MASTER'S THESIS

Digital technologies and support mechanisms to improve service delivery in Farmers' Organizations: an exploratory study

Mooij, R.

Award date:
2022

Digital technologies and support mechanisms to improve service delivery in Farmers' Organizations:
an exploratory study

Opleiding:	Open Universiteit, faculteit Betawetenschappen
	Masteropleiding Business Process Management & IT
Degree programme:	Open University of the Netherlands, Faculty Science
	Master of Science Business Process Management & IT
Course:	IM0602 BPMIT Graduation Assignment Preparation IM9806 Business Process Management and IT Graduation Assignment
Student:	Richard
Mooij Identification number:	
Date:	16-01-2022
Thesis supervisor	Mw. Dr. R. Bosua
Second reader	Mw Dr. V. Dirksen
Version number:	1.0
Status:	<~~draft~~/final version>
Wordcount:	19.858 (from Abstract onwards, excluding appendices)

Abstract

The growth in datafication as basis for the data-information-knowledge cycle is leading to a transformation in the nature of organisations highlighting the importance of knowledge. One sector where knowledge is becoming more entwined than ever is agriculture, where data is converted into actionable knowledge enhancing on-farm decision-making. A wide technology diffusion in rural areas of upcoming economies may not only provide timely and cheaper information services but also support the coordination of agricultural agents. It is however unclear how digital technologies can be put to use to support the service delivery of consultants in a close-knit community of practice. The research therefore revolves around the major research question: *"How can digital technologies be harnessed to improve service delivery of consultants in a community of practice?"* A case study approach was used in this research to examine the influence of digital technologies whereby extension officers mediate extension service delivery in farmers' organisations. Following an interpretive qualitative research paradigm, interviews were held with 6 extension officers from different farmers' organisations in Kenya, a project manager in Kenya and an observational field day in The Netherlands.

Findings indicate that the use of digital technologies can reduce the necessity of physical contact between extension officers and the farmers and in the same time digital technologies providing extension officers with more tools to customize and deliver services based on each farmer's unique needs. Findings further indicate the need for physical interaction between extension officers and farmers is essential in order to provide more personal and accurate customer-centric extension services and that farmer feedback can indeed improve the extension services provided.

This research shows that there is a need to further investigate to what extent digital technologies can replace physical contact between extension officers and farmers and which elements can be embedded in digital technologies allowing a more customer-centered approach.

Key terms

consultants, digitalisation, extension services, farmers' organizations, information dissemination, service delivery

Summary

This research looks at the influence of digital technologies on service delivery by consultants. The case study applied is set in the agricultural sector where extension officers traditionally provided extension services in a face-to-face form. The use of digital technologies such as Social media, Analytical tools, Big Data and the Internet of Things in the agricultural sector, boost information dissemination and causes many disruptions in the way extensions services are being delivered. Many of the farmers in developing countries live in rural areas where digital technology is not yet embedded in daily life. Digital technologies may help decline the impact of the decreasing ratio of extension officers to farmers by supporting the extension officers in decision making, spreading knowledge, experiences and information and change the value proposition of extension service delivery.

The main research question is: *"How can digital technologies be harnessed to improve service delivery of consultants in a community of practice?"*

Four key themes emerged from the literature review in this study: *Extension services in agriculture*, *Digital technologies in service delivery*, *Extension officers and the supportive role of digital technologies* and *Adoption of digital technologies*. To investigate the phenomenon this research is using the building blocks of digital transformation, created by Vial (2019), as a guideline to collect qualitative data. Multiple extension officers have been interviewed and an observational field study, was conducted to gather qualitative data. As digital technologies are used differently over the world (developed and developing countries) Kenyan extension officers have been interviewed and the observational field study took place in the Netherlands. Involving extension officers from different organisations allows a comparison of both similarities and dissimilarities between extension officers.

The results show important findings on the role of digital technology in service delivery by consultants. Digital technologies support the dissemination of information but it is important to know the recipient of the information and depending on their capabilities the information is interpreted and used in a specific context. Explicit knowledge and 'know how' can be replaced by digital technologies where a new role for the consultant appears in the form of supervision of the applicability of information and supporting the use of digital technologies. Due to the change of the information dissemination, placing the information in the right context and replacing explicit knowledge and 'know how' the value proposition of the consultant's service delivery is changing.

Proposition 5a: *Digital technologies' support targeting dissemination of information via service delivery in a CoP requires a level of 'digital maturity' and applicability to the recipients to ensure that the information/knowledge received can be applied to a unique context.*

Proposition 5b: *The role of a consultant in service delivery is changing due to the influence of digital technologies digitalizing 'know-how' (explicit knowledge) but requires skills in supervising the quality of information being disseminated while also propagating the use of digital technologies.*

Proposition 5c: *The harnessing of digital technologies has a significant impact on the value proposition of service delivery.*

Next to these propositions four more propositions are stated as a result of the sub research questions. The five propositions together resulted in a final proposition:

Proposition 6: *Digital technologies can support the dissemination of information and replace the 'know how' aspect and explicit knowledge of service delivery in a CoP, but human interpretation of information ('know-how') cannot be substituted by the use of digital technologies alone.*

Contents

Key definitions and acronyms

TERM	DEFINITION
AGRICULTURAL EXTENSION SERVICES	A service that provides technical advice on agriculture to farmers, while also supplying them with the necessary inputs and services to support farmers' agricultural production (FAO, 2017).
COMMUNITY OF PRACTICE (COP)	A Community of Practice (CoP) is an (informal) network of people who shares common practices and join forces to share ideas, search solutions to solve individual or group issues and find new innovations for shared goals (Schneider et al., 2012).
EXTENSION OFFICER (EO) OR EXTENSION ACTOR OR EXTENSION WORKER	In this context, an extension officer is a knowledge expert who works with farmers to transfer knowledge and improve the farmers' production.
FARMERS' ORGANIZATION (FO) OR FARMER COOPERATIVE	A farmers' organization (FO) is a membership based collective action group providing services towards its members to improve the members' livelihoods by facilitating access to information, knowledge, markets, advocacy and inputs.
THE FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS (FAO)	The Food and Agriculture Organization (FAO) is a specialized agency of the United Nations that leads international efforts to defeat hunger.
KNOWLEDGE INTENSIVE ORGANIZATION (KIO)	An organization whose operations depend on specialized knowledge.
KNOWLEDGE WORKER	A worker whose work is primarily intellectual, creative, and non-routine in nature, and involves both the utilization of existing and creation of new knowledge (Hislop et al., 2018).
SMALLHOLDER FARM	A small farm where the farmers own/control their land with a low asset base, producing crops or livestock and operating in less than 2 hectares of cropland (World Bank Group, 2017).

1. Introduction

1.1. Background

The notion of 'work', its character and work-related activities that people undertake, and also the nature of organizations are being transformed by the rising importance of knowledge. This can be attributed to the growth in datafication as the basis for the data-information-knowledge cycle that supports complex decision-making as argued by Hislop et al. (2018). In this setting the indispensable role of knowledge workers in knowledge-intensive firms is apparent as a constituent element of the knowledge society. A knowledge worker is defined by Hislop as "*someone whose work is primarily intellectual, creative, and non-routine in nature, and which involves both the utilization and creation of knowledge*". This definition is backed up by De Sordi et al. (2020) who apply the term knowledge worker to professionals whose work is highlighted by the continuous, systematic, and predominant expansion of organizational knowledge through the mechanism of exploration. An example of a sector where datafication in combination with knowledge-intensiveness is becoming more entwined, is the Agricultural sector. Large volumes of agricultural data are being converted into actionable knowledge in order to enhance on-farm decision-making along the agricultural value chain (Sheperd et al., 2018).

The agricultural sector also represents a number of close-knit information and knowledge-driven Communities of Practices (CoPs). A CoP is an (informal) network of people who share common practices and join forces to share ideas, search solutions to solve individual or group issues and find new innovations for shared goals (Schneider et al., 2012). In such a CoP, the human factor implies that both tacit and explicit knowledge is apparent and used in decision making and decision support systems (Eastwood et al., 2012). Since data and information form the basis of both tacit and explicit knowledge, it can be expected that digitalization and datafication are both important for tacit and explicit knowledge.

One way to improve the production of commodities (e.g. live-stock, dairy, spices and pulses) by farmers is service delivery, also known as agricultural extension services or advisory services in the agricultural domain (Davis, 2008). Davis defines extension services as the support and facilitation required by people working in the production of the agricultural sector (e.g., farmers and farmer groups) to solve key issues and improve information flows, skills, and technology use. Extension services may involve different types of organizations e.g., governmental agencies, non-governmental organizations, organizations from the private sector and farmers' organizations.

Digital technologies, embedded in training processes and training methods, are a crucial vehicle to improve agriculture by giving better access to data and information, thereby expanding knowledge and allowing the intensification of crop growing and raising animals by farmers (Nyarko & Kozári, 2021; Salam & Khan, 2020). By integrating knowledge at different levels (local, national, regional, or global), it is expected that the innovations that ICT (i.e., digital technologies) bring, will impact the value proposition of extension services, training programs and increase the adoption of (new) technologies in both developing and developed countries.

There are still steps to take to unlock the full potential of digitization and digital technologies in the context of the agricultural sector (FAO, 2017), where exchanging experiences and information, communication and knowledge transfer are crucial (El Bilali et al., 2018). One challenge is the declining ratio of extension officers to farmers, negatively influencing the development and adoption of new technologies by farmers (Anabel et al., 2018). Digitalization and the use of digital technologies have become omnipresent in the agricultural sector leading to changes in the service delivery propositions (Munthali et al., 2018), contributing to the transition of sustainability (El Bilali

et al., 2018) and leading to new research opportunities around advisory services, advisory service models, value propositions, data ownership and the interaction between advisors and farmers (Klerkx et al., 2019). Little, however, is known about how digital technologies transform the service delivery by a consultant combining virtual and physical on-farm interaction. In this research the focus is therefore on identifying how digital technologies can influence the service delivery by consultants of farmers' organizations to farmers.

1.2. Motivation

Acting as an innovation intermediary, farmers' organizations (FOs) play a vital role in enabling extension workers to provide their farmer members with improved service delivery. Being a knowledge intensive organization, the FO should be able to benefit from global digitalisation and datafication in order to provide better, timely and more reliable information via digital technologies and support systems to their extension officers. The FO can provide the extension officer with applicable tools, knowledge, and skills necessary to optimise their service delivery.

Due to datafication, digital technologies are taking up a prominent place as enablers for extension services towards farmers. In these extension services, extension officers should thus be able to make use of these (new) digital technologies. However, extension workers are not always sufficiently capable to embed digital technologies in processes that are an integral part of service delivery.

The use of digital technologies can help extension officers to reach more farmer groups and spent more time in the field thus improving the quality and quantity of their work. Extension officers have become more comfortable in using and helping farmers to access the Internet. The plea is thus made to increase the use of digital technology use by agricultural extension officers. The increase in using these newer technologies by extension officers can be achieved via on-the-job training or by complementing its use with other extension delivery methods (Tata & Mcnamara, 2017).

Not much attention has been yet paid in the literature on the role of digital technology supporting the work of agricultural extension officers, even though there is an expanding number of justifications for the use of digital technologies in agricultural extension for on-farm production (Klerkx, 2020; Tata & Mcnamara, 2017).

1.3. Aim and Scope

The aim of this study is to investigate how digital technologies can harness extension officers' service delivery to farmer organizations. The case study will focus on extension services delivery and how these services are being delivered. In addition, this study will explore way in which digital support mechanisms can be harnessed by extension officers to improve service delivery. The theoretical relevance of this study lies in the expansion of the theoretical body of knowledge on digital technologies and service delivery, specifically in the field of agricultural extension services where digital technologies and accompanying disruptions it causes, offer an extensive area for research. Klerkx (2020) mentions that digital technologies have become one of the biggest factors that can, when used properly, accelerate innovation in service delivery through knowledge diffusion, cooperation between, and communication amongst farmers in rural areas. A better understanding should be gained on this topic as the body of knowledge in agriculture is forever expanding being propelled by digital technologies.

1.4. Research questions

The given context of this research shows that there is much to explore when it comes to enabling extension worker service delivery through digital technologies, especially in the field of agriculture and farming where digital technologies have not been actively used but can make a major impact at

this point in time. There is still much to gain on the 'extension science' research where recent developments in technologies, innovation theories and worldwide trends are picking up their pace (Klerkx, 2020).

With an increased focus on sustainable farming and the need for improvement of farming management adding value in the agricultural sector, this study will focus on the influences those digital technologies bring to the field of 'extension science' research. Since there is very little literature that covers the unique role of these technologies as enablers to mobilize extension workers, the main research question (MRQ) for this study is formulated as follows:

"How can digital technologies be harnessed to improve service delivery of consultants in a community of practice?"

1.5. Research approach and outcomes

For this study, an interpretive qualitative research method was chosen. Due to the novelty of the topic, an exploratory research method was considered the best method to conduct this study. After gaining insights in the current literature via a literature study, a case study was selected as the preferred data collection method consisting of interviews and observational field work.
The data gathered was analysed after which the findings of this study show that digital technologies can be harnessed to support service delivery replacing aspects as 'know how' and explicit knowledge but that human interpretation of information cannot be substituted by digital technologies completely.

1.6. Structure of the thesis

In the next chapter (Chapter 2), the literature review approach and key themes emerging from the literature analysis will be described followed by a description of the theory chosen for this study. The literature review will provide deeper insights into the use of digital technologies in service delivery. In Chapter 3 the research method to be followed for the empirical part of the study will be described together with the case study that will be used to collect data from agricultural extension officers to explore their use of digital technologies to provide extension services to farmers. Chapter 4 will describe the results of the study. In the final chapter, chapter 5, a discussion follows together with recommendations on the improvement of service delivery in farmer organisations through digital technologies. In addition, recommendations for practice and further research will be given.

2. Literature background

In the previous chapter an outline of the research topic was presented along with its context, the problem statement and the main research question was stated. Chapter 2 revisits the current literature and presents the emerging themes from two different strands of the literature on digital technology and service delivery by consultant in the context of agriculture. Next a theoretical model is selected to guide the data collection and finally the sub research questions supporting the main research question are presented.

2.1. Literature Review Method

It is imperative for academic research to start with a thorough literature review (Webster & Watson, 2002). This review highlights outcomes of existing studies and gaps in the literature with respect to the study, and finally based on these gaps and themes from the literature, proposes a set of research questions. To do so, this study used the grounded theory as a basis to approach the literature review method (Wolfswinkel et al., 2011). In this approach Wolfswinkel proposes five stages of activities for reviewing literature: define, search, select, analyse, and present.

The first phase of the method recommended by Wolfswinkel, was used to shape the criteria for inclusion or exclusion of literature and gather information. Information was collected about digital transformation, knowledge experts, knowledge intensive organizations and the use of ICT in the agricultural sector. The literature was selected by searching for peer reviewed articles not older than 5 years, with an exception made when articles were referenced in the articles selected for this study. Peer reviewed articles hold more 'truth' than non-reviewed articles, books, blogs etc. and by involving articles not older than 5 years the risk of obsolete or outdated articles was minimised. Every search term was entered in English. Literature was systematically searched by using the OU Library, EBSCO (Host) and Google scholar. In some articles the researchers pointed towards a more extensive theoretical models published in books. These models have been reviewed as well.

Search terms

First, literature about the broader terms *Service delivery*, *Knowledge transfer, Agriculture & Digital technologies* and *Extension services* were searched. After the initial results, the scope was narrowed down using the following search terms:

Search term	Argumentation
"Knowledge transfer" **AND** "Consultants" **AND/OR** "service delivery"	Retrieving information about knowledge transfer by consultants in service delivery.
"Community of practice**" AND "**Agriculture**" AND/OR "**Knowledge intensive organisation**" AND/OR "**Farmers' organization**"**	So that a deeper understanding can be gained about how agricultural communities of practice are using knowledge or the role of knowledge within agricultural organizations, as this knowledge is diffused to members of the Farmers' organization.
"Extension services**" AND "**Agriculture**" AND/OR "**Extension workers**" AND/OR "**Advisory services" **AND/OR "**Knowledge workers**"**	These search terms result in a better understanding of the agricultural sector and the extension services that farmers receive. Synonyms have been used here in the search terms as in the literature these are all common and used in the same way.
"Digital technology**" AND/OR "**ICT**" AND/OR "**ICT adoption**" AND/OR "**Extension services**" AND/OR "**Extension workers**"**	To gain insights in the role of digital technologies and ICT and their impact on the extension services.

AND/OR "Advisory services**"** **AND/OR "**Knowledge workers**"**	
"Digital technology**" AND "**Adoption**" AND/OR "**Agriculture**" AND/OR "**ICT**"**	To review the current literature on the role of digital technology and technology adoption in the agricultural sector.

Table 1: Search terms and combinations of search terms used for this study

In some cases, also specific terminology has been used in the literature review based on the terminology used in several articles. Examples are "Agriculture 4.0", "E-extension", "AgriTech" and "agricultural innovation systems". Next to that, in the search terms synonyms and abbreviations have been used, an example here is "coop" instead of "cooperative".

An iterative process took place while entering the phases of *search and select*. The search, as described above, for literature resulted in 121 articles. By reading the title and the abstracts the content of the articles became clearer after which articles have been marked as 'relevant', 'potentially relevant' or 'irrelevant'. The latter articles were not used further in this study. The remaining papers were narrowed down by reading the title and the abstracts. Of (potentially) relevant articles the introductions, literature background and methods and the discussions & conclusions gave a clear insight total content of the article. 58 articles that eventually proved to be relevant have been entered in EndNote.

Clustering of topics

The articles have first been clustered by the topics 'Digital technology', 'Knowledge transfer' and 'Service delivery' to gain a deeper understanding of the context. Separate sections were appointed for 'Literature review' articles as they provided a valuable source of information on certain topics and 'Books'. The last but certainly not least cluster contained the articles that expected to be highly valuable for their relevance to this study.

In analysing the articles, open coding and axial coding to cluster open themes were used to get insights in the concepts and possible connections between the articles and their topics (Wolfswinkel et al., 2011). From this exercise more insights were gained, and new key terms could be defined which then led back to phase one where a new search took place based on these new insights.

Key topics

A final interpretation of the literature came up with four themes shown in the table below (table 1.) together with applicable sources for each theme.

THEME	AUTHORS
1. Extension services in agriculture	(Abate, 2018; Davis, 2008; Eastwood et al., 2019a; FAO, 2017; Hislop, 2008; Kansiime et al., 2019; Knierim et al., 2017; Kudyba, Fjermestad, & Davenport, 2019; Lameck & Hulst, 2020; Nakasone & Torero, 2016; Namyenya et al., 2021; Oyinbo et al., 2019; Purnomo & Kusnandar, 2019; Silva et al., 2017; Wang et al., 2019; Yang, Klerkx, & Leeuwis, 2014)
2. Digital technologies in service delivery	(Aker, 2011; Aker et al., 2016; Álvaraz-Mingote & McNamara, 2018; Deichmann et al., 2016; Eastwood et al., 2019a; Eller et al., 2020; Fleming et al., 2018; Kansiime et al., 2019; Lubell & McRoberts, 2018; Nakano et al., 2018; Nakasone & Torero, 2016; Oyinbo et al., 2019; Purnomo & Kusnandar, 2019; Rattenbury & Nafus, 2018; Rose & Chilvers, 2018; Rose et al.,

	2021; Salam & Khan, 2020; Sebastian et al., 2017; Steinke et al., 2021; Tata & Mcnamara, 2017; Zhao & Gong, 2020)
3. Extension officers and the supportive role of digital technologies	(Ayre et al., 2019; Christensen et al., 2019; Eastwood et al., 2019a; Heeks, 2002; Jayasingam, 2015; Knierim et al., 2017; Müller et al., 2019; Nyarko & Kozári, 2021; Ortiz-Crespo et al., 2020; Rose et al., 2021; Steinke et al., 2021; Tata & Mcnamara, 2017)
4. Adoption of digital technologies	(Ayre et al., 2019; Deichmann et al., 2016; Eastwood et al., 2012; Evans et al., 2017; Kansiime et al., 2019; Lundström & Lindblom, 2018; Mwombe et al., 2014; Namyenya et al., 2021; Oyinbo et al., 2019; Purnomo & Kusnandar, 2019; Ragasa & Mazunda, 2018; Steinke et al., 2021; Tata & Mcnamara, 2017; Uddin et al., 2019; World Bank Group, 2017)

Table 2: Key themes derived from the literature analysis

2.2. Background literature

The paragraph below presents the synthesis of the literature found after the literature review (conducted as described in the former paragraph). A deeper analysis of the literature identified key sub-themes, that are essential for service delivery (also known as extension services in agriculture) supported through digital technologies by farmers' organizations.

2.2.1. Extension services delivery in agriculture

The need to improve the production of farming globally is already recognised as world population will continue to grow and thus more (nutritious and high quality) food needs to be produced (FAO, 2017). To produce more value to their customers organisations will need to find a mix of technology, individual skills and leadership (Kudyba et al., 2019). One of the ways to improve the production of farmers is *service delivery*, also known as *agricultural extension services* or *advisory services* (Davis, 2008). Davis defines extension services as the support and facilitation required by people working in the production area of the agricultural sector (e.g., farmers and farmer groups) to solve key issues and improve information flows, skills, and technology use. Extension services may involve different types of organizations like governmental agencies, non-governmental organizations, organizations from the private sector and farmers' organizations. The next 3 sections consider key aspects of extension services in more depth.

i. Service delivery

Service delivery often takes place via extension officers who physically visit (member) farmers, offer advice and training, educate farmers on new technologies and assist them in, for example, crop and livestock disease prevention (Lameck & Hulst, 2020). Lameck & Hulst's research indicates that, when resources are scarce, extension officers are often met with circumstances that are far from ideal. Visiting farmers or farmers' groups, extension officers often need to travel large distances while lacking suitable transport for travelling. Face-to-face agricultural extension has been the traditional way to diffuse knowledge and experiences among farmers. Hence, extension officers will visit farmers, groups of farmers or conduct farmer field schools[1]. There are several downsides to these traditional methods (Nakasone & Torero, 2016), i.e., weak infrastructures in developing economies make visiting farmers and farming organizations in remote (rural) areas expensive, and information

[1] "*A farmer field school brings together a group of farmers, livestock herders or fisherfolk, to learn o how to shift towards more sustainable production practices, by better understanding complex agro-ecosystems and by enhancing ecosystem services.*" FAO: https://www.fao.org/farmer-field-schools/home/en/ consulted on 30th of January 2022.

is often shared only once and not spread over several activities/dates, and finally, extension workers are not held to any accountability for the quality of their services.

Digital technologies are considered a disrupting force which may give (cheaper) alternatives and the option to overcome all the downsides of traditional extension service delivery methods. Using digital technologies, information provision can be richer ranging from weather information to instructional videos, online meetings and the distribution of accurate pricing information (Kansiime et al., 2019; Nakasone & Torero, 2016). Namyenya et al. (2021) recognises digital technologies being of great impact in two main areas namely *agricultural extension advice* and to utilise the *spread of market price information directly* influencing the farmers' position in bargaining better prices for their produce. Regarding agricultural extension advice, digital technologies can cater in reducing the costs of communications and information flows compared to the traditional (face-to-face) advice.

ii. Extension officers

A consultant is a role who gives expert advice to another person or organization on a particular subject[2]. According to the framework developed by Hislop (2008) a consultant uses both social and intellectual skills. The work of an extension officer is alike that of a consultant requiring a large portion of travelling, working at different locations, and meeting the client's needs and requirements making no two clients the same. Regarding the latter an extensions officer (as is the case for a consultant) employs both theoretical and contextual knowledge to define or tailor a solution for a client. As for a consultant, an extension officer, uses theoretical knowledge in a real life situation (Hislop, 2008).

Originally the term "extension" was coined to capture a service which "extended" research-based knowledge transferring to the rural sector so that the livelihood of farmers and their produce would improve. This so-called extension may include the transfer of technology (Davis, 2008). The research of Silva et al., (2017), indicates that it is important for the extension officer to contact the farmers frequently, especially in the case of using complex technologies, because otherwise the chances are big that the farmers abandon these (new) technologies.

From a historical perspective, extension officers are advisors on subjects they are an expert in and focused on the improvement of productivity. Nowadays many more topics belong to the extension officer's portfolio for example environmental sustainability, climate change and helping farmers identify their needs (and decision support) with respect to technology investments (Eastwood et al., 2019a).

In the context of FO's, an extension officer's frequent in person support is vital having a positive effect on the adoption of digital technologies by famers. At the same time the infrequent availability of the extension officers and their support are major limiting factors in ICT adoption by farmers, as mentioned by Silva et al. (2017). Oyinbo et al. (2019) found that farmers' experiences benefit from ICT especially when ICTs is targeted to site-specific management instead of having a more general character. Oyinbo et al., (2019) further state that today, digital technologies should be an integral in the portfolio of an extension officer.

iii. Farmers' organizations' role in service delivery

Farmers' organizations (FOs) are powerful entities playing a key role in the science of agriculture, innovation of technology and transformation stages (Wang et al. (2019). In agricultural Communities of Practice FOs are often capable to deliver more market power for their (member) farmers and it is up to the cooperative to attract more members by providing solid demand-driven services (Abate,

[2] Collins dictionary: https://www.collinsdictionary.com/dictionary/english/consultant consulted on 19th December 2021.

2018). The role of FOs is seen as connecting technical, social, and economic dimensions of farming practice and providing corresponding services. The FO therefore fulfils a coordinating role towards (individual) farmers in the service system. Examples of services include giving advice on how to use fertilizers, the effect of pesticides and techniques to improve crop production but also provide credit supply and facilitate collective market access (Yang et al., 2014).

Typical examples of service delivery in Ethiopia include FOs that offer collective input to purchasing (the FO will buy the farmer's crops) and output marketization (the FO will sell the farmer's crops to the market) (Abate, 2018). Access to market information, land records and services, accounting and farm management information, management of pests and diseases and access to rural development programs are other examples (Purnomo & Kusnandar, 2019). Agricultural extension and advisory services therefore facilitate the transfer of knowledge and information, improvement of techniques and practices to farmers (Kansiime et al., 2019).

2.2.2. Digital technologies in service delivery

The fourth agricultural revolution, or agriculture 4.0, might have started already. Expectations are that new technologies like the Internet of Things, Artificial intelligence, Drones and Cloud computing will be transforming the agricultural sector in a disruptive manner (Rose & Chilvers, 2018). Sebastian et al., (2017) coined the term 'SMACIT' for new digital technologies categorizing them in Social, Mobile, Analytics, Cloud and Internet of Things technologies. These digital technologies form key enabling elements in the flow of information that could improve the yield and efficiency of farming, and lower costs for farmers (Deichmann et al., 2016). The benefits of these new smart (agricultural) technologies are that they can be put to greater use in reducing inputs, reducing labour and at the same time enhancing environments enabling the production of more food and increase eco-friendly efficiency (Rose et al., 2021).

i. Information and knowledge dissemination

An industry-wide technology diffusion in rural areas of upcoming economies may not only provide timely and cheaper information services but also help in coordinating agricultural service delivery (Aker et al., 2016). A study from Nakasone & Torero (2016) however shows a gap between developed and developing countries where the developing countries, especially the poorest areas, are still behind in the provision of, access, and use of digital technologies. One potentially effective method to diffuse new technologies among farmers in rural areas is agricultural training. This method does have its constraints including knowledge constraints, capital constraints, and labour constraints. It is however apparent that inadequate extension services are a significant cause of low adoption of production technologies, proper training in their use is crucial (Nakano et al., 2018).

To improve the dissemination of information and knowledge, digital technologies offer tools that are almost indispensable for farming communities (Purnomo & Kusnandar, 2019). In their study Salam & Khan (2020) found evidence of this by researching the perception of farmers in relation to the use of information and ICT in agricultural extension. The larger part of the farmers, involved in their study, believes that ICT is a less expensive and quicker source of information than the traditional face-to-face information exchange. Using digital technologies to spread information to farmers promises the increase of reaching more farmers than via the traditional face-to-face services (Lubell & McRoberts, 2018; Tata & Mcnamara, 2017).

ii. Data driven decision-making

Data driven decision making is one of the current trends that may change the service delivery offered by extension officers in agriculture (Eastwood et al., 2019a) but only for those that adopt (new) digital technologies. Big Data and user-based interfaces lead to more transparency in decision-making taking into account that decision-making is in line with tacit agricultural knowledge (Fleming

et al., 2018). Parallel to this is the increased development of data science making information even more insightful (Rattenbury & Nafus, 2018).

To improve decision making (smallholder) farmers need to have access to context-based information which could enhance their decision-making capabilities, allowing farmers to make knowledgeable choices on for example, which crops to produce or how to improve the quality of their produce (Kansiime et al., 2019; Purnomo & Kusnandar, 2019). Digital technologies ranging from access to information via mobile phones (Nakasone & Torero, 2016) to the use of Big Data to analysing the markets (Zhao & Gong, 2020) can support the farmers in their decision making.

iii. Change in value proposition

Adopting digital technologies, including for example AI, big data processing, social media and internet of things, by service-oriented organisations will eventually change their value proposition (Eller et al., 2020). Designing services should be done bottom-up where the demands or needs of the farmer are the central point of the service (Álvaraz-Mingote & McNamara, 2018). An example in agriculture is online e-business where extension officers, while training farmer groups, can reach more farmers because the technology allows for a transparent clustering of famers into groups including documented information per registered farmer and their training needs so that extension officers can assess the training needs faster and more accurate than working from paper (Tata & Mcnamara, 2017). Another example is that co-creation of new products and services is possible where new extension services are developed together with civil society and private sector (Steinke et al., 2021)

To make use of the numerous digital technologies that are available a transition needs to be made from the current tendency in extension service development for centralised top-down decision-making to more decentralized and diversified extension services (Steinke et al., 2021). An example of centralised top-down is the mass dissemination of agricultural information to farmers such as weather forecasting which is relevant for many farmers (Aker, 2011). This can, however, not be adapted to the context of a small group or individual farmer where, according to Steinke et al., biophysical conditions, input use and aspiration and other farmer dimensions cannot be addressed via mass disseminated information (2021). Oyinbo et al. (2019) studied the use of digital tools that support extension services. Evidence was found that general recommendations, with the use of digital tools, made to farmers are less preferred than the use of site-specific visits for this. Steinke (2021) proposes that digital technologies must be designed around user-centredness and problem-orientation instead of around standardized solutions and techniques.

2.2.3. Extension officers and the supportive role of digital technologies

The traditional extension services provided by extension officers, like Field days or Farmer Field Schools, do not always meet the expected outcomes when it comes to the adoption of technology or the improvement of farmers' livelihood (Steinke et al., 2021). Nyarko & Kozári (2021) argue that digital technology is one of the most influencing factors and evident tools for modernising extension delivery systems to new standards.

i. The role of the extension officer

Following Hislop (2008) a consultant uses both social and intellective skills and often requires a large proportion of travelling, working at different locations, and meeting the client's needs and requirements since no two clients are the same. Regarding the latter, a consultant employs both theoretical and contextual knowledge to tailor or come up with a solution for a client. The consultant uses theoretical knowledge in a real-life situation. The work of an agricultural extension officer is similar to that of a consultant. Extension officers fulfil the role of a broker of agricultural

knowledge and are therefore an important element of any agricultural knowledge system (Knierim et al., 2017).

An extension officer, having the role of knowledge-broker and service provider, therefore plays an important role in the digitalization of the agricultural sector (Eastwood et al., 2019a). Manual labour is often influenced by digitalisation (Rose et al., 2021) but this study also concludes that extension officers will also experience the effect of digitalisation as their advice needs to be targeted towards 'smart farming' where machines make autonomous evidence-based decisions. Using digitalised services (e.g., an online forum) increases the adequacy of advisory services and enables the extension workers to answer more inquiries of farmers than conventional communication channels (Ortiz-Crespo et al., 2020).

Eastwood mentions that a new role is laid out for the extension officer due to the rise of digital technologies where now, analytical skills with data and digital literacy will become a part of the skillset of an extension officer (2019a). An example is the skill to base decisions on data provided by digital technologies (Müller et al., 2019). Digital technologies will also enable peer-to-peer information sharing between farmers. To make sure that the shared information is understood and placed in the receiver's context, the extension officer might need to claim a supervisory role (Steinke et al., 2021)

ii. Influence of digital technologies on the role of the extension officer

New technology allows the dissemination of (agricultural) information without the physical presence of the extension officer where digital services have already been developed and are in use giving the smallholder farmers access to agricultural information (Ortiz-Crespo et al., 2020). Ortiz-Crespo also mentions that the availability of digital tools allows for two-way communication between extension officers and farmers, whereas the traditional physical extension services were often a one-time-only occasion.

Even though extension officers have a very pertinent role in the networks of FO's, it is however not always clear for the extension officer how to use ICT in such a way that farmers benefit from their services (Nyarko & Kozári, 2021). The use of ICT enables extension officers to have a wider and longer reach and allows them to spend more time in the field to improve the quality and quantity of work. To realise having extension officers more empowered by ICT training-on-the-job should be an integral part of the schooling of extension officers (Tata & Mcnamara, 2017).

Digital tools however, also pose a challenge to the extension officers as they will need to learn the nature and effects of these tools and how (new) services become a part of their extension services (Ayre et al., 2019). New developments like smart farming have a disruptive potential that is not yet caught. Training for extension officers should include topics like smart farming so that extension services and the delivery thereof stay adequate and up-to-date (Eastwood et al., 2019a).

Eastwood et al., (2019a) concluded in their study that there are several factors to be considered that influence the extension officers:

1) professional identity may be influenced by the officers' perception of the (new) technologies.
2) organizational context if their organization does not support (new) technologies.
3) professional identity which needs peers to conform to/learn from when dealing with (new) technologies.
4) practices when it comes to farm visits and (different) interaction with their farmers.

iii. The role of the farmers' organization

There is a great need for knowledge intensive organizations to create a culture whereby knowledge workers are facilitated in their work and workers' expectations are met (Jayasingam, 2015). One significant problem after all, is when knowledge workers leave the organization, they will leave a gap in the organization's knowledge. Digital innovation, embedding digitalisation and ICT in an organization, will change the organizational structure as services and products will be transformed (Eastwood et al., 2019a).

Digital tools can accommodate extension officers in their work, allowing them to deliver better targeted advise and spent more service delivery time per individual farmer. Dashboards, including farmers' Q&A sections make quick responses possible and reduces the communication time (compared to phone calls or visits). Extension officers could even reply to several farmers at the same time instead of individually, thereby increasing the information flows towards the FO's members (Ortiz-Crespo et al., 2020). Ortiz-Crespo states that, via digital tools, the extension officer's labour burden can be reduced, and time freed up to do more research to improve service delivery and answer more complicated questions.

The farmers' organization may claim a prominent role in deploying new digital technologies in extension services and promote these technologies to increase adoption (Christensen et al., 2019). Notably, their extension services need to be continuously improved, and extension officers need to be adequately trained to keep up with farmers who are ahead of the game (Heeks, 2002).

2.2.4. Adoption of digital technologies

Regarding the adoption of digital technologies in the context of this research two elements below are highlighted in literature.

i. Adoption by extension officers

With the rise of digital technologies, challenges also arise for the extension officer as this phenomenon brings rapid changes and a multiplicity of tools and effects that come with digital innovation (Ayre et al., 2019). Digital technologies also bring several factors that negatively influence the working conditions of extension workers including: lack of office-wide internet connectivity, unstable power supply and non-subscription to relevant online resources (Uddin et al., 2019). Other factors influence the type of training preferred by an extension officer, here demographics play a role (education and age) but also having no records of farms, the (lack of) literacy of farmers, defective software, and no or low-quality technical support as mentioned by Tata & Mcnamara (2017).

Purnomo & Kusnandar (2019) found that there are several barriers in the acceptance of ICT, which has an impact on agricultural extension officers. These barriers are clustered in individual, cultural, organizational, policy and technological barriers. Digital tools also hold the promise of more accountability of the extension officer. The current practice of extension services is a one-way practice and, if given, feedback does not arrive at the correct place. The improved accountability might form an obstacle for the extension officer to adopt digital tools (Namyenya et al., 2021).

ii. Adoption by farmers

A farmer's observation and experience are needed in managing their farm, decision support systems are not capable of taking over all the work of a farmer (Evans et al., 2017; Lundström & Lindblom, 2018). Often there is a limited use of the capacity of farmer decision support systems as the farmer operates using tacit knowledge and might thus cause a conflict with the support systems (Eastwood et al., 2012).

A study from Kansiime et al. (2019) shows that the use of digital tools are more effective to reach a larger number of farmers compared to using less of no tools in traditional farm visits. Once information reaches farmers, their study found evidence that the services delivered, led to new evidence-based farming practices. It is important that farmers experience the use of ICT at least useful. The quality of the advice received is more important than the type of delivery method. Investing in extension services becomes more beneficial that way, as shown by the research of (Ragasa & Mazunda, 2018).

Oyinbo et al. (2019) mentions that there is a difference that was found between farmers that were quick to adopt new technologies compared to those who do not do so. Famers that are more inclined to adopt technology rapidly are often farmers with higher incomes, better access to services and are more willing to invest in capital- and labour-intensive production systems. A limitation of technology adoption by farmers is the digital maturity of the farmers where, for example, access to mobile phones is sometimes depending on gender or wealth status (Deichmann et al., 2016; World Bank Group, 2017). Also the technological literacy of farmers or the willingness and capabilities of investing in internet availability may cause different adoption rates (Steinke et al., 2021). Another example is that not all farmers are able to capture the mass information (e.g., radio or television broadcasts) simply because they are at work or because the content does not apply to them (Mwombe et al., 2014)

2.3. Main research question

There is ample evidence in the literature about the benefits of digital technologies in the agricultural sector, not only for the organizations active in the sector itself, but also for extension officers and the individual farmer. The farmers' organization is one of the organizations in the agricultural sector that plays a key role in the dissemination of (agricultural) information, experiences and techniques. Via extension officers the farmers' organizations reach the (member) farmers and supporting them in improving their production, link them to financial resources and enable decision-making based on accurate information.

As digital technologies are making an undeniable impression on the agricultural sector, it is directly affecting the farmers' organization and their extension officers. In the current agricultural revolution (agriculture 4.0), farmers' organization should transform so that they can enable their extension officers to work with digital tools in their work environment and extension services.

What is not explicitly mentioned in literature is which factors play a role in the evident digital transformation of the knowledge intensive organizations and more specific knowledge intensive farmers' organization. Especially the focus on (digital) service delivery by knowledge experts (also known as extension officers) seems underexposed in this context. Hence the main research question of this study is:

"How can digital technologies be harnessed to improve service delivery of consultants in a community of practice?"

2.4. Theoretical model selection

In order to answer the main research question and its sub questions that follow, further research was done to identify an applicable theoretical model to shape the study. In the field of usage and adoption of digital technologies, some of the most cited and used theoretical models in literature found are:

- The Technology Acceptance Model (TAM) (Davis, 1989)
- The Technology-Organization-Environment Framework (TOE) (DePietro et al., 1990)
- Diffusion of innovations theory (DOI) (Rogers, 2003)
- The Unified theory of Acceptance and Use of Technology (UTAUT) (Venkatesch et al., 2003) and
- Building blocks of the digital transformation process (Vial model) (Vial, 2019)

The abovementioned models and theories focus on the adoption and usefulness of (new) technology. They aim to give structure to the possible adoption of (new) technology by certain contextual factors that are of influence. By analysing each factor, the models try to predict whether an adoption will be successful.

The researcher studied each of these theories to identify its suitability for this study. A deeper analysis indicated that the UTAUT and TAM models are more targeted at an individual unit of analysis and not the organizational level of analysis. The DOI model is aimed towards the diffusion of innovations and at what rate these innovations are adopted. The TOE model and Vial's model are more suitable since both are based on the characteristics of an organization making these two models appropriate for this study. Each theory is briefly described in the next two paragraphs.

The Technology-Organization-Environment Framework/Model (TOE)
Literature points towards the use of the Technological-Organizational-Environmental (TOE) model which captures three aspects of an organization's context that influence the adoption of technology: technological context, organizational context, and environmental context (DePietro et al., 1990). The application of the TOE model is multi-fold in research. Throughout the years the model has been used to research the influence of Electronic Data Interchange (Kuan & Chau, 2001), E-business (Oliveira & Martins, 2010a; Zhu et al., 2006b), the determinants of ICT Adoption and usage among SMEs (Kilangi, 2012), Web knowledge exchange in small and medium sized enterprises (Palacios-Marqués et al., 2014) and ICT adoption by small and medium enterprises (Jere & Ngidi, 2020).

Building blocks of the digital transformation process
The model created by Gregory Vial (2019) consists of eight building blocks. Central is the block 'Use of digital technologies' which is based on the SMACIT-classification of Sebastian et al. (2017). Another important block is the "Changes in value creation paths" where an actual product or service undergoes a change enabled by using digital technologies. The other six blocks are linked via a statistical relationship or causality drawn from the knowledge of digital transformation at the time of creation. The building blocks have been used recently as a foundation for different research purposes in, amongst others, education (Livari et al., 2020), small and medium enterprises (Guo et al., 2020; Peter et al., 2020) and governmental analysis (Gong et al., 2020)

Ultimately, for this study the building blocks of the DT process will be used as a reference to guide the data collection and will then form the basis for the data analysis. Compared to the TOE-model, which uses external factors to focus on technology adoption, the building blocks are more focus on influencing role of digital technology on a service or product. This makes the building blocks model of Vial (2019) more suitable to investigate the influence of digital technologies on service delivery in agriculture. A description of the building blocks can be found in the appendix of this report.

2.5. Research questions

The results of a literature review, presented in chapter 2.2, give a scientific context from which four key themes emerged. In this literature review no evidence was found that a TOE framework was used in combination with farmers' organizations, digitalisation, and extension services. Recall, the main research question was formed:

"How can digital technologies be harnessed to improve service delivery of consultants in a community of practice?"

Based on the main research question, the gap in the literature and the thematic analysis of the literature the followed, the sub questions required to further unpack the main research question and collect empirical data for this study:

Sub question 1: *How do digital technologies change service delivery by consultants?*
Sub question 2: *How can digital technologies support service delivery by consultants?*
Sub question 3: *How do digital technologies change the role of a consultant in service delivery?*

2.6. Summary

In this chapter the literature background has been investigated via a literature study where four key themes emerged. Based on these key themes the research question was formulated and a theoretical model, the building blocks of Vial, has been employed to support the data collection and answering the main and sub research questions. The next chapter, chapter 3, describes the research method followed in this study.

3. Methodology

In chapter 2 the literature analysis provided insights in digital technology involved in service delivery in the agricultural sector. Chapter 3 presents the methodology used to conduct the empirical work for this study.

3.1. Research approach

There are three types of research approaches according to Saunders, Lewis and Thornton (2019): i) qualitative research, ii) quantitative research or iii) a mix of both (mixed methods research). A quantitative research focusses on the gathering of numerical data and uses highly structured data collection techniques such as surveys that measure the strengths of relationships between different constructs. The data is therefore used to test a certain (existing) theory or to confirm relations between variables. Qualitative researche is used to gather experiences and opinions of participants and then analyse whether there is an connection in the results (Saunders, Lewis, & Thornton, 2019).

A new phenomenon, digital technologies enabling the extension workers of FOs to improve their extension services is the focus of this study. Hence, this characterizes this study as explorative (Blaikie, 2000). This is also indicated by the research questions that start with "How". The building blocks of Vial (2019) are used as a guidline in this explorative study. Exploratory studies are not only suitable for studying new phenomena , but also where the exact nature of the phenomena being studies is unknown. Exploratory research is appropriate to research attitudes, motivations and behaviours of both individuals and organizations. Another advantage of an exploratory study is that it is flexible and can be adapted depending on the results during the investigation of the phenomenon (Saunders et al., 2019).

To answer the research questions of this study a qualitative interpretive approach was therefore selected, as it focuses on antecedents and the experiences of interviewees rather than numbers and statistical data. The necessary data will come from people rather than recorded (statistical) measurements and insights from the literature study will be applied.

3.2. Data collection techniques

There are several types of techniques to collect data to analyze a phenomenon amongst which 'Experiments', 'Surveys' and 'Case studies' (Saunders et al., 2019). In an experiment the researcher should be able to control all variables. This is, for the current study, impossible as there are too many uncontrollable factors that will influence the study. Also surveys are not suitable as these are too individually focussed and best used for pure numerical data collection. As this study investigates a certain phenomenon in it's real life setting, the research form found most suitable for this study was a case study. A case study does not need control of (all) variables as in an experiment, but allowa the researcher to be immersed in the study context and thus focus on the studied phenomenon. A disadvantage of a case study however is generalizability as the results may prove difficult to apply to other (alike) cases (Saunders et al., 2019).

3.3. Case study description

Using a case study allows for an in-depth analysis of a certain topic or phenomenon (Yin, 2018). For a case study, boundaries are necessary as the case might grow out of proportion (Flyvberg, 2011). For this study three farmers' organizations were selected, one situated in a developed country (EU) and two in a developing country (Africa). Selection criteria required the organizations to have digital tools in place when it comes to service delivery. The names and

data of these organisations are anonymised in this study to retain confidentiality. Several parameters have been included to allow for a 'as fair as possible' comparision between the organizations:

Details of org.	Organisation 1	Organisation 2	Organisation 3
Type of organization	Service delivery	Service delivery	Service delivery
Country	Kenya	Kenya	Netherlands
Sector	Dairy	Dairy	Dairy
Extension officers	Yes	Yes	Yes
Type of services	Advising & training farmers in dairy production, farm structures, feed formulation, cow bearing, food establishment & conservation, artificial insemination	Advise & training farmers in dairy production, feed establishment, conservation of milk, hgiene, artificial insemination	Specialised in feed quality, youngstock rearing, transition period and forage

Table 3: Case study selection parameters

An explicit choice was made to involve organizations from different countries where the level of digitalization and use of digital technologies is different. Using this contradiction allows for an interesting comparision of the use of digital technologies and how the extension services were benefitting from it. The first requirement is that the organisation was providing, or delivering services to their clients, provided by employed extension officers. The type of service was another requirement as comparing economical services to lobbying would not be a fair comparison. Lastly the organisations needed to have their service delivery towards farmers in the dairy sector. Any other sector may require a different service delivery approach making a comparision harder.

The following sources were selected to shape the outcome of the study. Two farmers' organizations have been selected from different communities of practice: FO-1 located in the northern part of the Rift Valley province of Kenya and FO-2 located in the southern part of the Rift Valley province. A third organization, from the Netherlands providing extension services in the Dutch dairy sector, has been involved as an observational field day is organized joining one of their extension officers for a day. Below a description of both Kenyan farmers' organizations.

Farmers' organization 1 (FO-1, Kenya)
The FO is located in a close-knit CoP in the northern part of the Rift Valley province in Kenya. The FO provides extension services in the dairy sector to both dairy organizations and individual farmers. The total number of members reaches up to 17.000. The FO has between 20-30 active extension officers. With regards to the digital technologies the FO uses foremost WhatsApp for communication (both internal and towards their farmer members) but also Skype and Zoom for calls and training sessions. The Dairy Competence Builder platform is used to monitor, track and improve their extension services. The FO provides laptops and smartphones to their extension officers.

Farmers' organization 2 (FO-2, Kenya)
FO-2 is a part of a close-knit CoP in the southern part of the Rift Valley province in Kenya. Alike FO-1 they provide extension services in the dairy sector to both dairy organizations and individual farmers. The total number of members reaches up to 6.000. FO-2 employs between 10-15 extension officers. With regards to digital technology the FO uses WhatsApp (both internal and towards their farmer members), broadcasts via a radio and uses Skype and Zoom for calls and training sessions. FO-2 also uses a Union app worksite and a Monitoring & Evaluation tool to evaluate the work of their extension officers. The Dairy Competence Builder has been implemented to monitor, track and improve the FO's extension services. From a hardware perspective they mostly use laptops and smartphones.

Data collection
For this research semi-structured interviews were held with multiple extension officers per case organization. This allowed input from different angles within a single and across multiple organizations. They have their own perspective and experiences with digital technologies and what role digital technologies play in extension services. Interviewing an extension coordinator will also involve a stakeholder on a strategical and tactical level of decision-making on digital technologies. Of the organizations also interviews were held with extension officers. The extension officers provided valuable insights in their wishes/demands and experiences in using digitalisation.

The interviewees were selected based on the following criteria that required them to have:
1. a role in (facilitating/organising) extension services (5+ years)
2. experience with providing (digital) extension services
3. managing a project where new digital technologies are proposed and implemented for extension services

For the case study, interviews were held with extension officers, the equivalent of consultants, employed by the selected farmers' organizations. The extension officers have the same level of experience (5+ years) in providing extension services and use digital technologies to support their service provision.

After the interviews it was decided if saturation has been reached, meaning that additional information will not give new insights, or additional interviews were necessary.

3.4. Research phases
The case study work involved three phases: preparation, data collection and data analysis. These followed steps in are presented in this paragraph.

3.4.1. Preparation
Semi-structured open-ended individual interviews were used as the primary data collection instrument for this study. Compared to structured interviews semi-structured interviews have the advantages that more information can be obtained interviews (Saunders et al., 2019) and are a better suited for explorative studies. Semi-structured interviews also allows the interviewer to deviate slightly from the actual topic and dive deeper on the interesting topics.

The interview protocol was inspired by the main research questions and sub questions guided by the building blocks of digital transformation (Vial, 2019), along with topics related to the key themes found in the literature study. The building blocks have been selected to guide the interview towards the literature study topics, hence not all building blocks are selected.

Number	Topic	Based on
1	Use of digital technologies	Vial, 2019
2	Changes in value creation paths	Vial, 2019
3	Structural changes	Vial, 2019
4	Organizational barriers	Vial, 2019
5	Impacts (positive & negative)	Vial, 2019
6	Extension services in agriculture	Literature study
7	Digital technologies in service delivery	Literature study
8	Extension officers and digital technology	Literature study
9	Adoption of digital technology	Literature study

Table 4: Interview themes

Each interview took place via an MS Teams meeting or Zoom, which does not require pre-installed software and allows the recording of an interview. After the interview the recording was saved and used for transcriptions.

A first interview was held with extension coordinator of the farmers' organization. Via this interview insights were gained in how the organization used and valued digital tools. Next, interviews with the extension officers took place. As a preliminary understanding of the organization has been received in the first interview, these interviews focus more on the actual situation for the extension officers and their experiences.

3.4.2. Data collection

Before the actual interviews took place pilot interviews were carried out. Based on the results of these interview flaws and ommissions were corrected prior to the real interviews. In this test interview attention was paid to the used terminology, how the terminology was interpreted and if the questions were understandable. The test interviews were held with colleague's of the researcher, all professionals in the field of farmers' organizations and extension services. To reflect on the real interviews even more, a colleague from the Netherlands and from abroad (developing economies) have been interviewed.

Based on criteria mentioned in chapter 3.3, interviews were scheduled and held. For the first criterium the person involved in facilitating and/or organising extension services was approached and the second criterium involved different extension officers who have experience in providing extension services and actively provided these. The selection of multiple extension officers was to make sure that the interview results were not based on a single person's opinion/views. To accommodate the third criterium contact was made with a project officer who is responsible for the implementation of new digital technology that support extension services.

Each interview took approx. 60 minutes online via either MS Teams or Zoom. Before the interviews started, constent was asked and given. Each interviewee was then firstly asked if the interview may be recorded, after which the interview took place. A consent form was email beforehand and afterwards interviewees received an interview transcript.

The empirical research consisted of interviews with extension officers from different organizations in Kenya providing extension services in the dairy sector. The semi-open interviews were guided by the building blocks of the digital transformation process (Vial, 2019) with a focus on the effect of digital technology on the work of extension officer and how this helped to improve their service delivery. In both Kenyan organisations, FO-1 and FO-2, interviews were held with multiple extension officers and the manager (or coordinator) of extension services.

Following the data collection all the interviews were transcribed verbatim and shared with the participants to receive confirmation that the transcription is representative for the interviews.

Additional interview
The interviewees of FO-1 and FO-2 often mentioned their recent implemented digital platform [the Diary Competence Builder] supporting them in their extension services. Therefore an extra interview was held with the project manager who was responsible for setting up this platform. This interview was added because of its potential value and contribution to the quality of the end results for this research.

Field visit
To collect more data of an observational nature, a lengthy day long field visit was conducted. During the field visit an extension officer, specialised in feed formulation for cows, joined for a full working day. During this day, three visits were made to farms giving insights in how extension services are provided and which role digital technologies played. Attention was also paid to the themes that arose from the literature study and were linked to the observations through note taking during the visit.

After the field day the findings and quotes of the extension officer were written in a report and this report was shared with the extension officer so that he could confirm that the content is representative to the field visit.

All data from the interviews was included in Atlas.io where it can be analyzed and coded, a process described in paragraph 3.4.3.

3.4.3. Data analysis

The transcripts were analysed using the well-known coding technique from the grounded theory method of analyzing qualitative data (Corbin & Strauss, 1990) that consists of three steps.

The first step is *open coding*. In this step the textual data was divided into parts that are linked to the research questions (see table 4) and these parts are coded accordingly. The codes from the open coding are matched with the key themes and new themes were added when providing additional insights. Next, *selective coding* is used to connect the equally coded parts and analyse the differences and connections between the parts. Finally the third step of *axial coding* it employed. During the coding excersize the essence of building blocks of Vial and the themes from the literature study have been used to interpret the data (chapter 2.5). A more detailed description of the coding steps taken and clustering of themes steps taken can be found in the appendix “Coding scheme”.

The results of the analysis are described in chapter 4.

3.4.4. Research quality

This paragraph will show the measures taken to increase the validity, generalizability, reliabilty and ethical aspects of this study. With regard to the validity, there is a division in construct- , internal- and external validity.

Construct validity

In this study the construct validity was strenghtened by using the terminology found in the literature study (chapter 2). The semi-structured interviews were based on the same literature study using the same terminology. Pilot interviews showed to what extent the results answered the research questions and how the terminology was interpreted by the interviewee. Documents and software were analysed to reach triangulation (Saunders et al., 2019).

Internal validity

In this study the influence of digital technologies on service delivery was researched using a case study where employees of different organizations were interviewed and insights were received in documents and digital tools. Triangulation was used by collecting data from different organizations with different properties. The empirical data that was retrieved was tested against the constructs of the conceptual model. Outliers and anomalies could then be recognised. Lastly, the interviews were transcribed and the transcriptions were sent to the interviewees for validation. This confirmed that the interviewer and the interviewee share a similar understanding of the questions and answers.

External validity

Triangulation was used to improve external validity by selecting different organizations and in these organizations different stakeholders to interview. As the organizations acted within the same sector (dairy) future research can be extended by involving organizations from different sectors. Besides that, the type of services provided by the organizations did not cover all types of services employed in the whole sector, as the services were based on the farmers' needs.

Generalisation

In this study farmers' organizations in the dairy sector were selected. The outcome of this study may not be by fully generalisable to similar organizations in the same sector nor may it be generalisable to other sectors in or outside agriculture. Generalisability will however always be a point of attention in qualitative studies (Saunders et al., 2019).

Reliability

By reliability it is meant that when the case study is performed a second time, the outcome should be the same. In order to improve the reliability of this case study each step taken was described which improved the transparancy. All research data, including the interview transcripts and recordings will be kept and will be available as will be the interpretation of the researcher following the analysis of the interviews. Involving multiple extension officers employed by a farmers' organization helped to make sure that the results did not depend on a single person's view on digitalisation.

After the interviews, the transcripts were sent to the interviewee with the request to confirm if the transcripts were correct and show the interviewees' answers and intentions. In addition the study supervisor will periodically discuss the validity of the findings with the researcher.

Ethical aspects

With regards to the ethical aspects of this study, the names of the involved organizations and persons are anonymized. The interviewees were asked at the start of the interview whether

they consented to doing the study. In addition they were also asked at the end of the interview if their names may appear in the study. If not, their names were anomized as well. When documents and/or software was demonstrated, participants were asked if these may be included in the study and in which way. When an interviewee did not want his/her data saved or wanted his/her data back, applicable actions were taken and the data removed from the case study. The collected data transcripts were deidentified if required by the participants. This also involved pseudonyms of participants used in the final report. In addition, to protect the data, the collected data was stored securely in a protected environment.

4. Results

The setup of the research is discussed in chapter 3. In this chapter, chapter 4, the result of the qualitative research is presented. After transcribing the interviews, the three steps of coding have been applied, *open coding*, *selective coding,* and *axial coding,* in which key themes and sub themes emerged. These themes form the paragraphs below:

4.1. Improving service delivery using digital technologies

Based on the final analysis of the data, and according to each of the interviewees their extension services benefit from utilizing digital technologies. Four specific themes related to this emerged:

i. Digital technologies enhance information dissemination

Both the organisations in Kenya see the use of mass communication as a huge step forward. They use WhatsApp groups to inform farmers about trainings, experiences and new techniques via photo's, messages, and videos. In this way more farmers can be reached than via the traditional field visits. The shared information is for the benefit of both the individual farmer and the extension officer as information is not only shared by the extension officer, but also by farmers themselves. The information shared by farmers, through WhatsApp, may help other farmers in improving their techniques and could even be new information for the extension officer as well.

"Digital technology is very important because we [the extension officers] have up-to-date information [of the farmer]. The ratio of our extension services staff to farmers is a challenge. What is happening is that [with] digital tools for extension services, we are able to reach many [more] farmers and then the information we get is up-to-date and with all the data acquired, we can just upload and add it to our farmers' information and that is very good." – Extension officer 1 FO-2, Kenya

It has been observed that in the Netherlands the extension officer holds more direct contact with an individual farmer and did not use any group communication. The corresponding factor between the Kenyan and Dutch extension officers is that both organise 'Farmer days' where the farmers are invited to discuss (new) technologies or visit one of the farms. During these visits the farmers are able to see the (new) technologies or techniques in the context of the farm they visit.

In Kenya the communication towards the farmers is not the only communication that changed. Also, in the organisations themself, communication is now done via WhatsApp having almost the same advantages as in the communication towards their farmers.

"The way of communication has changed. We now use WhatsApp groups for our managers, for our chairman, for our extension staff and also a group for all employees. This makes sharing information very easy." – Extension manager FO-2, Kenya

ii. Availability of data improves decision-making and targeted services

In the past both the Dutch and Kenyan extension officers had to rely on their own manual notes written down in a notepad. This was very inconvenient as every time a farmer was visited by the extension officer, s/he had to look up his/her information, a time-consuming process. In addition keeping this information up to date is a tedious task. A new digital platform, the DCB, allows the extension officer to have a direct and immediate insight into the progress of a farmer, the agreements made with the farmer and, when new data is entered, an updated advice schedule.

"*It [the Dairy Competence Builder] helps me greatly in my work having everything for the farmers together [through] software and not having to look it all up in papers [is] saving me a lot of time and mistakes because [my] papers may be outdated or not updated*"- Extension manager FO-2, Kenya

The Dutch extension officer has a similar experience. He brings his laptop with him on his visits, so he is able to immediately access all required information about the farmer, the farm and the history of feed formulation and milk production. He is thus able to help the farmer on-site based on real-time information.

"*For instance, we have multiple extension officers and if they have a need for information, they can have it directly without having to go through too much trouble. Also, when we will have new employees who require information, they can use our digital tools to access this information easily. This makes it much easier for everyone because the information is stored there already*" – Extension officer FO-1, Kenya

iii. Adoption of digital technology limitation due to farmers' capacity

There is however a limitation when it comes to using digital technologies for farmers who are not capable of understanding these technologies. Illiteracy among farmers is not uncommon in Kenya. They may not even have had any formal education and cannot write or read. Illiteracy forms a barrier as these farmers do not understand what is going on, they are knowledgeable because they have learned how to be a farmer, by learning from practice. For these farmers, using a smartphone, receiving messages or making decisions based on data, is not an option.

"One of the challenges that we are experiencing is when we are trying to reach farmers' literacy is one of the challenges. Some of our farmers went to school and learned to read and write and some farmers did not." – Extension manager FO-2, Kenya

During the field day in the Netherlands, no limitations linked to farmer capacity have been found. Each visited farmer uses software to monitor their production and is using software to track the consistency of the delivered feed.

iv. Extension service delivery based on farmer categorization

In Kenya the extension officers mentioned that they categorize their clients, not an uncommon a practice as confirmed by the project manager of the Agri-agency. Categorization is done to provide better targeted services to certain groups, for example, a farmer with 2 cows will need different advice than a farmer with 50 cows. The same categorization is done for being able to handle digital technologies. There are farmers who are already experienced with digital technologies and farmers who are not.

"*They [the extension officers] categorize farmers via several factors and from there they will be able to tell: these ones are high producers which means that challenges are different from those that are producing the least. The high producers you will find that, maybe they are keeping fodder or a zero-grazing unit, maybe their challenge is feed formulation. So maybe if you recommend to them use of Rumen8 ICT technology to get better feed formulation, they will be like "*yes, this is what we needed*". But if you take Rumen8 to a low producer who is producing like 2 or 3 liters, they will be like "*No, what is this? I don't have this kind of feed". - Project manager Agri-agency

The topic of farmer categorization was more explicitly mentioned by the Kenyan extension officers. This may be caused by an incomparable clientele. The Kenyan extension officers had over 1.000 (smallholder) farmers in each individual portfolio containing both technologically advanced farmers and illiterate farmers. The portfolio of the Dutch extension officer was smaller and appeared to have only technologically advanced farmers.

4.2. Adoption of digital technologies

Another part of the research was to investigate the level of adoption of digital technologies in service delivery. Next to the personal skills of the extension officer, an important role was laid out for the employer, the farmers' organization, of the extension officers. The following 5 themes related to elements that harness the adoption of digital technologies in extension services, arose from the data analysis:

i. Familiarity with digital technology

Each of the interviewees showed that their organisation was familiar with using digital technologies. There is however a big difference between the Dutch and Kenyan extension officers. The Kenyan organisations (FO-1 and FO-2) use their applications mostly for sharing knowledge and experiences. These organisations are now in the process of adopting a new technological platform that allows them to store (individual) farmer data, access this data and base their decisions on this data.
In the Dutch organisation the knowledge sharing and experiences component in the digital world is less prominent. The service delivery is already tailor made towards their clients (e.g., feed formulation per client), but their clients also have less need for sharing knowledge and experiences.

ii. Learning perspectives for the extension officer

From the interviews it can be deducted that an extension officer has three 'learning perspectives' when it comes to digital technologies: self-learning using other digital technologies (YouTube, internet forums, calls), learning from farmers (those that are using a new (digital) technology), and learn from their organisation (e.g., courses and training) and colleagues (sharing experiences and information). No difference has been found between the interviewed extension officers. They all mentioned that their organisation provided any necessary training and that they can 'teach themselves' a lot using the available (online) sources.

"We keep our extension officers up-to-date via training and monthly meetings. In these meetings all the extension officers are present and are informed of any changes.
The workshops are mostly given by ourselves, by our extension officers for example. Sometimes we need support from external experts."- Extension manager FO-2, Kenya

iii. Extension officer's skillset

Each interviewee has the perspective that the role of the extension officer is already changing. In the past, extension officers had to travel a lot to reach their farmers, where nowadays digital technologies make it possible to reach groups of farmers, for example via radio broadcasts, SMS or WhatsApp as mentioned by the Kenyan extension officers. The extension officer's role is no longer a role of expertise in dairy but also in digital technologies. In Kenya a consultancy role more focused on digital technologies is required, which relates to the digital literacy of their farmers compared to the farmers of the Dutch extension officer.

"*My services won't change because I will have more new technologies and I will be a consultant because of technology. I will give more consultancy on importance to technology and at the same time the technical part of extension services*" - Extension officer 1 FO-2, Kenya

The extension officers will also use digital technologies to become better informed themselves. Having internet connection and experiences with digital technologies gives them the opportunity to search for other, maybe even more advanced, digital technologies. They will watch videos on YouTube for example, or search for specific digital tools that fulfill a certain need for a farmer and propose these tools to their organization.

"*Without training the collection of data [by extension officers] would be flawed, having gaps or incorrect data*" – Extension manager FO-1, Kenya

iv. Barriers in harnessing digital technologies

There are several barriers in harnessing digital technologies in service delivery. The Dutch extension officer experienced this some years ago with the introduction of laptops, whereas conservative farmers did not want anything to do with that. Throughout the years all the farmers in his portfolio became more knowledgeable on digital technologies. No current barrier has been observed during the field day, nor has it been mentioned during the talks.

Farmers themselves also form a barrier for the adoption of technology, not because the extension officer does not want to, but because the farmer is not capable of using certain technologies, for example, because they do not own a smartphone, simply because they cannot afford one, or they cannot read. The technology adopted by the extension officer still helps the EO in deciding which advise should be given and monitoring the farmers' progression. An example is the Dairy Competence Builder platform which supports the extension officer but the farmer, him or herself, will have no use for this technology.

v. Farmers' organizations facilitating extension officers

The farmers' organization has a facilitating role providing the extension officers with the necessary equipment and trainings. All the interviewees had devices (smartphones, laptops, or tablets), the necessary software (e.g., the Dairy Competence Builder) and data bundles for internet access provided by their organization. Without the support of their organization, it would be hard for the Kenyan extension officers to purchase this by themselves.

"*As an organization we have had to purchase devices like smartphones and tablets. Next to that we also needed to train our staff in using the devices and the new tools like the Dairy Competence Builder. Without trainings the collection of data would be flawed, having gaps or incorrect data.*" – Extension manager FO-1, Kenya

4.3. Contextual observations and services

Digital technologies have been making their impressions in many sectors, not in the least in the agricultural sector. Can digital technologies eventually take over the work of an extension officer, making the extension officer obsolete? The answer from all the interviewees is a clear no, but their angle is somewhat different. Three subthemes related to this emerged from the data analysis.

i. Digital technology cannot replace physical visits

The observational field day showed that no paper was used, only a laptop and a phone. However, none of the interviewees believed digital technologies could replace extension services. All were very clear that physical visits are necessary. A clear example, from the Dutch extension officer, was the example of how cows respond to a person entering the shed/barn. If the cows do not respond as expected, then something might be wrong. This will not be trackable via camera's, hence the need for physical observations on that topic.

"*It is necessary to visit the farms, technology cannot replace an extension officer in this. Visiting a farm gives me a complete picture and allows me to 'feel' the cows. I need to see how they react whether they look lively and alert or if they seem exhausted and sluggish. It is also important to see the details: how is the cow's body condition, is the floor rough which keeps cows from tripping, is their dung of the expected consistency, is there a draft*". – Extension officer FO-3, Netherlands

The Kenyan extension officers agree with the notion that digital technologies cannot fully replace the extension officer. In their close-knit CoP farmers still require physical demonstrations and need guidance in using applying new information and knowledge in their personal context. In Kenya the characteristics of the farm and its environment plus the occasional ignorance regarding dairy

farming, require that extension officers *must visit the farm* to give their advice. The farmers are more susceptible to change due to their circumstances.

"I don't think technology will replace an extension officer because an extension officer is needed to do the demonstrations on the ground, technology will make our work easier but it will not replace everything. The extension officer should still be there to give directions and interpret what the farmers actually need and help them to understand it if they are not involved in technology themselves. The extension officer will be needed on the ground with the farmer to understand what is going on, to do things practically and to see or know if the farmer is going in the right direction or not. From the ground you can give better advice than via digital technologies." – Extension manager FO-2, Kenya

The Dutch extension officer knows each of his clients, sometimes for years. He can focus much more on their specific needs like the feed formulation, the response of the cows to humans and condition of stored feed. Services on topics like marketing, access to milk prices or weather forecasts are not necessary. In Kenya the extension officers also spread general information and knowledge (for example via WhatsApp groups and radio broadcasts) next to farm specific services.

"Some days you can indeed use the WhatsApp platform to receive some issues and sometimes you can discuss/handle them. Other times a demonstration is necessary to solve an issue, so that cannot be discussed through WhatsApp, so you have to do it practically and you have to go to the field. You have to be there physically." – Extension manager FO-2

ii. Difference in data collection (Developed vs Developing country)

Collecting farm- and production related data is, in Kenya, manually done on the site of a farmer. Using digital technologies (such as the Dairy Competence Builder) and handheld devices (e.g., mobile phones and cameras) make this efficient and effective as the data can immediately be added to the farmer's profile. However, a backup scenario is required due to a lack of internet connectivity or empty batteries that cannot be charged during a field visit. The extension officer would still need to bring his/her paper notepad, write down his/her findings and agreements with the farmer and, when there is connectivity again or the battery is recharged enter the farmers' data. Only at that moment the application Dairy Competence Builder can give extra advice. This example shows both the efficiency and effectiveness and demonstrates the risks.

"The type of information that we collect from farmers, for instance, the first thing that we ask of our farmers and which is something we see when we visit the farmers is if the farmers are practicing zero grazing and then we can look at farmers who are conserving for them." – Extension manager FO-2, Kenya

The use of digital technologies is on a different level when comparing the service delivery in Kenya to the service delivery in the Netherlands. In Kenya the availability of the internet is not as reliable as in the Netherlands. Here you see that the extension officers in Kenya still use their traditional methods of registering data and uploading it later to their platforms. In the Netherlands, where internet is almost always available, IoT technologies make it possible that, for example, extension officers can interfere with the feed formulation of cows while they are working from home.

iii. The need for more targeted service delivery

All the extension officers visit farmers, next to organising group trainings. These visits are necessary because no two farmers are the same. Farmer data is collected at the level of the individual farmer to see what services are required. So next to the categorization, based on the (digital) competences,

of farmers, farmers of the same 'level' are trained, each farmer also has his/her individual needs and demands.

"*Each farmer will be having his/her own profile [in the Dairy Competence Builder]. When you log in to one farmer and have a look at the information of this particular farmer then we see where we can start a visit because of what they need*" – Extension manager FO-2, Kenya

4.4. Value creation and perceived benefits of digital technologies

Due to digitalization the means of communication have changed in Kenya. No longer are paper notepads required where the extension officer writes down his/her information about every farmer. Instead, digital tools help the extension officer to organize him/herself and the information about the farmer having this information up to date and timely available. Four themes could be derived from the data analysis.

i. Farmers giving direct feedback

The farmer is now able to give direct feedback about the work of an extension officer and the quality of the extension services delivered. This feedback is used by the FO's management to see how the organisation is doing and to allocate resources to where they are required. Next to that, it allows the extension officer to improve his/her services based on this feedback. The feedback is regarded as highly valuable by the FO, the extension officer, and the farmer.

"*What I see form my end is a bright future in extension services using digital technologies. In that course we will be able to reach more farmers, and our farmers, it will be a two-way communication [where farmers] will be able to give us feedback at the same time*" – Extension manager FO-2, Kenya

ii. Perceived benefits of new digital technologies

Remarkable is that in every situation the 'seeing is believing' or rather the perceived benefit plays a role in adopting and working with new (digital) technologies. In Kenya it is often the farmer that needs to be convinced that any new technique, whether it is digital or not, can be beneficial. Many times, the farmer needs to see this new technique in practice first before they develop a willingness to adopt. This is also called the perceived benefit.

The same goes for Dutch farmers. In the Netherlands 'open farm days' are organised where a farmer shows his/her techniques allowing other farmers to perceive this new technique first before trying it out themselves. Not only does this apply to the farmers, also the extension officers need to be able to assess new digital technologies and may need convincing before they start using any new technology, for example the Dairy Competence Builder

"After seeing the advantages of the digital tools, the goodness of it, that made the adoption easier." – Exension manager FO-2, Kenya

iii. Monitoring by the Manager

Another item that appeared is the monitoring of the extension services provided by the extension manager. The new tool in use in Kenya, the Dairy Competence Builder, is facilitating monitoring of the farmer progression and the advice given by the extension officer. The extension manager is thus able to assess whether all the advice given is valuable for the farmer and if it has effect on the farmer. Besides that, not all extension officers are equally capable and thus by monitoring the advice the extension manager can see the strengths and weaknesses of an extension officer. Now, more

than before, monitoring of an extension officer is possible and the farmer may benefit from this as the extension manager will contact the farmer for any feedback.

"*Also, there is the management information tool [Dairy Competence Builder] an app where information can be filled in digitally allowing the monitoring of the current situations and performance of the extension officers, digitalization makes this easier than on paper*" - Extension manager FO-2, Kenya

With the use of digital technologies, like the Dairy Competence Builder in Kenya, the advice given to a farmer is now reviewed by the extension officers' manager. Via the same platform the progression a farmer is making can be tracked and linked to the given advice. This allows the extension officer to build a portfolio of his/her work and the results. Next to allowing

"We, as an extension officer, can track our own performance now so that we can also see our strengths and weaknesses which are important to improve our services. We can then also improve our interpersonal skills. This all comes with the DCB and therefore it is the best success for us."- Extension manager FO-2, Kenya

iv. Value creation

Guided by the building block 'Changes in value creation' in the Vial model, the data from the interviews and the observations in particular addressed interesting topics.

In most of the interviews the extension officers mentioned that the farmers are now better enabled to give feedback on the provided services. During the observational field visit the extension officer, together with the farmer, compared the data of the delivered feed on the computer of the farmer with the extension officers' feed formulation data, weighted this against the milk production of the cows and discussed any adjustments. The data here thus allows for cooperation between the farmer and the extension officer in order to reach the ideal feed formulation. In the past this was not possible due to a lack of data.

"*The farmer is able to sent feedback concerning the effectiveness of an extension officer who attended the farm or training*. *So via email the farmer is able to sent feedback and we add this to the farmer details in our system.*" – Extension officer FO-1, Kenya

In Kenya the value proposition of service delivery changed due to including the feedback of a farmer in the new platform (Dairy Competence Builder) where feedback was usually not included in the service delivery and feedback was lost. Due to the use of the Dairy Competence Builder the extension officer is able to register farmer feedback but also receive feedback from the extension manager who is able to read up on the advice given and the progression of a farmer.

"*We really appreciate the feedback. The farmers are now able to give us complaints or feedback when they are not satisfied about a particular situation. So now we can adapt our trainings to what the farmer actually needs. We also get feedback from the extension manager after sending all the information we collected from the farmers themselves."* - Extension officer FO-1, Kenya

The Dutch extension officer is able to take over the ordering of feed formulation from a farmer. Being at home the extension officer is able to monitor and adjust the feed formulation without visiting a farm, as has been mentioned during the field day with the extension officer. This is a disruptive change in the value proposition where the farmer is thus able to outsource work.

Analysing the data of farmers, for example provided by the Dairy Competence Builder, allows the extension manager to see which demands are trending and in which area. The extension manager can thus intervene in the service delivery, adapt the service delivery more towards the farmers demand and locate strenghts and weaknesses in the current service delivery.

"*The DCB has key performance indicators for each individual farmer helping us to decide which services or trainings the farmer will need. So you can have information of all of the farmers and have it separately for each individual farmer with its own explanation*."- Extension manager FO-2, Kenya

5. Discussion – reflection

Analysing the results of the data collection in chapter 4 gave insights in the current standings of service delivery by extension officers to farmers in the agricultural sector. Data from the analysis and from the literature is used to answer the main and sub research questions.

5.1. Discussion

In this paragraph the sub research questions are answered first before answering the main research question.

5.1.1. How do digital technologies change the service delivery by consultants?

Three elements have been found that highlight the change of service delivery by consultants in the context of extension officers providing extension services.

v. Easier Information and knowledge sharing

All the interviewed extension officers used pen and paper in the past to write down the farmer's information, their appointments and the farmers' progression. Each extension officer made the transition to use digital technologies instead allowing them to store data, share information and facilitate the information sharing by farmers. Sharing information via digital technologies is in line with the findings in other research (Kansiime et al., 2019; Nakasone & Torero, 2016) where digital technologies enrich the information sharing (e.g., instructional video's). Now, they use a set of different applications helping them in (e.g.) communication (WhatsApp and radio broadcasts) and data collection, storage and sharing (Dairy Competence Builder) extending their reach and improving the quality of their services. Proof has been found that agricultural extension and advisory services facilitate the transfer of knowledge and information, improvement of techniques and practices to farmers (Kansiime et al., 2019; Ortiz-Crespo et al., 2020).

The sharing of information and knowledge seems to be more tailor-made towards the farmer when the sector is more developed. A difference is found between the Dutch and Kenyan extension officer where the Dutch extension officer is more focussed on service provision towards the individual farmer and the Kenyan extension officers who have a focus on tailored information for lead farmers and general information for other farmers. This is in line with Nakasone & Torero (2016) who found that the use digital technologies is lacking behind in developing countries as compared to developed countries.

vi. Farmer feedback (a change in two-way communication)

Farmer feedback on the provided extension services is a new phenomenon for the interviewed extension officers in Kenya. In the literature this is an underdeveloped topic (Kudyba et al., 2019) but Ortiz-Crespo et al., found that digital technologies include feedback options as opposed to traditional physical services, which were often a one-time occasion. The feedback a farmer gives allows the extension officer(s) to improve their services and to give tailored advice to the applicable farmer, next to the farmer feedback digital technologies, like WhatsApp, give. This is a change in the distribution channel of the service delivery which previously (In Kenya) relied on radio broadcasts, SMS and farm visits.

Two-way communications also include the possibility of feedback about the digital technologies itself. In this study only evidence was found that extension officers, as a user of digital technology, gave feedback to the developer. Via this method the digital technology can be improved, which has also been stated by Karlsson & Spyrou (2020).

vii. Data driven decision making

Another element in how digitalization changes knowledge transfer, is that decisions can now be made immediately and be based on data using digital technologies (Ortiz-Crespo et al., 2020). The Dutch extension officer has an online database available where he can zoom in on the details of the feed and discuss this with the farmer. Together they can decide if any adjustment is necessary and without the intervention of other sources this feed can be ordered. An example is that the Dutch extension officer can calculate the feed formulation for cows based on historical data and analytical data of the current feed consistency. Based on this historical data and on the information on the applicable herd, the extension officer can determine the ideal feed formulation for the herd. The Kenyan extension officers take their tablets with them and after entering the farmer's information they can immediately decide on what kind of services or trainings would the farmer best benefit.

From the above the following propositions can be formed:

Proposition 1: *The availability of and access to information and knowledge (expertise) via multiple digital channels in a CoP: increases outreach to each other, simplifies communication between stakeholders and CoP members which improves service delivery, decision-making and at the same time adoption of digital technologies itself.*

Proposition 2: *A higher level of digital maturity in using digital technologies throughout a CoP enables tailormade individual service delivery towards the clients.*

5.1.2. How can digital technologies support service delivery by consultants?

The interviewed extension officers see digital technologies as tools to support their work, to make it easier and more structured. The Kenyan interviewees added that digital technologies give them the opportunity to reach out to more farmers than traditional (physical) extension services.

i. Availability of data

The availability of data allows i) the extension officer to make decisions on the advice required given to a farmer, and ii) the tracking of the advice given related to the progression of the farmer. This holds true for all organisations where digital technologies are in use. The Dairy Competence Builder for example, allows the extension manager to see which advice has been given to a farmer, to give feedback to the extension officer and to see whether the advice has been effective for the farmer. This example shows that the availability of data can improve the service delivered both towards a group of farmers (coping with the same challenges), and the individual farmer which is in line with the findings of the study by Aker et al., (2016).

ii. Targeted service delivery

Another element is that service delivery can be more tailored towards the needs of an individual. All the interviewees agreed on the notion that no two farmers are alike and thus should not receive the exact same support. Farmer's capabilities, their environment, and (in case of an animal raising) their herd are examples of characteristics that define the individual farmer, and all characteristics play a role in making the farmer's context unique and, to provide optimal extension services, should receive tailor made support.

iii. The supportive role of the farmers' organisation

Not only service delivery is influenced by digital technologies, also the supporting role of the service providing organisation changes. A supportive role from the farmers' organization is confirmed. Extension officers themselves are not in the position to purchase all digital tools necessary to keep

up with the (new) digital technologies that support them in their service delivery. Evidence shows that the FO indeed has a supportive role enhancing the capabilities of their extension officers and services (Wang et al., 2019). The FOs provided their extension officers with the necessary equipment to use digital technologies (one specific case is the purchase of tablets to use the 'Dairy Competence Builder' in Kenya) and training allowing the extension officers to give more accurate, personalised, and timely advice. All organisations involved in this study have provided their extension officers with training and digital equipment (e.g., tablets and internet access). From the above the following proposition can be formed:

Proposition 3: *The availability of data allows for more targeted service delivery finetuned to the client's needs when consultants are able to use supportive digital technologies.*

5.1.3. How do digital technologies change the role of a consultant in service delivery?

In their work, extension officers traditionally visit their clients, and even in established models the physical farm visits are a core element of the work of an extension officer (Umar et al., 2017). This has been found true after analysing the data from the case study.

i. The role of the extension officer

Extension officers travel extensively to meet their clients and understand their needs to base their advice on their client's context. Their role is much alike the role of a consultant as described by Hislop (2018). A large part of their work is to convince farmers of using the right techniques using both theoretical and practical knowledge. However, in several interviews it is mentioned that the role of the extension officer is changing due to digital technologies. Instead of only transferring knowledge and experiences the extension officer now also needs to know about digital technologies and moreover, convince farmers that these digital technologies are beneficial. "Seeing is believing" from the viewpoint of the farmer, aligns with earlier research where the digital technologies' perceived usefulness (Silva et al., 2017) and perceived economic wellbeing (Verma & Sinha, 2018) lead to a higher adoption rate.

No evidence however has been found that digital technologies allow extension officers to spend more time in the field (Tata & Mcnamara, 2017). The Dutch extension officer mentioned even that he is now able to work from home using digital technologies while he could still help to improve the production of the farmer by adjusting the feed formulation.

An addition to the role of the extension officer, it was found that the extension officer fulfils a key moderating role in WhatsApp group chats (Steinke et al., 2021). However, this only applied to the extension officers in Kenya.

ii. Skill set of the extension officer

The skillset of an extension officer has also changed over time. Compared to traditional advisory services, without any use of digital technology, the extension officer now needs to be able to work with digital technologies him/herself, needs to be able to advise on the use of specific digital technologies (e.g., convince the farmer that their digital technologies are beneficial,) and needs to be able to train farmers in using or dealing with digital technologies.

Having digital technologies supporting service delivery and, according to the interviewed extension officers digital technologies are becoming indispensable, shows that digital technologies are becoming a central part of the extension officers' portfolio, in line with Oyinbo et al., (2019)

From the interviews it also became clear that digital technologies also raise challenges (Ayre et al., 2019) as any flaws in technology design or incorrect use thereof, may cause incorrect or flawed data

influencing the sharing of content related the extension services. The extension officer will also have to learn how to integrate the digital technologies into their services.

Another part of the skill set of an extension officer is to determine the level of digital technology capabilities of farmers. This requires the classification of farmers according to requirement levels based on skills and aptitude. This impact the provision of applicable services towards these different farmer groups (Anabel et al., 2018; Davis, 2008), as the farmer may not be able to benefit from the provided services otherwise.

iii. Physical observation is necessary

The study confirmed that each and every client is different and situated in a different context. This does not only apply to the work of a consultant in general (Hislop et al., 2018) but also the work of the extension officer in the dairy industry. All interviewees and the observational field day confirmed that each farmer has his/her own context and service delivery should be tailored towards this context as best as possible allowing the farmers to improve their crop production or animal raising (Kansiime et al., 2019; Purnomo & Kusnandar, 2019). This highlights the importance of 'person-centred' extension service delivery, that confirms that service delivery needs to be targeted and specific to a farmer's needs.

Also worth mentioning is that the findings suggest that sometimes, the digital technologies in use did not enable the transferring of the correct information, for example videos of (new) techniques in farming practice shared by famers. Hence why the close monitoring of extension officers by managers on correct information sharing and adoption of techniques is necessary. This holds true according to Nakano et al., (2018) and Steinke et al., (2021), but it is only found in Kenya, while it is not the case in the Netherlands.

The following proposition can be distilled:

Proposition 4: *Including digital technology capabilities and (digital) supervisory skills the role of the extension officer changes allowing digital technologies support service delivery focused on the farmers demand and capabilities.*

5.1.4. How can digital technologies be harnessed to improve the service delivery of consultants in a community of practice?

The main research question for this study was *"How can digital technologies be harnessed to improve service delivery of consultants in a community of practice?".* After gaining insights in the current literature, key themes have been defined which resulted in three sub questions to be answered before answering the main research question. Using a case study approach the research focussed on ways in which digital technologies can be applied to the delivery of extension services [service delivery), provided by extension officers [consultants] in the agricultural sector (community of practice) and more specifically the dairy sector. With the abovementioned answers to the sub questions, we see that digital technologies have a significant influence on the service delivery by consultants highlighted by the following three perspectives:

I. Information and knowledge dissemination

Information and knowledge dissemination, especially in rural and/or underdeveloped areas is a topic much discussed in literature. These studies look at the dissemination of general information that

would be beneficial to every recipient, but does not take into account the individual context of the recipient. In this study a difference is noticed between the digital technologies used in the Netherlands as a developed country, and Kenya as a developing country. In the Netherlands the digital technology is more aimed towards the needs of the individual farmer and takes the specific context of this farmer into account. In Kenya the (upcoming) use of digital technology is more aimed towards the dissemination of information and knowledge towards a broader audience and not (yet) customized towards the recipient's individual needs. The implementation of the Dairy Competence Builder system for Farmers' organizations in Kenya is a positive step in the direction of tailored advice, or person-centred extension service delivery for the individual farmer through the application and use of digital technology.

Using digital technologies for information and knowledge dissemination not only requires the necessary skills to use these tools but also requires monitoring the information that is and needs to be spread towards a certain audience. Now, with tools like WhatsApp, multiple persons can receive the same information, but this information may not be applicable to the individual recipient. Based on the characteristics and context of the recipient, the information may or may not be of any useful, perhaps even misleading or wrong. There is thus a monitoring role required that allows for the monitoring whether the information and knowledge being shared is useful and applicable.

Proposition 5a: *Digital technologies' support targeting dissemination of information via service delivery in a CoP requires a level of 'digital maturity' and applicability to the recipients to ensure that the information/knowledge received can be applied to a unique context.*

II. Role of the extension officer

Explicit knowledge can be saved and shared using digital technology. Applying this knowledge however depends on the knowledge context, and in this study, on the characteristics of the individual farmer. It is the extension officer whose role in the dissemination of information is changing due to the use of digital technologies. The farmers may become more knowledgeable by using communication software such as WhatsApp but it is the extension officer who should ensure that the knowledge is applicable for the farmer. In order to do to, the role of the extension officer will thus include some 'supervision' related to the sharing of information.

Next to that, the role of the extension officer now also includes a digital component as s/he will need to know how digital technology works while also being able to explain or help the other users of the technology in their adoption and correct use of digital technology.

What will not change however, is physical visits to farmers and physical demonstrations of certain techniques to individuals or groups of farmers. 'Seeing is believing' is still very much applicable in both developed and developing countries. Not everyone is able to interpret a video, for example, of a certain technique nor is everyone able to apply it in their own context. It is the extension officer who should thus translate and apply new techniques to the actual needs of the farmer (or a group of farmers) for a specific context. This supports the findings of Lameck & Hulst (2020) who mentioned that service delivery takes place by (or requires) physical visits.

Proposition 5b: *The role of a consultant in service delivery is changing due to the influence of digital technologies digitalizing 'know-how' (explicit knowledge) but requires skills in supervising the quality of information being disseminated while also propagating the use of digital technologies.*

III. Changing value creation paths

The use of various new digital technologies has found to have a certain impact on the value creation paths of extension services. Guided by SMACIT, examples found are Social (whereby WhatsApp,

enables multiple farmers to share and discuss new ideas, experiences and technologies), Mobile (phone calls with farmers to answer questions or enquire of any demands or challenges) and Platforms (The Dairy Competence Builder, where information of farmers, their progression and advice given allows monitoring the quality of extension services).

Specifically, as a part of the value creation path (Vial, 2019), the value proposition and the digital channels make a positive impact. Proof has been found that the value proposition has changed, instead of general training and advisory services, extension officers are now able to change their services and training tailored to a group of or individual farmers. Digital channels are increasingly harnessed to disseminate information while the analysis of available data allows for the monitoring of farmers (progression) and signalling any current or upcoming challenges which can then be embedded in service delivery or communicated via digital channels to the applicable farmers.

No proof has been found that all of the agricultural challenges in service delivery can be fully replaced by digital technologies (Zhai et al., 2020). As found in other research (Evans et al., 2017; Lundström & Lindblom, 2018), a farmer's observation and experience is still essential to interpret the information that becomes available. In this research it is apparent that the extension officer is crucial as a broker and advocate to guide and facilitate the correct transfer of experiences, techniques and knowledge via service delivery and to prevent any form of misinterpreting these. Also, when new techniques are found both in the developed countries (in the form of 'Open farm days') and in developing countries (Field days and demonstrations) the farmers' personal input to context is a deciding factor whether any proposed technique can be applied. As a result, the following proposition is formed based on the above:

Proposition 5c: *The harnessing of digital technologies has a significant impact on the value proposition of service delivery.*

The propositions above give a partial answer to the main research question. Each of the interviewees is using digital technologies in their service delivery and see digital technologies supporting their service delivery and changing its value proposition. It is the characteristics and context of the information recipient that determine whether the information is suitable/applicable. Current digital technologies are not capable of making that decision (Ventikachalam & Bosua, In press) and is limited to a facilitating role to facilitate customer-centered service delivery (Ghrab et al., 2017). These findings are supported in the interviews showing that the extension officer's physical presence is needed in decision-making and turning information into action.

The final proposition of this study is therefor:

Proposition 6: *Digital technologies can support the dissemination of information and replace the 'know how' aspect and explicit knowledge of service delivery in a CoP, but human interpretation of information ('know-how') cannot be substituted by the use of digital technologies alone.*

5.2. Limitations

In this research, organisations from Kenya and the Netherlands have been involved to allow for a comparison between their services provided in the dairy sector. Although this does give insights on the different ways service delivery in the dairy sector takes place, it also brings limitations:

I. The study is limited to three service providing organisations in the dairy sector. If more organisations from other parts of the world could have been involved, the study would gain more data allowing to raise the generalisability aspect of this study.
II. The study took place only in the dairy sector. It is not expected that service delivery in any other sector is comparable. Hence, the study would benefit from more research among likewise service delivery entities in other sectors of the same or other industries.
III. An extra interview has been conducted with a project manager of a highly praised new digital platform in Kenya. While this interview was highly insightful, the limitations of time and distance, allowed only for conducting a single interview. Multiple interviews with multiple stakeholders would have been preferable to confirm outcomes of this interview.
IV. In the Netherlands an observational 'field study day' was conducted. From that field day much information has been gathered but the limitation was that only a single extension officer could be interviewed. Multiple field days would result in more qualitative better data.

5.3. Recommendations for further research

The goal of this research was to gain insights in the harnessing of digital transformation/digital technologies in service delivery by consultants. Drawing on a case study research approach, the study focussed on agricultural extension services provided by extension officers towards farmers.

Proposals to this research are:

I. As mentioned, the 'level of maturity' of the CoP plays an important role in the use of digital technologies being used to target information dissemination, it is worth to investigate which factors are decisive for this 'level of maturity' and how information and knowledge can then best be disseminated.
II. To broaden the scope of this research both vertically (by involving more stake holders of extension services in the dairy or any other sector), horizontally (by reproducing this research in different agricultural sectors) and geographically (in different regions).
III. More research related to two tipping points of digitalisation in service delivery is necessary:
    a. At what moment is a physical visit by an extension officer no longer necessary? Or to what extent does digital technology influence the frequency of physical visits/contacts?
    b. To what extent can digital technologies replace the work of an extension officer up to the point where the support from digital technologies becomes saturated. In this study it was clear that digital technology cannot fully replace the extension officer, but it is yet unclear to what extent this is the case.
IV. Feedback given by the farmers about the provision of extension services is still underdeveloped in literature.
V. Which elements in the customer-centered information needs can be met by the use of digital technologies.

5.4. Recommendations for practice

Service delivery organisations may benefit directly from this study by taking the following into account:

I. Feedback from a client should be used to validate and improve service delivery. Especially when feedback is monitored closely, and the options arise to provide services to the client in the most efficient way for the client. It may not only result in improved service delivery but also in improved use of digital technology.

II. When introducing digital technologies in service delivery, the role of the consultant will change significantly (perhaps over time). Where the role used to rely on explicit knowledge, this is (partly) replaced by 'digital technology skills', and communication about or propagating digital technologies.

III. When introducing digital technologies, the managing organisation must be aware of the digital capabilities of both its extensions officers and its clients. Outdated technologies may not be as supportive whereas new digital technologies may be overwhelming.

Literature list

Abate. (2018). Drivers of agricultural cooperative formation and farmers' membership and patronage decisions in Ethiopia. *Journal of Co-operative Organization and Management, 6*, 53-63.

Aker. (2011). Dial 'A' for agriculture: A review of information and communication technologies for agricultural extension in developing countries. *Agricultural Economics, 42*(6), 631-647.

Aker et al. (2016). The promise (and pitfalls) of ICT for agriculture initiatives. *Agricultural Economics, 47*, 35-48.

Álvaraz-Mingote & McNamara. (2018). Demands, responsibility, and influence in Malawi's participatory agricultural extension services. *Development in practice, 28*(1), 81-94.

Anabel et al. (2018). Role of hub and spoke model for ICTs in agriculture. *CSI Transactions on ICT, 6*, 231-243.

Ayre et al. (2019). Supporting and practising digital innovation with advisers in smart farming. *NJAS - Wageningen Journal of Life Sciences, 90-91*.

Blaikie. (2000). *Designing Social Research: The Logic of Anticipation*: Wiley.

Christensen et al. (2019). *Are you magicians? The collaborative work of an agricultural information service.* Paper presented at the Proceedings of the 10th international conference on Information and Communiation Technologies and Development (ICTD19), Ahmedabad, India.

Corbin & Strauss. (1990). Grounded theory research: Procedures, canons, and evaluative criteria. *Qualitative Sociology, 13*, 3-21.

Davis. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly, 13*, 319-339.

Davis. (2008). Extension in Sub-Saharan Africa: Overview and Assessment of Past and Current models, and Future Prospects. *Journal of International agricultural and Extension Education, 15*(3).

De Sordi et al. (2020). Defining the term knowledge worker: Toward improved ontology and operationalization. *The Journal of Corporate Transformation, 28*(1), 56-70.

Deichmann et al. (2016). Will digital technologies transform agriculture in developing countries? *Agricultural Economics, 47*(51), 21-33.

DePietro et al. (1990). *The context for change: Organization, technology and environment* (T. Fleischer Ed.). Lexington MA: Lexington Books.

Eastwood et al. (2012). Networks of practice for co-construction of agricultural decision support systems: Case studies of precision dairy farms in Australia. *Agricultural Systems, 108*, 10-18.

Eastwood et al. (2019a). Making sense in the cloud: Farm advisory services in a smart farming future. *NJAS - Wageningen Journal of Life Sciences, 90-91*.

El Bilali et al. (2018). Transition towards sustainability in agriculture and food systems: Role of information and communication technologies. *Information processing in agriculture, 5*(28), 456-464.

Eller et al. (2020). Antecedents, consequences, and challenges of small and medium-sized enterprise digitalization. *Journal of Business Research, 112*, 119-127.

Evans et al. (2017). From Data to Decisions: Helping Crop Producers Build Their Actionable Knowledge. *Critical Reviews in Plant Sciences, 36*(2), 71-88.

FAO. (2017). The future of food and agricluture: Trends and Challenges.

Fleming et al. (2018). Is Big Data for everyone? Perceptions in the Australian grains industry. *Agron. Sustain. Dev., 36*(3).

Flyvberg. (2011). *Case Study* (4th edition ed.).

Ghrab et al. (2017). A Core Ontology of Know-How and Knowing-That for improving knowledge sharing and decision making in the digital age. *Journal of Decision Systems, 26*(2), 138-151.

Gong et al. (2020). Towards a comprehensive understanding of digital transformation in government: Analysis of flexibility and enterprise architecture. *Government Information Quarterly, 37*.

Guo et al. (2020). The digitalization and public crisis responses of small and medium enterprises: Implications from a COVID-19 survey. *Frontiers of Business Research, 14*(19).

Heeks. (2002). Information systems and developing countries: Failure, success, and local improvisations. *The Information Society, 18*(2), 101-112.

Hislop. (2008). Conceptualizing Knowledge Work Utilizing Skill and Knowledge-based Concepts. *Management Learning, 39*(5), 579-596.

Hislop et al. (2018). *Knowledge management in organizations*: Oxford University Press.

Jayasingam, e. a. (2015). Instilling affective commitment: insights on what makes knowledge workers want to stay. *Management Reserach Review, 39*(3), 266-288.

Jere & Ngidi. (2020). A technology, organisation and environment framework analysis of information and communication technology adoption by small and medium enterprises in Pietermaritzburg. *SA Journal of Information Management, 22*(1).

Kansiime et al. (2019). Effectiveness of mobile agri-advisory service extension model: Evidence from Direct2Farm program in India. *World Development Perspectives, 13*, 25-33.

Karlsson & Spyrou. (2020). *A consultant perspective on Digital transformation – Experiences of successful digitalization.* (Master). Linköping University, Linköping.

Kilangi. (2012). *The Determinants of ICT Adoption and Usage among SMEs: The Case of the Tourism Sector in Tanzania.* (PhD). Amsterdan Business Research Institute, Amsterdam.

Klerkx. (2020). Advisory services and transformation, plurality and disruption of agriculture and food systems: towards a new research agenda for agricultural education and extension studies. *The Journal of Agricultural Education and Extension, 26*(2), 131-140.

Klerkx et al. (2019). A review of social science on digital agriculture, smart farming and agriculture 4.0: New contributions and a future research agenda. *NJAS - Wageningen Journal of Life Sciences, 90-91*.

Knierim et al. (2017). Pluralism of agricultural advisory service providers - Facts and insights from Europe. *Journal of Rural Studies, 55*, 45-58.

Kuan & Chau. (2001). A Perception-Based Model for EDI Adoption in Small Businesses Using a Technology-Organization-Environment Framework. *Information & Management, 38*(8), 507-521.

Kudyba, Fjermestad, & Davenport. (2019). A research model for identifying factors that drive effective decision-making and the future of work. *Journal of Intellectual Capital, 21*(6), 835-851.

Lameck & Hulst. (2020). Explaining coping strategies of agriclutural extension officers in Tanzania: the role of the wider institutional context. *International Review of Administrative Sciences, 86*(4), 749-764.

Livari et al. (2020). Digital transformation of everyday life - How COVID-19 pandemic transformed the basic education of the young generation and why information management research should care? *International Journal of Information Management, 55*.

Lubell & McRoberts. (2018). Closing the extension gap: Information and communication technology in sustainable agriculture. *California Agriculure, 72*(4), 236-242.

Lundström & Lindblom. (2018). Motivations and needs for adoption of the agricultural decision support system CropSAT in advisory services. *International Journal of Agricultural Extension*, 71-82.

Müller et al. (2019). Emergency drills for agricultural drought response: A case study in Guatamala. *Disasters, 43*(2), 410-430.

Munthali et al. (2018). Innovation intermediation in a digital age: Comparing public and private new-ICT platforms for agricultural extension in Ghana. *NJAS - Wageningen Journal of Life Sciences, 86-87*, 64-76.

Mwombe et al. (2014). Evaluation of information and communication technology utilization by small holder banana farmers in Gatanga district, Kenya. *Journal of Agricultural Education and Extension, 20*, 247-261.
Nakano et al. (2018). Is farmer-to-farmer extension effective? The impact of training on technology adoption and rice farming productivity in Tanzania. *World Development, 105*, 336-351.
Nakasone & Torero. (2016). A text message away: ICTs as a tool to improve food security. *Agricultural Economics, 47*, 49-59.
Namyenya et al. (2021). E-diary: a digital tool for strenghtening accountability in agricultural extension. *Information Technology for Development, 27*.
Nyarko & Kozári. (2021). Information and communication technologies (ICTs) usage among agricultural extension officers and its impact on extension delivery in Ghana. *Journal of the Saudi Society of Agricultural Sciences*.
Oliveira & Martins. (2010a). Firms patterns of e-business adoption: Evidence for the european union. *The Electronic Journal Innformation Systems Evaluations, 13*(1), 47-55.
Ortiz-Crespo et al. (2020). User-centered design of a digital advisory service: enhancing public agricultural extension for sustainable intensification in Tanzania. *International Journal of Agricultural Sustainability*.
Oyinbo et al. (2019). Farmers' preferences for high-input agriculture supported by site-specific extension services: Evidence from a choice experiment in Nigeria. *Agricultural Systems, 173*, 12-26.
Palacios-Marqués et al. (2014). Analyzing the effects of technological, organizational and competition factors on Web knowledge exchange in SMEs. *Telematics and Informatics, 32*, 23-32.
Peter et al. (2020). Strategic action fields of digital transformation: An exploration of the strategic action fields of Swiss SMEs and large enterprises. *Journal of Strategy and Management, 13*(1), 160-180.
Purnomo & Kusnandar. (2019). Barriers to acceptance of information and communication technology in agricultural extension in Indonesia. *Information development, 35*(4), 512-523.
Ragasa & Mazunda. (2018). The impact of agricultural extension services in the context of a heavily subsidized input system: The case of Malawi. *World Development, 105*, 25-47.
Rattenbury & Nafus. (2018). Data Science and Ethnography: What's Our Common Ground, and Why does it Matter?
Rogers. (2003). *Diffusion of innovations* (5th edition ed.). New York: Free Press.
Rose & Chilvers. (2018). Agriculture 4.0: Broadening Responsible Innovation in an Era of Smart Farming. *Frontiers in Sustainable Food Systems, 2*.
Rose et al. (2021). Agriculture 4.0: Making it work fo peope, production, and the planet. *Land Use Policy, 100*.
Salam & Khan. (2020). Farmers' Perception Analysis about the se of Information and Communication Technologies(ICT) in Agriculture Extension services of Khyber Pakhtunkhwa. *Sarhad Journal of Agriculture, 36(3)*, 754-760.
Saunders, Lewis, & Thornton. (2019). *Research Methods for Business Students* (Vol. 8). New York: Pearson Education Limited.
Schneider et al. (2012). No-tillage farming: co-creation of innovation through network building. *Land Degradation & Development, 23*, 242-255.
Sebastian et al. (2017). How big old companies navigate digital transformation. *MIS Quarterly - Executive, 16*(3), 197-213.
Sheperd et al. (2018). Priorities for science to overcome hurdles thwarting the full promise of the 'digital agriculture' revolution. *Journal of the Science of Food and Agriculture, 100*, 5083-5092.

Silva et al. (2017). A Technology Acceptance Model of common bean growers' intention to adopt Integrated Production in the Brazilian Central Region. *Die bodenkultur: Journal of Lang Management, Food and Environment, 68*(3), 131-143.
Steinke et al. (2021). Tapping the full potential of the digital revolution for agricultural extension: an emerging innovation agenda. *International Journal of Agricultural Sustainability, 19*(5-6), 549-565.
Tata & Mcnamara. (2017). Impact of ICT on agricultural extension services delivery: evidence from the Catholic Relief Services SMART skills and FARMbook project in Kenya. *The Journal of Agricultural Education and Extension, 24*(1), 89-110.
Uddin et al. (2019). Information Needs and Challenges of Agriclutural Researchers and Extension Workers in Edo State, Nigeria. *Path of Science, 5*(6).
Umar et al. (2017). Core competency requirements among extension workers in peninsular Malaysia: Use of Borich's needs assessment model. *Evaluation and Program Planning, 62*, 9-14.
Venkatesch et al. (2003). User acceptance of information technology: toward a unified view. *MIS Quarterly, 27*(3), 425-478.
Ventikachalam & Bosua. (In press). Demysifying the link beween Big Data and Knowledge Management for Organisational Decision-making.
Verma & Sinha. (2018). Integrating perceived economic wellbeing to technology acceptance model: The case of mobile based agricultural extension service. *Technological Forecasting & Social Change, 126*, 201-216.
Vial. (2019). Understanding digital transformation: A review and a research agenda. *Journal of Strategic Information Systems*, 118-144.
Wang et al. (2019). Farmer Cooperatives' Intention to Adopt Agricultural Information Tehchnology - Mediating Effects of Attitude. *Information Systems Frontiers, 21*, 565-580.
Webster & Watson. (2002). Analyzing the Past to Prepare for the Future: Writing a Literature Review. *MIS Quarterly, 26*(2).
Wolfswinkel et al. (2011). Using grounded theory as a method for rigorously reviewing literature. *European Journal of Information Systems*, 1-11.
World Bank Group. (2017). *ICT in agriculture: Connecting Smallholders to Knowledge, Networks, and Institutions.* Washington.
Yang, Klerkx, & Leeuwis. (2014). Functions and limitations of farmer cooperatives as innovation intermediaries: Findings from China. *Agricultural Systems, 127*, 115-125.
Yin. (2018). Case Study Research and Applications: Design and Methods. In (Sixth edition ed.): SAGE publications.
Zhai et al. (2020). Decision support systems for agriculture 4.0: Survey and challenges. *Computers and Electronics in Agriculture, 170*.
Zhao & Gong. (2020). Analysis on the Mechanism of Digital Economy Boosting the High-quality Development of Agriculture in China. *E3S Web of Conferences, 218*.
Zhu et al. (2006b). The process of innovation assimilation by firms in different countries: a technology diffusion perspective on e-business. *Managent Science, 52*, 1557-1576.

Appendix: Building blocks of the digital transformation process

The building blocks of the digital transformation process come forth of a literature research of Vial (2019). Quoting the paper "*the framework foregrounds digital transformation as a process where* digital technologies *create* disruptions *triggering* strategic responses *from organizations that seek to alter their* value creation paths *while managing the* structural changes *and* organizational barriers *that affect the* positive *and* negative *outcomes of this process*". The framework consist of eight building blocks which are summarized below, where the linking factor is printed in bold:

i. Use of digital technologies

The building block 'use of digital technologies' is based on the SMACIT classification (Steinke et al., 2021). SMACIT stands for *social*, *mobile*, *analytics*, *cloud* and *internet of things*. The building block has been enriched with *platforms* as this term is applied many times in literature (Vial, 2019).

ii. Disruptions

Disruption is a term often linked to, or even **fuelled by**, digital technologies and forms another building block. This block consists of the elements *Consumer behaviour & expectations*, C*ompetitive landscape* and A*vailability of data*.

iii. Strategic responses

The disruptions caused by the use of digital technologies **trigger** an organisational response to stay competitive as the disruptions form game-changing opportunities and threats. The organisational strategy and a transformation strategy form the core elements of this building block. The use of digital technologies **relies** on the strategic response of the organisation.

iii. Changes in value creation paths

The **enabling** effect of the (new) digital technologies in the services and/or products an organisation offers and the (new) methods used, make sure that the effect of these digital technologies is actually applied. The building block consists of the elements *Value proposition*, *Value networks*, *Digital channels* and *Agility and ambidexterity*.

v. Structural changes

To apply the digital technologies enabling changes in the value creation often the organisation may need to change profoundly. Based on literature the building block is constructed of the elements *Organizational structure*, *Organisational culture*, *Leadership* and *Employee roles and skills*. These structural changes **affect** the changes in the value creation paths.

vi. Organizational barriers

In this building block the elements *Inertia* and *Resistance to change form* the most prominent reasons for an organisation affect the changes in the value creation paths. Inertia is about the existing resources and capabilities that may hinder the changes in the value creation paths whereas resistance is coming from the employees.

vii. Positive impact

The positive outcomes **generated** by the changes in the value creation paths. The positive outcomes are subdivided in *Operational efficiency*, *Organizational performance*, *Industry & society improvements*.

viii. Negative impact

The undesirable outcomes **generated** by the changes in the value creation paths. These negative outcomes are linked to *Security & Privacy*.

Appendix: Generic interview protocol

As the research is a qualitative research, many questions will start with “How” or “What are…” to invite the interviewee to elaborate on the different topics. Next, to the generic questions other questions are asked to further dig into a topic or to ask for examples, views or opinions.

Each interview started with an introduction from the interviewer explaining the purpose of the interview and stating that all data/answers will be treated confidential. Next, the interviewee is asked to give an introduction and tell the interviewer something about his/her work.

General questions

- ➔ What type of services does your organization deliver to its members?
    - To who do you provide these services?
        - How do you handle non-members in your services?
    - How do you provide these services?
- ➔ What is digital transformation to you?
- ➔ Which technologies do you currently use in your work?
    - How do you use them?
    - You told me about technology X, how does this work?
- ➔ Which technologies make a big difference in your daily work?
    - How do they change your work?
    - What is the added value of these technologies?
    - How does it improve your service delivery?
    - Do you see any room for improvement and how would you like to improve?
    - How would digital technologies play a role in this improvement?
- ➔ What type of information do you collect?
    - How do you use the information collected?
    - Do you see any privacy issues?
    - Whose data is it after collecting?
- ➔ What are the elements that made you decide to start using these systems?
- ➔ Why are digital technologies important to you?
- ➔ Who uses these support systems and what are their benefits?
    - How do users perceive the support systems?
    - How do the targeted persons perceive these support systems?
    - What do you use the collected data for?

Questions related to technology adoption

- ➔ Why would you need digital technologies? *(What problem are you solving? Competitors? Quality improvement? Anything else?)*
- ➔ You have been using digital technologies in your work (examples are mentioned earlier)
    - How easy was it to start using new technologies?
    - What did you have to change?
    - How did you change?
    - Where did you get any help?

Questions about organizational challenges

- ➔ How do the digital technologies transform your organization? *(extra personnel? Extra trainings? New processes? Improvements? Investments?)*
- ➔ Which opportunities do digital technologies give your organization?
- ➔ What experience and expertise do you think are required?
- ➔ How capable is your organization in handling digital technologies?

- ➔ Do you have specific roles for working on digitalization/ICT in your organization?
- ➔ How do you manage change in the work of an extension officer?
- ➔ What was the most successful digital technology?
- ➔ Why was it the most successful?
- ➔ What was the least successful digital technology?
- ➔ Why was it the least successful?
- ➔ Where should an organization start when using digital technologies?
- ➔ How do you manage/control the digital technology? (*outsource, hire consultants….)*
- ➔ How do you create a 'digital support systems mindset' in your organization?

Questions regarding the context in which digital technologies are used

- ➔ How do digital support systems fit in your environment? *(at your own organization, at farmers…)*
    - What are the obstacles/barriers you encounter? Do you have any examples?
- ➔ Which external factors influence the use of digital technologies, are there barriers or constraints?
- ➔ Who are all the stakeholders involved? *(Government, local authorities, private organizations, public organizations, extension officers, farmers)*
    - What is their role in your service delivery?
- ➔ How do these stakeholders experience these digital tools? *(extension officers from your organization, farmers themselves?)*
- ➔ What do you need to optimize the use of digital tools? (computers, network, internet?)

Final questions

- ➔ How do you see the world of service delivery moving forward?
- ➔ What would be your suggestions to make service delivery even better?
- ➔ Where do you think your organization would find itself in five years?
    - How do you think the transformation is going to affect the organization?
- ➔ Will the role of an extension officer be replaced by technology?
    - If so, how?
    - What are the limitations?
    - If not, why not?
    - What are the challenges technology cannot overcome?
- ➔ Is there something you would like to mention that was not yet asked?

Appendix: Coding scheme

The coding is applied using the following steps:

The interviews have been transcribed in MS Word and uploaded in Atlas.io. After uploading the documents open coding has been applied where the building blocks of Vial have been used as guidelines. As a result nine 'code groups' have been created, before the coding started, one group for each building block. An extra group has been created for all codes that did not fit into one of the building block groups.

During the open coding new groups were formed as theme's became more clear in the data. The result thus showed several themes in line with the building blocks and several themes that are not a part of the building blocks. As new codes emerged during the coding of data, the codes may need rephrasing and/or to be linked to new groups. Rephrasing was only done so that the distinction between codes became more clear. An example is further detailing "Availability of data" into "Availability of data – assess information" and "Availability of data – information sharing" and also adding "Availability of experiences" and "Availability of knowledge".

After the coding was done in Atlas.io a list was available of codes and a list of code groups that had codes applied to. Due to some limitations in Atlas.io an export has been made to an MS Excel file where the emerged themes were identified and where the code groups have been linked to these themes.

Coding Table 1: code -> group

Code	Grounded	Code Groups
I Availability of data	50	Vial I Availability of data
I Availability of data - assess information	1	Vial I Availability of data
I Availability of data - information sharing	7	Vial I Availability of data Information dissemination
I Availability of data -> data input	8	Vial I Availability of data
I Availability of experiences	2	Vial I Availability of data
I Availability of knowledge	2	Vial I Availability of data
I Consumer behaviour & Expectations	6	Vial I Availability of data
I Farmer specific needs	2	Vial I Availability of data Farmer differences
I Information exchange	1	Vial I Availability of data Information dissemination
II Analytics	16	Vial II Use of digital technologies
II Analytics - decision making	4	Vial II Use of digital technologies
II Broadcasting	4	Vial II Use of digital technologies
II IoT	1	Vial II Use of digital technologies
II Mobile	10	Vial II Use of digital technologies
II Platforms	36	Vial II Use of digital technologies
II Radio	3	Vial II Use of digital technologies
II Social	35	Vial II Use of digital technologies
II Value networks	3	Vial II Use of digital technologies
III Agility & ambidexterity	3	Vial III Changes in value creation paths
III Digital channels	24	Vial III Changes in value creation paths

III Value proposition	25	Vial III Changes in value creation paths Value proposition
III Value proposition - result oriented	4	Vial III Changes in value creation paths
III Value proposition - target single farmer	7	Vial III Changes in value creation paths Farmer targeted services Value proposition
IV Costs	8	Vial IV Organizational barriers Farmer organization
IV Inertia	1	Vial IV Organizational barriers Farmer organization
IV Network issues	5	Vial IV Organizational barriers Farmer organization
IV Resistance	1	Vial IV Organizational barriers Farmer organization
IX Accept change	4	Farmer adoption of digital technology
IX Adoption by farmer	13	Farmer adoption of digital technology
IX Adoption rate of advice can be low	1	Farmer adoption of digital technology
IX Analyse feed samples	1	Farmer differences
IX Business mindset is needed	1	Farmer adoption of digital technology
IX Collect feed samples	1	Observation
IX Conservative people	4	Farmer adoption of digital technology Farmer differences
IX Corona catalysator	1	EO adoption of digital technology
IX Cost issue	1	Farmer differences
IX cut costs	1	Farmer benefit
IX different from the past	1	Other
IX Digital is dynamic	1	EO adoption of digital technology
IX Dissemination	1	Information dissemination
IX DT definition	3	Other
IX Educate youth	1	Other
IX Everything is in technology	1	Familiarity with digital technology
IX External support to implement DCB	1	EO adoption of digital technology External support
IX famers share information	6	Information dissemination
IX Familiarity with digital technology	2	EO adoption of digital technology Familiarity with digital technology
IX Farm characteristics	1	Farmer differences
IX Farm level data	16	Farmer differences Observation EO adoption of digital technology Information dissemination
IX Farmer age	1	Farmer differences Observation EO adoption of digital technology Information dissemination

IX Farmer capabilities	3	Farmer differences Observation EO adoption of digital technology Information dissemination
IX Farmer categorization	4	Farmer categorization
IX Farmer decision	1	Decision making
IX Farmer EO ratio	1	Outreach
IX farmer feedback	11	Farmer feedback
IX Farmer illiteracy	7	Farmer adoption of digital technology Farmer differences Digital equipment/hardware
IX Farmer needs	15	Farmer needs
IX Farmer needs/Demand driven	7	Farmer needs Demand driven
IX Farmer targeted advice/KPI	19	Farmer targeted services
IX Farmer targeted advice/KPI costs	1	Farmer targeted services
IX Feed formulation can be inconsistent with advice	1	Farmer needs Farmer targeted services
IX first accept change then adopt	1	Farmer adoption of digital technology
IX Hardware for EO	2	Digital equipment/hardware
IX help from family	1	Farmer adoption of digital technology
IX Higher income	1	Other
IX Humans resist change	1	Other
IX Improve production	12	Farmer adoption of digital technology Farmer benefit
IX Inform farmer when taking data	1	Other
IX Information about farmer	2	Farmer differences
IX Interaction between farmers	1	Information dissemination
IX Kenya	1	Other
IX Knowledge exchange	4	Information dissemination
IX Lack of technology	2	Farmer differences
IX Lead farmer	5	Farmer categorization
IX Learning by doing	2	Physical
IX Learning curve	1	Farmer adoption of digital technology
IX Learning via technology	1	Familiarity with digital technology
IX Manipulate data	1	Vial VI Negative impacts
IX Need technology to produce more	1	Farmer adoption of digital technology
IX New information	2	Information dissemination
IX no more without technology	2	Technology is a must have
IX No technology means left behind	1	Technology is a must have
IX Online farmers	2	Outreach
IX Organisation profited from DT	2	Vial V Positive impact
IX Other	3	Other
IX Physical visits	1	Observation
IX Rich farmer adopts fast	1	Farmer adoption of digital technology Farmer differences
IX Share with farmer	3	Information dissemination
IX share with non-members	1	Information dissemination

IX Smallholder farms	1	Farmer differences
IX Stakeholders	1	Other
IX Tablet easier than phone	1	Digital equipment/hardware
IX Taking my work mindset	1	Farmer adoption of digital technology
IX Technology adoption is sometimes slow	1	Farmer adoption of digital technology
IX Technology costs	1	Farmer differences
IX Technology gives ideas	1	Vial V Positive impact Technology supports
IX Technology is needed	1	Technology is a must have
IX Technology knows no difference	1	Farmer differences
IX Technology resources	1	Farmer differences
IX Technology supplements EO	1	Technology supports
IX Technology supplements knowledge	1	Technology supports
IX Technology to replace manual work	2	Vial V Positive impact Technology supports
IX Technology will prove itself	1	Vial V Positive impact Technology supports
IX Training in use of technology	4	EO adoption of digital technology
IX Two way communication	1	Information dissemination
IX used to be time consuming	1	Technology supports
IX Youth will do DT	1	Farmer adoption of digital technology
V Avoid data distortion	1	Vial V Positive impact
V Customer centered services	3	Vial V Positive impact Farmer targeted services
V Feedback possibility	5	Vial V Positive impact Service delivery improvement
V Increase of production	1	Vial V Positive impact
V Industry & society improvements	2	Vial V Positive impact
V Monitor farmers activity	1	Vial V Positive impact Farmer needs
V Monitor performance	2	Vial V Positive impact Service delivery improvement
V Operational efficiency	10	Vial V Positive impact Service delivery improvement
V Organizational performance	7	Vial V Positive impact Service delivery improvement Farmer organization
V Outreach	12	Vial V Positive impact Outreach
V up to date data	1	Vial V Positive impact
VI Ambiguous data	1	Vial VI Negative impacts
VI Bad data	1	Vial VI Negative impacts
VI Data from other organisations unavailable	1	Vial VI Negative impacts
VI Data ownership	2	Vial VI Negative impacts
VI Failed project	1	Vial VI Negative impacts

VI Farmers interpretation of online content	1	Vial VI Negative impacts
VI Hard to track data	1	Vial VI Negative impacts
VI Incomplete data	1	Vial VI Negative impacts
VI Security & Privacy	1	Vial VI Negative impacts
VII Demand driven from EO	1	Vial VII Structural changes
VII Employee roles and skills	14	Vial VII Structural changes EO Skillset
VII Leadership	2	Vial VII Structural changes
VII Management support	1	Vial VII Structural changes
VII Organizational culture	8	Vial VII Structural changes Farmer organization
VII Organizational structure	8	Vial VII Structural changes Farmer organization
X Downside no technology	1	Physical
X Physical demonstration	1	Physical
X Physical observation	26	Observation
X Physical visit	44	Physical
X seeing is believing	13	Physical
X Technology cannot replace	9	Technology is a must have
X Technology general benefits	8	Vial V Positive impact Technology supports
X Technology savvy	1	Physical
X Visits per day	1	Physical
XI Convincing organisation	1	Software development/project management
XI Feedback on functionality	1	Software development/project management
XI Government extension officers	2	Software development/project management
XI Ground demonstration leaves no room for interpretation	3	Software development/project management
XI Pilot	1	Software development/project management
XI Project management	2	Software development/project management
XI Software development	2	Software development/project management
XI Software feature	4	Software development/project management
XI Software implementation	3	Software development/project management
XI Software improvements	5	Software development/project management
XI Technology specific training	3	Software development/project management
XII Adjust advice based on data	1	Service delivery improvement
XII Advice was not clear	1	Service delivery improvement
XII Distance between farmers	1	Service delivery improvement

XII Farmers will leave when advice is ineffective	1	Service delivery improvement
XII Give advice from home	2	Service delivery improvement
XII Group services	1	Service delivery improvement
XII Improve services	4	Service delivery improvement
XII Management monitoring EO	4	Service delivery improvement
XII Monitoring & Evaluation	1	Service delivery improvement
XII New technology from farmer	1	Service delivery improvement
XII Notify farmer	1	Service delivery improvement
XII Service approach	2	Service delivery improvement
XII Various ways to reach farmer	1	Service delivery improvement
XII workplan	1	Service delivery improvement
XIII EO adoption of technology	12	EO Capacity improvement
XIII EO competences	19	EO Capacity improvement
XIII EO performance	4	EO Capacity improvement
XIII EO requests training	2	EO Capacity improvement
XIII EO shortcomings	6	EO Capacity improvement
XIII External trainings	4	EO Capacity improvement
XIII help farmers with technology	1	EO Capacity improvement
XIII improve/evaluate extension officer	6	EO Capacity improvement
XIII Internal trainings	4	EO Capacity improvement
XIII Persuade the farmer	3	EO Capacity improvement
XIII Persuade the farmer to change	1	EO Capacity improvement
XIII Share between EO's	1	EO Capacity improvement
XIII Update information in own time	1	EO Capacity improvement
XIV Decision to use technology	4	Decision making
XIV Management decision	2	Decision making
XIV willingness to use new technology	2	Decision making
XIV Workaround when no internet available	2	Decision making

Coding Table 2: Coding groups

Group name	**Codes**	**Code**
Decision making	5	IX Farmer decision XIV Decision to use technology XIV Management decision XIV willingness to use new technology XIV Workaround when no internet available
Demand driven	1	IX Farmer needs/Demand driven
Digital equipment/hardware	3	IX Farmer illiteracy IX Hardware for EO IX Tablet easier than phone

EO adoption of digital technology	8	IX Corona catalysator IX Digital is dynamic IX External support to implement DCB IX Familiarity with digital technology IX Farm level data IX Farmer age IX Farmer capabilities IX Training in use of technology
EO Capacity improvement	13	XIII EO adoption of technology XIII EO competences XIII EO performance XIII EO requests training XIII EO shortcomings XIII External trainings XIII help farmers with technology XIII improve/evaluate extension officer XIII Internal trainings XIII Persuade the farmer XIII Persuade the farmer to change XIII Share between EO's XIII Update information in own time
EO Skillset	1	VII Employee roles and skills
External support	1	IX External support to implement DCB
Familiarity with digital technology	3	IX Everything is in technology IX Familiarity with digital technology IX Learning via technology
Farmer adoption of digital technology	15	IX Accept change IX Adoption by farmer IX Adoption rate of advice can be low IX Business mindset is needed IX Conservative people IX Farmer illiteracy IX first accept change then adopt IX help from family IX Improve production IX Learning curve IX Need technology to produce more IX Rich farmer adopts fast IX Taking my work mindset IX Technology adoption is sometimes slow IX Youth will do DT

Farmer benefit	2	IX cut costs IX Improve production
Farmer categorization	2	IX Farmer categorization IX Lead farmer
Farmer differences	16	I Farmer specific needs IX Analyze feed samples IX Conservative people IX Cost issue IX Farm characteristics IX Farm level data IX Farmer age IX Farmer capabilities IX Farmer illiteracy IX Information about farmer IX Lack of technology IX Rich farmer adopts fast IX Smallholder farms IX Technology costs IX Technology knows no difference IX Technology resources
Farmer feedback	1	IX farmer feedback
Farmer needs	4	IX Farmer needs IX Farmer needs/Demand driven IX Feed formulation can be inconsistent with advice V Monitor farmers activity
Farmer organization	7	IV Costs IV Inertia IV Network issues IV Resistance V Organizational performance VII Organizational culture VII Organizational structure
Farmer targeted services	5	III Value proposition - target single farmer IX Farmer targeted advice/KPI IX Farmer targeted advice/KPI costs IX Feed formulation can be inconsistent with advice V Customer centered services

Information dissemination	13	I Availability of data - information sharing I Information exchange IX Dissemination IX famers share information IX Farm level data IX Farmer age IX Farmer capabilities IX Interaction between farmers IX Knowledge exchange IX New information IX Share with farmer IX share with non-members IX Two way communication
Observation	6	IX Collect feed samples IX Farm level data IX Farmer age IX Farmer capabilities IX Physical visits X Physical observation
Other	9	IX different from the past IX DT definition IX Educate youth IX Higher income IX Humans resist change IX Inform farmer when taking data IX Kenya IX Other IX Stakeholders
Outreach	3	IX Farmer EO ratio IX Online farmers V Outreach
Physical	7	IX Learning by doing X Downside no technology X Physical demonstration X Physical visit X seeing is believing X Technology savvy X Visits per day

Service delivery improvement	18	V Feedback possibility V Monitor performance V Operational efficiency V Organizational performance XII Adjust advice based on data XII Advice was not clear XII Distance between farmers XII Farmers will leave when advice is ineffective XII Give advice from home XII Group services XII Improve services XII Management monitoring EO XII Monitoring & Evaluation XII New technology from farmer XII Notify farmer XII Service approach XII Various ways to reach farmer XII workplan
Software development/project management	11	XI Convincing organisation XI Feedback on functionality XI Government extension officers XI Ground demonstration leaves no room for interpretation XI Pilot XI Project management XI Software development XI Software feature XI Software implementation XI Software improvements XI Technology specific training
Technology is a must have	4	IX no more without technology IX No technology means left behind IX Technology is needed X Technology cannot replace
Technology supports	7	IX Technology gives ideas IX Technology supplements EO IX Technology supplements knowledge IX Technology to replace manual work IX Technology will prove itself IX used to be time consuming X Technology general benefits
Value proposition	2	III Value proposition III Value proposition - target single farmer

Vial I Availability of data	9	I Availability of data I Availability of data - assess information I Availability of data - information sharing I Availability of data -> data input I Availability of experiences I Availability of knowledge I Consumer behaviour & Expectations I Farmer specific needs I Information exchange
Vial II Use of digital technologies	9	II Analytics II Analytics - decision making II Broadcasting II IoT II Mobile II Platforms II Radio II Social II Value networks
Vial III Changes in value creation paths	5	III Agility & ambidexterity III Digital channels III Value proposition III Value proposition - result oriented III Value proposition - target single farmer
Vial IV Organizational barriers	4	IV Costs IV Inertia IV Network issues IV Resistance
Vial V Positive impact	16	IX Organisation profited from DT IX Technology gives ideas IX Technology to replace manual work IX Technology will prove itself V Avoid data distortion V Customer centered services V Feedback possibility V Increase of production V Industry & society improvements V Monitor farmers activity V Monitor performance V Operational efficiency V Organizational performance V Outreach V up to date data X Technology general benefits

Vial VI Negative impacts	10	IX Manipulate data VI Ambiguous data VI Bad data VI Data from other organisations unavailable VI Data ownership VI Failed project VI Farmers interpretation of online content VI Hard to track data VI Incomplete data VI Security & Privacy
Vial VII Structural changes	6	VII Demand driven from EO VII Employee roles and skills VII Leadership VII Management support VII Organizational culture VII Organizational structure