	1
WhatsApp (*n*)	7	1	8
WhatsApp, Facebook (*n*)	1	3	4
WhatsApp, Web page (*n*)	0	1	1
Due to climate change, do you know anyone that has decided to abandon agriculture? (%)	56	38	47
Due to the residential building pressure to urbanize, do you know anyone that has decided to abandon agriculture? (%)	69	19	44
Before the COVID-19 pandemic, did you maintain contact with extension or technical assistance? (%)	75	81	78
What method did you use to maintain contact with them? (%)			
In person	50	100	76
Phone call	25	0	12

(Continued)

TABLE 4 (Continued)

	RM (n = 16)	OH (n = 16)	Total (n = 32)
WhatsApp	25	0	12
During the social crisis, did you maintain contact with extension or technical assistance? (%)	62	81	72
What method did you use to maintain contact with them? (%)			
In person	40	92	70
Phone call	30	0	13
WhatsApp	30	8	17
During the COVID-19 pandemic, did you maintain contact with extension or technical assistance? (%)	69	88	78
What method did you use to maintain contact with them? (%)			
In person	9	29	20
Phone call	18	43	32
Whatsapp	64	29	44
Other	9	0	4
Do you use a computer or cell phone for work related to your agricultural production? (%)	62	69	66
If so, what specific features do you use (%)			
Whatsapp	56	69	62
Facebook	19	31	25
Email	6	6	6
Text message	6	0	3
Phone call	19	25	22
Other	6	6	6
Which means of information to you prefer for technical assistance and/or workshops (%)			
Visits to land by extensionist	19	56	38
Visit days	31	19	25
Demonstrative farms	50	19	34
Forums or roundtables	0	6	3

farmers use mechanization for production, but only 38% reported that they are motivated to make changes in mechanization or other changes to continue producing agriculture. Two-thirds of farmers also reported that they believe the price of gas has increased due to climate change, while 58% believe that the price of gas also changed due to the COVID-19 pandemic. Half of the farmers reported that during the COVID-19 pandemic, they had to sell their products via digital platforms, primarily through WhatsApp. Approximately half of the farmers in this study also reported that due to climate change, they knew of someone who had decided to abandon agriculture while 44% of farmers reported that they knew someone who had decided to abandon agriculture due to the residential building pressure related to urbanization. Prior to the social crisis up through the COVID-19 pandemic, most farmers maintained contact for extension or technical assistance, but what was previously in-person contact changed to phone calls (32%) or WhatsApp (44%) during the COVID-19 pandemic. Specifically, more rural farmers preferred phone calls to maintain contact for extension or technical assistance during the COVID-19 pandemic compared to urban farmers (43% vs. 18%), while urban farmers preferred WhatsApp (64% vs. 29%). The means of information that a farmer preferred for technical assistance and/or workshops also varied by region. Over half of rural farmers preferred in-person visits by an extensionist, while half of urban farmers preferred to visit demonstrative farms.

Digital literacy intervention and food systems dialogue

This pilot study from which we are presenting results was done to validate the digital literacy intervention. The baseline digital literacy level statistically significantly differed between farmers, vendors, and consumers across some variables, including having internet at home, using a computer, and online Bill Pay (Table 2), revealing that farmers and vendors have similar digital literacy levels compared to that of consumers. Thus, although the 5 digital literacy intervention competencies were similar across food system actor groups and regions, the expectations for each level (basic through expert) were different for consumers. For example, for the key competency digital trust level 1 for small-scale farmers and vendors was "Fear and insecurity of technology," while for consumers it was "Apply data protection measures such as double encryption and secure locks (Table 1)." In addition, the third key competency of sales networking was tailored to small-scale farmers and vendors to consider their

TABLE 5 Intervention process indicators by food system actor group and region Urban RM (Metropolitan Region) or Rural OH (O'Higgins Region).

	Farmer (RM) (*n* = 16)	Farmer (OH) (*n* = 16)	Vendor (RM) (*n* = 16)	Vendor (OH) (*n* = 16)	Consumer (RM) (*n* = 16)	Consumer (OH) (*n* = 16)	Total (*n* = 96)
Reach: % with a valid number during 1st intervention week	100	100	100	100	100	100	100
Reach: % with WhatsApp during 1st intervention week	100	94	100	88	94	94	95
Average reach %	100	97	100	94	97	97	98
Dose delivered: % received all digital intervention	100	100	100	81	94	75	92
Dose received (receptive to materials): % viewed all digital intervention[1]	94	88	88	75	94	69	84
Dose received (satisfaction): % expressed satisfaction with digital intervention in any week	81	56	25	37	69	44	52
Average dose received %	88	72	57	56	82	57	68
Intervention implementation score (%) (Average reach*dose delivered*average dose received*fidelity[2])	88	70	57	43	75	41	61
% Participated in food systems dialogue (FSD)	0	0	6	0	0	0	6
% Expressed satisfaction with FSD	0	0	6	0	0	0	6

[1]Based on WhatsApp blue check mark system.
[2]Assumes an intervention fidelity of 100%.

business needs while for consumers the third key competency was "Continuous and extensive use of APPs to buy food (e.g., UberEats)." During the first week of the digital intervention, all 96 survey participants were included and sent the first intervention material to a valid number and only a few participants did not have WhatsApp at the time (Table 5). All farmers and urban vendors received all 5 weeks of the digital intervention while some participants in the other groups declined to participate at some point. Of those who received all of the digital intervention, most participants viewed all the digital intervention materials, except for rural consumers according to the blue check marks feature of WhatsApp. Most urban farmers and consumers also expressed their satisfaction with the digital intervention at any week during the intervention (e.g., responding "*Many thanks*" or "*Thanks, I'll share it with the community*"). The overall implementation score was highest amongst urban farmers (88%) and consumers (75%), and lowest amongst rural vendors (43%) and consumers (41%) (Table 5). All 88 participants who completed the dialogue literacy intervention were invited to the food systems dialogue over Zoom to close out the project. Ten people expressed interest via WhatsApp message in attending the event. After waiting 20 minutes, only one person, a rural farmer, showed up and thus, the food systems dialouge was canceled for lack of a suitable quorum (three people minimum) for the activity. The rural farmer that showed up expressed interest in the study and such an event because "*We want everything to be more organic, better for health and society. So I'm interested if you all do another dialogue in the future.*" After the event closed, five people expressed barriers to attending the event after its conclusion which included being busy with farm work and not being proficient in Zoom, forgetting about the event, and family caregiving.

Discussion

A digital literacy intervention was moderately implemented amongst key food system actors (small-scale farmers, vendors, and consumers) in the Metropolitan and O'Higgins regions of Chile. Thus, when considering all the intervention process indicators, implementation was highest amongst (≥70%) farmers and urban consumers, but lower amongst the other groups, with an average of 61%. The pilot implementation took advantage of tailoring a digital literacy intervention to distinct actors in the food system based on their baseline digital literacy level, and that nearly all participants knew how to read and send WhatsApp messages. During the intervention study, we carried out most of the activities envisioned within the operational plan. The objectives, subject population, and 5-week intervention timeline were not significantly altered during the pilot study implementation. However, the methodological strategy of a food systems dialouge to assess the acceptability of the digital literacy intervention had to be adjusted, and ultimately canceled, because the attendance of only one participant prevented its successful implementation.

As indicated in the Introduction, our secondary purpose was to identify how the fragility of food systems in Chile had manifested itself during concomitant crises (social, COVID-19, climate change) and elucidate trends in the usage of information and communication technologies (ICTs) to produce, sell, and consume food over this period. In both regions, half of the farmers declared knowing someone who abandoned agriculture due to climate change. The pilot study also revealed statistically significant changes in the main source of food for the household comparing

the time periods before the social crisis, during the 2019 social crisis, and during the COVID-19 pandemic, and indicated that the COVID-19 pandemic stimulated additional business models and sources of income. During the COVID-19 pandemic, a third of all participants started an online business for more income, while farmers and vendors made adaptations to their actual business to sell more fresh fruit and vegetable products.

Some of the main contributors to the success of the pilot study was the focus on conducting the study entirely virtually and tailoring the digital literacy intervention to each food systems actor group. Analyses of telephone surveys involving small-scale farmers, farmers market vendors, and consumers indicated that small-scale farmers and vendors have a different baseline digital literacy level and, as expected, have different needs for digital tools from those of consumers. For example, more small-scale farmers and vendors reported starting an online business as well as adapting their actual business to sell foodstuffs from home during the COVID-19 pandemic for more income. Amongst all participants, there was a notable trend in the decline of supermarkets as the main place to buy food for the household during the Chilean social crisis and the COVID-19 pandemic, and a parallel increase in delivery as the main means to obtain food for the household. To the best of our knowledge, this is the first digital literacy intervention to be designed and implemented across different food system actors, in any setting. With the COVID-19 pandemic, there is a greater awareness of digital literacy as a limiting factor in telemedicine utilization in the United States (Bejarano, 2022), but scientific studies of digital literacy are severely lacking in other areas, such as food access.

The incorporation of ICTs into both professional and personal life shows no signs of abatement, but little is known about how digital literacy is an essential component of ICT use. One area where ICTs have been explicitly studied in relation to digital literacy and that has increased dramatically since 2012 is with regard to digital health interventions (Benny et al., 2021). In their review of digital health interventions between 2001 and 2020, of which only 7 of 131 eligible studies included digital literacy, Benny et al. assert that there is no clear explanation as to why studies about health literacy have dramatically exceeded those about digital literacy. Further corroborating the findings of the review by Benny et al., reviews since 2021 on digital literacy have also focused on health outcomes (Campanozzi et al., 2023), and specific segments of the population, such as older adults (Oh et al., 2021) and students (Gutiérrez-Ángel et al., 2022; Nogueira et al., 2022). While the COVID-19 pandemic elucidated the importance of digital literacy for students inadvertently forced into online learning and an increased reliance on telemedicine by the elderly, there is still a paucity of digital literacy research, let alone interventions, as it relates to other areas essential for human resilience.

In our study, we obtained a group of food system actors representative of other small-scale producers, vendors, and consumers when compared with similar food system actors across Latin America, in terms of the increase in, and utilization of, home delivery services through digital platforms, especially of fresh foods, during the COVID-19 pandemic (Boza, 2021). For scaling up the intervention more broadly to the Chilean population, it will be important to assess digital literacy levels and interest through shorter more flexible instances. Study participants demonstrated a high level of receptivity to the digital literacy intervention in terms of viewing all the materials and only eight participants did not complete the full 5-week intervention. Rural consumers were the only group in which less than two-thirds of participants viewed all of the digital intervention materials.

Strengths and limitations

Throughout the course of the digital intervention, participants, especially urban farmers and consumers, expressed satisfaction and perceived benefit that is consistent with other personalized mobile health interventions (Alessa et al., 2018; Cao et al., 2022). Despite the moderate success of the pilot study, we encountered several barriers related to the successful implementation of the food systems dialogue and thus, the assessment of digital literacy in general. The low attendance is consistent with emerging literature on the challenges in qualitative research using online video conferencing methods, especially with underserved populations and in the absence of childcare, even when advanced training (e.g., how to use Zoom) is offered (Lathen and Laestadius, 2021; Tran et al., 2021). These findings are important for considering the replication of a similar digital literacy intervention in other regions of the country. Organizers of such interventions or synchronous virtual events will need to consider alternative ways to assess digital literacy as well as co-creating the event with targeted participants to select a more feasible time and foster greater accountability to show up. Another important barrier that the study faced because the food systems dialogue could not be completed was the lack of an alternative method within the study protocol to assess digital literacy as well as other indicators of intervention satisfaction/usability post-intervention. One study, however, suggests that the blue check marks in WhatsApp when one views a message are related to the fact that some participants prefer to listen rather than verbally express satisfaction through other means (Yeshua-Katz, 2021). Future implementation of digital literacy interventions will also require infrastructure resources to improve cellular signal coverage, especially for small-scale producers that, even though they may live in urban and rural areas, are more likely to be working in more remote areas.

To the best of our knowledge, this is the first digital literacy intervention specifically tailored to and implemented amongst food systems actors. The fact that nearly all participants knew how to read and send a WhatsApp message reflects the increasing prevalence of WhatsApp in global health services research (Manji et al., 2021), participatory research in other Latin American settings (Börner et al., 2023), and within food systems (Samoggia et al., 2021). Participants were able to express a form of satisfaction with the digital literacy intervention because they were already proficient with WhatsApp. We believe that the positive comments observed are likely because the participants truly liked the intervention material even though we did not capture more specific information related to the perception of the intervention content. However, it is inherently challenging to implement a digital literacy intervention through digital means because it is possible that a lack of digital literacy, and/or cellular signal, may still limit user participation and satisfaction during the intervention. Future studies might also consider giving part of a digital literacy intervention in person, with virtual follow-up.

Policy implications

This study has implications for public policy and research within Chile as well as the Latin American region, if not globally. Given the growing incidence of extreme weather events due to climate change, such as massive flooding in the O'Higgins region that instantaneously affected both food production and consumption (Gálvez and Canales, 2023), there is an even greater imperative for multiple ministries (e.g., agriculture, social and family development, health, education, women and gender equity) to incorporate digital literacy programming into their materials. For example, the Uruguayan government through its Ministry of Education and Culture has a National Plan for Digital Literacy (PNAD, for its acronym in Spanish) that consists of free guided workshops for the population on different digital literacy objectives (Ministerio de Educación y Cultura and Centro MEC, 2010). The government of Nigeria, a middle-income country, through its National Digital Economy Policy and Strategy, has set a goal of achieving 95% digital literacy by 2030 with a related agenda for how to do so through its National Digital Literacy Framework (NITDA, 2019, 2023). Chile and other countries globally might consider adapting similar public policy efforts that aim to increase digital literacy levels nationwide in an equitable manner, rather than inadvertently exacerbating an already existing digital divide.

Conclusion

Based on the study results we conclude that different crises in Chile, from a social crisis in October 2019 to ongoing climate change to the COVID-19 pandemic, have impacted how the Chilean population in both urban and rural regions navigate their food environment for their household as well as small-scale agricultural production in these areas. This taken together has elucidated a greater dependence on ICTs amongst small-scale farmers, vendors, and consumers in Chile to buy and/or sell food. Amongst these key food systems actors, we determined that it is feasible to implement a digital literacy intervention for key food system actors in urban and rural settings in Chile. Therefore, we conclude that the digital literacy intervention was successfully implemented across food system actor groups in the urban Metropolitan region as well as rural small-scale farmers. The results also suggest that basic literacy in WhatsApp facilitated the implementation of this pilot study. It is important to adapt a digital literacy intervention to the distinct realities of small-scale farmers and farmers market vendors, especially in rural areas, compared to consumers and better understand the context-specific barriers to implementation in rural areas to improve the design of subsequent digital literacy interventions. In future analyses, it will be important to include measures related to implementation outcomes beyond those used in this study to assess the impact of a digital literacy intervention more precisely on improvements in digital literacy. The experience of this pilot study in two different regions in Chile has implications for policy and research both in Chile and for the Latin American region. Future projects and studies will contribute to the evidence base about the feasibility and impact of similar digital literacy interventions, an area of increasing importance due to the rising prevalence of the digital food environment worldwide. In conclusion, greater digital literacy amongst food systems actors will help strengthen local food systems for concomitant crises and climate change in an increasingly digitalized world.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by the Ethics Committee on Human Subjects Research of the Faculty of Medicine of the University of Chile. The studies were conducted in accordance with the local legislation and institutional requirements. The ethics committee/institutional review board waived the requirement of written informed consent for participation from the participants or the participants' legal guardians/next of kin because this study was conducted entirely through virtual means. Therefore, permission was granted to obtain only verbal informed consent.

Author contributions

RK, SB, and PA-S were involved with conducting the study that is the base of this manuscript. RK led the analyses and drafted the manuscript. SB provided the critical contributions to the text, including suggestions for additional analyses, and interpretation of the results. PA-S led the digital literacy intervention and contributed primarily to this part of the methods section of text. All authors reviewed and approved the final manuscript.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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