Critically Stewarding ICTs for Sustainable Agricultural Development

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In collaboration with
Development Research Communication and Services Centre, India

A thesis submitted in partial fulfilment of the requirements of
Sheffield Hallam University
for the degree of Doctor of Philosophy

January 2021

Candidate Declaration

I hereby declare that:

1. I have not been enrolled for another award of the University, or other academic or professional organisation, whilst undertaking my research degree.
2. None of the material contained in the thesis has been used in any other submission for an academic award.
3. I am aware of and understand the University's policy on plagiarism and certify that this thesis is my own work. The use of all published or other sources of material consulted have been properly and fully acknowledged.
4. The work undertaken towards the thesis has been conducted in accordance with the SHU Principles of Integrity in Research and the SHU Research Ethics Policy.
5. The word count of the thesis is 80,463.

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Peer reviewed book chapters

- Kendall, Linus, and Andrew Dearden. “Towards alternate theories of change for M4ARD.” Digital technologies for agricultural and rural development in the Global South (2018): 92-103.

Peer reviewed conference papers

- Chaudhuri, Bidisha, Dasgupta, Purnabha, Hoysala, Onkar, Kendall, Linus, & Srinivasan, Janaki (2017, May). “Actor-networks and “practices” of development: impact of a weather information system in West Bengal." *International Conference on Social Implications of Computers in Developing Countries*. Springer, Cham, 2017.

- Kendall, Linus, and Andy Dearden. "ICTs for agroecology." International Conference on Social Implications of Computers in Developing Countries. Springer, Cham, 2017.

- Chaudhuri, Bidisha, Kendall, Linus, Srinivasan, Janaki, Hoysala, Onkar & Dasgupta, Purnabha, "Understanding capabilities through everyday practice: The case of a weather information system for farmers in West Bengal." Proceedings of the Ninth International Conference on Information and Communication Technologies and Development. 2017.

- Kendall, Linus, and Andy Dearden. "Disentangling participatory ICT design in socioeconomic development." Proceedings of the 15th Participatory Design Conference: Full Papers-Volume 1. 2018.

- Chaudhuri, Bidisha, and Linus Kendall. "The ins and outs of participation in a weather information system." International Conference on Social Implications of Computers in Developing Countries. Springer, Cham, 2019.

Peer reviewed journal publications

- Kendall, Linus, and Andy Dearden. "The politics of co-design in ICT for sustainable development." CoDesign 16.1 (2020): 81-95.

- Chaudhuri, Bidisha, and Linus Kendall. "Collaboration without consensus: Building resilience in sustainable agriculture through ICTs." The Information Society (2020): 1-19.

List of Abbreviations

ALS - Action Learning Set
ADR - Action Design Research
AR - Action Research
AWS - Automated Weather Station
CA - Capability Approach
CBO - Community Based Organisation
DR - Design Research
DRCSC - Development Research and Communication Service Centre
DSR - Design Science Research
EAR - Ethnographic Action Research
GIS - Geographic Information System
GR - Green Revolution
HCI - Human Computer Interaction
HYV - High Yielding Variety
ICT - Information and Communication Technology
ICT4D - Information and Communication Technology for Development
IMD - Indian Meteorological Department
IPCC - International Panel on Climate Change
IRB - Institutional Review Board
IVR - Interactive Voice Response
MDG - Millennium Development Goal
MWS - Manual Weather Station
NABARD - The National Bank for Agricultural and Rural Development
NGO - Non-governmental Organisation
NRM - Natural Resource Management
PAR - Participatory Action Research
PD - Participatory Design
PRA - Participatory Rural Appraisal
SDG - Sustainable Development Goal
SHG - Self-Help Group
SLF - Sustainable Livelihoods Framework
UNFCCC - UN Framework Convention on Climate Change
VSD - Value Sensitive Design

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Abstract

This thesis explores how information and communication technologies (ICTs) can contribute to sustainable agricultural development. ICTs have for a long time been seen as important tools to support agriculture, in particular supporting the resource-constrained agricultural extension services of the Global South. However, previous research has largely failed to consider how ICTs can play a role in sustainable, agroecological farming. Not only that, existing approaches to agricultural ICTs have by and large failed to ensure that the interventions themselves are sustainable.

Sustainable farming demands a holistic approach to agriculture, which extends to the way technologies such as ICTs are employed. The question of sustainability is critical for a sector that employs nearly a third of all workers worldwide, and a majority of those who are classified as poor. This has become especially acute considering the effects of the global climate crisis. Deploying technological interventions that cannot be sustainably maintained and do not take into account whether the agriculture they are promoting is sustainable, can only serve to exacerbate the issues at hand.

Through action research conducted together with a non-profit organisation, Development Research Communication and Services Centre (DRCSC), in West Bengal in India, I have explored how to address ICTs in sustainable agriculture. In our work, we have developed an approach to ICTs that is both sustainable and also contributes to the long-term resilience and sustainability of the agroecosystem within which DRCSC operates. This required recognising the specific nature of the knowledge ecosystem of sustainable agriculture and understanding the way in which technology interventions can operate within the same.

Understanding development as an expansion in capabilities, the emphasis of this process has been on DRCSC developing collective capabilities of technology stewardship, i.e. individual and organisational capacities to critically assess and constructively approach technology in ways that they (DRCSC) have reason to value. As a result of the project, we have developed two interventions that are currently sustainably adopted within the organisation, helping them in their work to support resource-poor, smallholder farmers. These interventions have been built incorporating values of self-reliance, autonomy and low resource use that are central to DRCSC in particular and to agroecology in general. The interventions, as well as the way that DRCSC and I developed them, illustrates how ICTs can be approached in the space of sustainable agricultural development.

Drawing on a critical understanding of sustainability and technology, this thesis, however, not only informs approaches to ICTs in agriculture but ICT in development in general. Critical technology stewardship is an approach that can help researchers in ICT4D to engage in ways that are sustainable and lead to sustainable outcomes. Stewarding provides a means by which to incorporate situated understandings of the role that ICTs can play in any given context. It frames how ICT designers and researchers can participate ethically in supporting long-term development outcomes. It serves as a practical example of approaching ICT in development in a way that combines concerns for sustainability and resilience with a capabilities perspective on development.

Acknowledgments

I first want to acknowledge all the people in DRCSC and at their field sites who helped conduct this research. The research that I report on in this thesis was the result of a collaboration that started quite a few years ago now and has continued to expand since. This is a collaboration that has not only shaped the work done in this thesis, but also my understanding of sustainable agriculture and how I perceive ICTs in development work. In particular I want to recognise the contributions by Ardhendu Sekhar Chatterjee, Tapas Mondal, Somjita Chakraborty, Purnabha Dasgupta, Debabrata Guchhait and Saptarshi Ghorai.

I have been tremendously fortunate with my supervisory team. Andy Dearden has, from my very first day in Sheffield, challenged and supported me. I have enjoyed our many conversations in person as well as virtually about issues of development, technology, action research, ethics and much more. I am grateful that he enabled me to undertake this research in the way that I did - especially accommodating long periods of working in India. He has played an important role in shaping me as a researcher. Sohrab Moshiri joined the supervisory team as I was writing up this thesis helping take it to submission, challenging me and improving the way I have presented my work. I also want to recognise Sheffield Hallam University for providing the funding and resources to conduct my PhD.

I am very grateful to both students and staff at IIIT in Bangalore. Having had an academic home in India while conducting the PhD has been a great help both in making the research practically possible but also in providing a context within which to discuss and develop my research. I want to thank Amit Prakash for connecting me to and making me feel part of the institute. I also want to recognise Bidisha Chaudhuri for our collaborative research work and our many writing sessions.

Doing a PhD where the research takes place far away from your university can lead to being quite separated from the general academic environment, especially as far as contact with other PhD students is considered. Considering this, I am very grateful to have started my PhD at the same time as Caroline Claisse, Amelia Knowlson and Mark Subryan. Having our pot-lucks and long conversations to return to any time I was in Sheffield was an important part of my PhD experience.

I want to thank my wife Rupsa Nath, for the wide (an understatement if there ever was one) variety of support that she has provided to make it possible for me to undertake my PhD. She has joined me during field work, helped me interpret and make sense of my findings, suggested solutions to problems and

challenges as well as helped me focus on what was important. She has been incredibly patient with me while at the same time constantly nudging me towards the finish line. I also want to thank my in-laws Sukhendu Nath and Rekha Nath for their support - including amazing cooking that have kept morale up.

Finally, I could not have completed the PhD without the encouragement that my parents Gunilla Carlsson Kendall and David Kendall as well as my siblings Ellen Kendall and Simon Kendall have always provided. I am lucky to have a family who are interested in and values the kind of work I am involved in. I also really appreciate their help in giving feedback and proof reading this thesis.

I dedicate this thesis to my wife, Mishtu,
as well as our first two cats – Pabda and Hulo

1. Introduction

The starting point for this thesis was a relationship that developed in 2014 between myself and an organisation involved in sustainable agricultural development - Development Research Communication and Services Centre (DRCSC). Together, we sought to understand how information and communications technologies (ICTs) could support their aims of guaranteeing agricultural livelihoods that were both ecologically and economically sustainable for smallholder farmers.

Unpacking this question requires addressing several interlocking issues. First of all, what kind of development is sought and what does it mean for that to be sustainable? This is a question that is much contested, but which any initiative operating in this sphere needs to orient themselves around.

Second, what is the role that ICTs can play, if any, in contributing to development goals? Here we need to address both the potential positive mechanisms whereby ICTs can help strengthen the goal, but also seek to avoid adverse or negative impacts of the introduction of new tools or technologies.

Finally, what is the process by which we can introduce ICTs in a way that they can play this role? This addresses how those (such as myself) involved in researching, designing, developing and implementing ICTs in this context can go about our work. In doing so we need to consider not only how to ensure that we contribute productively towards interventions that have a positive impact on the context, but also how we avoid potential negative effects that the introduction of technology through design activities can have.

In summary, the overall aim of this project is to explore how ICTs can be designed and implemented in a way that is sustainable - both from the perspective of the ICT intervention itself but also in the type of agricultural development it supports. With this aim in mind, I sought, together with DRCSC to investigate three research questions:

1. What are current practices of communication and knowledge management around sustainable agricultural development in DRCSC's work and how are they structured?
2. How can we apply social and situated understandings of knowledge and learning to design socio-technical interventions that evolve or strengthen these practices?
3. What can the role for technology and technology designers be in these interventions?

Throughout this thesis, I have employed the pronoun “we” to describe the research work undertaken. This is a conscious choice made to emphasis that this was a collaborative research project between myself and DRCSC from the start, including the research questions just presented. At the same time, I consider it important to not make my own actions and presence in the project invisible. Thus, I will also employ the pronoun “I” where it is relevant to emphasis my own personal standpoint, actions and interpretations.

1.1 Context of DRCSC and their work

The context of this project is centred around DRCSC’s area of work and projects. They are a non profit organisation established in Kolkata, West Bengal, since 1982, originally focused on research and dissemination of sustainable agricultural practices. After about a decade of existence, they moved towards also directly supporting rural and agricultural livelihoods and food security. They frame their work “on the basis of principles and actions, that are environment[ally] friendly, economically appropriate, socially just and developed by mutual cooperation” (DRCSC, 2016a). This focus has led them to approach rural and agricultural development with an emphasis on long-term sustainability when it comes to managing natural resources. They primarily promote practices that are organic in nature, rather than conventional agricultural practices which involves the use of external inputs such as synthetic fertilisers, pesticides and herbicides.

Their work is based in and around eastern India particularly West Bengal (see Figure 1) but also neighbouring states and limited activities outside of India in Bangladesh, Cambodia and Japan. As per the 2011 census, West Bengal was the fourth largest state in India with a population of over 90 million people, out of which about 60% live in rural areas (Census of India, 2011).

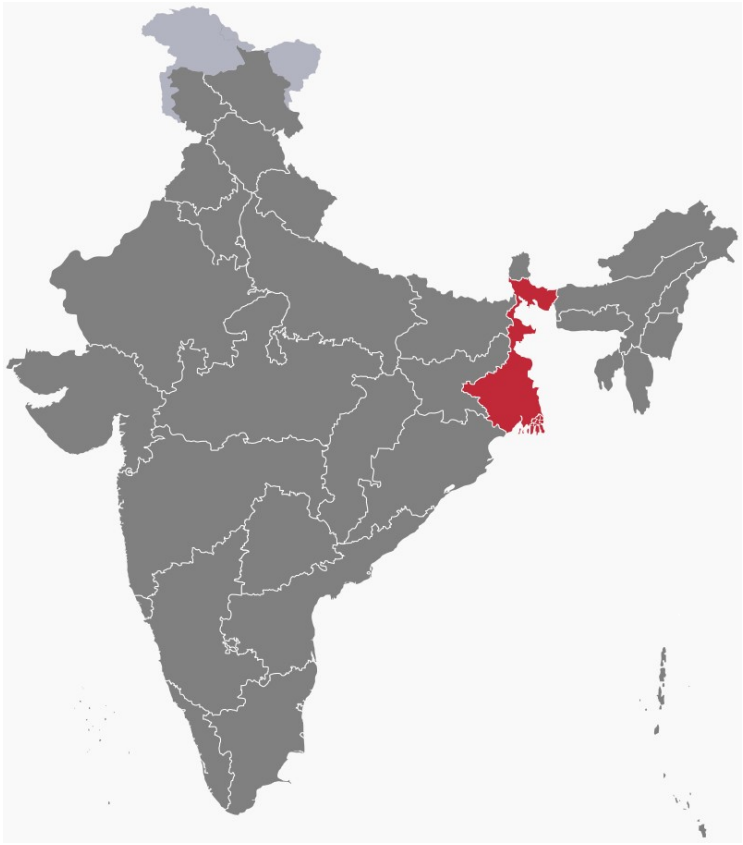


Figure 1. The location of West Bengal in India (फ़िलप्रो, 2016)

Within West Bengal, DRCSC divides their working areas on the basis of agroclimatic zones. There is a semi-arid region or "Dry Zone" (covering the districts Birbhum, Bankura, Purulia and Paschim Medinipur), a flood prone region (East Medinipur, Murshidabad, Howrah), and a hilly region (Jalpaiguri, Alipurduar). Finally there is the region of the Sundarbans (North and South 24 Parganas) or "Wet Zone". For an overview of the districts of West Bengal, see Figure 2.

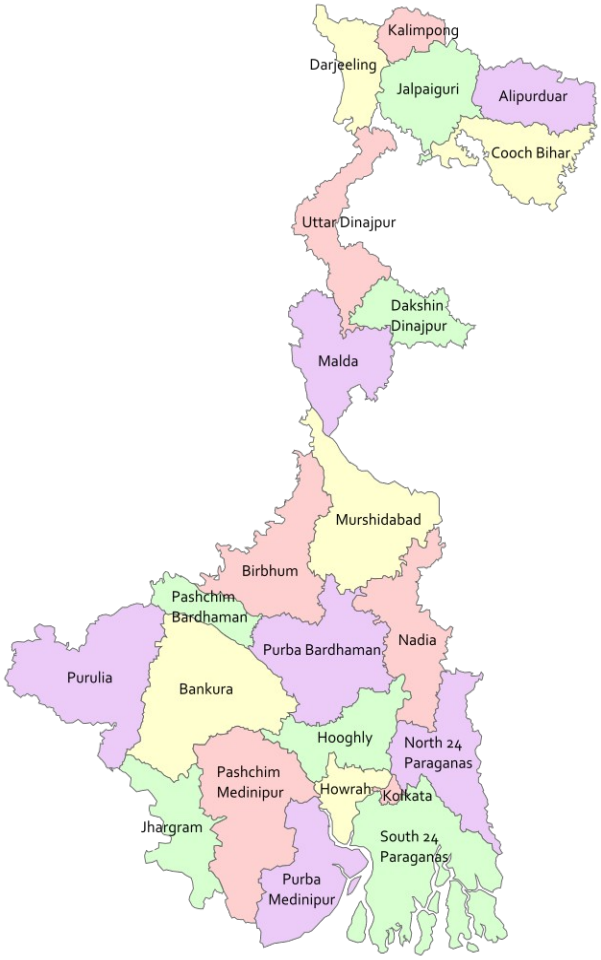


Figure 2. The districts of West Bengal (deeptrivia, 2006)

The Sundarbans is the name of the deltaic region formed where the river Ganges meets the sea (for location see Figure 3). Large parts of this region (which stretches across southern West Bengal and western Bangladesh) consists of a mangrove forest, and the mangrove ecosystem is of critical importance to all activities within the delta. This region (located primarily in the South 24 Paraganas district, see Figure 2), along with their head office in Kolkata, is where most of my activities together with DRCSC have taken place. Like all parts of West Bengal, the Sundarbans faces significant agricultural and environmental challenges. There has been an increased number of extreme weather events (primarily cyclones), which have caused destruction and loss of life (Government of West Bengal, 2010). The monsoon has also been perceived as becoming more irregular, arriving later and having longer breaks in between heavy rainfall - leading farmers to have to adjust their traditional practices. These have largely been attributed to effects of the climate crisis (Government of West Bengal, 2010). For the Sundarbans region in particular, these adverse

events are compounded by the region being an already marginal area for agriculture, with limited fresh water access (most water bodies being saline or brackish). Recent events, such as the large cyclone Aila in 2009, caused flooding that left many agricultural fields in the Sundarbans impossible to cultivate (due to soil salinity) for almost a decade afterwards.

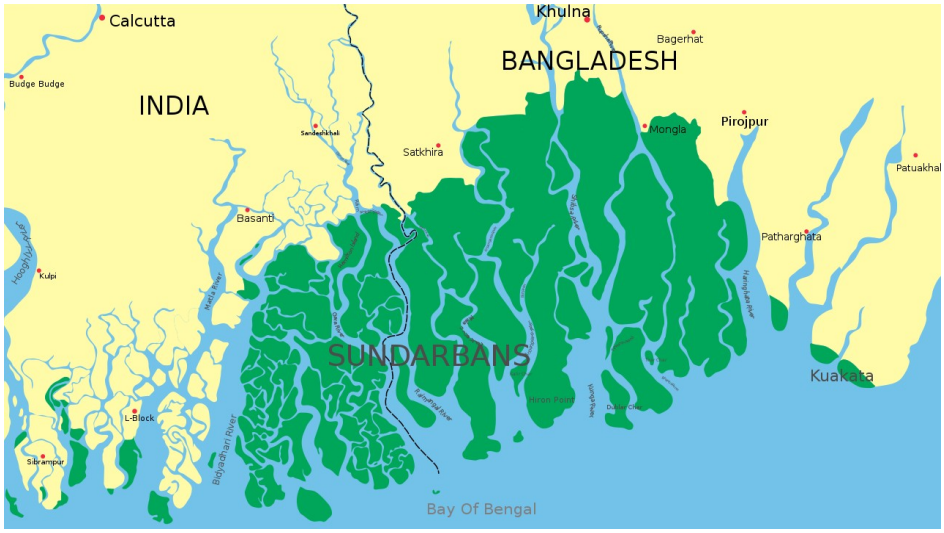


Figure 3. The Sundarbans (Nirvik12, 2015)

In all regions, DRCSC primarily works with smallholder and marginal farmers, and they also have some projects that directly benefit landless rural populations. Agriculture for these groups is rain-fed and therefore depend on the annual monsoon for provision of water for crops. The main crop is monsoon season (kharif or amon) rice, which is grown between May and harvested latest in January. In addition to this, each region has specific additional crops that are grown for both livelihood and nutrition. The other main season is boro or rabi, which is the summer period (November to April). For many regions this period represents limited agricultural opportunities as there is a scarcity of water available for crops. In the Sundarbans, traditionally the kharif or amon period would be used to cultivate lentils (daal), as well as vegetables such as chillies. Increasingly, however, there has been promotion of “boro paddy” - hybrid varieties of rice that can be grown during the warm season, as long as they are irrigated. Irrigation using pump-sets and ground water has accordingly become more common.

Originally DRCSC’s funding came from a single funder that provided them with the ongoing capital needed for their operations. As DRCSC matured, and became able to apply for and receive funding on their own, this funder gradually reduced and eventually withdrew their funding entirely. Currently, the organisation therefore funds their work through a number of funders that

support varying projects in the region where DRCSC works. Their number of employees varies on the basis of the projects conducted, but span between 80 and 100. About 30 are employed from the head office in Kolkata, with the rest in field offices in the various regions. These field offices have typically registered a community based organisation (CBO), under which much of the field work takes place. The locations of the head office and the two field offices wherein the work in this thesis took place is illustrated in Figure 4.

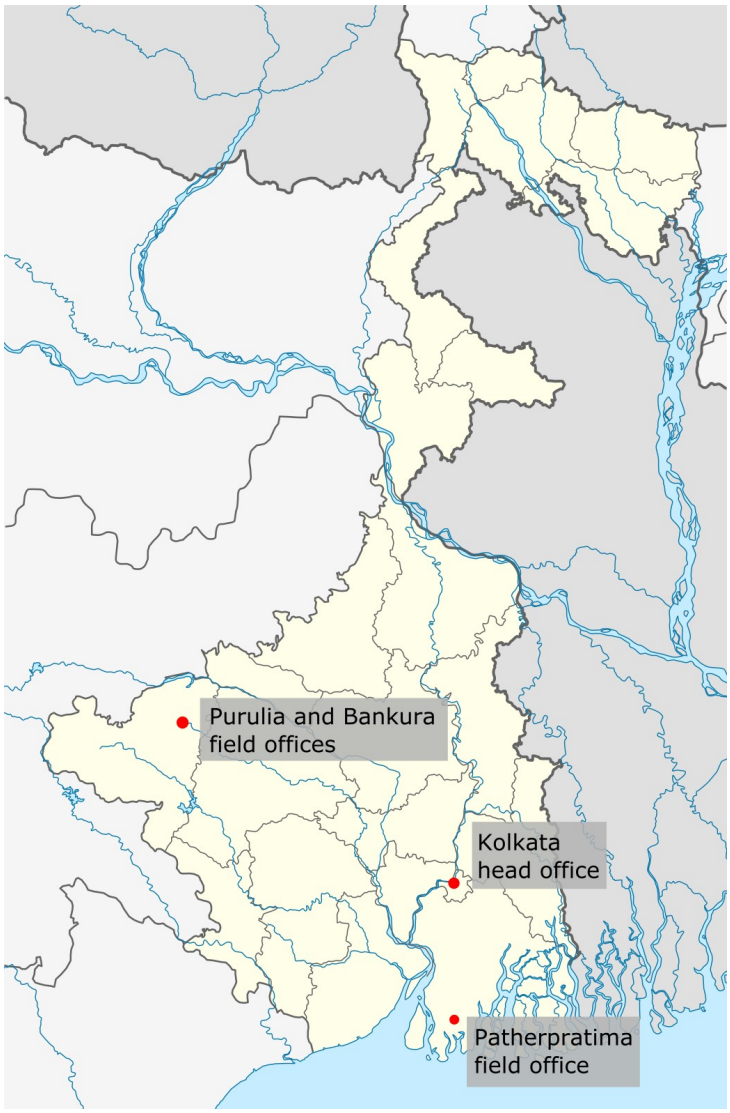


Figure 4. Locations of the head office and the two field offices wherein most of the work in this project took place. Illustrated by author on basis of map (NordNordWest, 2010).

The original plan for DRCSC was to act as a support organisation for these CBOs, providing them with infrastructure, knowledge and communication material. The CBOs, in turn, would manage local staff, organise farmers' groups and take care of much of the implementation activities. Eventually the aim was for the CBOs to be able to operate independently of DRCSC, and even manage their own funding. For this reason, much of the assets in the field offices did not belong to DRCSC itself but was rather kept under the ownership of the CBO. While there are examples of CBOs, established by DRCSC, that have become fully independent organisations, in other cases the CBO existed in a much more limited role, with field staff employed directly by and under the management of DRCSC. This latter pattern had become more prevalent in the past decade for two main reasons. The first being the transition in funding arrangements, where DRCSC received funding targeted at implementation of specific activities with specific outcome goals. They found it difficult to secure funding for operating in an indirect, supportive way as a resource centre. They were thus taking on a more direct implementing role. Secondly, the tightening of foreign funding regulations for NGOs through the amended Foreign Contributions Regulation Act of 2010[1] (Ministry of Home Affairs, 2010; Sampath, 2016; V. Singh, 2020) has made it difficult or impossible for the smaller field organisations to independently raise funding from foreign donors, meaning that they would have to rely on DRCSC to manage funding.

1.2 Overview of methodology

The research presented in this thesis is undertaken with an action research orientation, based in the paradigm of pragmatism. As an action research project, the main goal is for the project to positively impact the context within which it is taking place. The core of the research approach is cycles of planning, action, observation and reflection. Each cycle's ending is the beginning of a new cycle, and the intention is for the insights and reflections from the previous cycle to inform the planning and action of the following. In this way, action research is emergent; while there was an initial set of questions and aims for this research at the outset, there also needed to be a wide scope for the research to evolve as the cycles progressed. Care was taken to not create a too rigid framing of the research project before participants had the opportunity to weigh in on it. An early priority of the research was to gather input, ideas and feedback from DRCSC on how the research should be focused. As part of this, organisational infrastructure was created (in the form of an "action learning set") to continuously anchor the work of the research project, its findings and its focus on and within the priorities and views of key members from DRCSC. I have illustrated this process in Figure 5below.

[1] As well as later amendments, including most recently the 2020 amendment (Ministry of Law and Justice, 2020).

Action research is participatory research and is conducted not *about* or *on* any specific situation or participants, but rather *together with* people in the context of the research. In this research programme, the methods employed throughout every cycle have had as their primary focus to support participation. This includes making both inquiry and analysis accessible and transparent to participants beyond the researcher. This has important influences on the choices of methods for both data gathering and analysis. For instance, techniques that would be difficult to make intelligible for participants would be inappropriate as, even if they could produce interesting insights for an audience familiar with the technique, they would be exclusionary when employed in an action research project.

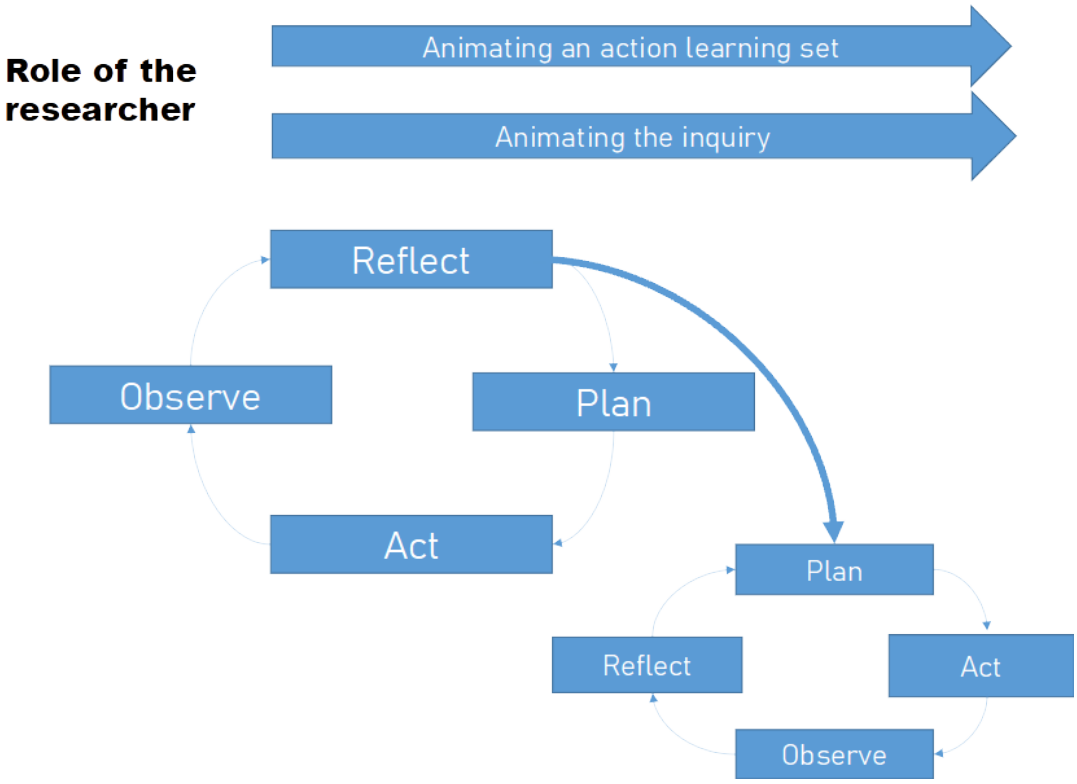


Figure 5. The Action Research process. Illustrated by author (2020).

A linear progression of framing of research questions, literature review, data collection/field work and finally analysis and presentation, sits poorly with this form of research. Accordingly, this thesis attempts to present and reflect the cyclical and ongoing nature of the research activities while still presenting a linear narrative structure. In the following section I will discuss the structure of the thesis in more detail.

1.3 Structure of this thesis

This thesis reports on an action research project. The structure of the presentation of this work has been shaped accordingly (illustrated in Figure 6). In this initial introductory chapter I have introduced the context of this research, situating it within the collaboration between me and DRCSC as well as taking place against the geographical and social backdrop of their work in West Bengal in India.

In chapter Background, I go into depth on the literature and theoretical background of this thesis. I locate this thesis as part of the broad field of ICT4D research. With this starting point, I first identify what is meant by development, and then discuss the relationships between ICTs and development. I finally discuss the question of development in relation to agriculture and how ICTs play a role in sustainable agricultural development. Following this, in chapter 3 Methodology, I discuss my approach to the research questions raised in this introduction, including the pragmatist epistemology that underpins it.

Action research, taking place in a cyclical manner with the understanding of the research continuously evolving as the cycles progress, is challenging to present in the linear format of a thesis. An action research project in many ways begins before what can be considered the official "start" of the project, and continues beyond any specific ending point. Cycles also typically defy neat characterisation, so while it is possible to frame them as separate there is overlap both in their starting points and their endings, where they flow into each other. There will also be iterations within the cycles themselves, where evaluation and reflection happens in parallel to the action that is being undertaken. There is also the issue of how to account for work that takes place before the project even begins. To some degree, the start of the research has its antecedents in earlier work and relationships that I built prior to the research programme's start. I try to account for some of this in the description of the first cycle (which I call cycle 0) of this project.

I present a total of 5 cycles across two chapters. The first two cycles - 0 and 1 - are presented in chapter 4 Studying the context. This represents the initial phase of the research where theories concerning the research project and the domain of DRCSC's work was developed. Cycle 0 encompasses a lot of the work done in preparation of the research, including collaboratively framing the research with DRCSC. Some of the discussions undertaken as part of cycle 0 informed the research questions as posed in this introductory chapter. Cycle 1 discusses the initial year of the research where I spent time observing, interviewing and (in collaboration with DRCSC) creating a better understanding of their work, their values, the challenges they are facing, their experiences with and approach to technology.

Following this description of the first two cycles, chapter 5 Framing the research, delves into discussing how the findings of these first two cycles framed the way I (and DRCSC) approach the interventions undertaken in the following three cycles. This chapter discusses an analysis of the ecosystem of DRCSC, including meanings attached to notions such as sustainability, work practices and use of technology. I also discuss the presence of a central conflict between two different approaches to knowledge - what I call knowledge systems. This understanding of the underlying knowledge systems within the ecosystem centred around DRCSC was crucial for how the following interventions were planned and executed.

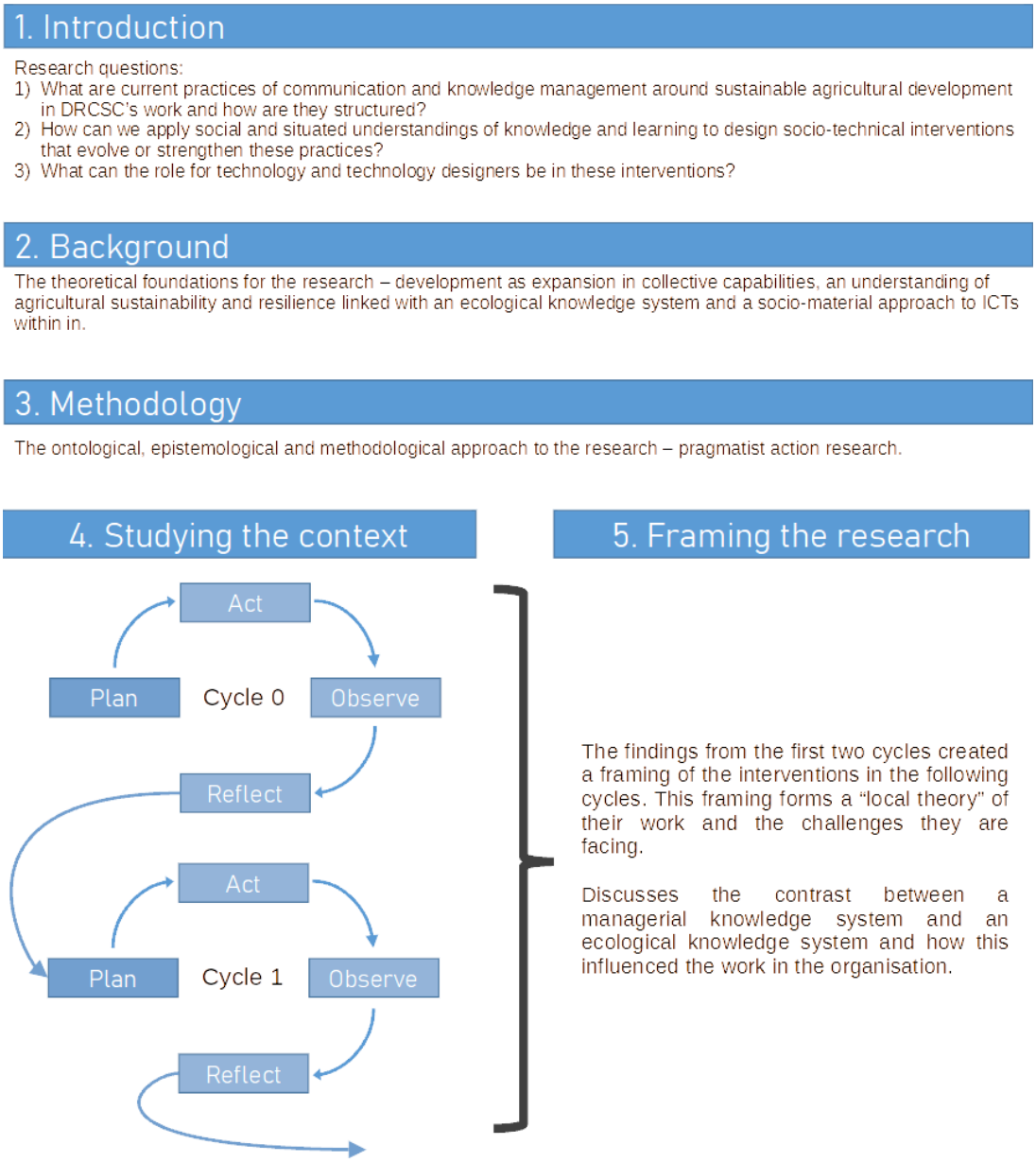
The next chapter, 6 Intervening in the organisation's work, describes the second phase of the research and discusses three cycles. Cycle 2 - "The Technologians" - relates our initial work with stewarding as an approach to technology, where we developed and deployed a design intervention within the everyday work of the field officers and project managers of the organisation. Cycle 3a and Cycle 3b describes a project that began as a collaborative qualitative research project. In Cycle 3a, I obtained funding for a researcher from the organisation to work together with me to understand how technology was deployed within one of their existing projects. We later took this insight and established an action research project in a different region. This later project is described in Cycle 3b. Cycles 2 and 3 took place partially in parallel.

Each cycle in the two chapters that address action research cycles is described in a similar format, divided into sections "Plan", "Ethics", "Act", "Evaluate" and "Reflect". The "Plan" section discusses the preparatory work done for the cycles, including decisions and discussion on the specific methods to be employed within the cycle. The "Ethics" section discusses the ethical implications and concerns for the specific cycle, along with steps taken to incorporate ethical concerns into the later work. "Act" describes the activities that happened throughout the cycle. "Evaluate" includes the initial analysis of the cycle. Often this analysis was begun or conducted directly in connection to the cycle itself, so that it could be presented back to the organisation and discussed with them in a timely manner before the follow-up cycle. Analysis was thus oriented towards making the research findings practically useful for the action learning set - both in their everyday work but also in planning and conducting the next cycle. Finally, "Reflect" contains my personal reflections and insight drawn from the cycle and how it informed my own view of the situation and the further work in the project.

In chapter 7 Implications of the interventions, I return to the research questions by drawing on the evaluations and reflections from each cycle to discuss the broader findings and implications of the project. I discuss what the implications of the research project is on the understanding of reporting,

monitoring and knowledge management within DRCSC. Following this, chapter 8 Towards Critical Technology Stewardship, discusses the critical technology stewardship approach that we developed and adopted. In this chapter, I draw some potential broader implications of this approach for work in ICT4D in general.

Finally, in chapter 9 Conclusion, I summarise the work undertaken in this thesis and discuss the contribution that this thesis makes in terms of practice, methodology and theory. I also discuss the limitations of this thesis and suggest potential future work.



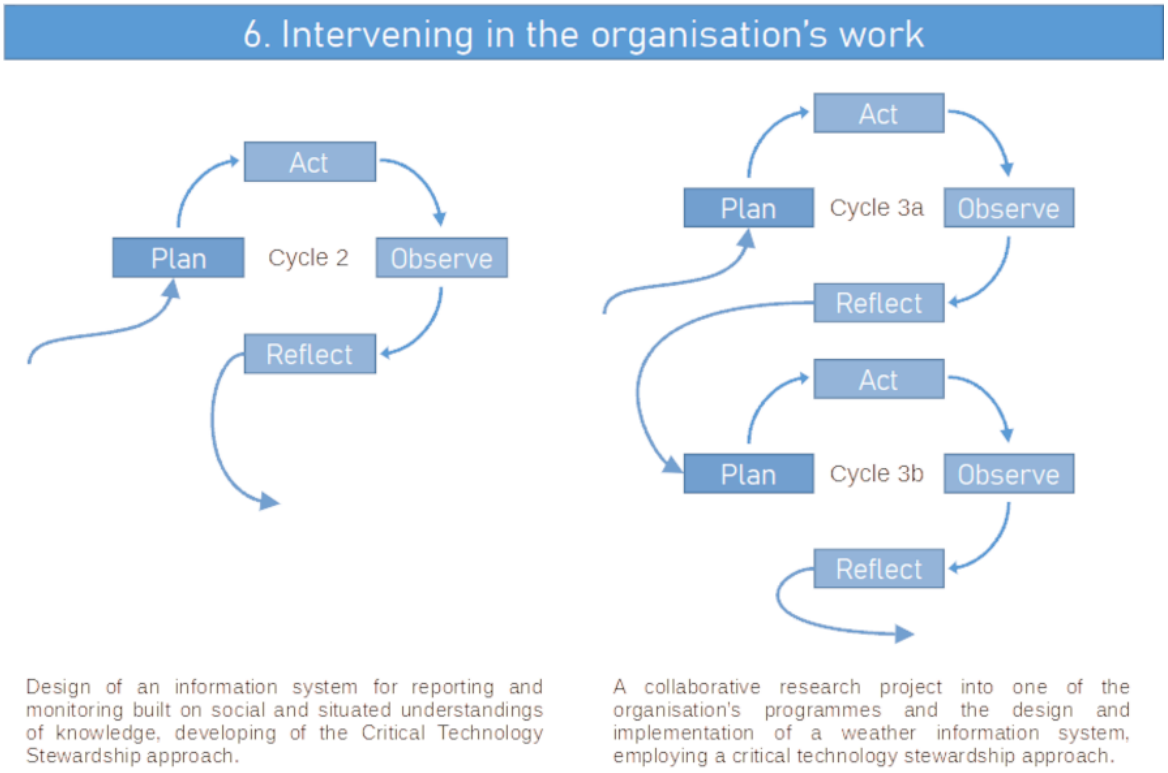


Figure 6. The structure of this thesis. Illustrated by author (2021)

1.4 Contributions

This thesis makes three main contributions.

First and foremost, being an action research project, the aim was to have a contribution to and within the context of the project. As part of the work in this thesis, a contribution to DRCSC's development work have been made through the introduction of new socio-technical practices. These socio-technical practices have helped develop their work with smallholder farmers in West Bengal. This includes the two systems introduced as part of the programme - firstly, a system of reporting and monitoring that relied on the informal communication channels using WhatsApp to connect field and head office staff. Second, a weather information system that provided a way for field officers and farmers to access and interpret weather forecasts and associated agricultural recommendations. Both these systems were developed by adopting a stewardship approach within the organisation. This approach to design and implementation of technology is the second contribution to DRCSC's work. It demonstrated that an intentional and critical approach to technology could help them imagine new uses for technology they have access to, as well as find better alignment between values held in the organisation and their use of technology.

Secondly, the thesis makes a methodological and conceptual contribution to interventionist research in ICTs for development through development of the Critical Technology Stewardship approach. This approach outlines a role for researchers in this space that emphasises supporting organisations to acquire the ability to critically interrogate and employ technology in ways that align with their values.

Finally, the thesis makes a theoretical contribution towards the question of how ICTs can be approached in the context of sustainable and resilient development. Sustainable agriculture rests on a set of ontological and epistemological positions and incorporates practices that diverge from those of conventional agricultural development. Taken together these form, what I will frame in this thesis as, a separate knowledge system. Through my work with DRCSC, I have demonstrated that, for ICTs to be part of this knowledge system in a way that enhances rather than detracts from it, the approach taken to them needs to operate on the basis of compatible ontological and epistemological principles. This means, for example, emphasising long-term resilience over short-term impact. It also means prioritising the creation of ongoing, social and relational practices and infrastructures over technological ones. This contribution holds implications beyond sustainable agriculture, and can inform further work to

develop resilient ICT interventions in sustainable development.

2. Background

For a large part of the last decade and a half, there has been sustained critique and questioning of the potential for, as well as conceptualisation of, the link between ICTs and development (Avgerou, 2010; A. Chaudhuri, 2012; Dodson, Sterling, & Bennett, 2012; Heeks, 2010; Qureshi, 2005; Walsham & Sahay, 2006). This critique has raised questions about the theoretical and ideological assumptions embedded in ICT interventions, the causal links between ICT and development outcomes, as well as of the field's practical ability to achieve them (Heeks, 2010; Kleine, 2009; Sein, 2005; Thapa & Sæbø, 2014; Walsham, 2017). While it is difficult to provide a complete account of the nature of development within the context of an ICT4D project - it is still necessary to outline a potential development paradigm to follow (Avgerou, 2010; Qureshi, 2015). Without this, it is impossible to orient the project towards what it perceives as progress or "development", which obscures both the assumptions that the project makes as well as the underlying goals it has. Any other choices about how the project is conducted are contingent upon this understanding.

In addition to a paradigm of development, Sein et al. (2019) argues that ICT4D interventions need to address the role that the technology (the ICT) plays in the development context and the transformative processes that connect such technology to development outcomes. Accordingly, in this chapter, I begin with discussing the notion of sustainable and human development, and the links that have been made between ICTs and development. I then place ICTs within the context of sustainable agricultural development, looking at how ICTs have been employed and what role ICTs have played in this context.

Drawing on this discussion, I identify ICTs in agriculture as located within a knowledge system and part of maintaining and upholding the knowledge system that they are embedded in. This leads to a socially embedded understanding of ICTs as created through recursive interactions between material attributes, practices of information dissemination and communication, and social structures (Orlikowski & Iacono, 2000). In this background chapter I therefore engage with the question of what the social practices of sustainable agriculture development are and the way in which ICTs have become entangled within them.

My discussion on ICTs in agriculture in this chapter leads to the insight that for ICTs to contribute to sustainable agricultural development, initiatives need to change in two ways - 1) how they approach and relate to agricultural knowledge

and knowledge management and 2) how they perceive the role of the ICT designer/implementer as an actor in the agricultural knowledge system.

2.1 What is development?

In its broader sense, the notion of international development, along with ideas of what are developed and developing countries, emerged after the Second World War. It was most notably exemplified in the Marshall Plan that sought to support economic recovery after the war. The fundamental premise was that that the "prosperity of [...] developed countries depended upon alleviating poverty and low economic development in developing countries" (Qureshi, 2015). Initially, the focus was for the US to support the reconstruction of Europe - with the rest of the world viewed primarily, through the lens of colonialism, as sources of raw materials (Escobar, 2011). This gradually changed, however, in the context of the Cold War where economic progress under a capitalist economic organisation was important to demonstrate across the world to stem the influence of communism (Escobar, 2011). While this was initially largely driven by state or intrastate organisations, the growth of neoliberalism from the 1970s onwards shifted the focus towards enabling free trade and markets to provide individuals with freedom to employ their skills and knowledge to improve their situation within a context of limited government involvement (Harvey, 2010). This movement saw an emphasis on countries opening their economies to trade, stimulating entrepreneurship and promoting private ownership and management of resources. It also saw an increasing number of Non-Governmental Organisations (NGOs) (together with individuals and private enterprises) becoming involved in development as governments were taking less direct involvement in socio-economic development programmes (Escobar, 2011; Qureshi, 2015).

Beginning from the second world war this process resulted in two-thirds world being labelled as "in poverty" - living in "third world" economies lacking the material standards of the citizens of the advanced, developed or first world economies (Escobar, 2011). Importantly, this rested on the establishment of a "poverty line" in terms of annual per capita income. Following this definition of poverty, the aim of development became economic growth to enable economies to raise their populations above this line (Escobar, 2011). This became intertwined and, in practice synonymous, with modernisation - whereby the technological advances, knowledge or tools are employed to develop countries deemed poor (Qureshi, 2015). Technological progress was seen as "inevitably beneficial" and inherently linked with achieving economic growth (Escobar, 2011).

2.1.1 Sustainable and Human Development

Towards the end of the 20th century, following the recognition of the harmful impacts of modernising economic development on natural resources, increasing attention was placed on the ecological and environmental basis upon which economic development rests. As one response, the United Nations initiated a commission called the "World Commission on Environment and Development (WCED)", eventually termed the "Brundtland commission" from the name of its chairperson, Gro Harlem Brundtland. The commission's report "Our Common Future" (World Commission on Environment and Development, 1987) famously defined and popularised the notion of sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs".

What followed was a considerable effort to incorporate issues of ecological and environmental sustainability into international development programmes. The 1992 Earth Summit in Rio drew heavily upon the Brundtland report and resulted in numerous global treaties and programmes - including Agenda 21, the UN Framework for Climate Change, and the Convention for Biological Diversity. These treaties as well as the series of international meetings that have continued to this day, made environmental protection an important part of the global development discourse.

While the notion of sustainable development has broadly been adopted, perhaps most visibly through its incorporation in the UN's 2015-2030 Sustainable Development Goals (SDGs), it is so far mostly a goal or vision; in the first evaluation report of progress towards the SDGs, the Global Sustainable Development Report concludes that "the current development model is not sustainable, and the progress made in the last two decades is in danger of being reversed through worsening social inequalities and potentially irreversible declines in the natural environment that sustains us." (United Nations, 2015). Even the notion that development can be "sustainable" at all has been questioned, perhaps most famously by Herman Daly who called "sustainable development" an oxymoron - arguing that development along modernising lines emphasising economic growth is inherently unsustainable (Daly, 1990; Redclift, 2005). What these arguments suggest is a need for a more fundamental ontological shift in the understanding of what both development and sustainability mean - especially one which can move beyond notions of progressive movement towards modernity and economic growth (Daly, 1990; Redclift, 2005).

Chambers and Conway (1991) argue that in order to address sustainable

development, a narrow focus on increased production or productivity, creation of employment and poverty as the only form of deprivation, needs to give way to emphasis on capability ("ability to lead the life that you value"), inequity ("unequal distribution of assets") and sustainability ("ability to maintain and improve livelihoods while maintaining or enhancing the local and global assets and capabilities on which livelihoods depend") (Chambers & Conway, 1991). Chambers and Conway suggest that the focus should be on sustainable livelihoods, which they define as those "... which can cope with and recover from stress and shocks, maintain or enhance its capabilities and assets, and provide sustainable livelihood opportunities for the next generation; and which contributes net benefits to their livelihoods at the local and global levels and in the short and long term". Various approaches to the development of sustainable livelihoods were developed from this definition - perhaps most influentially, the Sustainable Livelihoods Framework (SLF) adopted by DFID (Ashley & Carney, 1999).

The "Human" school to development (UNDP, 1990) has been a parallel, and in some ways complimentary, movement towards alternate paradigms of development. It informed the broadening of concerns from the economic, with GDP growth as the primary target, towards incorporating notions of human values and desires. It is incorporated, in a limited form, in the UN's Human Development Index, that sought to provide an alternate metric to GDP growth in evaluation of development progress and impact. One of the central theoretical underpinnings for the human development school is the capability approach (CA), that has proven influential not only when it comes to development as a whole but also to a wide variety of fields, including ICT4D.

2.1.2 The Capability Approach

The Capability Approach (CA) is a paradigm of development that proposes to view development as "a process of expanding the real freedoms that people enjoy" (Sen, 2001). In framing development "as freedom" Amartya Sen creates a vastly expanded conceptual definition of development than earlier notions which focused on economic growth, industrialisation and socio-economic modernisation (Potter, Binns, Elliott, & Smith, 2004).

While not rejecting either economic growth or individual income growth as important means of achieving development the CA suggests that these are just some of the drivers that contribute to expanding the fundamental ends of development - the freedoms that people have to "lead the kind of lives they value – and have reason to value" (Sen, 2001, p. p.18).

In the CA, the terms "capabilities" and "functionings" are used as two central terms. Capabilities refer to the various substantive freedoms that any given individual possesses and they together form an individual's "capability set". From this set, any individual will be able to use choice to select a certain set of actual achieved "beings and doings" which are referred to as the "functionings" of an individual (Sen, 2001, p. 175). This focus on a broader set of freedoms in comparison to simple measures such as overall well-being, happiness or income in combination with the distinction between achieved valued beings and doings (functionings) and substantive freedoms provides considerable conceptual richness and depth (Alkire, 2005; Robeyns, 2005).

First and foremost it recognises how the process of development is ultimately normative, i.e. they are based in what the individual values while at the same time qualifying this by stating that the relevant valued freedoms are those which the individual has reason to value. What capabilities are valued and on what basis an individual has reason to value certain capabilities is intentionally not specified in Sen's writing (Robeyns, 2005). The distinction between functionings and capabilities allows us to recognise that while the critical evaluative space for development is in the freedoms an individual enjoys, each individual has a choice in which capabilities he or she makes use of and turns into "beings and doings". Agency is critical to Sen's conceptualisation of development, using capabilities as a locus allows us to not "impose a particular notion of the good life, but instead aim at providing a range of possible ways of living" - i.e. our goal is to expand capabilities, but it is then up to the individual to translate these into functionings (Robeyns, 2006).

An important aspect to recognise, though, is that the way that an individual applies their agency and what choices he or she makes with regards to the conversion of capabilities to achieved well-beings is influenced by the factors such as social institutions and norms and the behaviour of other individuals along with the individual's history and personal preferences (Robeyns, 2005). This is in fact one of the important ways in which the capability approach integrates the role of groups and society into its understanding of how achieved well-beings are constituted (Robeyns, 2006). Further, another important consideration is that choice, via application of individual preferences, is constrained by restricted options faced and perceived by disadvantaged groups[2] (Nussbaum, 2001). This requires an awareness of power, and to understand that either expressed or

[2] For example women due to patriarchal power structures: "[…] disadvantaged groups internalize their second-class status in ways that cause them to make choices that perpetuate their second-class status" (Nussbaum, 2001, p. 27).

revealed preference as a measure is an incomplete approach to understanding valued beings and doings (Alkire, 2005).

The CA allows for substantial diversity between both communities and individuals – in terms of what freedoms are deemed to be valuable and also in the choice of freedoms to turn into achieved beings and doings. Furthermore, an important strength of the capability approach is that it allows for explicit recognition that individuals might need different resources to be able to achieve the same functionings (Robeyns, 2005).

This leads to a second important conceptual element of the approach in its recognition that an individual's ability to turn means (production, income, access to goods, services or resources) into ends (freedoms or capabilities) is influenced by what Sen calls conversion factors. These conversion factors can be personal (physical condition, disabilities, sex), social (gender, power structures) as well as environmental (geography, climate) (Robeyns, 2005). Understanding the ability of individuals to convert access to resources into capabilities and functionings in this way allows us to recognise the fallacies of approaches based on equal distribution of, or access to, resources. As individuals will have a unique configuration of their conversion factors this also means that the resources they need to achieve the same capability set and eventually achieved functionings are also uniquely determined. Material resources (such as ICTs) combine with broader social structures to provide capabilities that an individual can employ their agency to convert into functionings (Kleine, 2010).

2.1.3 Individual and collective capability

A critical challenge that has been voiced towards the Capability Approach is its focus on *individual* well-being and agency as the primary evaluative space and informational basis for understanding development (Alkire & Deneulin, 2009, p. 35; Deneulin, 2006, p. 54; Robeyns, 2005, p. 107). This critique has been divided into three components: that the capability approach is too individualistic and "works with a notion of atomised individuals" (Robeyns, 2005, p. 107), that the capability approach does not pay sufficient attention to groups and that the capability approach does not pay sufficient attention to social structures (Robeyns, 2005, p. 107).

With regards to the first component, Sen argues that the Capability Approach goes beyond individualistic assumptions in including "irreducibly social goods" (Deneulin, 2006, p. 57) – that is objects of value which cannot be reduced to individual characteristics or acts (Deneulin, 2006) - as necessary components of

individual capabilities. However, Sen maintains that fundamentally these irreducibly social goods are important because they enable individual well-being and agency. He terms it as taking a perspective of "ethical individualism" as opposed to "methodological" or "ontological" individualism, i.e. using the individual as the locus of moral concern (ethical individualism) while not believing that all occurrences can be explained with reference to the individual (moral individualism), nor that all social forms should be examined as the sum of the actions and characteristics of individuals (methodological or ontological individualism)[3] (Deneulin, 2006, p. 57; Robeyns, 2005, p. 107).

There remains, however, an argument about whether there are irreducibly social goods that while potentially negative to the individual's well-being or freedom can be considered positive in terms of the collective (Alkire & Deneulin, 2009, p. 36) or whether there are collective freedoms that cannot be understood using the informational basis of individual well-being alone (Deneulin, 2006, p. 62). From this view, the position of ethical individualism might need to be extended to also include collective or social structures and groups (Deneulin, 2006, p. 60). As such, there is an argument that there are certain "collective capabilities" – irreducible to the individual yet necessary for human well-being (Deneulin, 2006, p. 61).

The expansion of capabilities to include collective ones, rests on a notion of collective action and agency (Ibrahim, 2006). That is, collective capabilities are the agency of groups of people to act towards a common goal. Collectives are important for multiple reasons. First of all, considering the social nature of human beings, they have intrinsic value (Evans, 2002). Secondly, they are necessary for us to understand what "we have reason to value" - they help shape our individual notions of what is valued and important (Evans, 2002). Finally, they are an important means by which to achieve individual capabilities - especially for those marginalised or otherwise in a weaker position of power (Evans, 2002). Without collective agency and capabilities these groups may well experience unfreedom in a subtle way - for instance, the influence of institutions (whether social or commercial) on preference formation through dissemination of dominant cultures (Evans, 2002). It is important to recognise, however, that membership of a collective can both provide additional, new, capabilities as well as constrain capabilities of the individual - whether through voluntary obligations to the collective or through repression (Pelenc, Bazile, & Ceruti, 2015). The capabilities provided by the collective may also be differently valued by different members of

[3] Ontological individualism can be viewed as the stronger claim that not only should explanations be understood as the sum of actions and characteristics of individuals but "ultimate constituents of the social world are individual people" (Heath, 2020).

the collective, as well as unequally distributed amongst them (Pelenc et al., 2015). This means that participation needs to be free and voluntary in order to ensure that collective capabilities do not serve to inhibit individual ones (Ibrahim, 2006). Some important elements and steps of this process of constructing collective agency is illustrated in Figure 7.

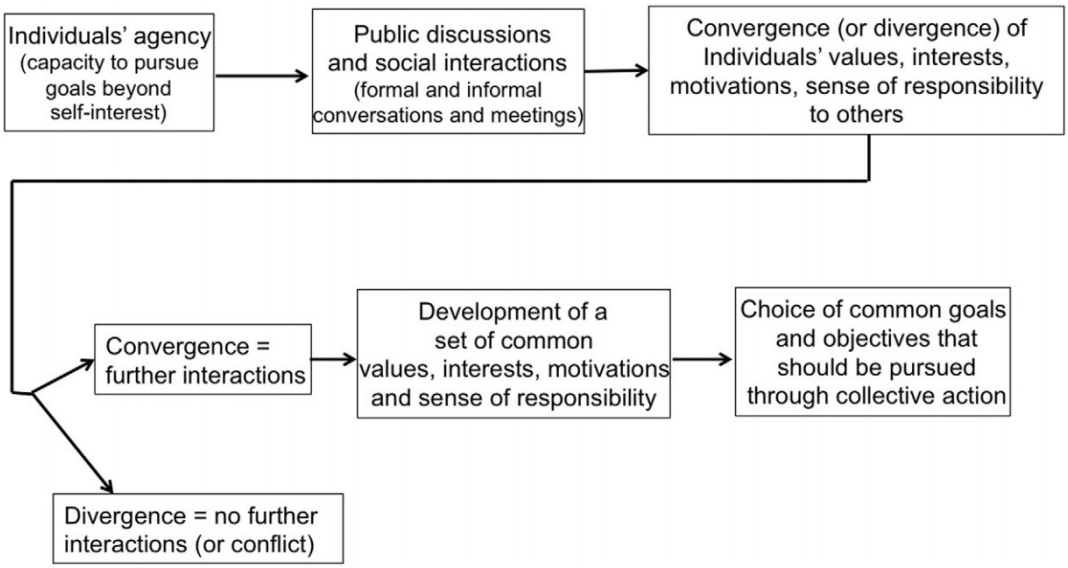


Figure 7. Crucial steps in constructing collective agency (Pelenc et al., 2015)

2.2 Sustainability, resilience & agricultural development

Whereas the CA addresses questions of how to view development, there is also the question of how to address sustainability—especially the relationship between development, natural resources and environmental conditions. In this section, I take as the starting point the definitions of sustainability employed in the "sustainable development" discourse discussed previously. I begin with an elaboration of the meaning of sustainability—including discussions of vulnerability and resilience in the context of socio-ecological systems such as agriculture. I then discuss agricultural development, extension and its sustainability.

2.2.1 What is sustainability?

In the past decades multiple ways of viewing sustainability have been proposed. These recognise that the "needs" drawn upon by the Brundtland commission

involve environmental conditions without which the world cannot support human civilisation. That these have increasingly been stressed by our current model of development is well established (J. B. Smith, Klein, & Huq, 2003). Rockström et al. (2009) defines these as "planetary boundaries" . What is clear from this assessment is that there are already boundaries that are beyond what is considered the safe zone. To this "ecological ceiling", Raworth (2017) contributes the notion of a social foundation consisting of the basics needed to support human needs. These models illustrate multiple things. First of all, that there are specific biophysical limits within which society needs to operate for human activities (perhaps most importantly, agriculture) in their present form to be sustained. Secondly, that the failure to provide the social foundation for human activity leads to an unsustainability of a different kind - a shortfall in provision of basic human needs, which could be perceived as "underdevelopment". Finally, they emphasise that neither the overshoot of the biophysical nor the failure to provide a social foundation is solely a concern for countries traditionally labelled as "developing". Adopting the notion of sustainable development as existing within the "safe and just operating space for humanity" precludes any notions of development as purely a question of economic growth.

Failing to address this leads to a situation where the socio-ecological system becomes degraded and existing activities can no longer be sustained. The degraded socio-ecological system can provide neither the natural resources nor support the social needs of affected populations. Furthermore, there are increased incidents of various types of hazards. However, what these definitions lack is a notion of the heterogeneous nature of the impacts of such deficits as well as ability to withstand or adjust to such situations. The notion of vulnerability (Gaillard, 2010) is important to address this. Vulnerability refers to the "the susceptibility to suffer damage in a potentially dangerous event, either natural, economic or political" (Gaillard, 2010). This places emphasis on the fact that the damages caused by any given hazard are contingent on social factors. For instance, the population in regions at greater risk from climate hazards (for example, the Sundarbans delta) are disproportionally from marginalised social groups (for example low caste or ethnic minorities) doing low-income jobs (farming, fishing, manual labour) (Gaillard, 2010). Even within a region, those from the most marginalised communities will tend to be landless or have access only to lower quality land, or limited access to land which lies in beneficial positions with regards to other natural resources, such as fresh water. Vulnerability also emerges from a lack of access to or knowledge of social protections against disasters such as crop insurance or government support programmes. Social support networks are important resources that can help mitigate vulnerability, and the lack of these (for

instance, in the case of migrant workers) can pose a significant vulnerability. Recent events in India related to the COVID-19 pandemic illustrated this clearly, as migrant labourers were incredibly vulnerable not just to the disease, but also to the effects of prolonged lockdowns that left them without the ability to sustain or feed themselves (J. Slater & Masih, 2020). It is not necessarily the case that the resources to mitigate the vulnerability do not exist, but that there is a failure of those in vulnerable positions to access or claim their entitlement to these resources. The migrants in India affected by COVID-19 had all migrated for work to locations where greater possibility for income existed - i.e. urban areas with greater economic activity. These areas would have better access to means (food, water, shelter, economic resources, and so forth) required to weather the hazard of COVID-19 and ensuing lockdowns, however these means were highly unequally distributed. The failure of entitlement of migrant labourers left them in a desperate situation. Amartya Sen's work on the Bengal famine of 1943, famously illustrates how vulnerability to starvation in the case of famines depends upon many other factors rather than the availability of food (Sen, 1983). Vulnerabilities combine and compound, one vulnerability can exacerbate another, to make it difficult to withstand shocks or hazards. Vulnerabilities exists on multiple scales (individual, community, regional, and so forth) as well as are both structural (e.g. caste, class, race, gender) and individual (low wage, lack of savings, no ownership of land). On a global scale, the countries that are at greatest risk from climate change are, with few exceptions, in the Global South. These countries have been negatively influenced by centuries of colonialism, and later on found themselves in the lower-income end of the scale in the globalised, neoliberal system of economic organisation that followed.

Understandings of sustainability that emphasises livelihoods (such as the Sustainable Livelihoods Framework) incorporate these notions. The sustainability of a livelihood is determined by the ability to both operate within the limits of the natural resource base, but also by how well it is able to cope with and recover from any hazards it is exposed to. Livelihoods that have limited ability to cope with and recover from stresses (whether chronic, such as climate related stresses or acute such as in a disaster situation) can result in a negative cycle of vulnerability, as the natural resource base may be further drawn down in order to maintain existing livelihoods (Gaillard, 2010). In the Sundarbans delta, this is perhaps most clearly exemplified through the destruction of mangroves to provide for livelihoods from increasing shrimp farming as a response to disasters such as cyclones. The cyclones caused flooding, making other agricultural activities impossible due to soil salinity, and the destruction of mangroves increases further flood risks (Gaillard, 2010).

2.2.2 How is sustainability achieved?

The ability of a socio-ecological system to continue existing and function sustainably, in the face of both crossed biophysical boundaries as well as socio-ecological vulnerabilities, has increasingly been discussed as the property of resilience (Folke, 2016). Resilience allows a system to be able to absorb change and reconfigure itself while "still retain[ing] essentially the same function, structure, identity and feedbacks" (Folke, Hahn, Olsson, & Norberg, 2005, p. 443).

Resilience involves withstanding, the ability to accommodate changes to the external environment without considerable change; adaptation, continuing current pathways of development of the system while adapting to changes in context; as well as transformation, changing the way the system operates in response to altered circumstances (Folke, 2016; Ospina & Heeks, 2010). Resilience is a property that emphasises the necessary dynamic nature of socio-ecological systems, that they cannot remain static or unchanged. This is especially true when the ecological systems of the entire planet is being influenced by humans. The foundation for socio-ecological systems that are resilient is that they incorporate diversity, redundancy, self-organisation and social learning (Folke et al., 2002). Under situations of abrupt or turbulent change in any system (such as those increasingly common in the face of climate change), consequences of actions become unclear and past experience become insufficient as a source of understanding of system dynamics (Folke et al., 2005).

In the context of intertwined human-environment systems (socio-ecological systems) the analysis of the system and its resilience requires an understanding of both the ability of the human/social system dimensions to reconfigure themselves on the basis of a changing environment as well as the impacts of human/social dimensions of the system on the ecological dimensions (Folke et al., 2005, p. 443). Pahl-Wostl et al (2007) suggests that this social process of learning occurs at multiple temporal and geographical scales of interaction:

- Short to medium time scales on processes between collaborating stakeholders
- Medium to long time scales on changes in actor networks
- Long time scales on changes in governance structures, institutions, values and norms

Dealing with changes to the system thus requires ongoing reconfiguration of the governance of the system at multiple levels. Actors such as scientists who previously used to being able to analyse the steady state of systems in order to provide data to decision makers now need to be one of several actors in the

process of learning and knowledge generation (Folke et al., 2005). Groups who live integrated into the human-ecological system and who observe it over a long-time on daily basis may have a substantial base of knowledge with regards to both its present state, changing dynamics as well as intertwined human and ecological functions (Folke et al., 2005, p. 446). In order to understand the desired states of any human-ecological systems, as well as how they are changing and how they need to be reconfigured to remain within desired states, scientific and local knowledge need to be combined. Folke et al. (2005) also suggests that when dealing with rapid change in social-ecological systems there are four critical factors:

- learning to live with change and uncertainty;
- nurturing diversity for reorganisation and renewal;
- combining different types of knowledge for learning; and
- creating opportunity for self-organisation toward socio-ecological sustainability

They emphasise that social capital plays an important role in enabling these factors. Social networks can provide access to outside sources of information, data or interpretation to enable sense-making. They are also necessary for there to be sufficient trust between different actors in order for these actors to self-organise and enact collaborative change. Through participation in social networks actors can access new models from which to generatively find new behaviours or social-ecological configurations.

Managing natural resources and socio-ecological systems is thus a social activity dependent upon social capital (Pretty & Ward, 2001). Social resources are important when attempting to respond or accommodate stress and shocks. While these resources can be viewed (as Sen has) as a conversion factor of individual capability, such a perspective does not adequately capture the value of collective agency and resulting capability (Pelenc et al., 2015). Pelenc et al. (2015) argues that being able to maintain and improve the current ecological foundations for development is a capability that can only be achieved collectively - an inherently social good requiring collective mobilisation and agency. Resilience is thus a collective capability. Improving sustainability means supporting this collective capability, which in turn requires the formation and development of shared agency, shared values and social infrastructures (Adger, 2009). In addressing concerns of sustainable development, especially with an emphasis on management of natural resources, supporting development of common values, interests, motivations and sense of responsibility among collectives freely and voluntarily

formed is therefore critically important (Pelenc et al., 2015).

2.2.3 What does sustainability mean for agriculture?

While there has been a long history of agricultural development programmes (Pretty, 2008), the modern notion of agricultural development can be most clearly traced back to the development of new plant breeding techniques and synthetic inputs being adopted throughout the world in the second half of the 20th century. Improvements in agricultural productivity, through the application of new scientific research, became integral to the overall programme of modernisation across the world following the second world war, as discussed in the previous section.

This period saw great increases in agricultural productivity through, most prominently, what became called the Green Revolution (GR). The GR programme focused on crop genetic improvement by developing high-yielding varieties (HYVs), as well as ensuring the availability to farmers of inputs such as synthetic fertilisers and pesticides. As a result, wheat, rice and maize saw yield increases of over 100% in developing countries, with the greatest impact in Asia (Pingali, 2012). While the GR as a programme was considered over by the 1980s, direct impacts were still seen into the 2000s and the varieties and practices developed as part of it are still in use (Evenson & Gollin, 2003).

While the Green Revolution improved many farmers' incomes and livelihoods, evidence suggests that the "modernisation of agriculture" achieved through GR and post-GR agricultural development have not benefited the most marginal farmers and in many cases been directly harmful to their food security and livelihoods (Altieri, 2002; Holt-Giménez & Altieri, 2012). In part this is because GR practices and HYVs were never designed to be used in marginal agricultural areas or address the needs of marginal farmers, but were still promoted and spread widely through government subsidies, extension programmes and commercial interests (Pingali, 2012). Typical approaches, such as "Training & Visit" where farmers are provided training on new agricultural approaches and then visited in the field by extension agents, are associated with high costs. In developing countries, such as India, there were limited budgets, highly constrained access to trained extension agents as well as insufficient political interest for these programmes. This made it near impossible for the programmes to reach the large majority of small-scale and subsistence farmers present in low and middle income countries (Feder, Willett, & Zijp, 1999). In India, despite more than a century of agricultural extension activities and nationwide agricultural extension services established since the 1960s (G. E. Jones & Garforth, 1997; Sajesh & Suresh, 2016),

the majority of farmers have not accessed nor made use of the agricultural information and resources provided by the government (Glendenning, Babu, & Asenso-Okyere, 2010). The ratio of farmers to extension agents is between 1:300 and 1:2000 across Indian states, and only a small proportion of extension agents have received university degrees in agricultural fields (Glendenning et al., 2010). Beyond the geographical and logistical challenge of reaching out to hundreds of millions of farmers spread across large distances, having access to sufficiently localised advice has been a big challenge for these services (Glendenning et al., 2010). The discrepancy between information provided and information demanded by farmers has been long recognised (Anderson & Feder, 2004; Glendenning et al., 2010; Pingali, 2012).

The outcomes of the GR programme have also increasingly been critiqued from the perspective of sustainability (Altieri, 2002; Altieri & Nicholls, 2005; Evenson & Gollin, 2003; Francis et al., 2003; Parayil, 1992; Pingali, 2012; Pretty, 1995, 2008). Sustainability in agricultural development can be interpreted as the combination of two properties. The first being the system's resilience i.e. Its ability to tolerate or adapt to external change, shock or stress (Pretty, 2008). The second, being its persistence - its ability to continue over long periods of time (Pretty, 2008).

There is evidence that the improvements in crop yields (especially for wheat and rice) have stagnated and in some cases collapsed (Ray, Ramankutty, Mueller, West, & Foley, 2012). Furthermore, the adoption and intensive usage of inputs such as pesticides and fertilisers have caused negative ecological impacts, degrading both soil and water resources (Pingali, 2012). Adding to this, HYVs were designed to transition farmers from rain-fed seasonal agriculture towards year round irrigation, which has led to overuse and depletion of ground water resources with subsequent fresh-water scarcity and increased soil salinity (R. B. Singh, 2000).

Indirectly, conventional agriculture has become highly dependent on energy - especially from non-renewable sources. Pesticides are manufactured from oil and nitrogen based fertilisers are made using natural gas (Schutter & Vanloqueren, 2011). Irrigation depends on access to cheap or free energy - in many regions of the world implemented through energy price reductions for running pump-sets.

The question of agricultural sustainability has become especially acute in the context of the anthropogenic climate crisis. This can be seen in both the direct sense that as climate changes, certain agricultural practices become unviable or less dependable. Practices that have depleted natural resources, such as soil

fertility or water resources, leave farmers vulnerable to external shocks or changes as they require much of their fertility and other resources to be sourced from outside.

A response to these challenges are approaches such as natural resource management (NRM) and agroecology (Altieri, 2002). Agroecology emphasises sustainable use of natural resources through locally situated agricultural practices developed in participatory ways with farmers (Francis et al., 2003). The UN Rapporteur on the Right to Food, holds that agroecology is a means by which to achieve "a low-carbon, resource-preserving type of agriculture that benefits the poorest farmers" (Schutter, 2010). Evidence for this can be found in a survey of 286 projects in 57 countries (Pretty et al., 2006) which suggests that agroecological and resource conserving practices could lead to considerable improvements in yields for smallholders while at the same time reducing water and pesticide use.

One of the hallmarks of these approaches is that they recognise a need to shift from a top-down research, extension and technology driven approach to one which is participatory and bottom-up focused on learning (Altieri, 2002; Pretty, 1995). Röling & Jiggins (1998) suggests that sustainable agricultural development requires transition to a new "ecological knowledge system" built upon participatory, social and action based learning. This contrasts with the emphasis in conventional agricultural extension on the notion of "technology transfer" from scientific experts and agricultural research labs to the farmer's fields (Warner, 2008). In the technology transfer model, the role of extension services is to serve as a channel for funnelling and operationalising agricultural technologies developed at agricultural research institutes or sites (Warner, 2008). It also involves a chain of actors, such as pesticide and fertiliser dealers and seed companies who provide the inputs necessary for the implementation of these scientific practices. As Röling & Jiggins (1998) discuss, these two approaches form entirely different knowledge systems, with not just different agricultural practices but entirely different roles for the actors involved, building upon entirely different epistemological views of knowledge, ecology and learning. Table 1 summarises these components that make up an agricultural knowledge system. The implication of their work is that adoption of one or the other requires a radical shift in not just how the agricultural development effort is organised, which actors are involved, what inputs are used or which practices are promoted. It also requires an evaluation of notions of how nature is perceived, what is considered knowledge, which knowledge is considered important and how it is validated. A knowledge system incorporates "practices, routines, structures, mindsets, values and cultures

affecting what and how knowledge is produced and used, and by whom" (Fazey et al., 2020).

Components	Description
epistemology	Beliefs about the nature of human knowledge
ecology	Beliefs about the interaction between humans and their biological and physical environment
practices	The set of practices by which an agro-ecosystem is managed.
learning	How people learn about agro-ecosystems.
facilitation	The approach to supporting such learning.
institutions	The institutional framework - actors and relationships between them
policies	The policy context

Table 1. Elements of an agricultural knowledge system (Röling & Jiggins, 1998)

Using this notion of knowledge systems in agriculture, Röling & Jiggins (1998) contrasts the "ecological knowledge system" with the "conventional knowledge system" in agricultural development.

Components	Description
epistemology	positivist, i.e., reality exists independently of human observer, it can be objectively known if discovered or uncovered by scientific methods;
ecology	the bio-physical environment serves to satisfy human needs; through inputs it can be made to yield wanted outputs
practices	(new) technologies are applied to enhance the productivity of components of the agro-ecosystem
learning	adoption of add-on innovations. Farmer is receiver;
facilitation	transfer of uniform technology packages developed by science for large recommendation domains

institutions	sequence of interlocked institutions along science-practice continuum, input companies;
policies	subsidies on inputs, public funding of research and extension, coincidence of national interests and those of innovative farmers through technology-propelled productivity enhancement, the benefits of which are passed on to consumers

Table 2. The conventional knowledge system in agricultural development (Röling & Jiggins, 1998)

As can be seen from Table 2 the conventional agricultural knowledge system places weight on scientific expertise, developed through publicly funded as well as private research. There is a hierarchical system of institutions beginning from the research institutes where knowledge about agriculture is developed through scientific methods and continuing through a continuum of institutions both public and private that translate this knowledge to practice. Farmers are placed at the end of this continuum and their role is primarily receivers of uniform packages of technology and recommendations for practice. The way success is measured is through the productivity of the system in producing desired outputs that satisfy human needs. The ecological knowledge system, summarised in Table 3, operates on a very different paradigm *(R*öling & Jiggins, 1998).

Components	Description
epistemology	reality is socially constructed, acceptance of multiple perspectives;
ecology	people are part of the bio-physical environment. They can amplify the human biotope by knowledgeable use of natural processes and cycles;
practices	applying general principles to the low-input management of locality specific, diverse and variable ecosystem

learning	farmer is expert on his/her own farm and takes decisions based on knowledgeable inference from observation and analysis, and relies on his/her ability to anticipate;
facilitation	creating conditions for discovery learning (through agro-ecosystem analysis, resource flow mapping, etc.), training in observation, experimentation and collective decision making
institutions	decentralised self-learning network of farmers and facilitators with access to scientific knowledge;
policies	financial support for facilitation, network activities, such as farmer meetings, the development of curricula for discovery learning, etc. Regulation of environmental pollution, poisoning and destroying bio-diversity and thus making it harder to externalise environmental costs.

Table 3. The ecological knowledge system in agricultural development (Röling & Jiggins, 1998)

In the ecological knowledge system there is both a different ontological view of ecology (understanding the environment as serving human needs versus humans being one of many parts of it) as well as a different set of epistemological understandings how knowledge is generated within the system - in the ecological knowledge system a farmer is an expert and relies on their own ability to understand their specific bio-physical environment and make choices about their own practices. The role of external parties is contrasted between to aforementioned technology transfer and a role where external partners "create conditions for discovery learning" and "collective decision making". The institutions that are envisioned in the ecological knowledge system can be seen as a form of collective capability (2.1.3 Individual and collective capability) for continued agricultural development and capability to respond to a changing bio-physical environment. The policies and modes of facilitation presented by Röling & Jiggins (1998) encompass means by which others can help support the development of these collective capabilities.

While the transition from a conventional knowledge system to one that is ecological has been recognised as necessary for a considerable time within the sphere of agricultural work, it has more recently been discussed as a broader need within a wide range of sectors - including when it comes to ICTs (Fazey et al., 2020).

2.3 ICTs and development

I turn now towards the question of ICTs in development in general and ICTs in sustainable agricultural development in particular. The relationship between ICTs and development is a continuously contested one - just as the question of socio-economic development is as a whole. This is unsurprising considering that the promise of new technological developments have been strongly associated with ideas of modernising development (Schech, 2002).

Discourses[4] around ICTs in development have emphasised the need for transfer and diffusion of the "technological progress" achieved in the Global North, suggesting that they are necessary means by which to achieve economic growth and progress[5] (Avgerou, 2010; Schech, 2002). The underlying assumption is that potential benefits of a technology can be separated from the social context where it emerged (typically in the Global North) and be adapted to and integrated into a new context - i.e. diffused (Avgerou, 2010). Accordingly, large sums of money have been invested by international development agencies, governments, NGOs and individuals into technology - spanning everything from digital infrastructure, large scale software and hardware development projects, digital literacy programmes as well as individual purchases of smartphones or airtime by those both above and below the poverty line. Yet, despite the massive diffusion of information technologies that this has resulted in, there is still considerable inequality in the benefits realised from this diffusion (Harris, 2016). Even where benefits are seen, the cost of the technologies may be considerably higher than the economic benefits they produce (Mpogole, Usanga, & Tedre, 2008). Within the domain of research, it has been suggested that ICT4D research largely fail those that it intends to benefit - commonly low-resource, poor and marginalised populations (Dodson et al., 2012; Harris, 2016; Heeks, 2010). Many projects get stuck as perpetual pilots (Dodson et al., 2012) - realising initial positive outcomes for smaller groups of beneficiaries and/or producing research results but little

[4] Avgerou (2010) defines discourse in this context as "the research language of concepts, theories, and methods through which researchers form the object of a research study and construct arguments about it"

[5] Through, for example, modernisation of work processes, increases in efficiency and opening of new economic sectors.

tangible benefit in the lives of the resource-poor populations they seek to support. The sustainability of ICT initiatives - especially once the initial proponents have left the project is a continued problem (Avgerou, 2008; Marais, 2011). There have also been questions of whether the projects actually address issues of relevance to those they are said to be for (Qureshi, 2015). The notion of transfer and diffusion of technology, however appropriately selected and adapted, is too limited to address the complexities of not just what the impact of new technologies will be in developing contexts, but also nuances of what they could or should be and what roles they can play (Avgerou, 2010). Even more critically, the challenge of shedding implicit assumptions and Western-centric discourses of modernisation (Avgerou, 2010; Schech, 2002) often embedded in ICT interventions remains - according to Qureshi (2015) - to this day. A contrast to transfer & diffusion is innovation that build on "the cognitive, emotional, and political capacities ... [of] individuals who are nurtured in their local social institutions" (Avgerou, 2010) as well as the social and organisational arrangements that pre-exist and come into creation through technology. In this approach, the focus lies on "what is locally meaningful, desirable, or controversial, and therefore, on how technology innovation and organizational change emerge (or are retarded) amid the local social dynamic" (Avgerou, 2010). ICT4D work in this frame should focus on local problematisations and strive to have their work embedded as closely as possible with those it affects.

2.3.1 ICTs and the Capability Approach

An increased theorisation of what "development" means in context of ICT4D (Walsham, 2013) can be a way to challenge the assumptions embedded within the ICT4D discourse and address some of the issues ICTs in development is facing. The Capability Approach is one view on development that places the emphasis not on externally defined outcomes but rather on identifying and addressing what is locally meaningful and desirable, and accordingly research located within this form of discourse has sought to understand its implications for ICTs. An early attempt at linking the capabilities approach with ICT can be found in Garnham (1997) who illustrated how a capability approach to telecommunication allowed the evaluative space to be broadened from simple indicators such as access and usage. In outlining the role of the capability approach in computer ethics, Johnstone (2007) makes the argument that ICTs can contribute both directly to capabilities but also indirectly via influences on "the wider social and material environment". In doing so she also highlights how the same ICTs may act to diminish certain individuals' capabilities while strengthening others. In one of the earlier case studies linking ICT and the capability approach, Madon (2004) shows how an e-governance initiative could be linked to the development of functionings

such as the ability of women to leave their house to socialise and network with each other. In contrast, Zheng and Walsham (2008) show how the introduction of a health care information system could be adverse to the capability of patients receiving high-quality care by adding additional burdens of reporting for highly strained health care staff with little direct benefit to local care practices.

Zheng (2007) highlights how work in ICT for development often operates under simplistic assumptions of the ability of ICT to stimulate economic growth along with the associated modernist assumption of a causal link between economic growth and poverty or deprivation reduction. She argues that by placing ICTs and the functionalities they provide[6] as *means* in the conceptualisation of the CA we can raise a number of important questions with regards to the use of these means to achieve valued functionings. This includes more developed understandings of what is considered well-being and successful development outcomes, an understanding of human diversity and equality as well as both opportunities and limitations in human agency with regards to ICT. Zheng (2009) further emphasises the importance of incorporating the concept of agency from the capability approach while suggesting that ICT research often treats users as "passive receivers" of technology that is supposedly "good for them".

Addressing examples of how ICT contributes to development from a perspective of capabilities – Zheng and Walsham (2008) draw on two case studies from South Africa and China highlighting how information literacy and information freedom/freedom of speech can serve as important conversion factors in turning ICT and information resources into valued capabilities. These case studies highlight how the introduction of ICT can also serve as a barrier to capabilities – essentially introducing new required individual conversion factors (such as knowledge about how to operate technological tools) the lack of which can cause exclusion and potentially a reduced capability set.

Kleine (2010, 2013) proposes the Choice Framework (illustrated in Figure 8) as a way to operationalize the CA. In her framework one of the major contributions of the CA is an emphasis of "choice" as the primary outcome of development and suggests with other outcomes – such as easier communication, increased knowledge or increased incomes – as secondary. She uses resources – an expansion on social and human capital (borrowed from the SLF) – as constitutive of what she calls agency, which in interaction with structures (such as institutions, discourses and laws) produces "degrees of empowerment" for an

[6] Functionalities of "information collection, storage, processing, and dissemination, […] facilities for instant communication across time and space, and the potentials for knowledge generation and diffusion" (2007, pp. 3–4)

individual to achieve primary and secondary development outcomes. In her framework, degrees of empowerment are constituted by the existence of choice, the sense of choice, the use of choice and finally achievement of choice. This can raise multiple valuable analytical dimension for ICT4D practice – such as the difference between existence of and access to technology (existence of choice), the subjective understanding of and access to sufficient knowledge resources to use a specific piece of technology (sense of choice), the interest and eventual choice to make use of technology (use of choice) and finally ability of technology to provide new freedoms or opportunities (achievement of choice).

ICTs are here placed as part of institutional factors that interact with an individual's agency to produce empowerment. This location of ICTs highlight how they participates in a complex network of interactions to eventually produce development outcomes. In comparison to a placement of ICTs as resources in Zheng (2007) and the more linear representation in Robeyns (2006) of the process of turning resources to capabilities by means of conversion factors, the Choice framework emphasises the dynamic interactions between resources, structure and freedoms.

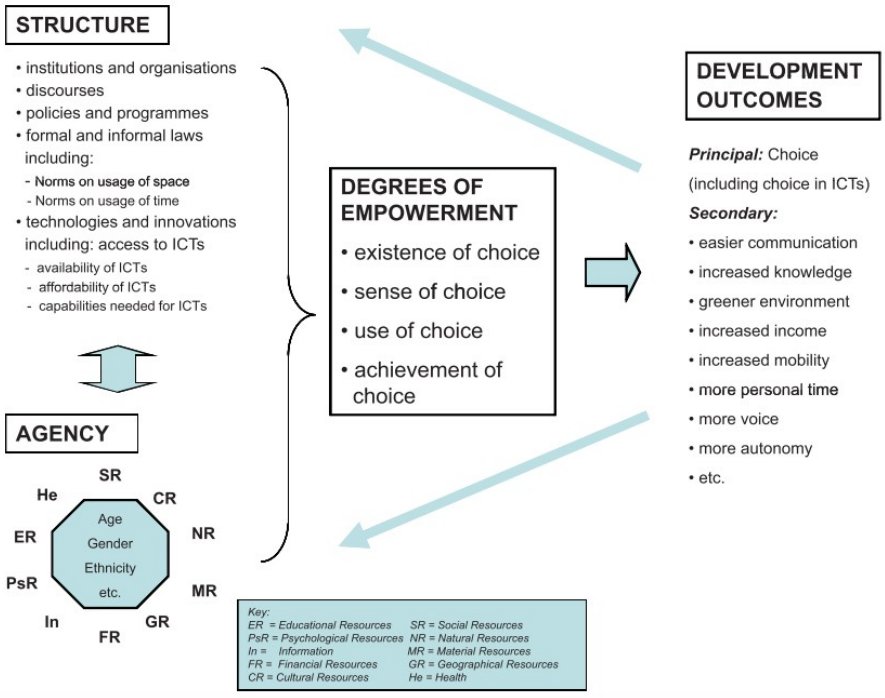


Figure 8. The Choice Framework (Kleine, 2010)

Both Garnham (1997) and Kleine[7] (2010) highlight how the ability or capacity to use technology is a critical component of whether or not technology can be used for capability expansion. In their discussion on the iREACH project in Cambodia, Grunfeld et al. (2011) also include an explicit emphasis on the continuous development of skills to make more advanced use of ICT tools as an important outcome of an ICT intervention. They highlight how this is both an instrumental capability, contributing in a cyclical manner to further the ability to use ICT to expand other intrinsic capabilities, but also an intrinsic one in its own right allowing the users of the system to satisfy "their desire to gain new knowledge in general, whether or not the knowledge was useful for instrumental purposes" (Grunfeld et al., 2011, p. 162). The capabilities expanded through access to iREACH were thus associated with a) learning to use technology and b) gaining further education and access to better learning, which in turn were deemed instrumental capabilities for gaining employment.

Development of collective capabilities through ICTs has been suggested to happen through their contribution to social capital (Thapa, Sein, & Sæbø, 2012) - ICTs can support increasing information flows within the community, improving transparency and trust, enabling co-ordination and alignment of different interests and extending networks to incorporate diverse parties. The social capital created forms the basis for collective agency and, accordingly, capability.

2.3.2 ICTs in rural development

The area of rural development is the context within which the work in this thesis is placed. Rural development itself is a broad area, covering education, livelihoods, health and many more areas. Agriculture - the primary economic activity in rural areas in India and elsewhere - plays a particularly important role, and influences all the others. Agricultural development and sustainable agricultural livelihoods are thus central to rural development.

Responding to the varying challenges facing farming populations, there have been many initiatives that have sought to identify how ICTs can help address them. In agriculture, services for farmers have been designed using a wide variety of modalities and for a wide variety of purposes (Aker, 2011). They have been employed in all stages of the farming cycle - from crop planning to harvest management and post-harvest value chains (Aker, 2011). The most common goals of these interventions have been to support farmers with two information needs: 1) accessing advice on agricultural practice, input use (fertilisers and pesticides)

[7] Via her "sense of choice" degree of empowerment, see Figure 8.

and identifying crop pests and diseases and 2) discovering market prices for different types of crop ((Aker, 2011; Gakuru, Winters, & Stepman, 2009; Saravanan & Bhattacharjee, 2014)). While the examples drawn from in this chapter emphasises services implemented in India (arguably one of the dominant sites for piloting agricultural ICTs) a large number of similar services have been employed across the world (Gakuru et al., 2009), (Qiang, Kuek, Dymond, & Esselaar, 2012; World Bank, 2017).

Early interventions included Internet kiosks and tele-centres (Cecchini & Raina, 2002). The e-Choupal initiative (Bowonder, Gupta, & Singh, 2003) was an early such intervention, where the initiating company - ITC - created a network of Internet enabled kiosks (lit. “choupals” or village meeting places). As ITC is one of India’s largest agricultural businesses, they could offer (through the kiosks) a direct market for the farmer’s produce and they had an interest in ensuring supply of high quality goods. The goal was “virtual integration of the value chain”, with a key element being disintermediation of information flows. The goal was not to entirely replace intermediaries (such as input dealers, money lenders or market middlemen) but rather to change and limit the role they played, as this quote from the e-Choupal website illustrates (ITC, n.d.):
“'e-Choupal' makes use of the physical transmission capabilities of current intermediaries - aggregation, logistics, counter-party risk and bridge financing - while disintermediating them from the chain of information flow and market signals.”
The model of the e-Choupal, or Internet kiosks, did face significant technical challenges (Ali & Kumar, 2011). Establishing each of these required considerable resources as both power and Internet connectivity needed to be provided and both of these have been (at least until recent years) scarcely available in rural India. Accordingly e-Choupal worked with lead farmers who could organise groups of other farmers. Another important challenge was the provision of information and data that was locally relevant in a wide variety of locations - including the localisation of the service into the local languages spoken in different regions of India. However, despite these challenges, the notion of employing ICTs for disintermediation of information flows became integral in many future initiatives.

The proliferation of mobile networks around the end of the first decade of the 2000s made simple cellphones increasingly available (Prakash & Velu, 2010). While it would still be a considerable investment, it was one that many rural households would prioritise. This allowed the development of new services that could more directly target individual farmers. Reuters Market Light (RML) (Prakash & Velu, 2010) was an early such service which, for a subscription fee,

provided farmers with relevant information on a customised set of topics. Subscriptions were provided in the form of scratch cards, that were sold through agricultural input shops and other agencies in the agricultural supply chain. Information was sourced from the Reuters network itself, as well as weather agencies and agricultural experts at universities. This information process is illustrated in Figure 9. Compared to the Internet kiosk model (Veeraraghavan, Yasodhar, & Toyama, 2009), direct access to these systems over cellphones provided multiple benefits - the devices were cheaper and simpler to operate than PCs - allowing individual farmers to own and manage their own device, they could rely on cellular connectivity as opposed to phone lines, they had built in batteries that lasted for considerably longer without any need to get access to power (especially important considering regular power load shedding).

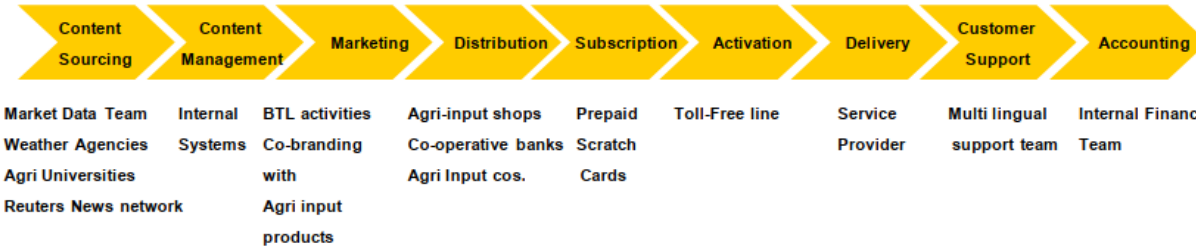


Figure 9. Model of the information flow in Reuters Market Limited (Prakash & Velu, 2010)

In addition to the modality of SMS, early mobiles phones and later generation "feature phones" (pre-dating smartphones), also provided for voice interfaces. One option drawing on these modalities were call-centres, where farmers would call in to the service and be connected to knowledgeable operators who could assist them with their services (Das, Basu, & Goswami, 2012). While these types of services have been implemented by both state agricultural extension services and private agencies, their synchronous nature make them costly to manage at scale as there needs to be sufficient operators available at any given time that the farmer need to contact the service. Another, more commonly seen option, are interactive voice response (IVR) systems. LifeLines India (Rizvi, 2011) provided an early such model, where farmers could call the service to enter queries using a numeric touch input on their phones as well as recording voice descriptions of their problems or questions. Operators would look up information relevant to the query in a database or contact an agricultural expert if such information was missing, and would then attach responses to the case. The farmer could then - as soon as the response was available - call back and listen to the response. This asynchronous interaction provided the benefit that it did not require an operator to always be on

stand-by, as well as allowing differential handling of queries - simple queries could be answered directly through the “frequently answered questions” database whereas more complex queries could involve an agricultural expert. A similar pioneering IVR system was Avaaj Otalo (Patel, Chittamuru, Jain, Dave, & Parikh, 2010) which had the unique feature of not just allowing farmer-to-expert interaction, but also a forum where farmers could interact among themselves providing peer feedback, questions and answers and a wider variety of discussion topics. Despite a stated preference for information delivered by scientists, in trials farmers engaged more actively with information delivered by peers (Patel et al., 2012). In another intervention, this peer role was performed by local project staff - sometimes referred to as “project champions” - who would act as intermediaries support farmers in their use of and access to the ICTs (Dearden, Matthews, & Rizvi, 2011). The availability of feature phones and eventually smartphones with cameras, allowed these services to expand into multimedia. In Dearden et al. (2011) farmers could record pictures and videos of, for instance, crop diseases or pests and send these to the service along with audio queries.

While some of the technical challenges of Internet kiosks (e.g. reliance on a costly, fixed installation, the need for wired Internet access and stable power supply) were alleviated by the proliferation of cellphones, other challenges remained. There were still issues with the quality of mobile network service in many rural areas, and only by the second decade of the 21st century did Internet access become good enough that services could begin to move towards Internet enabled services. While most agricultural extension services still operate on the lowest common denominator when it comes to modalities (primarily voice interfaces, SMS and IVR) the expansion of Internet services to rural areas have gradually allowed the adoption of tools such as video and multimedia messaging (Thakur, Chander, & Sinha, 2017). Using social media is suggested to allow for improved connections between farmers as well as possibility to share content in a richer, more interactive and continuous way than the limited depth that services that depend on voice or SMS can provide (Irungu, Mbugua, & Muia, 2015; Thakur et al., 2017). The simplified content creation and sharing that social media enables can help address a common theme of all agricultural ICT4D interventions - the importance of localised content, both in terms of languages used but also when it comes to cropping patterns and agricultural practices (Irungu et al., 2015). Online access to agricultural content, also provides means for greater self-directed discovery of content by farmers allowing them to seek out content specifically according to their needs or interests rather than those directed by an extension agent or other project owner (Irungu et al., 2015). As Digital Green’s participatory video service (Gandhi, Veeraraghavan, Toyama, & Ramprasad, 2007) - where

agricultural practices were recorded and later shared using video screenings in the villages to farmers' group - illustrates, there is great value in providing content to farmers that feature the practices of other farmers within the local region. These interventions combine localised content, with peer involvement and the ability for farmers to interact with each other through the social meeting points created through village video screenings.

What this brief review illustrates is the importance of locally contextualised interventions. Successful interventions take into account and actively involve local actors, whether as content creators, peer reviewers or project champions. They also take into account particular contextual factors such as the available technological infrastructure - whether roads, electricity or mobile networks - as well as incorporate locally relevant content. However, what the interventions discussed thus far has taken less cognisance of is the sustainability of the agricultural system they are designed to support, a question that I will address in the subsequent sections of this chapter.

2.4 ICTs for sustainable agricultural development

Many ICT4D interventions in agricultural development, including those discussed in section 2.3.2 ICTs in rural development, take as their starting point the challenges of government agricultural extension services to adequately reach out to and support farmers. As Patel et. al. (2010) notes "*only 6% [of respondents in an IFPRI survey] reported having interacted with an extension officer*", further highlighting how "*ICTs have the potential to increase the reach of agricultural extension*". Gandhi et al,. (2007) begin with the recognition that "*the scale of actual impact [of extension services] ... is confounded by logistical and resource challenges that include the sheer number of households that are assigned to a single extension officer*". Several of the initiatives that have been taken have also demonstrated that farmers find the content provided through ICTs of greater quality and accessibility than that provided through regular extension services (Aker, 2011; Baumüller, 2018).

This starting point is one which addresses the logistical and practical challenges of government extension programmes, suggesting that ICTs may increase access to private and public extension information, reducing costs for information delivery, improve extension services' accountability and support better linkages between farmers, extensions services and research centres (Aker, 2011). While this seems like a good starting point, extension services as well as ICTs designed to support them have faced challenges in achieving adoption of the new technologies and practices they are designed to promote (Aker, 2011). The evidence of whether ICTs

actually produced improved outcomes when it came to livelihoods or agricultural outcomes is mixed. There is some evidence that mobile technology helps reduce price dispersion (the difference in prices for the same product between different markets) (Aker, 2008) but does not necessarily raise farmers' incomes (Aker, 2011; Aker & Fafchamps, 2015). In Peru, Nakasone et al. (2014) report that farmers received improved incomes (especially from perishables), whereas in an experimental case in Colombia (Camacho & Conover, 2011) no significant impact of the ICTs was observed. Lokanathan et al. (2011) reports that in Sri Lanka, even though farmers did not use the price information available via ICTs for negotiation with the traders actively, farmers perceived that they received better prices since the introduction of the ICTs. One of the limitations is the ability of farmers to change their patterns of sales, due to limited competition between different traders and the inability to switch between wholesale markets (Baumüller, 2015; Lokanathan et al., 2011). There is little evidence that farmers employ ICTs for determining what crops to grow based on the price data provided through these systems (Baumüller, 2018).

When it comes to the main function of extension services (i.e. providing improved agricultural inputs, advice on farming practices, support with pests and disease and other relevant information such as weather information) ICTs have undoubtedly expanded the reach of the information, whether in the form of radio & TV programmes, IVR systems, SMS based systems or multimedia based interventions. However, whether information received in this way actually leads to changes in agricultural practices is a different issue. Several studies have found that ICT interventions only in a limited way helped farmers improve their agricultural practices and get improved agricultural outcomes (Aker & Ksoll, 2016; Camacho & Conover, 2011; Fafchamps & Minten, 2012). These effects were also highly heterogeneous, varying by income levels, gender and other farming household attributes.

Even after several decades of work in ICT4D for agricultural development, there is thus still an open question of whether these initiatives can reach their goals (Baumüller, 2015). Considering both the great potential envisioned for agricultural ICTs (World Bank, 2017) as well as the large sums invested in establishing these programmes, it reveals the need to question the broader premises of these programmes. Even if these initiatives actually were able to achieve their intended goals of increased farmer incomes, or make up for the limitations of state extension services, the question is whether this is a desirable direction to move in, in the first place. As we have seen in the previous discussion on agricultural extension, the present agricultural extension services are closely tied in with the

movement for technological modernisation. With few exceptions, all the initiatives discussed in the previous section were built around sourcing knowledge from outside the farming community - often provided through experts at agencies such as agricultural universities. The linear flows imagined by many of these services (starting from experts feeding data to farmers who are then intended to follow them in the field - exemplified in Figure 9) are only interrupted by certain systems' starting point being a question for help asked by the farmer. Rarely do these systems account for the expertise, knowledge or even feedback provided by farmers themselves. As a result they are premised on the goal of folding farmers into a relationship of dependence on scientific experts, as well as the ICT system itself. Rejection of this relationship, i.e. through non-use of the system or not following the advice given, is understood as a problem of either the farmer's understanding, their (inappropriate) risk averseness or the ability of the ICT to accurately convince the farmer of the benefits of following the practices given. When it comes to market prices and other market information, farmer's lack of integration with large-scale, commercial supply chains is central to the problem statement that these interventions seek to address. For example, e-Choupal's website (ITC, n.d.) states that:

> *e-Choupal also unshackles the potential of Indian farmer who has been trapped in a vicious cycle of low risk taking ability > low investment > low productivity > weak market orientation > low value addition > low margin > low risk taking ability. This made him and Indian agribusiness sector globally uncompetitive, despite rich & abundant natural resources.*

This is typical of systems that incorporate what Röling & Jiggins (1998) calls the conventional knowledge system (2.2.3 What does sustainability mean for agriculture?). The farmer in this system is the recipient of scientific knowledge that is transferred in a linear way from scientific institutions to practice with the help of a set of "interlocking institutions" (Röling & Jiggins, 1998). It builds on modernising notions of development, whereby through the adoption of technology transferred from elsewhere farmer's situation and livelihoods are improved. While issues such as food security or ecological sustainability are occasionally raised in discussion of these ICT based interventions, it is primarily seen through the lens of income (Marais, 2015). Rarely do initiatives deviate from modernising goals of improved agricultural development to ask whether these initiatives lead farmers towards an agriculture that they have reason to value. Equally, the question of whether the agricultural system that these ICTs contribute to is actually more or less resilient is becoming increasingly relevant in the light of the climate crisis. The dependence on outside agencies, and move away from depending upon other

farmers or local networks of middlemen, that these ICTs envision can mean that farmers become increasingly exposed when interventions break down or are discontinued. Considering my commitment to sustainability and resilience, my starting point for how to engage sustainably with ICTs in agricultural development is therefore the question of how to support a resilient ecological knowledge system (2.2.3 What does sustainability mean for agriculture?). However, as I have already suggested, this is a question that is rarely asked in ICT interventions in agriculture. Addressing this question, requires a shift in how we think about ICTs in this area, and how we go about implementing them.

In the remainder of this section, I will address the outline of this shift in perception that forms the basis for the work in this thesis. This includes understanding the context of the intervention as an ecosystem, understanding technology as socio-material and seeing the transformative process of knowledge management as social and situated.

2.4.1 Knowledge ecosystems

A foundational implication of the discussion in the previous section, is an understanding of information technologies introduced as not operating independently but as a small part of a much larger socio-ecological system. The Principles for Digital Development (Principles for Digital Development, n.d.) recognises this notion of ICTs embedded in a broader system by emphasising the need to understand the existing "ecosystem" surrounding a technology. They define an ecosystem as "culture, gender norms, political environment, economy, technology infrastructure and other factors that can affect an individual's ability to access and use a technology or to participate in an initiative". However, The Principles of Digital Development's notion of ecosystem does not adequately address the question of the discursive regimes that underpin any work in ICT4D. ICT4D engages with the world through specific discourses of development and technology (2.3 ICTs and development), and in the case of ICTs in agriculture it also involves a specific discourse of agricultural development. In other words, ICT interventions come embedded in a particular knowledge system of technology, agriculture and development.

Other researchers have been employing notion of an ecosystem (or, typically an "ecology")[8] in more expansive ways to describe the socio-cultural context of technology. Nardi & O'Day (1999) uses the term "information ecology" to describe

[8] While it has become common practice to employ the term ecology in this place (Lyle, Korsgaard, & Bødker, 2020), I have chosen in this thesis to retain the meaning of "ecology" as the "study of ecosystems" and use "ecosystem" as a noun to describe the system itself.

"a system of people, practices, values, and technologies in a particular local environment.. [i]n information ecologies, the spotlight is not on technology, but on human activities that are served by technology" (Nardi & O'Day, 1999). Further uses of the notion (such as artefact or device ecologies) place the practices around the artefacts or the networks of devices and their interaction in the centre respectively (Lyle, Korsgaard, & Bødker, 2020). Another influential perspective is communicative ecologies (Tacchi, 2015) which are defined as "a milieu of agents who are connected in various ways by various exchanges of mediated and unmediated forms of communication" (Hearn & Foth, 2007). In comparison to information ecologies and the Principles of Digital Development, communicative ecologies emphasises the discursive aspects of the ecosystem - the communicative practices that take place throughout the ecosystem as well as the content and meaning attached to them.

Within this thesis I will draw on these notions of an ecosystem of human actors and material artefacts, but at the same time incorporate the understanding of knowledge systems (1998) described previously (2.4.1 Knowledge ecosystems). This understanding emphasises social practices and institutional context, but also the ontological and epistemological understanding that underpins a knowledge system. In this thesis I will employ the term "knowledge ecosystem[9]" to describe the contexts within which I am intervening. I choose this term in order to emphasise that:

a. What I am intervening in (i.e. participating in) is an ecosystem - a set of living (e.g. humans, agricultural crops, pests and so on) and non-living (e.g. technology, climate) elements - that interact in complex patterns to produce socio-ecological structures and relationships and,
b. That any interactions (or interventions) within this system take place within a specific frame of a knowledge system that involves a particular set of positions:
    a. An ontological and epistemological orientation
    b. An axiological position on *how and who defines what* as the desired outcomes
    c. A normative understanding of the roles that different actors should play

Finally, within a knowledge ecosystem there can be multiple knowledges (Brown,

[9] The term "knowledge ecosystem" is used in management studies (e.g. Valkokari (2015)) in a somewhat similar way to describe the actors and relationships that contribute to a system that produces certain types of knowledge. However, my employment of the term falls closer to the information and communicative ecologies discussed by Nardi & O'Day (1999) and Tacchi et al. (2015).

2010) or knowledge systems operating at the same time (1998). The contrast between the ecological and conventional knowledge system exemplifies this (2.2.3 What does sustainability mean for agriculture?). Within any agricultural ecosystem, these two knowledge systems (as well as other knowledge systems) can exist at the same time and can influence individuals or groups of farmers or other actors. Fundamental aspects of ontology and epistemology will, however, determine any actor's primary orientation towards questions of practice, facilitation, learning, institutional and policy contexts. There are also issues of respective power and dominance of particular forms of knowledge within an ecosystem creating a hierarchy where certain knowledge systems can become the dominant ones (Brown, 2010). The "conventional system" has become the dominant norm for agricultural development (particularly since the Green Revolution and onwards) (2.2.3 What does sustainability mean for agriculture?), and this has carried over into approaches to ICTs within this space (2.4 ICTs for sustainable agricultural development).

2.4.2 Socio-materiality

The way that I seek to understand technology within this ecological view is through a theoretical frame of socio-materiality (Orlikowski, 2007; Suchman, Trigg, & Blomberg, 2002) and enactment (Irungu et al., 2015; Orlikowski, 1999). In this perspective, ICTs are not merely material artefacts to be adopted or employed. Rather, ICTs can be understood as produced in a recursive relationship between material properties, the practices of use surrounding them and the social structures of the context within which they are operating (Orlikowski, 1999). It is recognised that materiality of technology matters and is inextricably linked with the social world (Orlikowski, 2007). This recursive relationship means that ICTs are both shaped by and give rise to changes in practices and social structures. From this perspective, the material forms and the social practice need to be addressed simultaneously and in concert - they cannot be viewed or understood in isolation (Orlikowski, 2007). This view of the material implies that a research project positioned around ICTs is also one which needs to engage with the social practice which the ICTs are constitutively entangled with (Orlikowski, 2007) - an intervention that is understood as based upon the design and introduction of e.g. ICTs is equally is an intervention that engages with changing social practice. It leads the attention away from the singular act of innovation through invention or creation of an artefact (a focus typically embedded in the way that design is thought about) to development of socio-material assemblies (Bjögvinsson, Ehn, & Hillgren, 2012), a "practice of configuring new alignments between the social and the material" (Suchman et al., 2002).

2.4.3 Social and situated knowledge management

Thus far, I have established knowledge ecosystems as the framing of the context of intervention and socio-materiality as the lens through which to place technology in this context. Finally, I consider supporting improved agricultural information and knowledge management to be at the core of what agricultural information systems (such as those described in section 2.3.2 ICTs in rural development) do. Knowledge management is central to the transformative link (Sein et al., 2019) between ICTs and particular agricultural development outcomes (Aker, Ghosh, & Burrell, 2016). Typically, ICTs are framed as providing information and knowledge to locations and people where it would otherwise be inaccessible, prohibitively costly or insufficiently localised and specific (Aker et al., 2016; Kendall & Dearden, 2018b). However, as mentioned, past interventions have been primarily constructed around the (often only implicitly recognised) conventional agricultural knowledge system. The question for this thesis then becomes, how do we understand this transformative process in the context of an ecological knowledge system?

A core element of the way knowledge is managed within an ecological knowledge system is through social networks and social learning. Pahl-Wostl et. al. (2008) suggest that ICTs that facilitate social learning need to incorporate relational elements, as well as be designed to recognise that knowledge is socially constructed, situated and embedded within individuals and communities. Van der Velden (2002) highlights how ICT systems that take social learning systems into account need to be centred around the "knower", where the knower and the knower's process of creating and sharing knowledge is in focus. This foregrounds the idea that knowledge is, to a large degree, tacit and as such cannot be separated in a lossless manner from its knower and context (Van Der Velden, 2002). This requires that the situated aspects of knowledge need to be acknowledged including: documenting the reason and context for the creation of any knowledge captured, supporting diversity of knowledge rather than capturing best practice or single narratives as well as favouring networks of information over hierarchical portals. She suggests that such ICTs should:

- Be able to compare data, information and knowledge
- Develop alternative scenarios
- Support online communities of practice
- Help make information and knowledge accessible based on people's social, cultural and educational background (incorporating language translation, social translation and formatting tools)
- Help people present information and knowledge in appropriate and effective

ways

Oreglia (2013) argues that when viewing farmers as a community of practice (Wenger, 1998), it is clear that approaches which privilege disconnected information-sharing are inappropriate. In contrast, a "knower-centred" view of agricultural knowledge is one which recognises that it is embedded in and transferred through participation in a shared community practice.

In other words, while access to information, which a large portion of agricultural ICT interventions are premised upon (Kendall & Dearden, 2018b), may allow for learning *about* sustainable agriculture, in order to learn how *to be* a sustainable farmer and how *to practice* sustainable farming, more than access is required. Consequently, overcoming obstacles to information access is a necessary but not sufficient condition for improved performance. Attempts at disseminating knowledge (whether through text messages, audio clips or videos) to farmers with the expectation that they will be able to directly turn it into improved agricultural practice works only for certain farmers and in certain, particular situations (Kendall & Dearden, 2018b). Critically, to acquire "know how" and turn it into practice, such as farming sustainably, participation in a community of practice is needed (Wenger, 1998). This involves the negotiation of an identity in relationship to the practice, to be recognised (and recognise oneself) as a member of the group formed by that practice (Wenger, 1998). For example, it could involve recognising oneself as "a sustainable farmer", part of a sustainable farming community. This involves sharing certain values as well as developing shared meanings (Wenger, 1998). Returning to Röling & Jiggins (Röling & Jiggins, 1998) (see 2.2.3 What does sustainability mean for agriculture?) a community of practice that operates with an ecological knowledge system would have an understanding of ecology that places "people [as] part of the bio-physical environment [who] can amplify the human biotope by knowledgeable use of natural processes and cycles" and where the meaning of "expertise" is the particular situated knowledge that a farmer and a farming household has built up over time, interacting with a particular bio-physical environment.

Adopting this orientation towards knowledge management means moving away from placing designing systems for "knowledge dissemination" or "information access" as the central concern for an ICT researcher or designer. Rather, the emphasis lies on how the researcher or designer can support communities of practice through facilitating interventions, typically involving socio-material reifications (for example, some form of information and communication technology) (Wenger, 1998). These are reifications of a particular practice, and in

order to support a particular community they need build upon its specific identity and meanings developed through the practice (Bidwell, Winschiers-Theophilus, Koch Kapuire, & Rehm, 2011; Wenger, 1998). This is not to say that ICTs need to be involved with or adopt as their goal the creation of communities of practice. While communities of practice can form around an ICT intervention, there will commonly already be communities of practice within a knowledge ecosystem. Exploring and understanding the characteristics of these communities is an important element of an ICT4D project (Wyche & Steinfield, 2016).

The question for the design of information systems in this space then becomes what communities of practices there are, how (if at all) those can be supported or developed through ICTs and what the role of an ICT designer or implementer is in developing such support.

2.5 Summary

In summary, the period since the second world war has seen the emergence of multiple notions of what it means for a country to be developed or developing. This dichotomy became established as part of the globalisation of the world economy that took place in the post-war period. The notion of development became synonymous with the project of modernisation, where the application of scientific expertise along with rapid technological progress and economic liberalisation would see the improvement of human lives. There have been multiple challenges to this perspective in recent decades, building on both the embedded power structures that this notion of development brought (especially between those classified as developed economies and those classified as developing) as well as the exclusion and marginalisations of large sections of the world's populations as these developments have led to increase economic inequalities.

However, in recent years alternative notions of development have emerged. Sen's Capability Approach (CA) is one of the more influential. The CA builds on a contextualised notion of development as the expansion in freedom for individuals to lead lives that they have reason to value. In this chapter, I have laid out this notion of development but also discussed the related notion of *collective capabilities* - a broadening of Sen's focus on the individual to emphasise the development of inherently social goods. I have also argued that resilience towards external shocks such as climate change is in large part such a collective capability. Consequently, this thesis adopts a view of development as the expansion of collective capabilities. This will be the goal that is sought when I henceforth refer to or discuss "development". What it exactly implies in terms of development

outcomes will have to be defined by those in the specific context development takes place, and can therefore not be laid out a priori. A focus on expansion of collective capabilities in this case can, for example, involve the development of local institutions and capacities - in my case, supporting DRCSC and their work.

ICTs have, unsurprisingly, become associated with the notion of modernisation, as it is one of the technologies that have been (especially in the past three decades) expected to yield livelihood improvements if adopted broadly. Various programmes have suggested that ICTs could help countries improve their provision of essential services, expand their economies as well as alleviate poverty, hunger and address many other issues. The field of ICT4D originates in these notions of ICTs as bringers of modernisation and development. However, following the considerable critique of modernising development as discussed in the previous section, this discourse of ICT and development has been rigorously challenged both on its theoretical merits as well as when it comes to its practical ability to improve the lives of those it claims as its beneficiaries. One strand of work emphasises the need for ICT4D to address the question of what development theory underpins the work. This has resulted in various attempts at incorporating ICTs within larger development frameworks. The CA has been central to this effort in the past decade, and I have discussed the way in which authors such as Dorothea Kleine have approached operationalising the CA for ICT4D.

Within rural development, a wide variety of ICTs have been designed utilising a broad range of modalities. Considering the importance of agriculture to the livelihoods of rural populations, many of these interventions have sought to support farmers and farming activities. This has involved helping farmers reach markets with their goods, disintermediation of middle men in the agricultural supply chain (in order to provide greater income for farmers) and providing ways for farmers to access agricultural advice and knowledge - whether from extension services or other farmers. This wide array of projects have demonstrated the usability of various technologies for rural populations, been able to work around many of the infrastructure limitations of rural areas, as well as illustrated the importance of localisation of both technology and content.

Through the range of interventions discussed in this chapter ICT designers and developers, have become participants in agricultural knowledge ecosystems. However, present approaches have primarily operated on the basis of the conventional knowledge system. However, this conventional agricultural knowledge system have led to an untenable situation for many farmers - especially smallholders and marginal farmers. It has reduced both the sustainability of their

livelihoods, their food security and the agroecological system they operate within. It has also lead to an agricultural system that is less resilient to shocks. If ICTs and ICT designers, researchers or implementers are to contribute to sustainable agriculture they need to understand how they fit in within an ecological knowledge system. Supporting social learning and situated knowledge management practices (rather than, for example, top-down, expert-to-farmer information dissemination) is central to this. This also leads to a view of ICTs as embedded and situated in practice - enacted and socio-material.

Furthermore, anything but the most surface level interaction with an agroecological system involves "becoming a participant in an ecosystem" or in other words "entangled" with the broader social practices of the ecosystem. Inherently, entanglement and participation means changing the ecosystem - whether desired or not. Any interventions in the socio-ecological system must ensure that the continued abilities of the system to renew and recreate itself is not compromised - i.e. not compromising the resilience of the system. This involves nurturing self-reliance, internal redundancy and diversity of approaches. The opposite, attempts at streamlining and consolidation or introduction of dependencies on outside parties, would need to be avoided.

This is why the discussion of sustainable agriculture and development in this chapter is a crucial one. In order to become a participant in the ecosystem that improves the resilience and sustainability of the ecosystem, it is crucial to understand both the underlying dynamics of the system - but perhaps even more importantly the values, the ontological understandings and the epistemological position that underpin the system. There is, naturally, a great deal of variety both between and within different ecosystems which therefore requires an approach to inquiry and intervention that allows for a situated and context specific understanding and approach.

Returning to Sein et al. (Sein et al., 2019), I have in this chapter defined a theoretical framework of development for this thesis drawing on capabilities, I have established a theoretical socio-material understanding of ICTs and I have outlined the transformative process by which ICTs contribute to increased capabilities through social learning and situated knowledge management practices. Considering the question of sustainable agricultural development, these are theoretical perspectives that "are appropriate to the context where it is applied if we are to reach an accurate understanding about the phenomenon investigated" (Davison & Díaz Andrade, 2018). As I have shown in this chapter, similar theoretical positions are adopted in the literature on sustainable

agriculture and natural resource management (Altieri & Nicholls, 2005; Folke et al., 2002; Pahl-Wostl, 2006; Pretty, 1995).

Recognising that there is thus far little work in ICT4D for agriculture that adopts these positions on sustainable agricultural development and knowledge management key questions remain. One, how can this be employed in designing information technologies to support sustainable agriculture. Two, considering the alternate role of actors and institutions envisioned in an ecological knowledge system, what should the role of the ICT designer and implementer be in this kind of scenario. These form two of the research questions that I set out to explore in this thesis. In the following chapter I will discuss my methodological approach in addressing these questions.

3. Methodology

The starting point to discuss my methodological approach is the research aims and questions of the project. To reiterate (1 Introduction), RQ1 concerns itself with understanding communication and technology use in the work of DRCSC. RQ2 asks how we can design a socio-technical intervention within this context and RQ3 engages with the question of the role of ICT practitioners, researchers and designers can play in such interventions. These questions relate to understanding and intervening in a social setting and the role played by the person intervening. In this chapter I set out an epistemological approach towards answering these questions, as well as the broad methodological orientation taken. Discussions of specific methods of inquiry and analysis are left to subsequent chapters that discuss the different phases of the research.

3.1 Ways of knowing

The nature of my engagement in the context, as well as the issues that I am concerned with, lead to the potential for specific types of knowledge claims. Attempts at adopting a positivist or post-positivist stance where there is an absolute reality that can be observed and (possibly imperfectly) documented by a researcher striving for objectivity would fit poorly with this type of research project. An important weakness of a positivist approach in studying social phenomena is the seeming impossibility of reducing societal structures and human behaviours to underlying components and accordingly accurately predicting or explaining human action and society as a whole (Guba & Lincoln, 1994). Individually and collectively held notions of meaning and purpose cannot be excluded from the explanation of social phenomena - and will invariably challenge any attempts at reduction and consequent prediction (Guba & Lincoln, 1994). Stripping away complexities in order to achieve predictive theory results in issues of relevance, once a sufficiently narrow causal relationship has been found it may have no real relevance to actually relevant issues (Guba & Lincoln, 1994). Generalisation may provide statistical significance but provide little understanding of individual cases (Guba & Lincoln, 1994). Of even greater consequence is the way in which “observed facts” (especially in studies of social phenomena) are interdependent with the theoretical perspectives and values under which they were produced (Guba & Lincoln, 1994). This interdependence of the phenomena under study extends to their relationship to the investigator,

where there is no ability for a researcher to extract themselves from the way in which the phenomena are produced. A final challenge to positivist research in this sphere is the existence of multiple equally valid explanations of any given phenomena.

3.1.1 Interpretivism

Rather than a positivist paradigm, the type of research I am conducting could draw on an interpretivist paradigm (Goldkuhl, 2008). An interpretivist approach recognises that social phenomena are fundamentally different from natural ones as when studying humans they are continually in a process of interpreting and re-interpreting their own reality. Interpretivism understands reality as socially constructed, where the goal is understanding rather than causal explanation and prediction, and where the knowledge generated is based around discovery of meanings held by actors in the research situation. Theory is typically developed inductively, with theory serving as a way to abstract from observations or information gathered, rather than as a source of hypotheses to be tested. In an interpretivist paradigm, knowledge is fundamentally relative to the time and context in which it was captured. Rather than attempting to capture objective data, in interpretivist research subjective meanings are uncovered, interpreted and reported (Goldkuhl, 2012). Interpretivism is a common foundation for ICT4D research as well as information systems research in general, though other paradigms such as critical research (Lin, Kuo, & Myers, 2015) and critical realism (Heeks & Wall, 2018; M. L. Smith, 2006) have also been adopted. Ontologically, interpretivist research is premised on a constructivist understanding of the world - where the social world studied is not a "given" but continuously being produced and re-produced through action and interaction by humans (Orlikowski & Baroudi, 1991).

However, an interpretivist approach struggles to engage with the question of knowledge generated through action. Interpretivist research is commonly concerned with descriptive theoretical outcomes, inductively reached. Critical research seeks to uncover the underlying social structures that shape the interaction. The nature of this project, however, is not only to study and interpret the action and interaction of humans in a context (with the researcher as a "participant observer") but rather to directly act in relation to the context.

Positive action towards contributing to improvement in socio-economic conditions is a goal that this project shares with many other projects in ICT4D. This goal is

commonly achieved either through generating knowledge that can be directly useful for and applicable to those involved in the development context, or through generating a sustainable intervention that can continue to be maintained and developed after the end of the research project. Action as a means of generating knowledge is common for all kinds of design projects, where the act of designing is a way of inquiry, a means of inscribing the results of the inquiry into artefacts and a means of communicating the inquiry. Action is thus both the outcome of the research as well as a means by which knowledge is generated.

3.1.2 Pragmatism

For research which has as actionable knowledge as a primary aim, pragmatism has been suggested as a suitable approach - an alternative or perhaps addition to an interpretivist paradigm (Baskerville & Wood-Harper, 1996; Goldkuhl, 2012). The main concern of pragmatist research philosophy is the interaction between action and knowledge and the way this can support change (Goldkuhl, 2012). A clear distinction that can be made between a pragmatist philosophy and an interpretivist one is that the "meaning of an idea or concept lies in [its] practical consequences" - that is, what actions we conduct based on our understanding (Goldkuhl, 2012). An inquiry into a situation (in a pragmatist paradigm) is primarily intended to create knowledge that can transform a system in some, directed, way. Practical action, change, and generation of knowledge are thus inherently part of the same process. Knowledge generated in such a process can, similarly to interpretivist research, be descriptive, but can also be normative, prescriptive and prospective. Thus in addition to seeking understanding, pragmatist research can also seek to provide guidelines, exhibit values and suggest future possibilities (Goldkuhl, 2012).

I argue that these forms of knowledge are commonly part of ICT4D projects and Information Systems research in general - whether they explicitly identify as having a pragmatist orientation or not. Interventionist ICT4D seek solutions that contribute to socio-economic development (however defined) and therefore the knowledge that is generated through an ICT4D research project needs to be actionable. It is through the actions or practical consequences we can establish the value and relevance of the knowledge claims. Implicitly, this is commonly the case as most ICT4D interventions try to, in some form or the other, establish a theory of how the intervention leads to certain outputs, these outputs lead to specific outcomes and how these outcomes in turn generate valued socio-economic impacts.

Thus, the knowledge sought is one that can be demonstrated through or generative of, action. This is an approach to knowledge, "a way of knowing", that is neither entirely positivist nor interpretivist (Olson & Kellogg, 2014). Ontologically, a pragmatist research programme could involve either the notion of an absolute reality (indirectly observable through action) or consider our perception of reality as socially constructed - observed through the way socially constituted meanings and interpretations are turned into action (Morgan, 2014). As I have outlined in the previous sections, my understanding of knowledge systems and the broader notion of development as fundamentally social phenomena leads me toward the second view.

3.2 Possible methodological approaches

Having established the pragmatist epistemological orientation of my research, the methodological approach chosen needs to align with it. Any approach chosen for pragmatist research must involve and address the way in which intervention or action becomes part of a rigorous research process. Action being central to the inquiry, means that methods need to be appropriately employed to undertake the action as well as document and analyse action and its consequences appropriately. This includes an account of what kind of knowledge claims can be made, how to judge the quality and rigour by which these knowledge claims are made and how to engage with any ethical concerns that the approach raises. Considering the typically social nature of action in pragmatist research, the approach chosen must also account for participation of stakeholders within the research context.

In this section I compare two broad research approaches, Design Research (DR) and Action Research (AR), commonly taken in intervention-oriented information systems and ICT4D research (Goldkuhl, 2012). Most projects do not fall exclusively into any one of these but will in practice combine elements of them. These also do not form cohesive methodologies by themselves in that they do not have prescriptive methods, approaches to analysis, and are even employed under different epistemic paradigms. However, they serve as two research directions or focuses, and, I would argue, sit comfortably in a pragmatist paradigm. They also have existing research traditions whereby different methods have been employed, that I would be able to draw on.

These two research approaches involve the active participation of stakeholders

beyond the researcher to varying degrees and they see action or change as an inherent part of the research process. However, they vary according to the emphasis given to the material artefact, the respective role of participants and researchers in the process and the way they would evaluate their contribution both in terms of the quality and rigour of research outputs and impact on the situation within which they operate. I have summarised some of these differences in *Table 4* and will be discussing them in detail in the coming sections.

	Design Research	Action Research
Relationship between researchers and participants	Researchers as technical experts, collaborators or facilitators Participants as informants, evaluators or in some cases co-creators	Research is undertaken as a joint endeavour where researchers and participants are equally involved
Primary Outcome	Designed (meta)-artefacts Design theory	Situated knowledge and continued action
Role of the artefact	The production of an artefact is a means of inquiry, a way of documenting the research as well as the outcome of the process. The artefact as a means to test or verify and validate design theory.	The artefact can play a role in the process but is not a central or necessary concern beyond its contribution to action
Role of Theory	Theory consisting of meta-artefacts, blue-prints for systems within a conceptual domain Theory as annotations of design processes	Integration between theory and practice Theory emerging from action Theory building as translation

Pathways to social impact	The designed artefact provides affordances, functionalities and features that support improved ways of working or being	The activities that are undertaken as part of the project establishes new social practices in the context
Quality	Usability & usefulness of the artefact User gains from participation in the project	Positive change in the situation Development of new capacities and capabilities among those involved

Table 4. Summary of important features of Design Research and Action Research.

3.2.1 Design Research

Many projects undertaken with ICT4D in rural and agricultural development have operated on a model whereby an intervention is iteratively developed and tested with target communities. Commonly, an initial process of eliciting requirements is followed by the development of prototypes. The prototypes are brought to potential users who then test and provide their feedback, using which additional versions of the design can be created (Patel et al., 2010). Various approaches to eliciting requirements in the initial phase have been employed from ethnographic methods, including observations and interviews (Gandhi et al., 2007; Veeraraghavan et al., 2009) to focus groups and questionnaires (Patel et al., 2010). This initial phase commonly seeks to uncover both aspects of the social as well as the technical context of the intervention (Dearden et al., 2011). When it comes to the technical context, it is common to identify infrastructure as well as various resources available to the research team and in the local context and use these as limitations, opportunities or constraints for the design (Veeraraghavan et al., 2009). Early study often introduced limited prototypes or conducted experiments evaluating various modalities such as video (Gandhi et al., 2007), spoken voice and text interfaces (Patel et al., 2009), mixed multimedia messaging (Dearden et al., 2011) and multi-modal interfaces (Cuendet, Medhi, Bali, & Cutrell, 2013). To evaluate these prototypes, various methods drawn primarily from their use in Human Computer Interaction (HCI) have been employed such as card sorting (Camara & Abdelnour-Nocera, 2013), Wizard-of-Oz testing (Gandhi et al.,

2007) and technology probes (Camara & Abdelnour-Nocera, 2013). Largely, these approaches can be said to reflect a design research oriented approach to the introduction of ICTs in development contexts. The goal of projects with this orientation is often to produce a system that can eventually be deployed on an ongoing basis. There is also considerable research adopting design research oriented methods in order to understand the use of technology, new interfaces and different modalities within development contexts without aiming to create any permanent solution but rather inform general approaches to ICT4D (Cuendet et al., 2013; Thies, 2015).

Broadly, the core of what design research aims to do is to "extend the boundaries of human and organizational capabilities by creating new and innovative artefacts, including constructs, models, methods and instantiations" (Hevner, March, Park, & Ram, 2004). the intention is to address a general problem (for example information provision in agriculture) where there is a great deal of uncertainty about what new or innovative methods can be used to address this class of problems. In doing so, design research can seek to contribute both a conceptual ICT meta-artefact as well as a specific instantiation of it through the design of some form of real world information system. While there can be cases where the conceptual meta-artefact is of interest without a corresponding instantiation, it is typically the case that the instantiation is employed to validate the meta-artefact (D. Jones & Gregor, 2007). In some cases, this instantiation is intended to be a long-term specific solution to a problem faced by a partner, however it often ends up more as a proof of concept that is used for evaluation. The meta-artefact that is the outcome of the project is an innovative concept for a software-hardware combination usable and, at least in certain aspects, appropriate to the target context. Another potential outcome is an innovation in method and approach to design and development of technological interventions.

Design research projects follow one of two strategies (Iivari, 2015). In the first strategy, they construct a meta-artefact which is then tested through specific instantiations such as prototypes or actual systems that are intended for long-term use (Iivari, 2015). The second strategy involves developing a solution to a specific problem and then extracting a generalised concept from the knowledge derived through the specific instance (Iivari, 2015).

In either case, in a design research framework, there is an environment which defines a problem space and in which the project seeks to establish relevance

through identification of needs and their reification as requirements. The project operates within this space with design as a *search process* and *artefact*, which through experiments, field trials and pilot implementation is assessed and refined. These projects are research projects in the sense that the artefacts they produce are "experiments" that allow better understanding of the problem domain and potential creative approaches to addressing issues within it (Hevner et al., 2004). There is often an (sometimes acknowledged, sometimes unacknowledged) process of simultaneous framing of what the problem statement or issues to be addressed are through design process (Zimmerman, Forlizzi, & Evenson, 2007). Thus, design research approaches employ design as a way to both inquire into and learn about the problem space as well as create designs that address this understanding of the problem space (Zimmerman et al., 2007). It is also possible to view the generated artefacts as ways to document and communicate specific problem framings rather than as solutions (Zimmerman et al., 2007). However, in information system development in general (Hevner et al., 2004; Iivari, 2015) and in ICT4D in particular (Heeks, 2010), the expressed goal is often to produce a potential solution that can actually address the real world situation. The intention is often for projects to transition out of a pilot stage as part of a research programme into becoming a sustainable development intervention.

Role of theory

The role of theory in design oriented research is contested (Gaver, 2012; Gregor & Hevner, 2013) but is considered to be one way (in addition to the creation of novel IT artefacts) that design research can make contributions to knowledge.

Gregor & Jones (2007) argues for conceptualised design theory as an important contribution of design research beyond the artefact. In their view, design theory is structured around the set of meta-requirements and conceptual notions that specifies the design space for a particular meta-artefact, or blueprint (D. Jones & Gregor, 2007). It should also describe ways in which the artefact may be mutable to address differences when instantiated as well as a set of testable propositions ("truth statements") about the artefact (2007). Finally, design theory should incorporate "the underlying knowledge or theory from the natural or social or design sciences that gives a basis and explanation for the design" (2007). Theory in this sense can be prescriptive, in that it outlines the way that an information system (drawing on the blue print or meta-artefact) should be constructed for a given set of meta-requirements. It provides an abstraction and can help generalise

from one (or more) preceding instantiations[10] or underlying theories[11] towards something that is applicable across a variety of situations.

While the previous notions of theories is primarily drawn from design as practice in the field of Information Systems, there are other areas of Human Computer Interaction such as research-through-design that approaches theory not as testable or verifiable abstractions of meta-artefacts, but rather underspecified, generative and embedded within design exemplars (Gaver, 2012; Zimmerman et al., 2007). In this view, the specific conditions of the creation of any system or artefact is too complex to capture within the confines of a theory that can be easily generalised from one context to the other. The specific instantiation or artefact can embody this complexity by being the result of a myriad of choices made about the design (Gaver, 2012). To this, theory can be attached as annotation that explains and makes visible the choices and the process by which a particular design came to be. The notion of theory as annotation means that the artefact is not subsumed to theory, i.e. it does not exist as an instantiation that can help validate or exemplify the theory. Rather, the theory is there to point out what is salient or important about the designed artefact.

Role of the researcher

In general, design research projects strive for and seek, in various ways, to encourage the active participation of intended users in the development process of the intervention. The level of participation both sought and achieved, however, varies greatly - from intended users being asked to provide feedback or socio-cultural inputs to proposed designs to users being asked to participate as equal partners in the process (Dearden & Rizvi, 2015). Thus the role of the designer in relation to other stakeholders can vary from that of being an expert, producing technical designs and solution, to that of a collaborator or facilitator.

Participation is often sought as a way to ensure that the resulting artefacts are as closely aligned to the needs, conditions and desires of the users as possible (Halskov & Hansen, 2015). The source of this (pragmatic) orientation to participation in design was the recognition that many information system deployments failed (Spinuzzi, 2005). A commonly identified cause for this is the

[10] Gregor and Jones (2007) argues that design theory can exist without preceding instantiation, built upon other design theories.

[11] Gregor and Jones (2007) term these *kernel theories*, and can be theories drawn from natural or social sciences that justifies a particular theory of design.

large number of contextual factors that are tacitly known by those in the context, but inaccessible to an outside designer attempting to design for it (Muller & Kuhn, 1993). By involving potential users or stakeholders of a new system, the idea is that there can be a mutual ongoing exchange between them and the designer that would surface or help incorporate tacitly known factors in the design (Halskov & Hansen, 2015). This recognises that users possess a form of expertise (knowledge about their own context) that is necessary for designs to be successful (Muller & Kuhn, 1993).

Another approach to participation is focused more on the importance for those affected by technology to be actively involved in shaping it. This more emancipatory orientation is associated with participatory design (PD), particularly in the Scandinavian tradition (Halskov & Hansen, 2015). PD grew out of labour union movements that sought to address the potential for marginalisation of workers during the introduction of computers and software in the late 70s and early 80s. This tradition emphasises the role for technology and design to play in constructing alternative ways of being, and argues that the primary goal should be to improve quality of life. PD practice and research often aspire to a stronger form of participation than other design research, where the aim is for there to be a mutual learning process between designers and other stakeholders and where a greater deal of influence over the outcomes of the project is transferred to the user. That this process is intended to be mutual also highlights how the goal is for not only designers to gain access to the social world and tacit knowledge of the users, but also for the users to gain access to the world, methods and expertise of the designer - in the process gaining skills and capacities to design on their own.

Impact

There are several ways in which design research seeks to achieve impact on the problem or situation which it engages with. The first is to use the instantiation of the design (the designed artefact or system) to enable new ways of working or living. For example, farmers may use the system to get access to better crop advice (Gandhi et al., 2007), primary health workers can use it to track maternal or newborn health (Batool, Razaq, Javaid, Fatima, & Toyama, 2017), patients can be supported in following complex treatment regimes for diseases such as tuberculosis (Cross et al., 2019), citizens can hold local policymakers to account (Mudliar, Donner, & Thies, 2013) and primary school students can be helped improve their literacy (Kam et al., 2006).

Another way is through meta-artefacts created either from or validated through specific instantiations. These meta-artefacts can illustrate the way in which systems can be designed for low-resource contexts (Agarwal, Jain, Kumar, Nanavati, & Rajput, 2010), provide access to online content to remote and poorly connected regions (Mahla, Martin, Ahuja, Niyaz, & Seth, 2012) or enable those with low-literacy to access online services (Medhi et al., 2011). These meta-artefacts may not in themselves have an impact on the situation in which they are instantiated but allows technology to be improved and better adapted in the future. In this way, they seek to impact future instances of technology in ways that help improve it for those within the context.

Projects oriented towards critical and emancipatory designs, especially within PD, seek to create a design alternative that illustrates other ways of being, working or living. In these, the designed artefact both exemplifies the different way of being as well as helps bring it about through the modalities and affordances it provides (or doesn't provide) when compared to other (often presently dominant) technological approaches. These perspectives often incorporate, either implicitly or explicitly, the idea of an artefact as not just a collection of features or functionalities, but having affordances. An affordance perspective highlights that the potential of an artefact to support (or sometimes restrict) a user is not a product solely of the material attributes of the artefact, but rather the result of the interaction between the user's desires and goals, their capacities and the environment within which they are acting (Kaptelinin & Nardi, 2012; Thapa & Hatakka, 2017).

A final way is to use the designed artefact or system in such a way that it exposes or illuminates the issue or a particular understanding of the issue. This is perhaps most commonly associated with critical design (Bardzell, Bardzell, Forlizzi, Zimmerman, & Antanitis, 2012) or research-through-design (Zimmerman et al., 2007). Design, in this framing, is a tool by which knowledge about a situation is generated, framed and communicated. For example, it can help make abstract issues more concrete by reifying them into a physical or digital artefact. Artefacts have been deployed in this way to, for example, illustrate environmental impact (Zapico, 2013), climate change (Dolejšová et al., 2020) and social inclusion/exclusion (Le Dantec & DiSalvo, 2013). In this form, the artefact can be used to enable engagement with complex issues as well as creation of shared meanings and understandings (DiSalvo, Nourbakhsh, Holstius, Akin, & Louw, 2008).

Quality

The emphasis in DR approaches lies in the development of a designed artefact. An important way of establishing the quality of a DR project is therefore evaluating the designed artefact itself. Commonly, this means that the artefact will be judged on whether it is useful and usable in and for the target context and intended beneficiaries.

Usability is determined through factors such as learnability (how easy it is for the user to understand how to use the system the first time), efficacy (how quickly users can achieve tasks using the system), memorability (how easy it is for the user to remember how to use the system), the rate, severity and potential for recovering from errors as well as the satisfaction of the users with the design (J. Nielsen, 2012). While some projects adopt quantitative measures for these factors, especially during prototyping phases, a more common approach is to have qualitative evaluations through observation of, and interviews with, users of the system.

When it comes to the usefulness, the uptake and continued use by the target community as well as the self-reported benefits they draw from the functionality, service or information provided through the intervention are used as guides to quality. Quantitative evaluations of the outcomes of ICT4D interventions are more commonly conducted separately, both temporally as well as in terms of who conducts the research, from the design research (Chahal, Sidhu, & Kaur, 2012; Fu & Akter, 2016).

An alternate approach, associated with participatory design, seeks to capture benefits to the users from participation in the design process expanding the notion of impact beyond the designed artefact or intervention. While the conceptualisation of the primary project of a PD activity can be the designed artefact, actual use of that artefact in a context may fall outside of the scope of what a PD project can engage with (Bratteteig & Wagner, 2016). Therefore, an additional way that the outcomes of a PD project can be framed is as “user gains” - what users gain from participating in the research (Bossen, Dindler, & Iversen, 2010). User gains may be both indirect (e.g. having had their voices heard and incorporated in the design) as well as direct (e.g. gaining specific skills and competencies through their participation in the PD project) (Bossen et al., 2010).

Limitations

One of the main limitations for a DR approach to ICT4D is the strong degree of emphasis on the artefact (Sein, Henfridsson, Purao, Rossi, & Lindgren, 2011). This means that the main driver behind the project is the identification and instantiation of a designed artefact appropriate to the context as a solution to perceived problems. This has been a commonly raised critique of ICT4D (A. Chaudhuri, 2012) - highlighting the failure of technocentric approaches to produce development outcomes. The reason for these failures can either be traced to an incomplete understanding of the target context - resulting in design-reality gaps (Dodson et al., 2012; Heeks, 2010) or overly optimistic ideas about what technology can or cannot do. It is a continuing challenge for design research oriented projects (especially those framed as "for development" where an explicit aim is for technology to support positive changes) to avoid this trap of over-emphasising the potential role and importance of the artefact. In fact, the ontological assumptions underlying a research-through-design (Zimmerman et al., 2007) approach, suggests that the artefact is central as a means of inquiry and framing of the outcome of inquiry. In ICT4D such creation of artefacts can be a costly endeavour both in terms of time and financial resources - two things that are often scarce among the communities within which ICT4D projects take place.

Being able to take part in design of technology requires certain skills and understanding. This means that the designer either needs to ensure the there is support in terms of training or resources for users even before the design process, or there needs to be a sort of pre-qualification of the users (Dearden & Rizvi, 2008). Similarly, there is a need for the designer to acquire certain skills to be able to participate actively in the social world of the users - whether language skills, cultural understanding or an understanding of the context of the user's work. When acting in conditions of greater heterogeneity and difference between the social position, background and culture between users and designer the initial preparatory work required (i.e. work that takes place before anything that may be considered design) can be considerable (Puri, Byrne, Nhampossa, & Quraishi, 2004). In a project that emphasises design of an artefact the implications of this can be the exclusion of users without the requisite technological competency, or limitations in the level of participation that can be achieved (Kendall & Dearden, 2018a).

Furthermore, drawing on DR can obscure the very real social and political changes required for development. As Toyama (2011) notes, projects premised on the introduction of technology can not only not make up for lacking institutional

capacities or will, but can also amplify existing inequalities (Toyama, 2011). The need for a DR project to produce an artefact or exemplar of an innovative system can easily overshadow long-term institutional development and activism (Sein et al., 2011). The emphasis on production of prototype solutions and pilots and a corresponding lack of institution building and capacity development has been a detriment to the sustainability of many interventions (Dodson et al., 2012).

This leads us finally to the question of the ethics of design research oriented approaches (Kendall & Dearden, 2018a). One of the challenges of the introduction of new technological artefacts into vulnerable situations is that neither their actual usefulness in addressing the suggested problem situation nor their long-term viability or sustainability can be easily promised (Kendall & Dearden, 2018a). Time spent by intended beneficiaries in contributing to the design and evaluation of prototypes cannot be guaranteed to lead to any real improvement in their living conditions (Kendall & Dearden, 2018a). Even in cases where an intervention produces direct benefits, the inability of proponents to find long-term sustainable solutions for the management and upkeep of the intervention can mean withdrawal of the service causing upset and distress for those who drew benefits from it (Vashistha, Cutrell, Borriello, & Thies, 2015). In these situations, there is a very real question of the balance of benefit between the designer-researcher and the beneficiaries. While the designer-researcher can continue to benefit from the project,[12] any potential benefit for beneficiaries may be lost.

Another challenge for projects oriented around design research is that they will regularly look at finding new solutions based on innovative technology (Iivari & Venable, 2009). This may mean that the technological solution is itself not stable or robust. This can create a conflict of interest between stakeholders local to the context that are seeking technology solutions that work and have minimal potential for failure, whereas the researcher-designer is seeking to test or innovate with new, unproven approaches to technology (Niall Hayes, 2011; Olson & Kellogg, 2014). In some cases, it may even be that the answer to "what to design" is to "not design at all" (Baumer & Silberman, 2011) which would be a difficult finding to accept or incorporate within the framing of a design research project.

3.2.2 Action Research

[12] Through for example, their career advancement or their contribution to the broader field of ICT4D via the understanding derived from the meta-artefact.

A related, but distinct, set of approaches draw more directly on action research. Action research is an empirical approach to research that seeks to not only observe and interpret a phenomenon or situation, but also actively intervene, provoking change (Baskerville & Wood-Harper, 1996). Action research is an approach that seeks to make research directly relevant to those within the setting of the research (Baskerville & Myers, 2004). An action research project is thus evaluated not only, or even, primarily on the basis of advances in understanding or conceptual development but rather on the basis of positive change as a result of the project (Baskerville & Myers, 2004; Hearn & Foth, 2005). The main structure of an action research project involves engaging stakeholders in an iterative cycle of planning, acting, observing and reflecting. In an action research project, there is a simultaneous cycle of research and intervention in the target context (Mckay & Marshall, 2001). It is from these cycles that both research outcomes as well as intervention in the target context are sourced. As such, neither theory nor action is separated but rather are intertwined in an action research project (Hearn & Foth, 2005).

Conceptually, action research is thought of as research w*ith* rather than *for* or *about* people (G. R. Hayes, 2011). Similarly to the aims of participatory design, action research in the design of ICT interventions aims at mutual learning between all participants in the project. As such, active engagement of multiple stakeholders is critical and is often achieved through project working groups. These groups engage in what can be called *action learning* (V. J. Friedman & Rogers, 2008), which in a simplified form can be seen as an ongoing process of learning about a topic, theme or context through acting within in it and reflecting on said action.

The mode of inquiry within an action-research project can vary, however with the core notion that knowledge is generated through engaging in collaborative action. McKernan (2007) identifies action research inquiries into a typology of scientific-technical, practical-deliberative and critical-emancipatory. The scientific-technical mode of enquiry, in which he, for example, places Kurt Lewin's work, follows an empirical-rationalist and positivist understanding in which there is a knowable and measurable reality. In this mode, researchers would seek to identify, validate and test potential theoretical ideas or solutions. In the practical-deliberative, the aim is to work together with participants to identify local practices, issues and problems and solutions for them. The deliberative process of identifying problems and solutions is more central in this approach than the specific products of the

inquiry. In a critical-emancipatory form of action research, the emphasis lies on the equipping participants with the tools to critically understand the issues they are facing and empower them with tools to change the underlying structures that drive the emergence of these issues. Research in this mode is explicitly value-laden, and is concerned with altering political structures within the research context.

There are multiple variants of action research as have been applied in different contexts and incorporating different versions of these modes of inquiry. In information systems research, AR has been applied in ways that adhere more closely to the original approaches of Kurt Lewin (emphasising various numbers of stages of planning-acting-observing-evaluating) to those that drawn on other intellectual traditions like systems thinking (Checkland, 1988) and grounded theory (Baskerville & Pries-Heje, 1999). There are also approaches such as Action Design Research (ADR) that have sought to combine elements of the previously discussed DR approaches with an AR orientation towards the mode of intervention (Sein et al., 2011).

In socio-economic development, action research has most famously been used in what has become termed as "Participatory Action Research" (PAR) (Chambers, 2008). PAR is an approach to development that emphasises the active participation of those whom a development effort seeks to impact. A large number of methods and tools have been developed for the operationalisation of PAR in development contexts. In ICT4D, Ethnographic Action Research (EAR) (Tacchi, Slater, & Hearn, 2003) has become an influential approach. EAR combines an ongoing ethnographic inquiry and reflection on the context with action oriented intervention. It emphasises the development of local capacity to perform this ongoing inquiry as well as to take action in response to its findings. The emphasis on ethnography in EAR recognises the need for deep observation and reflection both on the initial situation but also on how the changes brought about in the AR project influences the situation.

Some would argue that both design research (Järvinen, 2007) and participatory design (Foth & Axup, 2006) are forms of action research. However, projects that base themselves in action research have a series of distinctive attributes that can set them apart from projects that are framed either as DR or PD. In looking at the differences and similarities between PD and AR, Foth & Axup (2006) see them as similar in their value of active participation, but different in terms of approach

and intent. Whereas PD projects often have a narrower focus on design of an intervention and seek participants' active engagement in shaping it, AR projects broadly ask participants to think about their situation and envision changes to it. AR projects do not necessarily pre-suppose that there should be specific tangible outcomes or have specific goals when it comes to technology (Foth & Axup, 2006). Foth & Axup (2006) suggest that the two approaches could be fruitfully combined - with the initial phase of a project operating more as an AR project and the latter phases as a PD project.

When it comes to DR, Iivari & Venable (2009) argues that, while AR and DR are similar in some ways, there are important differences. Importantly, while AR as an approach is interested in finding ways to improve a context (similar to DR), there is not specifically an interest in producing or designing an artefact. Furthermore, DR oriented research is much more likely to seek to address a whole class of problems (Iivari & Venable, 2009) for a specific "type of client" - i.e. stakeholders that share similar attributes or contexts. In doing so, it may be helpful to instantiate the more general solution in a specific context with a specific client. With an AR orientation, the client and the context are critically intertwined with the project itself. Sein et al (2011) argues that DR alone cannot address the intertwining of organisational concerns and change with the design of technological artefacts and meta-artefacts. In response, they provide a method that sits in between Design and Action Research (previously mentioned, ADR) (Sein et al., 2011). Iivari & Venable (2009) goes further in suggesting that much design research operates with a positivistic epistemology whereas AR is a primarily anti-positivistic approach.

Finally, the view of technology differs when looked at from an action research standpoint as opposed to either a participatory design or design research standpoint. A goal in Design Research (including methods built upon it such as ADR), is to create an innovative technological solution that can be generalised to a broad class of problems (Sein et al., 2011). In AR, on the other hand, it would generally be the goal to adopt technology that is proven (thus, less innovative technologically), that has as little chance of failure as possible (Iivari & Venable, 2009) and that can effectively address the specific issues of the problem context (rather than a class of problems).

Role of theory

Action research is built around the integration, to varying degrees, of theory and

practice. Bridging the gap between theory and practice is one of the fundamental drivers behind the development of action research (Dick, Stringer, & Huxham, 2009). Existing theory can inform and form the basis for an action research project (Dick et al., 2009). For example, an ICT4D project could encompass a theory of development and a theory of the material artefact's role in development. However, in an action research these theories need to be translated to and incorporated within practice - typically a series of plan-act-observe-reflect cycles (Dick et al., 2009). Critically, though, a theory that is not or cannot be grounded in practice is (from a pragmatist standpoint) not relevant (Baskerville & Myers, 2004). In a broad sense, all action is grounded in theory - when acting, people have a notion of the outcomes they seek to achieve by that action (Dick et al., 2009). This holds especially true for the consciously informed action that action research seeks (Dick et al., 2009).

When it comes to developing theory from action research projects, the source of theory is the actions that are undertaken. How these actions contribute to building theory can be viewed in different ways. There are more formalised approaches such as Baskerville's and Pries-Heje's (1999) integration of Grounded Theory into action research cycles to provide a rigorous framework of theory development. On the other side, more participatively oriented researchers argue that greater formalisation in theory building can be difficult to combine with commitments of research *with* rather than *for* or *about* participants (Dick et al., 2009; Genat, 2009). Methods of theory building that require training and tools can serve to distance the outcomes of the research project away from the practice and the practitioners. Modes of theory building that emphasises participation tend to focus on the production of local knowledge and understandings (theories) about the particular context and situation within which the intervention is taking place (Genat, 2009). As I will discuss further below, notions of rigour operate differently in this form of research and theory is judged by its meaning to, and applicability for, participants in the research context rather than by the fidelity of adherence to a specific methodological framework[13] (Genat, 2009). Approaches such as action learning, or participatory action research, often employ a participant focus group or action learning set to work throughout the action research project to develop locally embedded understandings of the findings of the research (V. J. Friedman & Rogers, 2008; Genat, 2009). These groups serve to critically review, interpret and analyse the outputs of the project. Identification and formation of such a group is a critical step in this form of action research, and

[13] i.e. that the rigour of the theory building is primarily determined by the adherence to a framework of methods

is a means by which theories of the work is developed throughout its progress.

Beyond the locally situated theory developed in an action research project, there is typically the need to generate knowledge relevant for outside agencies - for instance, other researchers or funding bodies. In approaches such as grounded action research (Baskerville & Pries-Heje, 1999) this process is made explicit and formalised. In the more participatory oriented approaches the generation of theory for outside use is often secondary to locally generated knowledge or theory (Genat, 2009). It becomes the responsibility of the researcher in the project to translate that situated understanding into discourse useful for outside parties (Genat, 2009). Theory building as a process of translation is in some ways similar to theory as annotation of situated design artefacts in design research (3.2.1 Design Research).

Role of the researcher

Participation is a core ethic of action research, and the term "participatory action research" is occasionally used as a synonym for action research. All action research assumes some form of collaborative inquiry between those who are considered the researchers and those who are considered participants. In some action research approaches (for example, EAR) the emphasis is on the participants gradually becoming researchers into their own situation, blurring the distinctions between the roles.

Depending on the mode of problem solving adopted in the project, the role of the researcher may be quite different. The scientific-technical mode of inquiry largely retains the role of the researcher as an expert on the research process, as well as the theoretical issues being investigated. While democratic participation is still a necessary element, the role of the participants can sometimes be limited to being consultative - providing feedback and input on issues or models proposed by the researcher. In the practical-deliberative mode of inquiry, the role of the researcher is largely a facilitator, seeking to support a process where the participants can themselves identify issues and solutions. In a critical-emancipatory mode of research, the researcher's role is much more active and could most closely be thought of as a researcher-activist. In this role, the researcher has a specific (identified and acknowledged) position from which they engage in the situation. Their role would include not just identifying issues and solutions together with those involved in the research, but also supporting consciousness raising and critical understanding.

Impact

Similarly to participation, the notion of impact is central and integral to action research. Specifically, the stated goal for action research is to have a positive impact on the situation within which it takes place. What is the desired impact and for whom must be defined within the project itself and will look differently based on the type of inquiry undertaken. In a scientific-technical perspective, the sought impact may be based on a theoretical or pre-defined notion of the change that is sought and the impact be judged by the acceptance or "buy in" of those involved in this change. In a practical-deliberative mode, the impact would be the identification of a relevant solution and the successful implementation of it. Finally, in a critical-emancipatory mode the impact would involve the development of critical awareness of issues and the capacity and scope for action to alter them created by the project.

The impact of action research is largely measured by the practical actions that are undertaken throughout the project and as a result of the project. While, action research projects do not necessarily have a specific starting and ending point, and it can be argued that they should ideally be considered perpetual, the practicalities of research means that there will usually be a "project period". Action cycles undertaken throughout the project period would be part of the impact created, and these may have certain direct impacts on the situation itself. This could include new resources such as tools or technologies being made available or the introduction of new activities such as meetings or workshops. However, longer term impact would seek to create sustained change in the everyday practices of those involved - for example new ways of working or living together, interactions between new groups of people or incorporation of a new technology or tool in pre-existing day to day activities. This longer-term impact could also include new skills, capacities or possibilities and opportunities for those involved in the programme.

Quality

Guba & Lincoln (1986) propose a set of criteria for research which they call *trustworthiness*, which have been applied to establishing quality and rigour in action research (G. R. Hayes, 2014). Trustworthiness stems from four distinct but related concepts: credibility, transferability, dependability, and confirmability.

Action research produces knowledge that is highly situated - knowledge that is actionable within the context (Hearn & Foth, 2005). Findings are considered

credible if they would be recognised as valid by someone from within the research context. The knowledge thus generated can be used within subsequent cycles, as well as to improve participant's own understanding of, for instance, the problem context that they are within. Such knowledge can no more be replicated than the specific time, setting and social situation can be replicated. Not only can it not be temporally replicated (i.e. repeated), it cannot be comfortably generalised to apply to other situations. *Transferability* is the desired quality of such findings as opposed to generalisability (G. R. Hayes, 2011). In order for findings to be transferable they need to be gathered, analysed, described and presented in a transparent and sufficiently rich manner - i.e. they need to be *dependable* and *confirmable*. While it is not possible for someone to replicate or validate the findings themselves, evidence needs to be available to others to confirm that the events described in the research took place in the way they are reported.

Moving away from a notion of generalisability also allows a different understanding of the researcher's role. Rather than attempting to avoid influencing the outcomes of the research and viewing such influence as 'bias', AR takes cognisance of the fact that the researcher is an integral part of the situated knowledge that gets created (G. R. Hayes, 2011). Eschewing generalisability also means a requirement for different ways of viewing rigour in the process.

Trustworthiness can be achieved through for example triangulation, the inclusion of multiple differing perspectives and member checking. Triangulation means contrasting findings between different groups, situations, researchers or time periods. Inclusion of multiple, sometimes conflicting perspectives, allows for differences between different participants in the learning process to be made clear and is especially important in combination with reflection on and awareness of the standpoints of different actors. The goal is not to achieve a single, confirmed, true narrative by this method but rather to identify similarities as well as differences in order to achieve a richer understanding of the issue or event.

Member checking involves checking data and interferences with those involved in the AR project allowing both transparency within the project as well as building trustworthiness in that the findings and inferences actually match with the community's own perception. Prolonged exposure to the field, long-term observation and interaction between stakeholders and the explicit learning and use of the participants' language to describe their own issues are other ways in which trustworthiness can be established.

While, these criteria are suggested as an alternative to traditional, positivist criteria, they can also be viewed critically as an attempt to adjust pragmatist research towards a different ontological and epistemological paradigm.

Limitations

A key limitation of the expanded scope of action research projects is that the focus on a broader set of actions and interventions can mean that introduction of technology can entirely be lost in the process. This is perhaps not as much a limitation when it comes to the goal of having a positive impact on the target situation, but can be a real challenge in a research project framed around the use of technology. The fact that AR would place positive change in the target context as the primary goal means that the outcome of the project may not involve technology at all. While this can be a problem for the achievement of a degree or being able to publish in specific research venues, the lack of specificity in many AR projects can also make them confusing or difficult for participants to make sense of. An open-ended exploration into participants' situation and context can be an unfamiliar activity, and can be perceived as a waste of time or less of a priority than seeking to address specific problems with a tailored solution.

The strong embeddedness of an AR project into the target context can also mean limitations for the project. First and foremost, long-term and close collaboration between researcher and other participants as equal partners in an action learning set can mean that the researcher moves from being an outsider, to an insider-outsider, to eventually more of an insider than an outsider. While this is in many respects desired, and a necessity for conducting this type of work, it also means that over time the amount of external perspective and input that the researcher can provide lessens. Furthermore, this embeddedness and the gradual adoption of an insider role can mean that it can become difficult to challenge existing power structures and relations - especially those within the institutional and organisational context that the project operates within.

3.3 Methodological choices

In approaching my research questions, I have argued that my research concern centres around the understanding of and intervention within socially constructed phenomena. Considering the action oriented nature of my research (especially RQ2) my epistemological standpoint is pragmatist. As I have outlined in this

chapter, this leads to a specific type of knowledge claim, one that builds on creating knowledge through action and reflection (Olson & Kellogg, 2014). Informing this action is a pragmatist understanding of the knowledge ecosystem which forms my RQ2 as well as the reflexive understanding of the role of the designer and the researcher which I seek to explore through RQ3.

A fundamental starting point for pragmatist research in general, and my project in specific, is that it is participatory and conducted in collaboration with those involved in the research situation or context. From a pragmatist standpoint, it is through action within the context, that we can claim novel knowledge about the context (Baskerville & Myers, 2004). Thus, it follows that it necessarily calls for participation. Furthermore, a core element of pragmatist research is that action (in other words, intervention) creates change to the context. The goal is for this change to be positive - i.e. that whatever change occurs is desirable. Pragmatist research is thus normative and involves axiological choices in addition to ontological and epistemological. What change is desirable (i.e. what norms are adopted), is in the end a question of which and whose values are incorporated into the research programme. While this is not always acknowledged explicitly, the normative nature of such interventions is inherent in any project that engages with socio-economic development - whether based around ICTs or not. Development is directed, and its direction is driven by values. The notion of development discussed and adopted for this project in the previous chapter recognises this - the goal for development is seeking to support individuals and communities to develop capabilities that they have reason to value. What these capabilities are and how they are valued has to be defined together with those who are the focus for the development effort. This highlights the need for ensuring that the primary benefits of the project should accrue to those participating in it, and that it is their values and positions that should take precedence over those external to the context - including my own. It becomes imperative that a primary focus for the research process is the agency of those who are involved in the research context.

3.3.1 Criteria for research rigour

However, this is not just a development oriented project but also one that positions itself as research. Research involves a systematic search for knowledge. The quality of any research draws on its relevance and the confidence that the research is the outcome of a legitimate research process (Burrell & Toyama, 2009). That is, the reporting of the research needs to establish transparency into

the research process so that it can be clear that a research process was carried out and that the findings are not "a product of the researcher's imagination" (Burrell & Toyama, 2009). There also needs to be sufficient evidence that the findings as presented can be justified and that the methods applied are sound (Burrell & Toyama, 2009).

Relevance

Relevant research can be defined broadly as research that is "interesting, applicable, current and accessible" (Keen, 1991) - that is, does it in a timely way address issues or concerns that are of interest to, and important for, practitioners and other researchers, and can they make use of it in practice through incorporating it in new methods or approaches (Fallman & Stolterman, 2010). Drawing on the pragmatist orientation of this project, I do not only seek to inform or provide interesting information to others. Rather I consider the outcome of the intervention as central to the validity of the findings - a form of "outcome validity". As mentioned, the outcome of the project or the knowledge that is generated, should lead to sustainable, directed action. The relevance of this research can thus mostly be measured not in whether the intervention "produce innovative solutions that would warrant additional interest from the computing research community"(G. R. Hayes, 2014) or even other practitioners, but rather whether it produces sustainable and relevant change for those involved in the project itself.

Confidence

In participatory research, Frauenberger et al. (2015) argue that coherence between epistemology, values, stakeholders and outcomes is a primary way by which confidence can be established. They highlight the need of coherence between the epistemological stance, the values that are sought to be incorporated and emerge through the project, the way in which stakeholders are considered and involved through the project and the sustainable outcomes that are achieved. Coherence does not suggest a single viewpoint but allows for "multiple even conflicting values present when this is reflected in the way outcomes are defined and stakeholders are involved" (2015).

Considering my research project, as I have already highlighted, my pragmatist epistemological stance aligns with the participatory and value-laden notion of development I have adopted. Seeking coherence does not mean seeking agreement. Rather it requires continuously asking questions about conflicting perspectives

and critically reviewing elements of the project. It also requires making myself and my interests, my values and my standpoint in relation to others in the project visible and as transparent as possible. Ongoing reflection and dialogue with all stakeholders (whether those directly involved in the project implementation, other collaborators or my supervisors) is necessary for this practice. Questions, such as those raised by Frauenberger et al (2015) (see *Table 5*), form the centre of this reflection and dialogue. This process of reflection & dialogue, as well as the written account of that same process given in this thesis, is the core of how I view establishing the confidence in this work as research.

Epistemology What are the kinds of knowledge constructed? To what degree can we trust the knowledge? What is the potential for transfer? How is knowledge shared?	Values Which values drive the process, explicitly or implicitly? What are the conflicts and dilemmas arising from values? How do values change in the process ? How are values reflected in decisions?
Outcomes What are the different interpretations of outcomes? Who owns outcomes? How sustainable are outcomes?	Stakeholders Who are the stakeholders and who participates? What is the nature of their participation? How do stakeholders and participants benefit? What happens when the project ends?

Table 5. Starter questions for a reflexive framework of research rigour, (Frauenberger et al., 2015)

3.3.2 Choosing a methodology

These framings of relevance and confidence need to be incorporated in the methodology chosen for the project. The methodology must be coherent with my pragmatist epistemology, with the values of participatory development and with achieving outcomes that are of primary relevance and benefit to those in the context. The methodology must place the me (in the role of the researcher) in a position to collaboratively develop knowledge and have impact with stakeholders within the research context.

The research questions I ask are about understanding and intervening in a social

setting. Onto to this social setting, I map the concept of a knowledge ecosystem (2.4.1 Knowledge ecosystems) as well as a notion of development. The knowledge ecosystem consists of both a social setting as well discursive elements based on a particular ontological and epistemological position. The social setting combines the varying interactions and relations between people and discursive elements such as the values, content, meanings and understandings that they share. The understanding of development laid out in the previous chapter, directly states that what development means and how it is constituted is created through a shared mutual understanding between those involved in the process. This process involves a negotiation of what can be considered progress (and what cannot) as well as how to prioritise different outcomes. It is a process that is underpinned by value judgements and that is subjective and social. It also involves collaboration and agreement between multiple actors. Thus, I consider these phenomena to be fundamentally socially constituted and constructed. By intervening, through designing a socio-technical intervention, I become part of this collaboration and negotiation. However, as I am undertaking not only an intervention but also a research project, I seek to contribute to knowledge and this requires an account not only of the ways and means of the intervention but also for concerns of the ways of knowing incorporated in the project.

I have in this chapter discussed and contrasted the difference between positioning a research project like this as either design research or action research. Both of these can be coherent with a pragmatist epistemology, supporting the creation of knowledge situated in action[14]. An important difference, however, is that design research frames the project around the creation of a novel (meta-)artefact. This would align with what I have discussed as a technical-scientific approach to problem solving which would seek to engage stakeholders in testing, evaluating or developing an intervention "... designed to create some change in the setting, which can include new practices and approaches, different power structures or group dynamics, altered patterns of action, or simply the incorporation of a new piece of technology into daily practice" (G. R. Hayes, 2011).

While this would perhaps more easily align with notions of relevance to an outside audience of this project (G. R. Hayes, 2011), it may not be the one that best

[14] Especially in incarnations such as Action Design Research (Sein, Henfridsson, Purao, Rossi, & Lindgren, 2011) and Research-Through-Design (Zimmerman, Forlizzi, & Evenson, 2007) that considers research and practice to be tightly coupled, recognising the way in which theory can be generated and incorporated via action into designed artefacts.

contributes to development within the knowledge ecosystem I am intervening in. Following this typology, my approach for this project is rather practical-deliberative or critical-emancipatory - focused "...more on unknowable, social realities with research problems that are constantly evolving and defined in the situation by a variety of stakeholders with dynamic and mixed values" (G. R. Hayes, 2011). In this framing, the social reality of the situation may or may not result in the design of technology. However, if it does, the primary focus will be on addressing problems of relevance to those within the social context. This represents a move away from a primary goal of seeking to address a class of problems or a class of solutions through the research process (as would be the case in design research).

Accordingly, the coherent choice for me is to place this project in an action research paradigm. The mode of problem solving and my own role, changes throughout the project, starting out in practical-deliberative mode during which my role involves observation, understanding and facilitation as part of exploring and understanding the knowledge ecosystem. This role then transitions towards a mode of critical-emancipatory problem solving as I move towards intervening, which invariably will involve communicating and taking stand-points on how the work is framed and structured.

3.3.3 Intended contributions

Drawing upon my discussion of the role of theory in AR (3.2.2 Action Research) and the participatory orientation that I am taking towards this project, I also adopt an understanding of situated theory and knowledge as the primary aim of this project. That is, my focus lies on adopting methods and tools that allow for the participants within the research setting, in collaboration with and aided by me, to build a theory about their own situation, the challenges they face and the way our interventions address them. Drawing upon this local theory, it is then my responsibility and the responsibility of this thesis to highlight how that local understanding can be, potentially, interesting for those outside of the specific project context. This does not, as I have discussed, imply any notion of generalisability or potential for "scale", but rather an invitation to take the local theories of this project and use them as inspiration or input in other settings and contexts. However, I will involve both theoretical understandings in my work (particularly those of development, of technology and of sustainable agriculture (2 Background)) and it is the aim of this thesis to contribute to understandings of what the implications are for ICT researchers and designers when conducting

work informed by these positions.

3.3.4 Theoretical outcomes

In research that aims for action, the theoretical outcomes sought are generative and aspirational (Frauenberger et al., 2015) - creating possibility for new realities to emerge (Gaver, 2012) - and often normative - suggesting ways in which action should be conducted (Hammersley, 2012). Theory serves as suggestion for further action, and is a way of framing or understanding problems within the context (V. J. Friedman & Rogers, 2008). Such theory is continuously tested through translation into practice, which may then challenge and develop the theoretical understanding. Reifications, such as technological artefacts, can serve as ways to articulate theoretical framings making them (temporarily) stable (Zimmerman et al., 2007). They can enable experimentation and testing of framings through action involving the artefacts (Zimmerman et al., 2007). This may advance shared understanding of both current reality as well as development of normative theories of what reality should be (Zimmerman et al., 2007). As such they can be difficult to quantify, compare, generalise or replicate (Frauenberger et al., 2015). Attempts of formulation of predictive theory in this form of research would (at best) have very weak predictive power (Frauenberger et al., 2015). Even if the exact settings were to be replicated along with all the same activities and resources, it is unlikely that the outcome of this project would be replicated if attempted a second time (Fallman & Stolterman, 2010).

Following this positioning, I consider that the theoretical outcomes of this project will fundamentally be tied in with the unique situation in which they are created and will be strongly situated, value-driven, collaborative and subjective (Frauenberger et al., 2015). They are inherently subjective and relational, as they are a result of interactions between the varying participants and their individual and collective interpretations including my own. Throughout the activities undertaken as part of the project, a shared theory of the context and situation would be developed between myself and the other participants in the project. This shared theory would be tested through action, whereby we employ intervention built upon such shared understanding. Broader implications of this work exist to the degree that these understandings can be used to inform action separated either spatially or temporally from this project. While theories about the nature of the work of DRCSC and their relationships to technology (RQ1) is specific to them, it can help inform understanding of technology in other contexts that have similarities to that of DRCSC - whether when it comes to their organisational

structure, the nature of their work or the social, economic, cultural or ecological conditions within which their work takes place. Likewise, theories of the type of intervention (RQ2) that can help strengthen this work (possibly incorporated in reifications and socio-technical practices) can be employed to inform, and critique, interventions (both current and future) within DRCSC and elsewhere. Finally, normative and methodological theories of the role of information technology designers and researchers in development (RQ3) can be developed through reflection on the way action is undertaken in this project and be employed as part of a methodological approach in other projects.

3.4 Summary

In this chapter I have laid out the methodological orientation of this research project. I began by discussing different approaches toward knowledge, or ways of knowing. I specifically discussed interpretivism and pragmatism as two potential orientations suitable for the type of questions that I raise in this thesis. My primary of actionable knowledge led me towards a pragmatist approach to the research. Following this orientation, I then discussed two potential methodological approaches - Design Research and Action Research. Both of these approaches have been adopted for research in a pragmatist tradition and can account for the role of action and intervention in the production of knowledge. While these methodological approaches have a great deal of overlap, they differ in the way they approach the focus of an inquiry, the role of theory, the role of the researcher, the impact they seek as well as in their understandings of the quality of research.

After having discussed these two different approaches, I turn towards the particular methodological choices that I have made for this research. My primary guideline is the notion that methodological choices should be coherent with my research paradigm and the theoretical underpinnings of development and sustainability I draw on. For example, the emphasis on situated understandings of sustainability and participatory development requires a participatory focus in the choice of methodology. This also leads to a particular stance on theory and what knowledge claims I seek to make. My emphasis not just on technology and design, but on broader organisational and social change likewise greatly influences the way I perceive the possibilities and limitations that design and action research affords. With this in mind I have chosen to frame this project as action research, with a strong participatory orientation. In the following chapters, I will begin to

account for the research as it was undertaken, by first discussing the two introductory cycles of action research that were intended to frame the research programme in collaboration with DRCSC.

4. Studying the context

In this chapter I begin to describe the action research programme undertaken through the project, by delineating the first two of a total of five different cycles of action research. The division into five cycles as presented in this chapter and chapter 6 Intervening in the organisation's work is an explanatory device intended to support an outside reader in making sense of the programme. This, however, is not a chronological description nor can either the cycles or the stages of the cycles be cleanly delineated from each other. During the action research programme, there would be several stages (for example, action and evaluation) that would occur partly in parallel. It is also the case that any presentation of an action research programme is by necessity incomplete and I have made choices as to which details to include and to focus on.

The first two cycles together form an initial inquiry oriented phase, where the goal was to set up infrastructure for the action research project, initial framing of the research programme and gain a deeper understanding into the *situation* within which the research was taking place. Baskerville & Myers (2004) might frame this as a "diagnostic stage", though with the participatory orientation of this project I would consider the diagnosis to be a collaborative inquiry that builds local theory and knowledge about the situation rather than any attempt at "external diagnosis". The idea is to build a shared theory about DRCSC's work, what important challenges there are and the framings of how we intend to address these challenges. This phase is equally about me learning from them about their ideas, values, and understandings, as it is about me helping them expand these situated theories and frame them in new or different ways (Genat, 2009).

The first cycle also involved setting up the infrastructure required for conducting the research programme. This included ensuring that there was a research proposal that matched both mine and DRCSC interests, that there was a suitable approach to ethical review and that my research programme was anchored within the organisation and among their staff.

4.1 Cycle 0: Starting the project

4.1.1 Plan

The precursor to this cycle was work that I had previously done with the organisation. During this work (which was part of my MSc thesis (Kendall, 2015)) we developed and evaluated interactive voice response (IVR) technology to support farmers. During this research, I had built an initial relationship with both the head office and field office staff members. On the basis of these relationships, I wrote a PhD research proposal. The proposal was discussed in broad terms with the secretary (Somjita) and the head of research & training (Tapas) from the organisation even before I applied to any university (they also provided a letter of support given in Appendix A). In this proposal, a project on technology design and appropriation within the organisation was agreed.

Once starting the PhD, I was going to be based outside of India (in the United Kingdom) for a considerable amount of time. Considering that my research proposal was placed as an action research programme which would be conducted in close collaboration with the organisation this created a set of challenges.

Perhaps most importantly, how could we ensure that the framing of the research is done collaboratively with the organisation? It was crucial that the research not only reflected my interests or the interests of my department and supervisory team, but was also clearly grounded in the goals, interests and aspirations of the organisation. This is a challenge for any action researcher but is greatly compounded by the fact that I would (partially) be based in a different country. I had discovered, during my previous work with them, that the organisation neither had the practice of holding online meetings nor the infrastructure (in terms of stable Internet connection) to do so. Therefore, we could only do limited coordination and collaboration over e-mail when I was not present in India. While there is always a certain distance between an outside researcher and other actors involved in an action research project, this physical distance between myself and the organisation when I was based in the UK would compound it.

This is not just a practical issue of being able to do the work, but also an ethical one. There has been significant critique in the field of ICT4D (Dearden & Tucker, 2015) - but also across other fields (Bockarie, Machingaidze, Nyirenda, Olesen, & Makanga, 2018; The Lancet Global Health, 2018) of researchers based far away from the countries in which their research takes place. A common pattern has been for researchers to “parachute” or “bungee-jump” into the research site during short, intensive periods of field work and then leave to go back to their home departments at universities elsewhere. This is an approach to research that,

even if it does not actively harm those involved, can easily lead to a situation where the benefits of the research almost exclusively flow to the researchers (in the form of degrees or career advancement). It would not be an option that aligns well with an action research orientation that emphasises the need for research to provide benefits to and solutions for real problems of those involved in the research (Hearn & Foth, 2005).

Regular time spent physically at the organisation was thus required despite the geographic distances involved. Considering all of this, I was keen to ensure two things. First of all, that I would be able to combine the time spent in the UK with regular periods spent in India at the organisation. The way we built this into the plan was for me to spend approximately four to five months in the UK every year (primarily during the university terms of autumn and winter) and then return to India during spring, summer and monsoon to work with the organisation. Secondly, I wanted to, as early on as possible in my research programme, spend time with the organisation discussing the outline and frame for the research programme. This was particularly important to ensure that I would not end up devoting too much time in the UK building a frame for the work I intended to do without grounding it in the work of the organisation. Working out a literature review or research proposals, while outside of the location where the research is taking place, creates a considerable risk for having a very clearly defined idea of what work is relevant and interesting. This would be entirely one-sided, based on my interests and those of the academic community I am part of. It then becomes easy (whether intentional or not) either to recruit partners that fit that idea, or convince existing research partners that this is what they want to work on.

Accordingly, my supervisor and I planned a period spent in India with the organisation only 3 months into my degree studies. The first phase started in January 2016 and lasted for approximately three weeks. This phase would produce a research project outline and establish the infrastructure necessary for me to conduct a longer action research cycle in 2016. This included both physical infrastructure (such as a place to stay and visa arrangements) as well as organisational infrastructure (within DRCSC) to conduct the research project. Another piece of infrastructure was a collaboration with an Indian academic institution.

In order to outline the research project, I wanted to get an initial idea of the types of challenges and concerns DRCSC and myself could deal with through the action

research project. I also wanted to get an overview of the current state of the organisation. Accordingly, I prepared a semi-structured interview protocol for a set of initial interviews as well as a structure for a short workshop. In this cycle, I also intended to deepen my pre-existing relationships with staff members by spending time at the organisation's offices, conducting initial interviews and holding the planning workshop.

4.1.2 Ethics

This phase was preparation for the actual project and was conducted before the final ethical review had taken place. The intention was that outcomes from this cycle should inform the submission for ethical review prior to starting cycle 1. A preliminary version of the ethical review submission had been submitted in November 2015. During cycle 0, I considered the interviews and meetings undertaken as primarily for planning. I also specifically did not interview or collect data from anyone who could be considered vulnerable - meaning that I only interviewed staff members at the head office of the organisation. All those interviewed for this planning phase were also part of the action learning set and were thoroughly informed about the project. We discussed how any data from individual or group conversations would be used as part of planning the research project, my submission to the ethics committee at Sheffield Hallam as well as for my thesis. I took explicit permission to include quotes in this chapter from those who provided them.

4.1.3 Act

02/01/2016-16/01/2016	Interviews with head office staff members
12/01/2016	Observing a Climate Field School meeting in Patherpratima
14/01/2016	Action learning set workshop

The action part of this phase involved a series of interviews with different members of staff - the founder of the organisation, the organisation's secretary, two team leaders and one team member. These were preliminary semi-structured interviews to ground the planning for my research project. As such I sought to discuss the current state of the organisation, potential challenges faced and important concerns. The interviews lasted between 30 and 90 minutes and helped me to orient myself and deepen my understanding of the organisation. They were also a way for me to introduce myself to more members of the organisation,

discuss the fact that I was conducting this research and explain some of my research interests.

Towards the end of the phase we established an action learning set (ALS). The idea with the action learning set was to have a group within the organisation that could fulfil several roles. First of all, they would help steer the project by providing their views on the needs and interests of the organisation. Secondly, they would provide a forum for discussing and interpreting any findings from the research project. Thirdly, they would provide a form of supervisory body within the organisation that could track the work and provide oversight from the organisation's perspective on my conduct as well as on the approaches taken in the project. Finally, the action learning set provided a way to anchor the project in the organisation, helping to develop a formal commitment to the project, and provide formal organisational approval of the work.

The composition of the action learning set was decided by the secretary of the organisation. I provided her with certain suggestions - for example, I thought it would be good if we had representation from different teams within the organisation as well as people of different seniority. From this discussion, she settled on the following composition of the group (also illustrated in Figure 10):

- The secretary – Somjita
- Team leaders - Chandrani (head of "Wet Zone"1 team) and Tapas (head of Research & Training)
- Team members - Kaustav (Wet Zone team), Mintu (Research & Training team), Purnabha (Research & Training team)
- One senior staff member - Rajkrishna

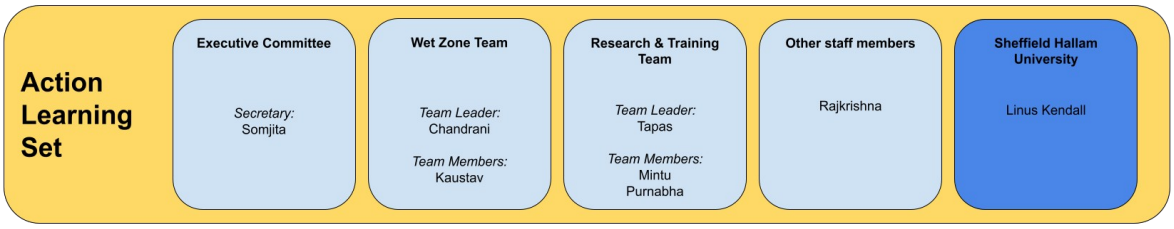


Figure 10. Composition of the Action Learning Set.

All of the people with whom I conducted initial interviews (apart from the founder

of DRCSC, Ardhendu) were asked to be part of the action learning set, and additionally one senior staff member and two additional team members joined. We held an initial workshop with the action learning set to frame and plan the project. All of the members of the action learning set attended this meeting, which lasted about 90 minutes. To this workshop, I brought with me the initial research planning that I had done in the UK. Practically, this was in the form of a research proposal and an application for research approval as had been required by the university in the first few months of my research[15]. This document included literature I had identified as relevant, a basic research and problem statement and my research questions. In this initial meeting, I presented the project as related to "knowledge sharing and communication about sustainable agriculture in the work that DRCSC is conducting". I stated that the goal of the workshop was to relate my academic and research interests to the practical context, needs and interests of DRCSC. For me, it was important to negotiate the balance between a framing of the project around knowledge sharing and learning and a framing emphasising development of ICTs. This broadened scope was one that I had previously only discussed with Tapas and Somjita. As the research proposal[16] that I presented was fairly short and limited, I made it clear that we needed to create most of the framing of the project collaboratively. Most of the participants in the ALS were already somewhat familiar with me since I had previously collaborated with the organisation. After my introduction, we discussed three questions extensively:

- What are the areas of knowledge which DRCSC are working with and communicating/sharing about?
- Who are the stakeholders involved in this knowledge sharing?
- What are the challenges DRCSC is facing with regards to sharing knowledge/communicating amongst these stakeholders?

Based on the research questions, the action learning set collaboratively mapped out areas of work (see Figure 11), stakeholders (see Figure 12) and challenges (see Figure 13). In these discussions I also shared my views as drawn from my previous work with DRCSC as well as from the initial interviews I had conducted in this cycle. While a thorough analysis of these interviews would need to wait until I returned to the UK, I did refer to them throughout our discussion in the workshop. The meeting was a fairly open ended discussion, which was documented in the form of flip chart notes as well as through a recording of the entire meeting. As an

[15] Sheffield Hallam University terms this submission the "RF1".

[16] The RF1, i.e. the research proposal I had submitted to the university for approval of the research programme.

action point from the meeting, I proposed that I would update and send them my research statement.

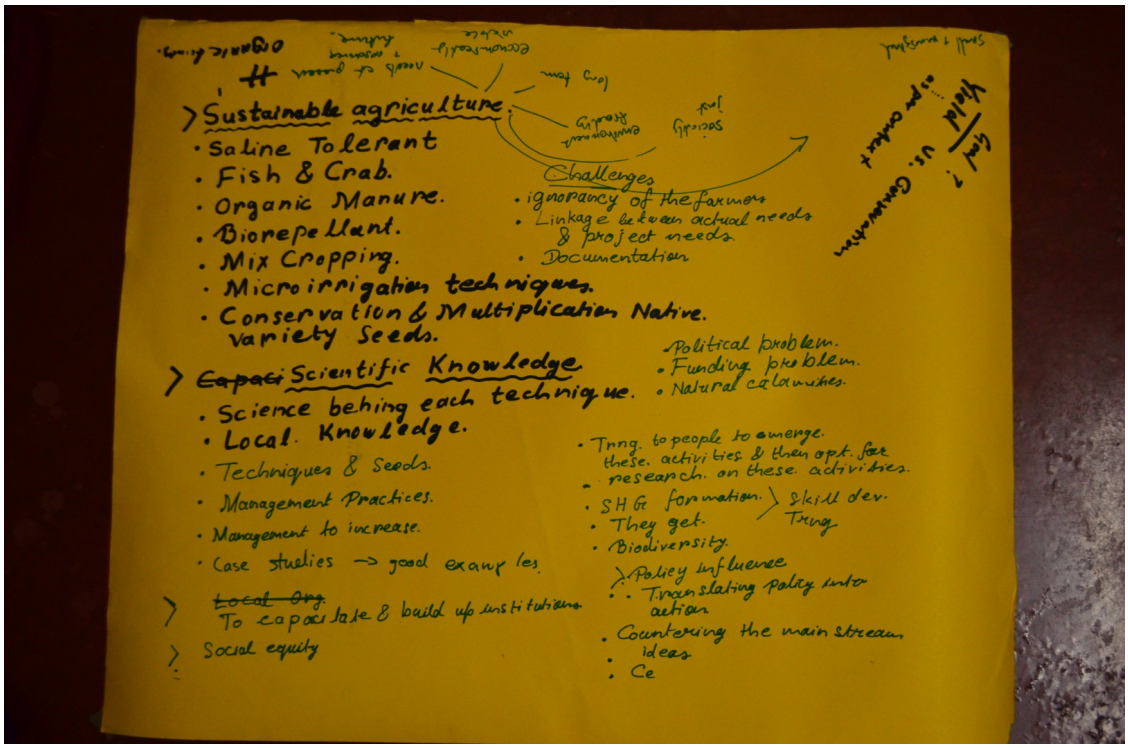


Figure 11. Areas of DRCSC's work. Initial output from planning workshop with the action learning set (2016).

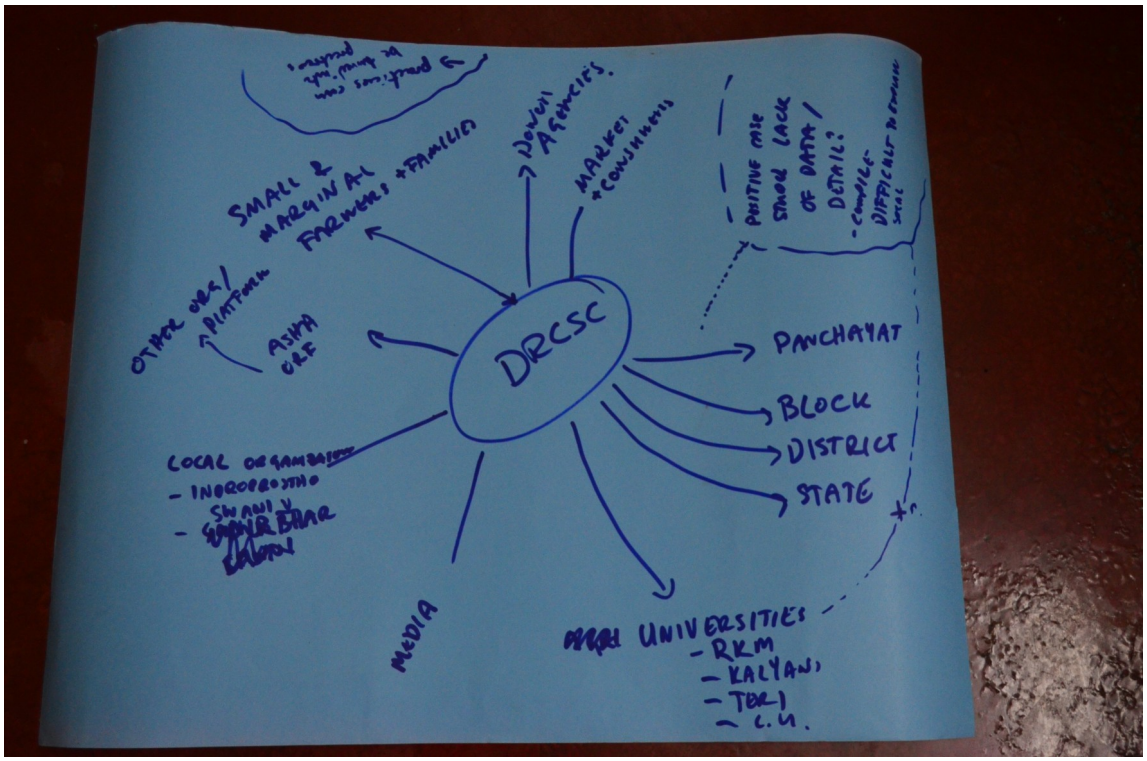


Figure 12. Stakeholders of DRCSC. Initial output from planning workshop with action learning set (2016).

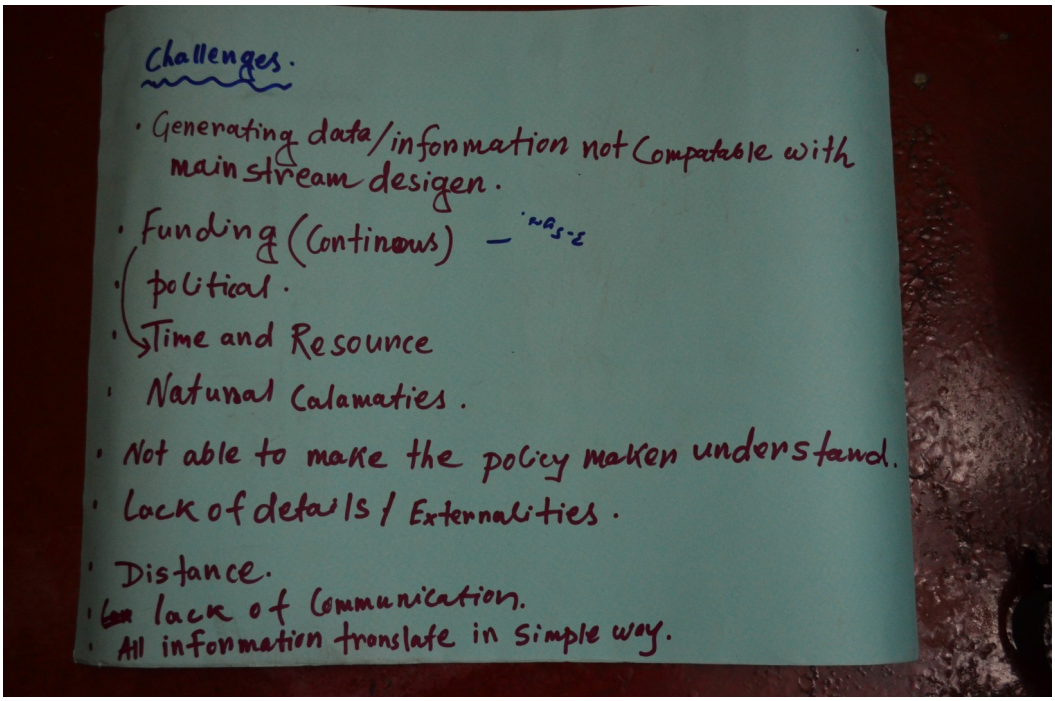


Figure 13. Challenges DRCSC is facing. Initial output from planning workshop with action learning set (2016).

Towards the end of the meeting we discussed a second document I had brought with me - a draft application for ethical review. This contained procedures for the ethical conduct of the research project that I had prepared. Even before travelling to India in December 2015 I had sent this draft to the faculty ethics committee at Sheffield Hallam, however I intended to update it based on the perspectives given by the action learning set. To this end, I asked the members of the action learning set to provide comments on potential risks, benefits and how we ensure that everyone who would participate would fully understand the project and its implication. This was done through e-mailing a questionnaire (see Table 6) as a follow-up to the meeting.

When it comes to research ethics we have to consider several important issues:

- How do we plan to explain the project to participants such as farmers or other stakeholders?
- How can we ensure that they are giving *informed consent* – that is they know what they are participating in, know the benefits and know the potential risks and then freely agree to participate?
- How can we minimise any risks associated with the projects – for the farmers, for DRCSC and for anyone else involved?
- What kind of monitoring and governance structure can we have within DRCSC to ensure that we keep track of risks, benefits of the project?

To start thinking about these issues, I would like you reflect about these issues using the questions below, please take a few moments to write down some notes and then return to me.

1. How would we best select participant farmers groups and villages for participation in the project?
2. What information should we provide them about a research project so that they can fully understand what action research is?
3. What can be the potential benefits for farmers to participate in the research?
4. What could the potential risks for farmers or other people participating in the project be? How could we reduce/manage those risks?
5. What would be the best process by which to obtain *informed consent* from farmers to participate?
6. How can we make the farmers aware of their right to withdraw from the research?
7. How can we ensure that we keep the farmers updated about the results and the process of the project?
8. Could there be conflicts of interests involved in the project? What would they be?
9. What would be your suggestions for how we can continuously monitor the project to ensure that: the project is providing the right kind of benefits and that risks are managed?

Table 6. Ethics reflection questionnaire

During this period, I also travelled to one of the field offices that I planned on working with - the field office in Patherpratima block (for location, see Figure 4). During my previous research work with DRCSC, I had conducted research in two

different regions - the Wet Zone (Patherpratima) and the Dry Zone (Purulia). However, at that time I concluded that the extreme vulnerability of farmers in the Dry Zone area made this region unsuitable for experimental action research of this kind. Therefore, I came to an agreement with Somjita and Tapas that the Wet Zone (which included both the Patherpratima block as well as other nearby blocks), would be the base for any further interventionist research.

The purpose of this visit was to renew contacts with the farmers and field officers that I had previously worked with. I attended a training programme that DRCSC was just starting up and which they called "Climate Field Schools". The idea behind the programme was to train farmers in methods with which they might respond to climate change, by (for example) adopting new crops and cropping practices. The programme was scheduled to take place over a six to eight month period, after which the intention was for the farmers to go back and train others.

A final important step that was taken through this phase was to establish contact with the International Institute of Information Technology in Bangalore (IIIT Bangalore) that would be the Indian partner for the research programme.

4.1.4 Evaluate

Creating research infrastructure

The initial actions taken in this cycle sought to lay the foundational infrastructure for the action research project in collaboration with DRCSC.

There was the documentary infrastructure, primarily the research plan, the research proposal submitted to the university[17] and the ethics committee submission. I used the output of this cycle to revise these documents. As far as the ethical review is concerned, while the questionnaire ("Ethics Reflection Questionnaire", see Table 6 earlier in this chapter) served as the basis for a few Skype conversations with Tapas and Somjita, the rest of the action learning set did not at this point respond or provide input on the questions I had raised.

Beyond the organisational infrastructure of the action learning set, there was also the academic partner in India. In this cycle, I successfully established a partnership with IIIT in Bangalore. As part of this partnership, I prepared a research statement and presentation for them. I also made the necessary

[17] The RF1.

submissions needed for a visa application to the Indian Ministry of Home Affairs. Opting to work with an academic institution in Bangalore, when the work was to be conducted in West Bengal, was done primarily for two reasons. First, the existing relationship between my supervisor and the institute. Second, the fact that the institute had a suitable department with researchers whose interests aligned with those of my project. While this created some distance between where the work was to be situated and the academic partner, IIIT-B had staff originating from West Bengal as well as staff who had conducted research work there. I made DRCSC aware of this partnership, and it was my goal to eventually be able to link DRCSC in some way to the institute so as to support their network with academic institutions.

A final element of infrastructure developed in this cycle was the relational infrastructure based around strengthening relationships between myself, the head office, the Patherpratima field office and some of the farmers associated with DRCSC.

The second goal of this cycle was to begin the process of framing the research (to be continued in the following cycle). This included gathering information about the history of the organisation and their work, as well as their current situation and challenges. In the following section I discuss the background of the organisation as well as themes identified from the early meetings and interviews.

Background to the organisation

Below I will describe the history and background of DRCSC. I draw this narrative of their development over time from the interviews I conducted with the founder of the organisation (Ardhendu) and the organisation's secretary (Somjita).

Since its start, the goal of the organisation was not to directly implement development programmes themselves. Rather, its primary objective was to be a *"Communication and Services Centre"* that provides support to local grassroots organisations - either existing organisations that they identified, or organisations that they would help to create. The support took many forms. It involved purchasing assets, such as office space, land, vehicles and equipment that could be transferred to the local organisation. It also involved conducting research on sustainable agricultural practice, as well as documenting and publishing it. In this role, the organisation ran a publisher, printing press and library, producing books, magazines and monthly papers. They also had a media section producing training

and promotional videos, mostly distributed on VHS.

Their emphasis was on cultivating locally situated, autonomous organisations and providing these organisations with the resources and support that they needed. These organisations should eventually have the capacity to manage themselves and contribute to development in their local area. The model was thus highly decentralised and based on the specific needs and contexts of the specific organisations. However, it was also a model that required long-term, in-depth engagement within the area where they sought to establish activities.

The work was funded by a single funder, who provided DRCSC with a great deal of autonomy in the activities that they undertook. The support this funder provided was for the organisation's activities as a whole, rather than for specific projects. The organisation could focus on developing long-term relationships and field offices in a few locations. After about 30 years (around 2010), this funder started to gradually phase out their support, as they considered DRCSC mature enough as an organisation to manage their own funding from different sources.

An interesting impact of this change took place in the early 2010s. The organisation had recognised that they needed to find ways to position themselves to funders. They had therefore involved a consultant to review their mission, vision, and programmes as well as how they could be structured and promoted to funders. The consultant recognised that the organisation's activities could be positioned within the notion of "climate change", an increasingly relevant topic. While in the early 2000s their work was primarily positioned around sustainable livelihoods and natural resource management, they now began emphasising climate change. This did not necessarily in itself change many of their programmes, but it created a new discursive structure. It meant that certain programmes got greater emphasis than others. For example, energy-related interventions such as cook stoves are more easily positioned within a climate change framework than integrated pest management, despite the latter being more in-line with the organisation's long-term values and goals.

Themes from the early meetings

The meeting with the action learning set in this cycle was the starting point for us to plan a collaborative inquiry within the organisation for the next cycle. The inquiry was mainly focused on their communication practices. Concerns for their communication practices stemmed both from my interests as well as from the

challenges around knowledge management and communication discussed in the action learning set. The output of this planning discussion was divergent, and suggested multiple different issues as well as some tension between different parts of the organisation with regards to how they viewed the challenges that the organisation was facing. Some of these challenges were only tangentially related to communication practices, suggesting that the inquiry might need to be broadened.

Once I returned to the UK, I took additional time to thematically analyse the recordings and output of the interviews and the meeting. I coded them using open coding and grouped them into rough themes (Ryan & Bernard, 2003). I chose this approach as it could easily be made visible to and understandable for the action learning set. Following a more participatory orientation towards theory (3.3.4 Theoretical outcomes), my primary aim was to contribute to a discussion with the action learning set that could help generate situated theories about DRCSC's context and challenges.

The main themes identified were "Fit between ICT4D approaches and sustainable agricultural development", "Communication with/persuasion of external stakeholders like agricultural ministry, extension services", "Sharing of information between teams" and "Funding, time, knowledge and resources to collect data, Data collection practices and Evidence gathering ". I discuss these in detail below.

The challenges identified through the ALS meeting strengthened my initial idea that knowledge management practices would be an important focus for the project. It also suggested that we should be looking into these practices as part of our inquiry into the organisation's work as well as any design interventions. I sent these findings to the action learning set and planned on introducing them in our first meeting of the next cycle planned in March 2016.

Fit between ICT4D approaches and sustainable agriculture development

One of the questions that came from our initial engagement (in my master thesis project) was the question of fit between ICTs as employed in ICT4D in general and the unique situation of the organisation. In that project we had implemented a (at the time) fairly commonplace technology in ICT4D - Interactive Voice Response (IVR). Drawing on the evaluation of that project Tapas and I discussed the issue of how we can approach ICTs within their work area (sustainable agriculture) where

the work is highly situated. From the IVR project we had realised that the ability of an outside expert (even someone with a considerable experience in the field, such as Tapas) to provide agricultural recommendations via ICTs was limited as there were a whole host of details that needed to be taken into account when suggesting solutions to any given problem. When working with their approach to agroecology, it was therefore not straight forward to replicate this type of technology solutions that had already been established elsewhere.

This can be exemplified by an early statement by Tapas on the use of IVR to provide advice over the phone:

> *"Actually not only over telephone. When I go to give training with them, there also when we do question and answer session most of the questions is pest and disease. The problem is that they have no orientation about holistic agriculture. Pest is one component. But there are soil fertility, seed, design of the farm[….] They think: now, now pest is come so what shall I do […] The pest is coming because you are not maintaining proper your field. Ecological balance is not right so pest is coming. You should know what kind of [farm] management you need for protecting against pest."*

What this quote illustrates is that in order to support development of sustainable agriculture, delivering a piece of advice about a specific pest attack is insufficient. You need to take a holistic view of the problems that a farmer faces and engage with long-term changes to their, and often their neighbour's, farm and farming practice. Furthermore, any solutions recommended would be highly dependent on the local agroecological environment of the farmer, including issues such as their location within the watershed, nearby ecological resources and type and quality of soil. For example, in the Sundarbans this depended on the particular way in which the farmer's plot had been affected by the large-scale flooding following the cyclone Aila in 2009. IVR systems designed to deliver short messages with advice to farmers spread across a large geographical area were unsuited to delivering this type of long-term, highly contextual advice.

<u>Communication with/persuasion of external stakeholders like agricultural ministry, extension services</u>

One of the issues highlighted in the initial action learning set workshop was the fact that the organisation struggled to communicate both their impact and the structure of their work to outside agencies. For example, one of the team leaders

stated that while they had interventions that they knew were beneficial for the farmers that they worked with, these could not necessarily be captured through the type of methods, reports and approaches used by policy makers and academics.

> *C: "[We are…] generating data[/information] not compatible with mainstream design… "*

To some in the action learning set, this was an example of the organisation's inability to record and present information in ways which were usable to policy makers or agencies such as agricultural extension services. While they did produce and provide educational materials, project reporting booklets and technical guides, they considered these unconvincing to audiences outside of other NGOs. Rather, additional quantitative data needed to be produced in ways that could allow them to make the case for their approach better. DRCSC seemed to currently lack or be unable to produce, manage and analyse such data.

> *T: "[No, we are…] just not able to make the policy makers understand… "*

Another take on the same issue was that the approaches they promoted were simply too far away from what "the mainstream" of agricultural development could accept. In this view, it was not necessarily a lack of data that was at issue, but limitations in the way that extension services were set up. In most cases, extension services were still based in the mindset of the Green Revolution, where their role was to provide new technology and translate scientific expertise to farmers - for example high-yielding varieties (HYVs) along with packages of practice that includes specific synthetic pesticides and fertilisers. Their focus was also primary food grains and commercial crops - in Eastern India rice and certain vegetables. Anything falling outside of this remit was not of interest to the state agricultural extension department. Thus, even if convincing data was provided, if it did not align with this paradigm the extension services would not be willing (or even able) to take it up - for instance if it related to crops which were not among their target crops.

They had better success in collaborating with other agencies such as the Forest Department and the State Veterinary Services. In one of the examples brought up by Ardhendu where they had convinced policy makers to adopt their practices, DRCSC had convinced the forest department to adopt an intervention of community leased and managed fallow land for growing fruit trees. This

intervention had been able to improve incomes of small-holding and even landless farmers who could take land on lease, grow fruit orchards and minor produce around them, and then sell at a profit while still paying for the lease of the land.

Sharing of information between teams

> *A: "All information [needs to be] translated in a simple way… [There is now]… a lack of visibility between the teams"*

Another issue that was brought up was increasing distance and lack of communication between different teams, especially since they had transitioned towards being a middle sized organisation structured around a large number of donor-driven projects. Previously, there had largely been a single team or a few members working on different geographical areas. Now they had multiple teams working on separate grant funded programmes within each geographical area. This created overlaps in activities, documentation and material produced, as well as gaps in communication and information sharing.

Several members of the action learning set brought up the issue that teams did not share good work that they had conducted, nor presentations or learning materials that they had created. To address this DRCSC had formed a separate reporting and documentation team at the Kolkata office. However, as this team was not directly attached to the field teams, they had struggled to get the information that they required or to even know what they should be documenting.

Funding, time, knowledge and resources to collect data, Data collection practices and Evidence gathering

The issues presented so far focus on DRCSC's data management practices as well as the way they treat data and information within the organisation. Two additional challenges were identified related to this. First of all, they considered there to be a lack of funding, time, knowledge and resource to collect and process data. Very few funders would provide funding for research outside of the impact measurements required by the funder itself. This meant that DRCSC struggled to allocate resources to engage in systematic data collection and analysis to build any evidence base for their work.

In late 2015, DRCSC appointed one staff member (Purnabha) to identify research opportunities and undertake research projects. They were therefore keen that

Purnabha take part in the action learning set and to be involved in discussions around the activities that I would undertake in my research programme.

4.1.5 Reflect

Even though this period was short, it turned out that it was a very important one. The timing of having it just at the beginning of my research programme allowed me to include the voice of the organisation into the planning of my first field work phase in a way that I could not have, had I remained in the UK for the greater part of the first five or six months of my degree studies. The practical realities of funding as well as the need for students to be involved in teaching at their home universities combined with the geographical distances between the location of the university and the site where the work takes place means that there are plenty of opportunities for a disconnect between the research and other partners. This is compounded by the academic realities of producing research proposals, progress statements, outlines of the project for ethical review and so on. This means that sometimes a lot of the initial framing for a project is done very far away from the location of the project. Even without these distances, it is a reality that in an action research project there are always multiple interests; there are the research goals and interests of the researcher, there are the interests and needs of the research partner organisation(s) and there are the interests and needs of individuals that are contributing their time to the project. These varying interests need to be negotiated, and had I not had time to do initial planning with the organisation up-front I would have, at best, needed to re-evaluate many of the ideas surrounding the project at the start of my first longer period of work with DRCSC. Even at this early stage there were ideas (about what the project might be about) that I realised needed to stay in the background (at least throughout the first phase of work in my project) to ensure that the project was relevant to DRCSC.

The relationships that pre-existed this research project turned out to be important to allow open communication about the framing of the project. Relationships formed an important part of the infrastructure necessary for the project. It was also the case that I was familiar with the region I was going to work in and that I could make a lot of the initial practical arrangements at an early stage. This meant that the time required to gain access to the organisation as well as to become comfortable with the area of work was limited.

Another important aspect, for me, was that the work should, to at least some

degree, be anchored with an Indian academic institution. I was aware that the choice of doing work in India but being based in the UK brought with it critical ethical and political questions. The establishment of a partnership with an Indian academic institution in this cycle was a way to (partially) address this. First, it provided some level of monitoring of the conduct of the project in the country within which it was to take place. Even though IIIT-B was located in a different region of India, staff there would still have a better understanding of the socio-cultural context of the research as well as of local research standards than could be expected from, for example, the ethics committee at Sheffield Hallam. As IIIT Bangalore appointed a local advisor, it allowed me to have someone based in Indian academia who could read and review my research proposal, as well as provide feedback and input. As part of this agreement I would also have regular presentations at the department to other PhD students and faculty providing further feedback and critique. Finally, it provided the anchoring required to have the appropriate visa and approval for my research work.

Altogether, the infrastructure initiated in this cycle helped me to address some of the pitfalls of short-term intensive "field work" and bungee-research by properly anchoring the work with both DRCSC and Indian academia. This is part of how I sought to address the risk of my research being extractive - where India would be my field site from where I would draw research data only to contribute mainly to an academic environment in the UK. The recognition from my supervisory team that it was necessary to avoid this pattern of extractive research allowed me to set up a plan for field work which involved long periods of time spent in India during each year of my PhD.

One of the challenges faced in this phase was to discuss the need for ethical review as well as address questions of risk and vulnerability. Largely, the action learning set did not see a great need for this type of discussions beyond the anchoring and approval of project activities with the leadership of the organisation, primarily the secretary, the founder and the executive committee. The very limited response to the ethics questionnaire highlighted two things. One was that more time needed to be allocated to discuss what the ethical concerns were and why such questions were asked. The roughly 15 minutes used in the first ALS workshop were inadequate, and it became apparent that more explanation was needed. The explanations needed to extend to what was meant by risk, vulnerability, consent and monitoring. In their own work, the organisation did not at the time have any encoded practices of ethical review and relied on the experience and knowledge of

team leaders and the policies of funders to govern field officer behaviour and handling of collected material. As such, there was quite a big difference between the codified practices of academic ethical conduct and those of DRCSC. This could be both an opportunity to adjust my approach to ethics, but also to potentially contribute to their thinking about ethical issues involved in development oriented work and how to address them. I used this insight to update and develop the approach presented for the ethics committee approval at Sheffield Hallam.

4.2 Cycle 1: A collaborative inquiry

4.2.1 Plan

The second cycle of the project began in March 2016. It started with an initial meeting with the action learning set to plan the activities of this cycle.

In the initial action learning set workshop in January (in the previous cycle), I had suggested that an initial phase of ethnographically oriented (Tacchi, 2015) work would allow a better understanding of the challenges DRCSC faced, what current communication practices are and DRCSC's current use of technology. Importantly, however, this work was not intended as a way to elicit a set of system requirements (Dourish, 2006) that could be used to build a system, rather it was a means by which to engage in a collaborative research inquiry with the action learning set. Initially spending time not focused around the design of technology would allow space for collaboration between myself and DRCSC to develop. In this way, I could deepen relationships with individuals within the organisation. Several meetings with the action learning set were held throughout this cycle to discuss ongoing plans for the project and output from activities undertaken.

As a result of this orientation, the main purpose of the outputs was directed at the action learning set, focused on creating a shared understanding of issues that might be addressed in later cycles. My main aspiration was not to seek to produce an account of the organisation and its work for an outside audience, but rather to create insights that could then be used as a way to discuss the challenges the organisation faced within the action learning set.

While the complete details of the project were not yet clearly outlined, on my suggestions the first phase was going to focus on current practices within the organisation and the farmers' groups before any technology design or

implementation would be undertaken. This would allow me to get a deeper understanding of their work and the challenges in it, as well as allow for the action learning set (including myself) to discuss and come to a better understanding of how ICTs may fit.

The inquiry was guided by a focus on three items - the communicative practices (Orlikowski & Yates, 1994; D. Slater, 2013) of the staff, technology use as part of these communicative practices and finally the values expressed or incorporated in the organisation's work. Already in January it had been discussed that I would focus on two field offices as well as two teams within the head office. As previously mentioned, both these field offices would be located in the Wet Zone (for a map illustrating the locations of the activities see Appendix E). This focus was discussed with both the action learning set and my supervisor. I had already worked with one of the field offices through my MSc degree project, so had an initial familiarity with the place, the people and their activities as well as relationships I could build on. Adding on another field office would allow me to compare and better understand another part of the organisation

4.2.2 Ethics

While it could be argued that we only handled non-sensitive data and only adults were involved, we (myself and my supervisor) still considered that there were potential risks and vulnerabilities involved that necessitated a full ethical review of this project prior to the first cycle. We considered that the specific context of working across national and cultural borders and with groups of people from a vastly different socio-economic position as the researcher mandated such review.

The main potential negative consequence for participants at this stage would be in them providing their time to the research project without getting a tangible or direct benefit. This should be considered as a risk of high likelihood and it must be made clear to all participants who choose to give up their time that this may occur. Such risk could be reduced by careful consideration of all activities undertaken along with the participants, with emphasis on maximising the potential research outcomes as well as direct benefits accrued while minimising the time taken from the participants. In this cycle, making judicious use of workshops specifically for this project, observation and interviews were important ways to make sure that we could minimise the time taken.

Other risks we considered include political risks and risks related to negatively

impacting relationships and trust between different stakeholders involved in the project. As this cycle sought to document and review an existing social configuration, there was a risk that this could harm existing relationships as well as upset (or strengthen existing) power relations in a way that can negatively affect either the organisation or the farmers. Further considering the distance both physically as well as culturally and socially between myself and participants, there might be a number of unknown risks which would only emerge throughout the project and which would be dependent on how the project is developed.

As a result of my initial discussion with the ALS I realised that they were inexperienced in working with informed consent for research and also did not entirely see the need for any longer discussion about it. In response to this, I made a continuous process of discussion of ethical issues a part of my project plan as well as the submission to the ethical review board. This meant that I did not seek to limit addressing questions of consent and risks to only an initial agreement or consent form. The plan was that I would, together with the action learning set as well as whoever I worked together with from the organisation, negotiate terms for any engagement. This included bringing up the use of voice recorder, taking pictures as well as using consent forms.

While we did end up using separately written and prepared consent forms for farmer's groups members, field office staff and head office staff in both English and Bangla, these were only part of the consent taking process. I also included questions of consent in group discussions and as an initial part of meetings with the ALS, field staff and farmer's groups (Sterling & Rangaswamy, 2010).

4.2.3 Act

12/03/2016	First meeting with the action learning set
14/03/2016-15/03/2016	Attending programme held by training team
21/03/2016-22/03/2016	Climate Field School (Patherpratima)
08/04/2016-09/04/2016	Climate Field School (Patherpratima)
20/04/2016	Second action learning set meeting
22/04/2016	Evaluation meeting with funders observed
24/06/2016-25/06/2016	Farmers Convention

20/07/2016	Wet Zone All-Hands Team meeting
02/08/2016	Third action learning set meeting
30/12/2016	Final evaluation & Next Phase Planning with the ALS

The inquiry was structured around two months spent at two different field offices, with the majority of the time focused on one of them and two months spent with various teams in the head office in Kolkata. During this time, I undertook participant observation of the organisation's regular programmes, along with both semi-structured and informal interviews with staff members and farmers. In the field offices, I observed their work with farmer groups, including group meetings, training and knowledge sharing sessions. Additionally, I observed field officers conducting activities with individual farmers such as budgeting, land planning, evaluation and data gathering activities. I also participated in a long-term "train the trainers" programme focused on supporting farmers in several regions to become lead farmers who could help others in their villages adopt sustainable agricultural practice. During the observation of these activities, I kept notes, discussed questions informally with team members and farmers as well as took pictures. At each meeting, I would introduce myself and explain what it was that I was doing there, as well as what data I was gathering and how it would be used. I would explain my relationship to the organisation and that I would be discussing my findings with them - giving the names of some of the well-known staff members that were part of the action learning set. I would ask for permission to take notes as well as for any of the pictures that I took. However, considering ethical concerns, I would take care to focus on the work of the field officer and the field officer's interactions, rather than the farmers.

At one of the field offices, I undertook several "rich picture" sessions (Monk & Howard, 1998), where we collaboratively mapped out the activities of the field office, the different agencies and the way they interacted with the organisation (an example of a rich picture in progress is given in Figure 14). These sessions took place with two to three of the field office workers. They lasted between 2 and 3 hours and were structured so as to progressively add layers of a rich picture drawn and written by the field officers. It began from the geographical layout of the areas in which the field office operated, then adding details about the various physical infrastructure they used, continuing to the different actors involved in their activities and finally what relationships there were between these actors. In these sessions I would take the role of facilitator, requesting the staff members to

take notes and making drawings on the flip charts. Typically, I would need to move the session forward by asking questions - initially broad ones and later specific questions referencing various parts of the pictures that emerged. The notion of a rich picture was unfamiliar to the participants, but in the sessions I tried to make connections to diagrams such as the maps created as part of the Participatory Rural Appraisal method with which they were familiar. However, it was still a challenge to capture both physical spaces, institutional arrangements, personal relationships as well as more abstract concepts within the maps. Occasionally, the pictures would end up looking more like organisation charts or diagrams than rich pictures. Nevertheless, the pictures did provide a supporting tool as part of the group discussion that was conducted during their creation. Audio from the sessions was recorded and pictures taken, along with field journal notes.

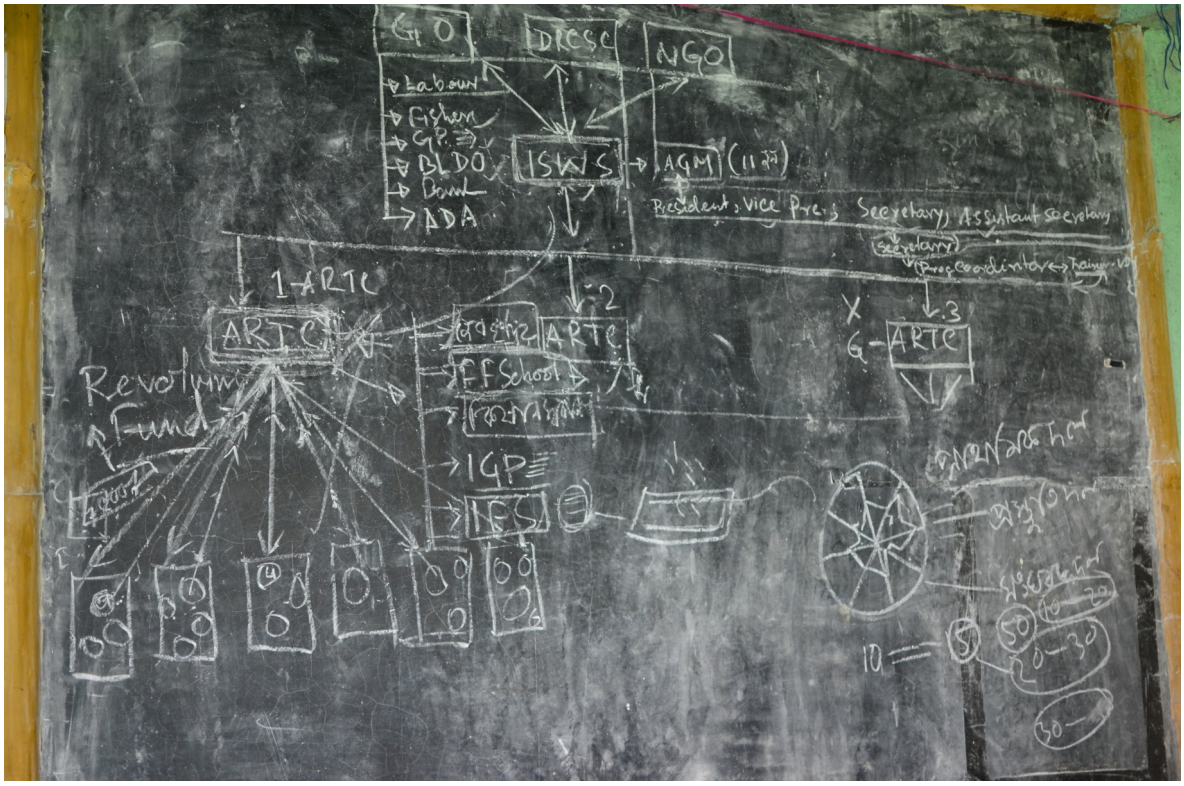


Figure 14. Sample rich picture created during sessions in the field offices (2016).

During the two months spent at the head office, I conducted a series of semi-

structured interviews focused on communicative practices of the head office, between head office staff as well as with the field offices. These interviews lasted between 30 and 60 minutes and were audio recorded. Two of the teams in the head office were the focus for these interviews. The first team being the "Wet Zone" team that were responsible for the field offices that I had previously spent time at. The second team was the "capacity and training" team that handled the training activities for the organisation. Within these teams I interviewed several of the team members, both in team member and leader positions.

During this cycle, three additional meetings with the action learning set were held, in March, April and August. The meetings in March and April focused on planning and discussing the progression of the research and the final one on discussing, reviewing and framing findings. In between these meetings, I held ongoing discussions with individual members of the action learning set about my observations.

At the March meeting we followed up on the discussion of the ethical conduct of the project. While the initial attempt at bringing this up (in the form of the ethics questionnaire distributed in the previous cycle) had only limited effect, it did have the result that one of the ALS members brought it up for discussion at the first meeting of the cycle. Initially unsure about why it was required or what it meant, after some explanation from my side, we discussed how to guarantee that the work could be conducted ethically, how to handle informed consent of all parties as well as issues of conflict of interest, anonymity and data usage. While the ALS initially felt that there was little need for these kind of in-depth concerns, this was something that I felt could be a contribution to their research culture. I therefore persisted in discussing these issues, showing consent forms that I had pre-prepared as well as discussing how we might handle group as well as individual consent. As I will soon discuss, throughout the next couple of months we got several occasions to practice this protocol.

At the March meeting I used the thematic analysis presented in section 4.1.4 Evaluate as well as my ongoing findings as an input to discussion with the action learning set and as input for planning what the focus of the work in this phase should be. Coming already with a set of themes (4.1.4 Evaluate) drawn from interviews and the first meeting of the ALS was a good way to allow them to give input to the otherwise fairly open ethnographic phase.

During the April meeting, I reported on the activities conducted thus far as well as discussed the planning for the project. I brought up observations and issues I had identified from my time spent at the field offices, drawn from my field journals. This allowed for two things. First of all, I could validate any interpretations I had made by gathering feedback from the organisation. Secondly, I could make my methods and the results they could generate visible, so that the action learning set could get a better picture of what my approach was and how I went about my work.

At the August meeting I brought an initial, rough, analysis of my observations from the field work. During the previous months I had set aside about 2 weeks for analysing my findings, which I had done through doing a rough coding of my field notes and some of the recorded material. I had written memos on the basis of these codes and my data, and this was presented to the action learning set. It was important that I did not wait until I had time to do a full analysis of the data before I discussed it with the action learning set as I wanted to gather their feedback and input.

Following this, I returned to the UK until December 2016. During this period, I conducted a more thorough analysis of the data I had gathered, which consisted of open coding and thematic analysis of the findings. This was again brought back to the action learning set meeting in the end of December. At this meeting, we discussed these findings and decided a focus for an intervention that was to be conducted as the next step of the project. The goal of having a cycle where I was involved in supporting design of some form of technological intervention had been decided even before the research project began, though the exact nature or form it would take, as well as its focus had been undecided until this point. One of the issues decided at this meeting was that the initial design project would focus on the field officers of the organisation.

Employing the ethics protocol

As mentioned, throughout this phase, we got multiple occasions to employ the ethics protocol and better understands its effect in practice.

In one instance, I attended a participatory mapping exercise with team members from the training team. The mapping exercise was part of a training programme for workers from other NGOs. I had brought my camera, and the team leader (who was one of the action learning set members) suggested I should take photos. As I

considered it part of my research activities, I requested we follow the oral consent protocol we had agreed upon. Through this consent procedure with the participants, we got a discussion where the conclusion was that they were comfortable with photographs of the entire group participating in the activities, but no photos of single individuals. In this case, we employed group consent only as I was primarily observing the trainer and the programme as a whole, rather than recording any individual farmer statements.

In the case of the group of farmers regularly attending the "climate field school", which I observed several meetings of, I suggested to the trainer that we follow both individual and group consent. This was motivated by the fact that I was meeting the farmers regularly and may use individually identifiable quotes or even pictures. At the first meeting in January, I observed but neither used a voice recorder, nor used the notes I kept for any subsequent analysis or publication. At the second meeting I attended, the trainer introduced me and my research, the data I collected and how I would use it, and took permission from the group for me being there, recording audio and taking pictures. At the third meeting we dedicated about thirty minutes to discuss the research I was conducting. After having verbally introduced the data I had collected and how I might use it, we provided the farmers with written consent forms that included the same details previously shared verbally. At this instance, most of the women were comfortable signing them directly even though we had made it clear that it was perfectly acceptable not to sign them then and there if they were not comfortable. One of the women clearly was not, and the others started asking her about why she was not. She said that she wanted to first discuss it with her husband. At this, one of the more long-term members of the group spoke up saying that:

> *"No, this is not right, you do not need your husband to tell you what you can do and what you cannot do - you need to take decision yourself"*

What followed was a debate among the women about whether it was correct or not for her to need permission from her husband. I took care not to participate or try to influence this discussion, however in the end the woman did sign the form.

4.2.4 Evaluate

An important goal of cycle 1 was to examine the ecosystem of the organisation and better understand the challenges they faced. This in turn should contribute to the framing of the design project intended for the following intervention. The findings

from this cycle were discussed with the action learning set through two presentations. The first was an initial analysis that was made during the cycle presented in August 2016. The second was a more thorough analysis prepared by me while I was in the UK between August and December 2016. This was presented on my return to India in December 2016.
Through this cycle, I observed how the conflicts and challenges discussed in the initial framing of the research in Cycle 0 translated into the everyday practices of the head office and the field office. I will here give a few examples drawn primarily from the initial analysis conducted by myself and the action learning set as to the impact of the changing organisational climate (4.1.4 Evaluate) and the challenges DRCSC was facing. I will return to the more thorough analysis of DRCSC's knowledge ecosystem in the following chapter (5 Framing the research).

Shifting notions of success

An important, somewhat subtle, shift that had taken place within the organisation was a change in what was considered important outcomes of the organisation's activity. Some of the staff members reported that this change, which had influenced the ways that their performance and their projects were evaluated, had led to a focus away from what they considered the important. The following quote from a project manager in the organisation illustrates this:

> *A: "What we usually thought about is that income is only indicator. [Others think] if the income rises the farmer will be fine. But that is not the case ... what we thought is that, in our case, in our like us organisation, where we focus on the ecological agriculture, yes, income is one of the indicator but there should be an ecological diversity also. [For example: Previously] there was not so much diversity but now there is an ecological diversity and maybe the food basket is diversified. And another one is the acceptance in society, maybe that farmer became a leader, that farmer became a trainer. That [is] what we need actually in the course of our implementation. Or maybe they are as an organisation, maybe as a group they formed, [in order for] the others [to] learn from them. The others meaning the outside villagers, they can learn from it. That should be the motto, but sometimes it is missed […], that kind of data."*

Here, he discusses how the impact assessments mandated by external funders emphasises a particular kind of data (income) as central to the evaluation of the success of the programmes. He also suggests that this does not capture things that are particularly important, but that perhaps is not so easily documented.

Changing perspectives on organisational sustainability

Early on, a team leader, C., suggested that the main challenge for the organisation was how to manage projects more efficiently and effectively and that a system should be designed to help them:

> *C: "I am managing multiple projects and if you ask me, I cannot tell you now what they did last month–I would need a few days to collect information to answer that. We need some way to better track what projects are doing".*

In explaining her system of managing projects she said:

> *C: "I look at the financial record. How much has been spent? Then I look at the project budget, how much should we have spent. In this way, I can see if we are on track.".*

The emphasis on increasing efficiency in project management as critical to the sustainability of the organisation was, however, challenged by other staff members. As one senior team leader (T.) explained:

> *T: "Actually project are not sustaining [our organisation]. How project is sustaining [us]? Project is a time-bound, na? There are 2 years, 3 years, after that what do we do?"*

He continued to explain that taking on new staff members as a result of external projects contributed to a continued and growing need for more funding diverting their attention towards donor objectives:

> *T: "Sometime it is happening by pressure, because there is so many staff. Let's say [...] project is completed they have so many staff, how we can provide salary to them? So agency is providing new project. So this is also pressure, for the new staff. Sometime we are doing for they are giving money and we are giving the project, sometime maybe that is not for our, for our thematic area, but we want to give salary to somebody. When we are taking project we are taking liabilities, so pressure is increasing. So we are so much busy so we have no time for learning."*

Furthermore, T stated, changes toward sustainable agricultural practices took many years to establish and required continuous engagement. The type of transition they were advocating for therefore fit poorly with the 3-5 year time

frames and specific project objectives required by external funders.

Another staff member, A., highlighted the potential conflict between an emphasis on accounting or budget utilisation and sustainability of their intervention:

> *A: "…from the [last] two to three years, the involvement of the funding agencies is much more... They are always thinking about budget utilisation, ok let us do that, utilise that gross budget. Whatever will be the impact. Let us utilise that money. What the ultimate work is [, is] not accepted actually. Yes, we have spent the money, we have do[ne] some more programmes. But ultimately it is not sustained."*

New staff composition and organisational cultures

The greater emphasis on projects, oriented towards specific targets was described as being implicated in changes to the way in which new project staff related to the work of the organisation. As the organisation's number of projects and funders had expanded they had needed to recruit a large number of new staff. They had also found that a new generation of staff recruited were increasingly coming not from agricultural studies but rather from "social work" and "development" backgrounds. This had meant both that those who joined were less knowledgeable and attuned to the organisation's focus, but also had a smaller personal interest in the actual work of the organisation. More senior staff considered that new staff members' interest and passion for agricultural development were lower. At the same time, the organisation spent increasingly less time on sharing their values and approaches to agriculture among their staff. A senior staff member shared how he and other staff, when they joined, would spend months living and working in the field areas, something that staff members now recruited would be unwilling to do.

In response to these changes, a staff member (R.) suggested that what was really needed was a system that enabled sharing of information and experiences between teams, increased democracy in decision making and introduction of new staff to the values of the organisation. Interestingly, a version of such an information system had previously existed in the form of Saturday film shows and annual study days:

> *A: "We usually, earlier, [the organisation] earlier used to have on Saturdays a film show. Not every Saturdays but maybe once in a month, there are various*

films on the awareness generation...”

Linus: “You say, before, we used to have?”

A: “Yes, now, now it is not there. Maybe the time is very much short. As you know, that there are various projects right now. So that there is no one who can spend, maybe it is not mandatory, but you have to spend one hour or maybe half an hour...”

However, as A. points out, increasingly this was something that no one in the organisation seemed to be able to make time for. Another thing fewer people had time to do was the kind of research that the organisation originally emphasised. The organisation had over the years built up a fairly extensive collection of both in-house publications and outside resources, organised as a research library (illustrated in Figure 15) .

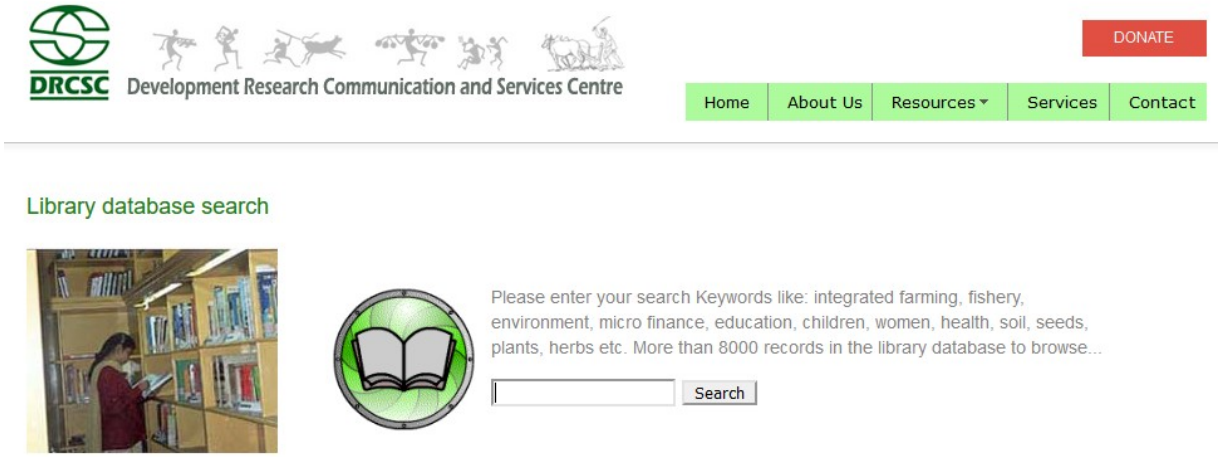


Figure 15. A picture from DRCSC’s library along with their library search function covering their archive of over 8000 publications (DRCSC, 2016b)

However, this kind of activity was difficult to integrate within the project focused

organisation. The responsibilities for research, publication and dissemination had seen multiple shifts and re-organisations. At one point it was intended to be integrated with individual project teams, at another point there was a separate research oriented team. There was a continuously expressed feeling among senior staff members that the research was poorly organised and that some form of change was needed.

Applying the ethics protocol

This cycle involved the application of the ethics protocol designed for this project, however, this was not without its challenges (4.2.3 Act). Clearly the procedures that I adopted were different from the standard practice of the organisation. In many of the activities of the organisation it was generally considered acceptable to capture information, photos and sometimes even videos of the events taking place in order to use for demonstration of impact, publication and marketing materials - especially in relation to funding agencies. In my application of a research ethics protocol, I had to take care not to disrupt or challenge the organisation's practices in a way that would have negative impacts on their work. At the same time, it was my aspiration that approaches to action research ethics would be one of the contributions that I could make in the organisation. While I did not observe a long-term impact on their practices in regards to ethics in the field work, I did notice that my collaborators from the organisation gradually became more comfortable with the approach I took and supported discussions about ethics in sessions that I attended. I note that this was most effective in situations where I could gradually introduce the protocol over time - such as with the Climate Field Schools. This lends support for the view of research ethics as an ongoing process throughout a research programme (Sterling & Rangaswamy, 2010) rather than as a single event or discussion that culminate in something like an informed consent form.

4.2.5 Reflect

Beyond gaining a deeper understanding of the organisation, its work contexts, goals and challenges, this cycle was also important as part of building relationships within the organisation and among its beneficiaries. Becoming a familiar presence among head office staff, field officers and farmers meant that my presence in meetings, trainings or other activities was no longer remarkable. My origin being from far outside the context meant that this process took longer than it might have had, had I originally come from Kolkata. Another important element of familiarity had to do with methods. Through this period I spent considerable time explaining how I conducted observation, how I would analyse

the data and how qualitative research works in general, primarily to the action learning set but also to field officers. Making my methods visible was a way by which I could also make the research more transparent to those I worked with.

It was important to make visible my approach to research ethics. An element of the way I approached ethics as a continuous process, was the creation of familiarity both among my collaborators in the organisation, but also among the farmers about my work, my role and my relationship to other actors. Without this, it would not be possible for the farmers to assess how I might use the information gathered, who may access it and what impacts it might have. In other words, they could not reasonably be expected to give *informed* consent without this long-term process. Even in the cases where I had a long-term interaction with the same group of people, it was not easy to explain and capture the use of their information in contexts far removed from their own - for example, as part of academic publications or conferences. To address this, I opted for a careful approach. I would rather that the research participants withhold information out of suspicion for my research activities than divulge it without informed consent. I also took great care with recordings and photos, both in taking them as well as in final use (such as throughout this thesis).

Within the organisation, there were also multiple situations where I had to consider both the ethics and the politics of my choices - especially in balancing my personal interest (conducting a research project with interesting academic outcomes that would eventually result in a degree) and the interests and needs of the organisation. Through the fact that the research programme was partially developed in continuous contact with the organisation, as well as discussed throughout in the action learning set, I judged that there was considerable alignment between the goals and interests of the organisation and the research aims of the project. This alignment, however, was not complete and there were disagreements both within the action learning set as to whether the investigations could be differently focused. The fact that I was trusted by many members of the organisation sufficiently to be invited into discussions about these conflicts, as well as entrusted with internal information highlighted the fact that I was - through this cycle - beginning to acquire an insider/outsider type status.

The way I choose to approach these disagreements was to have as open discussion as possible in the action learning set about them as well as to make conscious choices about when and in what way I should make my own position and interests

clear about it. At the end of this action cycle, I felt that the type of relationship I had with the action learning set allowed me to make my own position very clear. I could communicate to them that I was willing to work with different framings of and approaches to the project, but that I had my own preferences. At this point in the project, due to the now several years long experience I had of interacting with the organisation, I felt confident that the members of the action learning set would be willing to challenge any views or opinions I presented and prioritise according to what they saw fit for the organisation.

At the final meeting of the action learning set, the question seemed to stand between - do we run experiments on ways in which technology can further enable an increasing “project orientation” by, for example, improving efficiency by which metrics could be collected or do we seek to experiment on and identify ways in which technology can affect change to this development. Accordingly, there were two broad options for the framing discussed, that drew on the outcome of the two cycles. The first of these envisioned working to address issues of project management, reporting of activities and monitoring of staff. In this framing, the goal would be to create a project management tool that could professionalise the management of the organisation. In the second framing, the issue of communication and sharing of knowledge within the organisation were emphasised. This framing highlighted the differences between different parts of the organisation, and how there was a lack of communication and cohesion between different teams. It also placed the question of identity and values as an important area of concern, considering the challenges reported with the greater influx and turnover of new, inexperienced staff members. In the end, the action learning set chose to prioritise the second framing of the work. While this did not preclude the design experiments from focusing on project management and organisation, it was clear that communication between different teams - both within the head office and between head offices and field workers - should be emphasised.

A personal reflection concerns the nature of conducting work of this sort, being based in an academic department in the UK but conducting long-term work in India. Throughout this year, I visited India at three different occasions, including approximately six months spent there during the major field work portion. As discussed in the previous section, this regular physical presence was necessary to maintain the project and ongoing communication. However, it is neither environmentally nor personally sustainable to travel back and forth regularly over

a long period of time. An option would be to concentrate the travel to India in a fewer number of visits, however as mentioned previously this does not fit well with the type of research intended. In the end, this may be one of the contradictions that surface when based out of a university located far away from the research sites.

5. Framing the research

In this chapter, I ask: what is it that I am intervening in? I draw upon the first two cycles of action research to describe "the context" of my research. This chapter provides preliminary answers to RQ1 - what are current practices of communication and knowledge management around sustainable agricultural development in DRCSC's work and how are they structured? It also looks at how DRCSC and I decided to frame what work would be conducted in the second phase of the action research.

While it is now well recognised that an understanding of "context" is crucial for ICT4D interventions (2.3 ICTs and development), the specific question of what we include as part of the context is still contested (Zheng, Hatakka, Sahay, & Andersson, 2018). On the basis of the pragmatist orientation of this thesis, the question for me is not an attempt at describing an objective reality studied through the activities conducted in the two first cycles. Rather, the aim is to describe the interpretation and framing of the situation that I have come to, together with DRCSC. From this standpoint, the first two cycles of this thesis were interventions, *not* detached observation or gathering of information about an externally existing "context". My description of the context of intervention, follows this collapse in distinction between ontology and epistemology - i.e. between the known and the knower.

In the first two cycles, my role in constructing the research context involved animating an inquiry within DRCSC. In some situations this meant that I acted as a participant observer, in others that I conducted directed interviews and workshops. The primary goal of these activities was to gather data, document observations and create interpretations that could become actionable within the organisation itself (4.2.3 Act). I categorised my findings using procedures of open coding and thematic analysis in such a way that could be reviewed by others within the research context (typically staff members of the organisation).

Discussion of my interpretations happened continuously in the field offices, the head office as well as, most intensively, with the ALS. This allowed various participants to engage with, challenge and question my findings. It also allowed us to reflect together on how to view the organisation's situation. The framings discussed in this chapter is the outcome of this process of inquiry, undertaken in

the first two cycles. They represent situated theories about the context that I am intervening in, developed by me and the ALS and grounded in ongoing discussions with many different stakeholders within, and related to, the organisation.

I employ the notion of an ecosystem (2.4.1 Knowledge ecosystems) to frame my and the ALS's understanding of context, and within that I look at tensions within the context from the perspective of different knowledge systems (2.2.3 What does sustainability mean for agriculture?). While I did spend some time with the ALS explaining my theoretical starting point (2 Background), drawing on agricultural development literature helped make it relevant, recognisable and relatable to members of the organisation (many of whom already familiar with the discourse).

Interventions employing ICTs are part of re-configuring this socio-ecological ecosystem. To do so we must determine what is desired (what do those involved have reason to value). We must also understand the basis through which we approach knowledge and learning in the ecosystem, as this will determine the way in which we support the system using ICTs. This is important, because there can be multiple (sometimes conflicting) knowledge systems within the ecosystem, each with a different epistemological basis. Sustainable approaches to agriculture are embedded in, and require, a knowledge system that is different from those of conventional approaches to agriculture (2.2.3 What does sustainability mean for agriculture?). The "ecological knowledge system" of sustainable agriculture differs in how it regards the discovery of new knowledge, the validation of knowledge claims, the way external facilitators operate to support these processes and the various actors involved and their relationships to each other. It follows that, for any ICT intervention to contribute to what participants "have reason to value", it needs to operate within this same knowledge system. Attempting to disaggregate the technological infrastructure from the broader knowledge system and focusing on it by itself would be entirely insufficient, as I will outline here.

ICT4D, in general, engages with the world through specific discourses of development and technology (2.3 ICTs and development). A discourse on development and ICT involves epistemological positions, modes of intervening, values and meanings. A description of the ecosystem must thus include the way technology is perceived and imagined, the values associated with the social context, and the ways in which an intervention may contribute to, detract from or challenge them. The discursive elements of the ecosystem shape what is considered true and the methods by which this truth can be established (N. Hayes

& Westrup, 2014). It shapes what outcomes are important and for whom, something of particular centrality when it comes to development as interventions are commonly centred around a particular notion of a deserving beneficiary (Chambers, 1997; Crewe & Harrison, 2002). As Hayes & Westrup (2014) discuss, these discursive elements are inherently tied in with the way that relations of power are structured within an ecosystem. Addressing questions of power has been a weakness within development work in general (Cooke & Kothari, 2001; Guijt & Shah, 1998) and ICT4D in particular (Dearden, 2012; Kendall & Dearden, 2020). Extending the inquiry into the ecosystem to emphasise its discursive elements can help uncover relations of power by foregrounding what's given importance, for and by whom.

Taking an ecosystem perspective emphasises that the situation is re-productive. A specific ecosystem or environment produces certain patterns of interaction, allows certain practices to flourish and limits the growth of others. Intervention into an ecosystem has to take the environment into account as it will greatly influence the ability of the intervention to take root in the ecosystem (Malhotra, 2002). Similarly, interventions can also disrupt or change the ecosystem in ways desirable and undesirable (Escobar, 2017). These disruptions can change the ecosystem so that it now allows new ways of existing to flourish, replacing older ones. Again, this may be desirable but it can also be undesirable. This holds true for both the social elements of the ecosystem as well as the biological elements traditionally considered in the ecological paradigm (Escobar, 2017).

As a general principle, most interventions are interested in allowing the ecosystem to continue to function but in a different[18] way. Rarely[19] are interventions - at least of the design kind discussed in this thesis - intended to entirely destroy the ecosystem they are intervening in. The continued function of the ecosystem for those that are part of it is therefore pre-supposed. While change is inevitable in any system, the question of how that change is brought about is central to my thesis.

Technology forms part of this ecosystem, both in its present state as well as in any

[18] What "different" means in the context of an ICT4D project is defined on the basis of a notion of development (implicit or explicit). It can mean the ability to provide greater nutrition, improved health, better economic livelihoods, or the removal of perceived inefficiencies (such as middle men).

[19] A limited exception to this might be projects that emphasises disintermediation (McLennan, 2016; Srinivasan & Burrell, 2015) - for instance, seeking to employ information technology to replace other sources of information such as fertiliser sellers or other middle-men in the case of agriculture (Cole & Fernando, 2012).

intervention that we might make. Technology introduced through an intervention can become incorporated into the ecosystem - either temporarily throughout the project period or permanently as a new element of the ecosystem. Technology alien to or ill-fitting in the ecosystem may be entirely rejected, or worse could serve to alter it in ways that are destabilising or that promote specific aspects of the ecosystem at the expense of others.

Turning towards the specific ecosystem that I have engaged with in this project, I placed DRCSC at the centre of the ecosystem and the focus of my activities. This was a choice that was made for both practical, ethical as well as methodological reasons. A different choice would have yielded an entirely different description of the ecosystem. That is to say, that the boundaries of what is part of the ecosystem, and what is not, are entirely shaped by choices made in describing it. The boundaries of the ecosystem cannot be fixed, and, as we shall see, different aspects can be understood to simultaneously co-exist, involving a similar set of actors.

5.1 DRCSC's knowledge ecosystem

This section is largely drawn from Kendall, Linus, and Andy Dearden. "ICTs for Agroecology." International Conference on Social Implications of Computers in Developing Countries. Springer, Cham, 2017 as well as as from the book chapter "Kendall, L. and Dearden, A., 2018. Towards alternate theories of change for M4ARD. Digital technologies for agricultural and rural development in the Global South, pp.92-103".

In discussing the findings from the first phase of the research, I use the three layers (discursive, social and technological) described by Foth & Hearn (2005) as the components of a communicative ecology. The notion of communicative ecologies is closely related to the concept of a knowledge ecosystem that I am employing in this thesis (2.4.1 Knowledge ecosystems). The "discursive layer" of a communicative ecology involves the content of communication, the shared meanings and understandings that are involved. The "social layer" refers to the social relationships and institutions involved. Finally, the "technological layer" consists of technology that is employed in communication.

While the notion of communicative ecology insufficiently addresses the questions of epistemological and ontological understandings within an analysis of a knowledge ecosystem, at this phase of the project the three layers serve as a helpful way of describing the inquiry thus far. It is important to remember,

however, that the notion of distinct layers that can be separated from each other neatly is inherently limiting as all elements of what is described interact with each other recursively to shape and produce each other. As discussed previously (2.4.2 Socio-materiality), I employ a notion of technology as enacted through this recursive interaction between the various elements of the knowledge ecosystem.

5.1.1 Discursive

When it comes to the discursive layer, my emphasis in the inquiry was on the way that members of the organisation, and the farmers they worked with expressed what sustainability meant in their context. In my evaluation, I have placed special emphasis on the values that underpinned this notion of sustainability.

Vignette 1 The seed database

In one presentation I attended during Cycle 1, one of the project managers was relating the outcomes of a project that he had undertaken. The goal was to generate a "seed database" where seeds from several field sites had been collated along with a list of attributes. The attributes (shown in Figure 16 below) included information such as the name, variety, its tolerance and its yield. This had been an extensive data gathering effort over multiple years, and was a core part of one donor funded project. However, after the presentation, one of the senior most members of the organisation raised a concern. He asked:

"You have listed here a series of seeds, with their local names and scientific (Latin) names, along with many useful details such as its tolerance for salinity, and its yield. Yet, while I personally know where this data comes from and the conditions under which this data was gathered, somebody accessing this database would not have any such knowledge. If they seek to try any of these seeds that have been collected and logged in this manner, they may get a completely different result. How can we account for this in a database of this format?"

To this question, the project manager had no direct answer. Afterwards, we discussed how the idea of a database in this format, as well as of the technology that we have to gather it (e.g. Microsoft Excel), almost by necessity creates this kind of problem. In a database like this, you are unable to capture the rich diversity of the agroecological conditions that produced a specific yield or a specific tolerance, and the theory is that these properties are innate to the seed rather than an interaction between the seed's genetic profile and the context in which and practices under which it had been grown. The database, in the digital

form of a spreadsheet, perpetuates a false notion that yield or other properties can be fixed in a definite form - or in best case as a specific range.

District	Block	Organization	Name of crop	Common name	Variety	Scientific Name	Season			Tolerance capacity				Yield (Kg/Bigha)	Seed rate (gm)	Practice				
							Winter	Summer	Rainy	Salt	Drought	Water logging	Pest Attack			Broadcasting	Sowing	Transplanting	Cutting	Sapling
south 24 parganas	Basanti	Champa Mahila Society	Yardlong bean	Barbati	Baro Sada	*Vigna unguiculata*	Yes	-	-	-	-	Yes	Low	8-10q	1kg	-	-	Yes		
south 24 parganas	Basanti	Champa Mahila Society	Chil	Lanka	Alret	*Capsicum annuum L.*	Yes	-	-	-	Yes	-	Low	-	-					Yes
south 24 parganas	Basanti	Champa Mahila Society	Coriander	Dhone	Deshi	*Coriandrum sativum L.*	Yes				Yes		Low			Yes				
south 24 parganas	Basanti	Champa Mahila Society	Golden green gram	Sona mung	Deshi	*Phaseolusragia latus*	Yes				Yes		Midium	1-1.5q	2500	Yes				
south 24 parganas	Basanti	Champa Mahila Society	Grass Pea	Khesari	Deshi	*Lathyrus sativus L.*	Yes			Yes	Yes		-	1-1.5q	10000	Yes				
south 24 parganas	Basanti	Champa Mahila Society	Pumpkin	Kunro	Gol	*Cucurbita moschata*		Yes			Yes		Low	50-60q	600-700			Yes		
south 24 parganas	Basanti	Champa Mahila Society	Ridge gourd	Jhinge	Patal	*Luffa acutangula (L.) Roxb.*			Yes				Low		600-700			Yes		
south 24 parganas	Basanti	Champa Mahila Society	Cucumber	Sasha	Baro pata	*Cucumis sativus L.*	Yes				Yes	Yes	Midium	40-45q	300-400			Yes		
south 24 parganas	Basanti	Champa Mahila Society	Ridge gourd	Jhinge	Baro pata	*Luffa acutangula (L.) Roxb.*			Yes			Yes	Low		400-500			Yes		
south 24 parganas	Basanti	Champa Mahila Society	Lablab bean	Sim	Kamranga	*Dolichos lablab L.*		Yes				Yes	Low					Yes		
south 24 parganas	Basanti	Champa Mahila Society	Bottlegourd	Lau	Sada	*Lagenaria siceraria (Mol.) Standl.*			Yes			Yes	-		300-400			Yes		
south 24 parganas	Basanti	Champa Mahila Society	Smooth Gourd, Vegetable	Dhudhul	Deshi	*Luffa cylindrica (L.) M.J.Roem.*			Yes			Yes	Low					Yes		
south 24 parganas	Basanti	Champa Mahila Society	Lady's Finger	Dharonsh	Panch sera	*Abelmoschus esculentus(L.) Moench*	Yes	Yes	Yes			Yes	Midium		600-700			Yes		
south 24 parganas	Basanti	Champa Mahila Society	Snake Gourd	Chichinge	Malhari Lamba	*Trichosanthes anguina L.*		Yes	Yes		Yes							Yes		

Figure 16. The seed database. Work artefact of DRCSC (2019).

Meanings of sustainability

When it comes to the content of their intervention, DRCSC adopted an approach to agriculture founded on agroecological principles (Altieri & Nicholls, 2005). Agroecology places the long-term sustainability of the farming system at the centre, suggesting that agricultural practice has increasingly chosen to focus on short-term yields, achieved through practices which are harmful for the long-term ability of the farming system to guarantee farmer livelihoods. Investments in programmes such as local variety seed saving, farm-level water harvesting structures and kitchen gardens were all designed to allow the village, the farm and the family respectively, to have greater resilience and self-sufficiency. Agroecology considers that human interventions into natural ecosystems create agroecosystems (Gliessman, 2006), but that the challenge of sustainability is to create agroecosystems that can achieve the characteristics of natural ecosystems while still providing for human needs (Gliessman, 2006). This approach leads towards agroecosystems of increased complexity, heterogeneity and diversity (Gliessman, 2006). However, they are at the same time systems that feature lower losses, greater resilience and stability and thus improved overall sustainability (Altieri & Nicholls, 2005; Gliessman, 2006). This leads to an inherently situated view of agricultural knowledge - the specific characteristics of any given

combination of an environment and human practices produces a unique and complex agroecosystem, if managed according to agroecological principles. The agroecological approach resists the idea of reducing agriculture to efficient packages of practice that along with HYVs can be transferred from one agroecosystem to the next. It also places limitations on the way that any agroecosystem can be reduced to its constituent parts - especially when separated from human practices and interventions.

As vignette 1 at the start of this chapter illustrates, these differences in agroecological views can lead to conflicts when more reductionist approaches to agroecosystems were adopted in projects within DRCSC. The seed database discussed in that vignette could encapsulate certain notions of sustainability (especially those which focused on a notion of seeds being possible to understand through discrete properties), such as saline tolerance, yield, or drought resistance. However, other notions of sustainability - whether culturally imbued or built on an understanding of the agroecosystem as more complex than what can be captured through discrete variables - fit poorly with this approach or technology.

Valued ways of being such as resilience and self-sufficiency are interrelated with a desire and need for holistic and long-term engagement. For a farm to become sustainable, many years of engagement are required. It is also not sufficient to engage with just a single farm, as neighbouring farms will influence it through both ecological as well as social interactions. The organisation had from the start engaged with communities in this way, focusing on deep connections with a few communities rather than shallow links across many. Many of the senior members of staff of the organisation had spent extensive amounts of time living and working in their project areas. Holistic engagement meant addressing different topical concerns – such as including food habits as part of their intervention – but also operating on different interlocking scales – the individual farmer, the village and the block[20].

That sustainable agriculture requires a holistic approach was highlighted through several of the challenges faced by the organisation and the farmers, as well as in the design of some of the organisation's programmes. One example of this is the intertwining of farmer food habits with the sustainability of their agricultural

[20] A block is an administrative area of India that can be compared to a county. A block is a subdivision of a District, and a District is a subdivision of a State. A block will generally include many villages and settlements distributed over an area of a few hundred square kilometres.

practices. Greater integration with agricultural supply chains have meant that farmers are increasingly looking to consume produce which does not grow in the nearby area. In one of our discussions a field officer noted: *"Now people want to eat cabbage, cauliflower and apples"*. As a result, farmers opt for a narrower selection of crops and seed varieties optimised for sale or exchange value as opposed to nutrition or local ecological conditions. Micro-nutrient deficiencies is a recognised challenge which few mainstream agricultural development programmes have been able to address (Pingali, 2012). Reduced crop variety and dependence on markets form challenges to the sustainability and resilience of these agricultural communities especially as they experience greater climactic variability. It is not only through the preference for newly available products that food habits impact the sustainability of farms in the area. The staple crop of Bengal–rice–plays a significant role in livelihoods and for nutrition in the area. As part of the food culture, a belly full of rice is a significant measure of well-being, "bhat gum" ("rice sleep") being the desired result of a good meal. Since the Green Revolution, HYVs have been introduced along with a package of practice, including irrigation, pesticides and fertilisers, which allow for a second rice harvest during the summer months. However, in a meeting at one of the farmer's houses a trainer from the organisation worked with farmers to tally outcomes from different summer cropping patterns. Their results showed clearly that not only were alternative crops such as lentils ecologically more sustainable but they were also more economically profitable and provided better nutrition. In spite of having generated this evidence for themselves, several of the farmers knowledgeable of agroecology still chose the HYV rice crop (as illustrated by vignette 2). These accounts highlight how promotion of agroecology needs to address the issue in a holistic way, taking into account both agricultural practice but also acknowledging socio-cultural preferences. vignette 2 illustrates how both successes and difficulties in promotion of sustainable agriculture was understood by the organisation through this holistic lens.

Vignette 2 Boro paddy

During one week where we visited multiple farmers, we came to discuss the question of *boro* rice - that is rice grown in the summer season when irrigation is required as there is no natural rainfall. Two cases were brought up by the field officers I was working with. In one case, he held up the female farmer that we had just met as an example of the organisation's intervention having had a deep impact. He related that "*Her husband, he works outside [as a migrant construction*

labourer]. Since he came back, there have been a lot of husband and wife problems[21] *[about the paddy crop]. Because of her involvement with DRCSC she is saying that they should not grow paddy this season, but he has come to do the planting work and insists they need to*". In the end, considering that their house had paddy growing in the land behind it, the husband's will had prevailed (perhaps unsurprisingly considering the patriarchal norms still dominating). However, the wife's strong resistance to growing it - the field officer held - was an illustration of the organisation's deeper success.

In another case, I noted to the field officer that a farmer - who had been featured as a lead farmer - had also grown boro paddy. We had just returned from a meeting at his house where he and several other farmers had discussed the lack of profit in boro rice and the ecological harms it brought. When I asked about this incongruity, he replied that even a lead farmer continuously needed support to trust their instincts, that ecological farming was better. When you observe the whole village seeding and growing rice, then it is very difficult to not feel that you should also do it to guarantee your and your family's food security.

5.1.2 Social

In this discussion of the social layer I focus on the institutional context of DRCSC and the work practices of its project officers. I will begin with a discussion of the everyday field work activities at the field office, and then discuss some difficulties expressed in terms of organisational knowledge management and finally end with a discussion of the way in which sustainability was perceived in relationship to the organisational structure.

Vignette 3 Learning about vermicomposting

I observed that a group of farmers who were well acquainted with the organisation and its programmes were being given training on a topic which most of them were already very familiar with (illustrated in Figure 17). When questioned about this D., the trainer, responded:

> *D: "these events are much more about creating a social meeting space [than training], this kind of discussion would have happened 30 years ago, but it is not happening any more…"*

These meetings served a bigger role than simply a way to deliver agricultural

[21] Implying frequent quarrelling between the husband and wife.

knowledge. I observed that more experienced farmers were given a forum in which they could reaffirm their knowledge in front of less experienced farmers by agreeing with, challenging or elaborating on what the trainer said. Events provided spaces for people who would have little opportunity to interact, for example the elderly farmer sharing the design of his vermicompost pit to a younger, female farmer from a completely different village.

Figure 17. Farmers sharing information about vermicomposting with each other. Picture by author (2016).

Doing field work

In looking at the proposals and reports the organisation provided to funders, there were often linear descriptions of activities leading to specific outputs contributing to specific development outcomes. In these proposals there was typically a direct set of activities that need to be run with the farmers along with the distribution or provision of tangible resources - for instance, cook stoves, seed or livestock. The activities are typically framed as imparting a specific set of information or knowledge that would then be directly employed by farmers to achieve outputs such as improved yield, greater incomes or improved nutrition. An example of this is given in the extract from a funding proposal in Figure 18.

Project/Programme Components	Expected Concrete Outputs	Expected Outcomes
	located at the centre of the project area and 40 weather kiosks managed by climate volunteers for collection and dissemination of crop-weather advisories	
3. Climate resilient technology transfer for enhancing the adaptive capacity of the community	*3.1* Sustainable soil and water conservation measures (e.g. semi-circular bunds, check dams, gully plugs, infiltration ditches and agro forestry plantations) for various ecosystems introduced for improvement of agricultural productivity and environmental sustainability *3.2* Multilevel cropping systems & integrated farming practices are introduced mainly through popularizing a combination of drought tolerant field crops, fast growing & multipurpose perennials and small livestock *3.3* Disaster-coping mechanisms like community grain banks, local crop & trees seed banks, fodder banks developed in targeted villages *3.4* Climate resilient appropriate technologies like energy efficient cook stoves, bio-gas, low cost water filters and community based drinking water facility are promoted.	Livelihoods have become less vulnerable to climate change and achieve higher levels of productivity

Figure 18. Sample from DRCSC's proposal. Work artefact of DRCSC (2013).

Within this framing, staff members - primarily from the head office - would describe their role as a) conducting activities as planned in the project proposal in a timely way b) monitoring that activities within the field (i.e. amongst the

farmers) align with the goals as specified by the projects and c) gathering and aggregating data for management and funders through various forms of reporting.

However, the descriptions in the project proposal and by some head office staff members were an - at best - incomplete representation of the work of the field office. The days at the field office would follow a regular schedule. Work would start rather late, leaving field officers time to do personal errands or work in the morning hours. For many, this also meant taking care of their own agricultural activities. Meetings would be held before lunch. After lunch, field officers would travel to various villages for meetings with individual farmers or with farmer self-help groups (SHG).

Those who worked at these field offices would typically come from and live either at the field office itself in guest rooms or have their houses nearby. Many of their families could easily have been beneficiaries of the organisation's programmes themselves. They also typically worked over a long period of time with the organisation, sometimes in fairly informally defined roles that changed over time. Unlike in the head office, where the staff turnover was high and where new projects introduced meant an entirely new set of staff members, in the field office it was common to see people disappear and return from active employment in the organisation. This follows, at least partially, from the nature of urban and rural employment, where the urban environment offers a much greater variety of jobs than possible in a rural area. However, reasons behind this pattern notwithstanding, it is unavoidable that it influences the ability of those involved to build long-term relationships to the work and the people.

The field officers would spend a large amount of their time on visiting the farmers, observing the land, discussing family matters, drinking tea and discussing matters of concern at farmer's houses. These individual meetings with farmers were spent explaining the current programme, discussing with the farmer how to implement the intervention, discussing how to manage financial matters and promoting their participation in the activities. These meetings were mostly organised by the time of the day. Field officer's would appear at someone's house in the afternoon, after the day's main activities in the field had been completed and the farmer had taken his or her lunch, and would sit down on the veranda or in the space in front of the house for a discussion. Occasionally the person would be out, at which point a message would be left and another nearby person would be visited. Notably, detailed scheduling, note taking or gathering of information

for reports played a very small role in these meetings - they rarely corresponded to gathering the exact information required by the head office or the funders. Information would be relayed orally back at the field office, and sometimes there be converted into notes during field office meetings that would later make their way into reports to the head office and funders.

Information directly related to the projects would typically mostly be collected during the SHG meetings. I observed multiple times where field officers would take part of the SHG meeting to ask questions about the assets the farmers' had or whether they had received a specific item (such as a cook stove) that should be provided through the programme, whether they had used it and so forth. These details were written down during the meeting and then provided the field project manager, who would input them into the computer. The self-help group meetings would, however, also have two different parts with the formal part of the meeting - using the agenda and notes and with mostly one or two group members speaking - followed by a second part that was more informal, "adda" (an informal group discussion typically involving tea or snacks) where there was greater participation from the whole group.

Looking at how field officers actually spent their time, whether around the SHG meetings or individual meetings with farmers, a majority of the work could be understood as managing social and community relationships. As field officers lived in or near their work areas, there were often relatively weak distinctions between social and work oriented relationships and interactions. This relates both to interactions between field workers themselves as well as with the farmers.

The example of the farmers receiving training on vermicomposting in vignette 3 illustrates the broader role that the field officers considered themselves and the organisation to play. As one of the field workers described it: their real purpose went beyond supporting agricultural development, it was really about promoting "social cohesion". As he saw it, their role was to bring together farmers from different communities around common concerns. Similarly, when describing their attempts at engaging new groups of farmers in sustainable agriculture, one of the trainers related that it was not so much about teaching new technical practices as about building relationships and trusts.

Vignette 4 Case Stories

A concept commonly used in the field offices context was the "case story". The

case story was a narrative description of the impact of a project gathered by the field officers at the farmer's site. These stories would be shared in various situations, orally with other farmers as examples. They would be told as positive examples to follow, but with the added note that other farmers could call and visit these people. They would often also be augmented with the challenges that the farmer faced in actually adopting whatever practice they were discussing - presumably to build confidence and make the practice accessible. Stories were often mentioned by the field staff and the head office staff as evidence for their projects' impact - in many cases the "lead farmers" quoted in them would be held up as positive examples to external parties (such as me, or in the funders meetings I observed).

Stories were also documented as qualitative features and used in project reports, funding proposals and on the website. As a report, they would typically include a picture of the farmer - for which a digital camera was available at the field office - and a description of the impact of the project on the farmer's agricultural activities and livelihood. These ranged from 0.5 to 2 A4 page lengths. An example of such a documented case story is given in Figure 19.

A case-story of a successful integrated farming

Farmer's name: Ajit Singhababu
Village: Panchasimul, Block: Chatna
District: Bankura

Ajit Singha babu, 73 years old is a very active and enthusiast integrated farmer. He has set an example of a successful IFS design in own holding with the support of DRCSC under the NABARD CCA Project.

In about 2 katha of land adjacent to his house where he has raised nutrition garden, mixed cropping. In the mixed-cropping bed he has introduced vegetables and leafy vegetables like coriander, onion, radish, punka, spinach, brinjal, tomato and the rest.

On the trellis he kept lab-lab beans, and bottle gourds with a 3g technique. The fruits have come-up with plenty of numbers.

In the other bed he cultivated fenugreek, carrot, beat punka, piring, cucumber, turnip, garlic, horse beans, spinach and all others; accompanying some medicinal plants & herbs . In the middle plot there is azola tank; ***Azola*** is used as the fodder for country chicks, ducks and goats. He used water trap for pest control of brinjal as per agro-advisory of DRCSC.

He has applied only cow-dung and vermi-compost as fertilisers. After consuming the produce (vegetables etc.) throughout the year, he regularly earns good amount of money by selling the products in market.

Beside nutrition garden and mixed cropping, he is engaged in livestock rearing. In another plot, there is a pond; additionally he has a poultry farm adjacent to the pond, where he is rearing native varieties of chicken and ducks. He also installed an incubator to hatch eggs scientifically and easily.

Ajit Singha babu is busy with his farm...

Major change in practice: Nutrition Garden, Adhar Muktangan, Livestock Rearing, Azola Culture, Incubator, Medicinal Plants, Ditch, Mixed Cropping etc.

Major outcome:

- Ajit Babu is now less dependent on market since he has been engaged in integrated farming.
- Through ***Adhar muktangan*** country chicks and ducks his family is now earning yearly Rs. 7000 onwards by selling eggs and Rs. 9500 onwards from country chicken.
- Hatching eggs through incubator his family is earning Rs. 5000 onwards by selling country chicks and ducks.
- ***Azola*** is used as the fodder for country chicks, ducks and goats
- He fetched about Rs. 3000-4000 per year as he sold vegetables in local market after self consumption

Figure 19. An example of DRCSC's case stories (2019).

In contrast to the way these cases were discussed in the field, the published versions tended to be a sanitised perspective on the story. Having as their purpose to positively document the impact of the intervention, they tended to focus on the assets that had been brought by the project, such as the native ducks, incubator and vermicomposting in the example given in Figure 19. Case stories would also cover the situation of the farmer and how these assets had been a solution to many problems, often documented in the form of increased income or - in some cases - nutrition.

Some members, especially those in more senior positions, lamented that the cases documented in this way by the organisation did not quite live up to the needs of either the organisation and the field officers themselves, nor external parties such as funders. Internally, in a similar way to the seed database discussed in vignette 1, the written case stories could not cover enough depth or richness to communicate what they considered really important about the case. Externally, they did not provide the objective measures of success that were considered a requirement.

Managing knowledge

The ability to produce quantitative data, compatible with "mainstream design" and that was "persuasive" to outside agencies were among the critical challenges that the organisation faced (4.1.4 Evaluate). The case stories discussed in vignette 4 held an intermediate position, quoted as evidence but not considered enough to convince outside parties. Rather than seeking to make these stories more convincing as qualitative research artefacts, I often heard that more quantitative data would need to be gathered to show better - statistically - the impact of the project. A common complaint was that insufficient "baseline data" were gathered, so that an absolute proof for the intervention's effectiveness could not be shown at the mid-point or end-point evaluation. Having not attended the negotiations with the funders myself it is hard to identify to which extent this is a self-imposed pressure and to which extent it is applied externally. However, the funders - and to some degree - government agencies were viewed as those who would be the users of this data and who should be convinced by the programmes through seeing it (4.1.4 Evaluate). In my discussions with members of staff, I got the impression that they considered quantitative analysis of the causal relationships between intervention and development outcomes to be the standard to which the organisation should aspire. Certain development scholars have indeed held that development interventions should be approached with the rigour of Randomised Controlled Trials (Duflo & Banerjee, 2011). If this is the standard by which DRCSC's interventions should be evaluated, it is worth noting that simply changing their data gathering and analysis would be insufficient.

An alternative way of perceiving knowledge management is illustrated by the case of the farmers learning about vemicompost in vignette 3, where the development in the relationships between the different farmers, across generations and villages, linked by mutual interests and values of sustainable agriculture, is the

critical outcome. Within this view, case stories would be used as narrative stories for inspiration and creating further connection, by connecting farmers to each other. In response to questions or concerns expressed by farmers in the field, the field officers would often talk about named individuals in nearby villages, give examples from those individuals' farms and suggest that they get in contact. Meetings at the head office for various purposes, such as for training or distribution of resources, would serve as a way to facilitate such direct personal contacts.

Organisational structure

Finally, I will discuss some elements to how the organisation's structure was changing. One of the ways that self-sufficiency and resilience was maintained was through the way in which financial support was provided. While the head office raised the greater part of the funds, for individual investments, these were provided to a fund held by the local farmer's group. That fund in turn, rather than providing funds as a "grant" to the beneficiary, provided it in the form of an "investment" which the beneficiary eventually should pay back to the farmer group fund. In this way, the farmer groups could eventually hold a revolving fund that could be used to continuously invest in improvement projects on individual farms. This ideal organisation structure is illustrated in Figure 14 that was produced during one of the Rich Picture sessions discussed in (4.2.3 Act) . The "ISWS" in the picture is the community based organisation (CBO) in Patherpratima, which DRCSC and various Government Organisations (GOs) interact with. It in turn organises a variety of ARTCs which operate at a village level to manage a revolving fund and implement various projects in the field (illustrated by squares with circles in the diagram).

This structure was kept in place at the village level, however on the level of the field office it had begun to change. While the level of independence varied greatly from field office to field office, the goal had for a long time been to support the establishment of entirely independent local, community-led grass roots organisations. To this end each local office had been created as a separate entity from the head office with its own governance structure and funds. Assets used through the projects would eventually be transferred to the local field office rather than remain with the organisation itself. However, with the change towards an increasing number of projects as well as changing expectations from funders, they needed to move towards acting as a project implementer. This meant that the organisation itself took greater ownership of assets as well as greater managerial

control over the projects. It also meant that the sustainability of the field offices became entirely dependent on the ability of the head office to raise funding and maintain the organisation.

5.1.3 Technological

In this section I discuss some of the ways in which technologies that can be clearly identified as ICTs were employed in the work of DRCSC. This is by its premise a very limited discussion as there is a wide variety of technologies employed by DRCSC that may not fall under a view limited to "ICTs". However, I still consider it helpful to illustrate their use of some common ICTs and the way that it interacts with their work practices (5.1.2 Social).

Vignette 5 GPS devices

One of the funders DRCSC had started working with wanted exact GPS coordinates for the beneficiary sites, in order to validate how many different sites there actually were. Accordingly, a not insignificant sum of money had been invested in buying specialised GPS devices. The field officers had been given these devices and asked to read off and then record the GPS coordinates while they were in the field. The coordinates were recorded alongside other information about the beneficiaries as part of a baseline survey and then later follow-ups. The idea was that this served as proof that there really was a beneficiary at that particular location, and one that could be uniquely separated from others. Considering that most of the data gathering happened in group settings, this meant that field officers had to ensure that they separately visited each household.

When asked if these devices had seen any use either in the project or in later projects the project manager said that no, they were probably stored in a drawer somewhere. He also noted that it had been very time consuming to both train field staff on their use, as well as maintain the resulting records. The coordinates would have been entered on paper, and later re-digitalised when entered into spreadsheets.

Socially and informally oriented technology use

There are a number of different technologies and artefacts employed in the management and work practices of DRCSC. There are the project proposals that DRCSC prepares to interest funders in financially supporting their activities. For the funders that accept, there are the project plans, including Gantt charts, the project budgets and the audit reports that are prepared throughout the project

activities to report on activities. At the middle and at the end of the projects there are also impact reports that numerically try to communicate impact. The contents of these are typically specified by the funders. There are also ongoing planning and reporting documents that are used in coordination between the field staff and the head office staff of the organisation (the project managers, the executive committee/leadership). I have already given an example of one such artefact in the form of the seed database discussed in vignette 1.

At the field office site, information gathered often needed to be collected, aggregated and then transmitted to the head office. When I started my engagement, this was done primarily using a desktop computer installed at each field site. This desktop would primarily be used by one member of the field office (see Figure 20). Gradually, however, the desktop was replaced by at first one and eventually several laptops at each field office. As skills in using a desktop computer were limited, not only were there only one or a couple of people at each field office that made use of it, but it was also a considerably time consuming activity, and I would often observe the field office manager spend afternoons painstakingly entering data into the computer.

Figure 20. The computer used at the office. Picture by author (2016).

The computerised records would later be e-mailed to the head office. E-mail was often a challenge as Internet connectivity was slow and unstable - especially before the introduction of 4G in 2017[22]. As connectivity was intermittent, e-mails would often fail to send and the attachments would then need to be re-uploaded

[22] 4G services were rapidly deployed after the introduction of Reliance Jio in the Indian market.

from scratch and sent again. WhatsApp provided a much better means of sending pictures, and - as will be discussed shortly - sometimes they would use it to “scan” documents with their cellphone cameras and send them as text. Financial information would be typically be sent in this way. Sharing images of documents and hardcopy materials between geographically dispersed staff could be achieved this way. Several of these uses may appear inefficient. Printing a digital document in order to send a photograph of it via WhatsApp is perhaps the most striking example. However, WhatsApp is a tool that fits with the social and informal nature of the field officers' work context where there is often little distinction between social and work oriented relationships.

There were clashes between this informal use of technology - especially in the field office - and a desire for central control from the head office. In one instance, a field officer related how she had been berated for posting pictures and information about one of the organisation’s programmes that she was managing in a Facebook group that involved multiple different organisations. The group had been the result of a coordination meeting with many different organisations running similar programmes. To her, sharing details was just a way of continuing the conversations in which she had participated during that organisation-sanctioned activity. However, to her superior there was a sense that there was too much risk that she would post something that could potentially illustrate that the organisation had not done everything it had promised to funders, who could potentially have joined in the group and viewed her messages.

The value attached to the role of the organisation’s activities as important social meeting places, as well as the relatively social and informal nature of their activities, meant that the technology should ideally support this type of interaction. Therefore, more formalised workplace tools may have been ill suited or directly working against these values. For example, the increased use of Microsoft Excel to track specific metrics in templates developed together with funders (primarily serving funders’ needs and emphasising budget utilisation) was a contributing factor to that “the real work” was not given importance. The GPS example given in vignette 5 is another instance of a technology that was the opposite of social and informal, as it was based upon a very formal way (and definitely not socially oriented) of identification of individual beneficiary households. This was a mode not only entirely irrelevant to the beneficiaries themselves (who did not much care about the coordinates of their house) but also to the field officers.

When it came to long-term storage of data, the organisation's management primarily relied on the use of shared laptops and hard drives. A new staff member would inherit the laptop from the previous staff member with the same responsibilities, and there would be several external hard disks within each team that held some of the info. While the organisation had previously largely relied on a well-organised internal library to manage knowledge such as training manuals or action research outputs, these now largely resided in these hard drives in the form of presentations or project reports. This had made them less discoverable than their non-digital counterparts.

Using digital photos

Digital cameras were employed in various ways by the organisation from the start of my engagement with them. They were commonly used by the project officers visiting the field from the head office to gather evidence of the activities for use in later reports or publications. The documentation gathered in this way was rarely systematically organised, but would be collected ad-hoc on the basis of the activities going on in the field at any given time. Occasionally, project staff would collect photos of a particular part of the intervention for the project in order to write it up as a case of a beneficial practice. These often ended up in various PowerPoint presentations presenting different types of interventions that the organisation had conducted. As smartphone cameras gradually improved over the years of my engagement with DRCSC, photos were increasingly captured on phones.

The photos captured in this way were often used in conjunction with the Case Stories discussed in the previous section to enrich the descriptions of the cases. Photos were to a limited extent employed in the field offices - at a couple of occasions presentations containing photos from other field sites were used in a farmer's training, and there were a couple of quite old paper posters in the office displaying various interventions and programmes.

The primary purpose of the photos, however, was for consumption outside of the field in the form of reports, on the website and in other training materials. The ethics of using photos was rarely discussed with the participants in the various activities, when asked those participants had only a limited idea of how their photo might be used (4.2.3 Act). This did not mean that participants in the various activities did not have an opinion about how they wanted their photo to be used

(4.1.3 Act). The prevalence of smartphones meant that there were an increasing number of photos taken and collected from the field activities, however in my discussions with the action learning set little discussion had taken place within the organisation about the appropriate ways to use them.

5.2 Knowledge systems

Having now described elements of the ecosystem of DRCSC - a discursive understanding of what sustainability means, that then underpins certain ways of organising and managing their work as well as affinity towards particular types of technology, I turn to looking at it with a knowledge system lens. Adopting an understanding of the potential for different knowledge systems to operate within the ecosystem helps explain some of the tensions identified throughout the first two cycles as well as the analysis of the knowledge ecosystem.

I place these observations and the conflicts identified throughout the field work into a framing of two knowledge systems: a managerial knowledge system and an ecological knowledge system. I will, in this section, argue that the development of a managerial knowledge system within DRCSC has had important implications for the way they approach their work.

This development has also created a particular set of tensions within the organisation. Making specific references to my findings about technology in DRCSC's knowledge ecosystem, I will illustrate how technological interventions play an important role in the development of these tensions. This will, in turn, illustrate the importance of the choices made when approaching new technology interventions - which is what the next cycles of this research project centre around.

5.2.1 A managerial knowledge system

One way of looking at DRCSC's work is as an example of a traditional donor-funded project implementing organisation. There are a series of stakeholders and actors that are discursively identified as "the beneficiaries", "the field staff", "the project managers", "the executive committee/the leadership" and "the funders". These interact with each other in ways that can be recognisable as a typical pattern of funded development projects. This involved a framing of the work of DRCSC as being to deliver specific trainings or to distribute particular assets or resources that generate certain outcomes which would lead to desired

development outcomes (outcomes typically framed prior to the project's commencement, often by the external funder) (5.1.2 Social). Accompanying this are recognisable artefacts such as project budgets, spreadsheets and Gantt charts created and used as part of the programmes, and recognisable work practices such as distribution of resources, trainings on topics relevant to the project, ongoing monitoring and reporting and impact assessment.

This understanding of the organisation was a recent development and had emerged as DRCSC had transitioned from a single funder providing funding for the organisation as a whole, to working on multiple short to medium term projects funded by different funders (see 4.1.4 Evaluate and 4.2.4 Evaluate). This meant that the organisation had transitioned towards having to compete in a marketplace for donor funded projects (4.1.4 Evaluate), resulting in changes to the framing of their work, their work practices and even the type of staff recruited. Having to compete for projects with other organisations in the "funding marketplace", meant that the organisation increasingly took on projects with limited time frames and funder-specified measures of impact.

This follows - both in timing and content - a broader movement in the development sector towards "managerialism" - a set of ideas and practices that have become a powerful force having expanded from the realm of business to encompass a wide variety of fields such as international economic management, national governments, public service and international development (Baines, Charlesworth, Cunningham, & Dassinger, 2012; Eagleton-Pierce & Knafo, 2020; Hvenmark, 2016; Mitchell, 2018; Roberts, Jones, & Fröhling, 2005). New Public Management (NPM) has been the most influential way of framing this adoption of private sector management techniques to public sector and non-profit work - including the introduction of market logics of competition and contractual relationships (Lane, 2000). This includes the experience shared by DRCSC of market logics becoming more central to the funding of development initiatives - where non-profits act as "quasi-firms" competing with other organisations to win "contracts" to produce specific development work (Hansen & Ferlie, 2016).

At its core, managerialism encompasses "*a belief that the world should and can be managed, involving ideologies informed by instrumental rationality, and techniques directed towards the control of organisations and other social outcomes*" (Eagleton-Pierce & Knafo, 2020). Managerialism is embedded in notions of modernity where the world can be organised and controlled, reducing "ambivalence, ambiguity, and

uncertainty" (Eagleton-Pierce & Knafo, 2020). It forms an ideology (Hvenmark, 2016) that has transformed the underlying logics by which many community-based and non-profit organisations have operated (Baines et al., 2012; Mitchell, 2018).

As a practice, amongst NGOs, managerialisation (Hvenmark, 2016) has led to a call for better targeted interventions with tangible measurable "impacts" for clearly identified "beneficiaries" (Baines et al., 2012; Eagleton-Pierce, 2020). These practices have become central to how non-profits make "legitimising accounts of their organisations" (Mitchell, 2018), their interventions and the impact they have to other stakeholders such as funders. This can lead away from the mission of the organisation ("mission drift") (Hersberger-Langloh, Stühlinger, & Schnurbein, 2020) as well as result in self-regulation by staff members not on basis of personal or organisational ethics and politics but rather (typically externally defined) performance metrics (Baines et al., 2012). This closely matches what staff members within DRCSC have been describing as an important tension within the organisation and their work.

When it comes to technology, vignette 5 is an example of managerialism in action. Here, the identification and location of the exact beneficiary and their house becomes an important goal, realised through the application of a specific technology. It embodies aspects of managerialism such as accountability, transparency and efficiency through the use of a technological tool to monitor the intervention in a seemingly objective manner (Hvenmark, 2016; Roberts et al., 2005).

In a less direct way, the seed database in vignette 1 is part of this same movement, where the inherent situatedness of agricultural outcomes - and its resulting ambivalence, ambiguity and uncertainty - is sought to be controlled through the application of control, management and formalisation of knowledge in the form of an Excel database (Ramos & Hayes, 2015). The demand for greater "professionalisation" of the organisation discussed in cycles 0 (4.1.4 Evaluate) and 1 (4.2.4 Evaluate) can, from this standpoint, be interpreted as a result of the incorporation of the values and goals of managerialism in the organisation's work. Looking at the outcome of cycle 0 (4.1.4 Evaluate), many of the other issues can similarly be seen as driven by managerialisation. For instance, the notion of "... *generating data compatible with mainstream design...*" can be understood as the organisation seeking to align itself with the impact measures of the funders -

creating a “legitimising account” (Mitchell, 2018). Professionalisation here seems to imply the ability to serve the needs and interests of the funders in a way that fits the funders’ notion of development as well as their need for control over how development is carried out (Roberts et al., 2005).

5.2.2 An ecological knowledge system

As became clear in cycle 1 (for example, see 4.2.4 Evaluate) there were discontents within the ecosystem. The values and beliefs dominant in the managerial knowledge system are not always aligned with the values or interests of either the farmers or those who had been involved with the organisation for a long time (5.1.1 Discursive). The values expressed by these actors, however, more closely follow the description of the ecological knowledge system (2.2.3 What does sustainability mean for agriculture?). There were members of the ALS who considered that the emergence of the managerial knowledge system had led to increasing unsustainability and was a threat to the organisation (5.1.1 Discursive). In their view, the function of the ecosystem around DRCSC was to be a resource that could contribute to the growth of independent community resource centres, to support “social cohesion” (5.1.2 Social) and to engage long-term in developing agroecological interventions. In this view, sustainable development is holistic - addressing interlocking issues such as food habits, relationships within the family or community cohesion. It also emphasises - as the example of the seed database in vignette 1 illustrates - situated action and knowledge, that cannot be easily separated or extracted from the context within which it is generated. The original set up with a single funder gave DRCSC a great deal of autonomy in how they organised their work, allowing for this type of holistic and long-term engagement. The framing at this time emphasised the combination of natural resource management and livelihoods. When it comes to staffing, the vast majority of the members of the organisation who were knowledgeable and experienced in sustainable agriculture had joined and learnt about the organisation’s work during this phase. These were regularly the same people who were highly critical of the managerial approach. There was a recurring problem (4.1.4 Evaluate) of staff turnover among those recruited under the regime of the managerial knowledge system, leading to a loss of knowledge and experience for the organisation.

Looking at activities from the perspective of a different knowledge system helps explain divergences such as the distinction field workers made between what is “real work” and what is not. For example, the way in which the field officers undertook their work in practice is very different from notions of planned or

controlled activities, executed along a specified schedule towards particular outputs that generate outcomes and impacts. From a viewpoint within the managerial knowledge system, this would seem problematic and there would be concerns about the efficiency of the work undertaken by the NGO (Eagleton-Pierce, 2020). However, for some in the organisation this was the very core of the "real work" of the organisation (4.2.4 Evaluate).

As another example, the participation of lead farmers in trainings on topics that they already knew very well (such as the vermicompost training described in vignette 3) can be understood to be part of a different pattern of interaction that does not fit with a managerially oriented understanding of the purpose of trainings. As the field worker described, it is not so much about delivering or receiving particular information or learning, as it is about taking part in a community of people doing similar things. Occasionally, it might also just be about attending a meeting to have lunch and some chit-chat with others that you know. In the managerial knowledge system, their participation was unnecessary - and in fact there were attempts within the organisation to track who had undergone which trainings in order to certify certain farmers as having achieved knowledge of a particular topic. However, in the discussion I had with the field project manager, their participation in the activity and the way it generated connections between the farmers in the community was very much the point of the activity - rather than the acquisition of specific knowledge on vermicompost. A "certificate" of having "acquired" specific knowledge - along with the idea of progressing through trainings without repeating information - would reduce or entirely eradicate much of the value that the meetings provided.

Data about interventions operate differently when viewed from these two different knowledge systems. The case stories discussed in vignette 4 were, in the field office and in their oral form, centred around the story about the person whose situation had changed, and would typically encompass both failures and successes. The discussion of boro paddy farming I describe in vignette 2 is an example of this type of story. The field workers, having worked for the organisation in various capacities for a long period of time, personally knew many of those who had been involved repeatedly in the organisation's programmes - despite there being thousands of farmer households in the region. However, when translating these into a format more suitable for use within the managerial knowledge system the case stories became more streamlined, emphasising successes, interventions or resources provided, specific measurable outcomes and

the direct causal implication between the two. This translation thus far saw limited success[23], as the collected, written, stories could not be accepted as a legitimising account in neither the managerial knowledge system nor the ecological knowledge system (see vignette 4).

From a standpoint within the ecological knowledge system, the case stories (in their written form) communicated little of the depth that the oral versions would have. They also did not provide the connection to the practice of the farmer as they could when related directly by a farmer, or by a field worker with direct, lived experience of the practices. Agricultural practice, viewed as fundamentally situated in the specific context of the farmer, could not be easily distilled or captured in this format. When approached from the perspective of the managerial knowledge system, the case stories in their written format were perceived as anecdotal and insufficiently scientifically documented. They did not lay out a clear numerical analysis of the situation prior to intervention, the technical details of the intervention, nor the situation after the intervention. The case stories would have some of these details, but were often insufficiently detailed to provide an analytical link between intervention and outcome. Perhaps more problematically, individual case stories were not perceived (e.g. by state agricultural bodies) to provide sufficient quantitative evidence. People within DRCSC expressed that, to convince outside agencies, there was a need for studies employing statistical methods to "prove" the causal effects of the interventions they proposed. Case stories, even if organised in a more rigorous format, could not provide this on their own. Data collection and analysis practices that could have yielded this type of data were not established within the organisation - an issue recognised as a problem by some at the very beginning of my research work (4.1.4 Evaluate). However, even if it had existed, this type of data would have been deemed of limited usefulness when viewed from a perspective of the ecological knowledge system. In fact, the search for statistical causality could obscure what - in the ecological knowledge system - would be seen as the set of complex factors and relations that produced the benefits of a particular intervention. The examples I have given of the seed database (vignette 1), as well as the farmer trainings (vignette 3) both illustrate this in different ways.

The changes taking place in the ecosystem - and potential conflicts and challenges - are important to understand in order to interpret discussions about and potential for technology in DRCSC's context. For instance, the demand from the project

[23] In the evaluation of the members of the action learning set.

manager discussed in cycle 0 and cycle 1 for tools to help run projects and better document the evidence they had from their work came from a specific notion of what data was considered evidence of what outcomes and how this data should be collected. When viewed from the perspective of the ecological knowledge system, this would have been an inappropriate choice of focus.

5.2.3 Negotiating tensions between knowledge systems

The past two sections illustrate a dynamic set of tensions in the interaction between the social structures of the organisation and the discursive elements of their work. They are dynamic because they are evolving as part of the organisation's activities, but also because they are taking place against a backdrop of much larger changes in the development sector as a whole. For instance, the greater emphasis on climate change as opposed to other focuses can mean that resources such as time and funds are spent on certain activities rather than others.

Adoption of certain technologies - for instance IVR or agrometeorological advisories - can either be in a position to promote certain values over others, or can find tensions between the goals they are aiming to achieve and the fundamental assumptions that guide agroecological approaches to agriculture. The organisation is seeking to negotiate this balance, but there are multiple elements of the broader environment that make this challenging.

While all members of the organisation invariably operate within both of these knowledge systems, the difference in their approach depends on their own values and orientations (for example, see 4.2.4 Evaluate). Diametrically opposed views, such as the debate about whether the project orientation of the organisation leads to financial sustainability or unsustainability, can be understood as a tension between people operating within two very different knowledge systems.

Within the managerial knowledge system, financial sustainability is associated with the ability to compete in a marketplace, growing the number of contracts that they can win and the number of projects that they conduct. Fundamentally, success is premised on growth and scale (Klikauer, 2015). On the other hand (as expressed by one of the members of the action learning set) growth and scale, for an organisation such as DRCSC, can also lead to unsustainability. In this view, the underlying assumption is that people who join the organisation should have sustained employment, gradually learning about the values and practices of

sustainable agriculture. The goal is deep, holistic impact among target communities with the help of staff members who have a long-term engagement with the organisation. Scale and growth, alongside contractually oriented 3-5 year projects, directly conflicts with this perspective on sustainability. If you consider relieving staff whenever the contractual commitments change as antithetical to your way of working, then growth in temporary projects lead to ever growing financial obligations when it comes to staff and maintenance of other infrastructure.

The seed database (vignette 1) can be seen in a similar vein. Seen from a standpoint of positivist science, the detailed data gathering, categorisation into characteristics and potential yield is a very valuable exercise. However, when viewed from the standpoint of senior members of the organisation operating within the assumptions of the ecological knowledge system, the value of the information becomes limited when divorced from detailed understanding of the context and practices from which the information was sourced.

This illustrates that the way technology is approached within the ecosystem has a considerable bearing on this tension. The introduction and adoption of tools and technologies that work within the framework of one mode of thinking can help strengthen that mode and its practices within the organisation. Which knowledge system the organisation should operate within is fundamentally a question of values and world-view. It cannot be said that there is a set of values that are universally held by all staff members or that can be viewed as "the organisation's values". However, it can also be noted that the values underpinning the ecological knowledge system are certainly more "traditional" to the organisation's work, in that they pre-date the emergence of the managerial knowledge system and align with the foundational ideas of the organisation. Secondly, when seen towards the development of the NGO sector as a whole, the introduction of managerial values[24] (Baines et al., 2012; Hersberger-Langloh et al., 2020; Mitchell, 2018) can be seen as an external imposition (Roberts et al., 2005). In DRCSC's case, it is one brought about (perhaps necessarily) by changes to the funding arrangements of the

[24] Referring to the expansion of managerialism in non profit social care organisations, Baines et al (2012) suggests that "collectivist ethics, relationship building, care and social justice are being colonised and displaced by the new technologies of performativity such as self-monitoring, target setting, outcome measures and technocratic solution".

organisation.

The managerial knowledge system within the organisation is strengthened by the adoption of managerialism in the sector as a whole, as well as within the other actors and entities that the organisation interfaces with - for example state government or extension services, funding organisations and international agencies. The argument of "aligning with mainstream design" suggests that what the organisation must do is further develop their adoption of this knowledge system. Proponents of this approach within the organisation would argue that this is necessary for the organisation to thrive. Proponents of agroecology - whether within the organisation or outside researchers and practitioners - however, would argue that the organisation must resist this in order to contribute to sustainable agricultural development.

While values are not static, and are of course amenable to change over time and in changing external contexts, externally imposed change can undermine the autonomy and the long-term existence of parts of the ecosystem that have grown up around the organisation.

Negotiating these choices is specifically one of the roles that the action learning set played in informing the interventions that were eventually to be undertaken (as discussed in 4.2.5 Reflect). The way that this thesis negotiated the question of knowledge systems within DRCSC was informed by both the action learning set as well as my own values. This illustrates how the understanding of "context" in a pragmatist research project cannot be separated from either the researcher or the actions undertaken as part of framing the context[25]. It also illustrates how framing the context involves an (ideally) reflexive choice by the researcher. In this case, I have framed this choice as being one of which knowledge system I seek to embed this project in, and seek to contribute to the development of (in this case, potentially in conflict with or resistance to another knowledge system). My ability to align myself in this way was drawn from engagements with the organisation that both precedes my work on this thesis as well as the period spent inquiring into the organisations situation in collaboration with the action learning set.

5.3 Summary

[25] Or in other words, the collapse of the distinction between ontology and epistemology in pragmatist action research (Frankel Pratt, 2016). There is not a context outside of the way that the context has been developed and framed through the actions of me and the action learning set.

In this chapter I have discussed the context of the research - as created through the inquiry conducted in the first two cycles of action research conducted with DRCSC. I have framed the context as a knowledge ecosystem and described using three layers - a discursive layer, a social layer and technological layer. This forms a situated theory of DRCSC's work, which I developed together with DRCSC through interaction and discussion with members of staff in the organisation - particularly the action learning set.

In the discursive layer I have discussed meanings of "sustainability" in DRCSC's work. In the social layer I have focused on how the various members in the organisation view their field work, the way they manage knowledge and the way the organisation is structured. I have related these elements of social practice to the meanings of sustainability. In the technological layer, I have discussed how they employ technology and how this relates to their notion of sustainability and their way of organising their work practices.

In seeking to address my RQ1 (1 Introduction), through inquiry into and description of the knowledge ecosystem, I also identified an important tension between two knowledge systems within DRCSC. One which I have framed as a managerial knowledge system, and the other an ecological knowledge system Understanding this tension helped frame many of the issues, disagreements and conflicts that I observed during my time spent with the organisation. It also meant that when I and the ALS decided upon the direction for the intervention, we did so with a conscious intention to strengthen the ecological knowledge system. This decision was grounded in the research conducted in the first two cycles, but also in the values and aspirations expressed by members within the organisation as well as my own values and aspirations. In practice, it shaped the way we thought about and planned the cycles discussed in the following chapter.

6. Intervening in the organisation's work

This chapter deals with three cycles of intervention that I undertook during the second phase of the program. These three cycles were where I in a more direct way sought to participate and intervene in the knowledge ecosystem of the organisation through a socio-technical design interventions and a collaboratively created research project. The interventions partially took place in parallel to each other (particularly cycle 2 and 3a, whereas cycle 3b took place at a later stage). The intervention oriented phase of the project began in 2016 and the interventions themselves are still ongoing. In this thesis I have included activities that were undertaken up to mid 2020.

6.1 Cycle 2: The Technologians

6.1.1 Plan

In the second part of the action research project, the goal was to engage in active design work, where myself and some group within the organisation would together design a socio-technical intervention based on the work conducted in the previous phase. Together with the action learning set, a design phase was framed where we decided that we could conduct technology experiments in an action research oriented way.

In this phase we sought to address some of the challenges identified through the previous phase. Specifically, the tensions that had emerged between the managerial and the ecological knowledge system within the organisation. This tension was often described as the increasing “project orientation” and “professionalisation” of the organisation. As discussed in the previous chapter, the requirements from funders on increasingly detailed and quantitative project reporting had led to what some considered “the real work” being forgotten and ignored. It had meant that the relationship between field office staff and those in the head office increasingly focused on financial reporting and project metrics. Those based out of the head office did not have as close relationship with the field nor to the issues that the organisation sought to address (such as long-term agroecological sustainability).

To approach these issues, the action learning set decided that we would recruit a

group of younger team members within the organisation to undertake design experiments. I was not personally involved in the selection of the team members, and this was left up to the action learning set. Only one member (Purnabha) from the action learning set also joined the design group (later termed "The Technologians", see 6.1.3 Act). The membership of the design group and the action learning set is illustrated in Figure 21. There were two reasons for working with a group of less senior members of the organisation. First of all, the organisation had very clearly identified that they faced challenges in developing and retaining a new generation of leaders in the organisation. The senior members of the action learning set considered that one way in which both skill development as well as leadership development could happen is through participation in programmes such as the one we proposed. Another reason was that the younger members may have more time to devote unlike the more senior members in the action learning set. The team members selected by the action learning set to participate in this intervention were drawn from the various teams that the senior members of the action learning set lead.

Figure 21. The composition of the action learning set and the design group. Illustrated by author (2021).

From a research standpoint, the main aim of this part of the project was to explore RQ2 and RQ3 (1 Introduction), that is how we could incorporate the understandings drawn from the collaborative inquiry conducted in the first two cycles (4 Studying the context) and the framing of the research context (5 Framing the research), and how these could form the basis for a socio-technical design intervention. I also sought to, through the work in this phase, better understand the role a designer can play within design/research settings such as this one.

Methodological approach

The methodological approach of this phase drew on multiple sources.

An important part of the planning process for the intervention was concern for how to incorporate the values that underpinned DRCSC's work in light of the contentions identified through the framing of the research (5 Framing the

research). In order to relate this to a design intervention, I drew upon Value Sensitive Design (B. Friedman, Kahn, & Borning, 2008) and Research-through-Design (Zimmerman et al., 2007). From this perspective, I viewed this cycle as an inquiry into the relationship between technological properties and structures and the way they support or hinder expressions of value through the design of a small socio-technical systems (2007). This involved a) technical investigations into how "existing technological properties and underlying mechanisms support or hinder human values" (B. Friedman et al., 2008) and b) "proactive design of systems to support human values" (B. Friedman et al., 2008). Specifically, the aim was to explore the way in which this socio-technical system might influence the tensions identified between the managerial knowledge system and the ecological knowledge system.

Incorporating values into the design phase of the project had two practical implications. First on the purpose and content of the intervention - including technology choice. We needed to pay attention to the properties of the technology we chose and how they aligned with the values of the organisation. Second, the approach that we took in designing the intervention. This means that the approach to design needs to be one which in as many ways as possible reflects the values of the organisation. This does not mean that the values of the organisation are the only concerns to take into account, however, and we must also recognise that this project had a specific research agenda as reflected in the framing of this research programme.

The structure of the design intervention was strongly influenced by participatory design (Halskov & Hansen, 2015) - specifically the more emancipation oriented Scandinavian practice of PD. This meant that I did not seek to have either the action learning set or the design group provide input for what I or any other designer should design or implement. Rather, the aim was that the design group should take a leading role in shaping the intervention, with me as an equal participant providing facilitation and technical guidance.

In structuring the approach to intervention, I also drew on the concept of technology stewardship. Wenger, White and Smith (2005) defines technology stewardship and technology stewards as follows:

"Technology stewards are people with enough experience of the workings of a

community to understand its technology needs, and enough experience with or interest in technology to take leadership in addressing those needs. Stewarding typically includes selecting and configuring technology, as well as supporting its use in the practice of the community."

In technology stewarding the idea is that stewards, from within the community, take up the responsibility for helping the community choose, configure and apply technology in ways that fit their needs and values. While participatory design often places the emphasis on the design process itself and the mutual learning taking place between designers and community members, technology stewarding centres the role of the steward and how they operate within an organisational or community setting (Wenger et al., 2005, p. p.24). In their example of this, Gow et al. (2015) structures their technology stewarding activities as "campaigns" that they define as: "limited duration activity that has a specific objective with respect to needs of the community to whom it is directed" (Gow et al., 2015). In Gow et al.'s (2015) approach they trained stewards to use open source tools, that are freely available, to quickly prototype services that can immediately support some need (that the stewards have helped identify) among the target community. The application of technology that is generally available for appropriation is a necessary but not sufficient condition for the project. By identifying with the values and orientations of the community, stewards help to incorporate and address broader challenges and aspirations through the ICT4D intervention (Gow et al., 2015).

While the goal was a participatory design process that could create a solution addressing a need within the organisation, this cycle also aimed to do two things: 1) stimulate the development of technology stewarding within the organisation through the design group and 2) enable the stewards (and by extension the broader organisation) to identify links between enacting technology in particular ways and the impact they may have on values and collective aspirations. As such, we hoped that from this design group would emerge people who could take up responsibility for and run activities of technology stewarding in the organisation and critically assess which technologies were adopted in which ways.

The younger team members selected as part of the design group were all involved in the day to day running of the organisation and had between 2 and 10 years of experience in the organisation. As such, they understood the workings of DRCSC

and some of its needs. However, before the project started they had not to any great degree engaged with the question of how to actively select and configure technology for the organisation, nor the potential conflicts that could emerge when doing so.

The action of this phase was thus to start a new short-term action research project run by me along with a few individuals in the organisation. The intention was that this would serve as an example for how the organisation could go through design interventions within their own work, forming a pattern that could then be replicated in the future.

As Wenger et al. (2005, p. p.24) recognises the "practices of the community" consists not just of activities that a group of people or organisation undertake, but also engages the values, norms, relationships and power structures that shape the community. Therefore, in our interpretation of stewarding it involves more than finding a specific technological setup that works for a community but also having the capability to actively question and challenge how that technology engages with these broader aspects of the community.

In order to provide some scaffolding in this first intervention, using WhatsApp was suggested by me and agreed with the action learning set. Together with Somjita, I developed a workshop plan for an initial full day workshop to start the work of the technology stewards (see Appendix F for a copy of the workshop plan and agenda). The choice of WhatsApp was intended to provide for a more informal technological tool that could help illustrate and further explore the issues discussed in the previous chapter. It was a technology that the head office staff and field officers already had access to and were familiar with. Through my observations and interviews, it was clear that it was tool that they had adopted because it fit well with the social and informal nature of their work practices (5.1.2 Social), but also provided suitable technical affordances in their situation. I considered that the informality and social nature of the tool provided a type of social affordance (Bidwell et al., 2011) that aligned with the values of expressed as part of the ecological knowledge system. As such it was a tool that might help navigate the tensions within the knowledge ecosystem of DRCSC (5.2.3 Negotiating tensions between knowledge systems). Finally, as a tool that the field officers were already familiar with it did not require any additional development time nor specialised training to make use of, allowing us to focus on the social practices of technology (2.4.3 Social and situated knowledge management) use

rather than on the technology itself.

6.1.2 Ethics

While the previous two cycles had encompassed intervention in the form of the establishment of the action learning set and participant observation of the organisation's work, starting from this cycle our intention was a more direct intervention. In this and the next cycle, through research and design activities the goal was to support the organisation to engage with technology in new ways. In doing so, there would be greater risk to the organisation and its beneficiaries from the work.

First and foremost, if any work is to engage or involve farmers we need to consider their relatively vulnerable position. In my previous work with the organisation (Kendall, 2015), I had actively decided not to conduct design oriented activities in the Dry Zone region as they faced extreme vulnerability due to drought conditions. This meant that they would have had little time to devote to a participatory design project and asking for such participation could have been directly harmful in their precarious position. Accordingly, in this project, even in my previous cycles I had focused on the Wet Zone area that - while vulnerable - faced less direct threats, presently, to their livelihoods.

However, this is not just a question of whether there could be harm from their participation. It is also a question of whether the participants could draw any benefit from the project. Participatory Design activities (such as the ones I intended for this cycle) are premised on mutual learning between different stakeholders. However, in order to achieve participation that can lead to mutual learning there needs to be a certain level of shared understanding and mutual intelligibility between, for instance, designer and other participants. I considered that it would be challenging within the limited time frame and scope of this project to achieve such mutual intelligibility between myself and the farmers. The level of participation that could reasonably have been expected would thus be constrained. Considering the limited participation possible with the farmers' groups it is also reasonable to expect that they would have limited potential gains to draw. With their vulnerability in mind, we adopted a precautionary approach rather than assume or overstate expected benefits to offset the "cost" of their participation. Taking into account the low likelihood (for practical reasons e.g. funding) of a continuous, long-term relationship between a researcher (such as myself) and the farmers' groups also raises questions about potential

sustainability of any intervention, thereby limiting long-term user gains. Accordingly, I considered locating the project at the organisational level more appropriate. Setting up this constraint, might make for a less "exciting" proposition as far as an ICT4D project is concerned, but can also address issues of exploitation and vulnerability.

6.1.3 Act

16/05/2017	Initial workshop
18/05/2017-30/09/2017	Operation of "Technologians" WhatsApp group
06/06/2017	Follow-up workshop 1
15/07/2017	Evaluation workshop
30/05/2018	Follow-up workshop 2
18/06/2018	Follow-up workshop 3

Initial workshop

The action phase of the cycle began with a workshop were the process of action research was introduced. The framing of their work as an action research project (consisting of planning, action, evaluation and reflection) was introduced. The group of eight head office team members were told that the goal of this intervention was to think about how to use technology to address challenges they could identify within the organisation. At the beginning of this first workshop the outcomes of the previous ethnographic work were presented.

The design group (which at the end of the session gave themselves the name "the Technologians", I will henceforth use this name rather than "the Design Group" to refer to this group of stewards) began by reviewing the current issues as they saw it when it came to communicative and knowledge sharing practices in the organisation. They raised a number of different potential issues that we could seek to address and I contributed by adding and discussing the issues that had been identified with the action learning set. From a list of different issues, that the group as a whole identified, we did a collaborative prioritisation using coloured stickers. After some discussion about the main three priorities, the group decided that we should seek to address the question of whether we could think about alternative ways to report on activities and work that aligned better with the organisations' values. Specifically, the Technologians identified that we needed means by which to communicate better between field offices and head office, in

ways which allowed for both a better understanding of work taking place as well as maintain better relationships.

From this, I introduced that we would work with a single technology that they already knew - WhatsApp - and find ways to appropriate this technology to address the issues they had identified. This choice of technology had already been discussed with the action learning set and it had been agreed that it would be a good starting point. Some among the Technologies suggested that a custom technology would be better - developed, for example, by me - saying that WhatsApp might not have the features that would be required. However, I responded by arguing that WhatsApp was a technology which they could sustainably design a new use for, without having to rely on me nor having to wait the time it would take for something to be developed.

We began this part of the workshop by reviewing what features and potential affordances[26] WhatsApp provides. The group began by listing all the different functionalities it had, and then discussed how it was a technology that all staff in the organisation knew how to use. Functionalities they identified included group and individual text chat, voice messaging, sharing picture and videos and phone calls.

They worked in three groups to identify a number of potential approaches to employ these affordances to the issue that we had selected. We then pasted these on a whiteboard, and reviewed them individually after which the group as a whole used round coloured circles to prioritise and select which one they felt was relevant to continue to work on.

In the end, from the numerous issues identified the group decided that the biggest challenge to them were being able to receive and manage reports from the field activities that they were responsible for. As the group was based out of Kolkata primarily, and could only visit the field sites every few weeks, they needed good tools to oversee and understand what was getting done or not. Drawing on the outcomes from the previous cycles, I raised the challenges that had been discussed in the action learning set - the difficulty of really representing what mattered

[26] I distinguish the notion of features - which were discussed as general functionalities provided by the technology - and affordances. In the workshop, we discussed affordances as the properties of the material artefact (or system) in relationship to the environment in which the Technologians worked - their goals, the people they communicated with and the relationships that were involved (Thapa & Hatakka, 2017).

about the activities through e-mails and text based reports. From this discussion we decided on a simple intervention - a WhatsApp group where both the project staff from Kolkata and the field sites together reported on activities through video, audio and pictures. The expressed goal of the intervention was to evaluate whether or not conducting reporting in this way allowed for a better connection between head office and field staff, as well as between different teams and regions.

Running the WhatsApp group

The WhatsApp group formed with a total of 15 members (apart from me) - 9 from the Kolkata office and 6 from the field offices. The field officers were encouraged to share voice updates, picture messages and videos from their activities while the Kolkata based staff provided feedback and comments on the updates shared.

Activity in the WhatsApp group began on the 18th of May 2017 and continued until the end of September. During this period 316 messages were shared, the majority of which were multimedia messages - voice, pictures and videos. Voice messages were primarily recorded plans for the next three days as well as updates on what had been done in the past few days. Videos were also taken of the field officers in the field, conducting everyday activities. For example, in one clip the field officer records a women's group pressing plates out of saal leaves[27]. In another, the field worker is recording another field worker doing initial household surveys with women in their area.

It was primarily the field officers who shared messages, with limited participation by the head office team members. Occasionally they would reply or comment on the activities conducted, but they did not contribute from their own activities or work.

Follow-up workshop

A second, follow-up workshop was held with the Technologians at the head office after about three weeks. In this workshop we reviewed progress of the initiative and whether we should continue the experiment, or focus on something else.

During this workshop we used post-its to gather feedback and identify both what

[27] The leaves of the saal tree has traditionally been used for many purposes in West Bengal, including as disposable plates. However, increasingly these kind of products have fallen out of favour and been replaced by styrofoam. Promoting saal leaf industry is one of DRCSC's projects.

worked about the current intervention as well as what areas needed improvement. These post-its were grouped into themes and these themes then discussed within the group. A sample worksheet from this exercise is show in Figure 22.

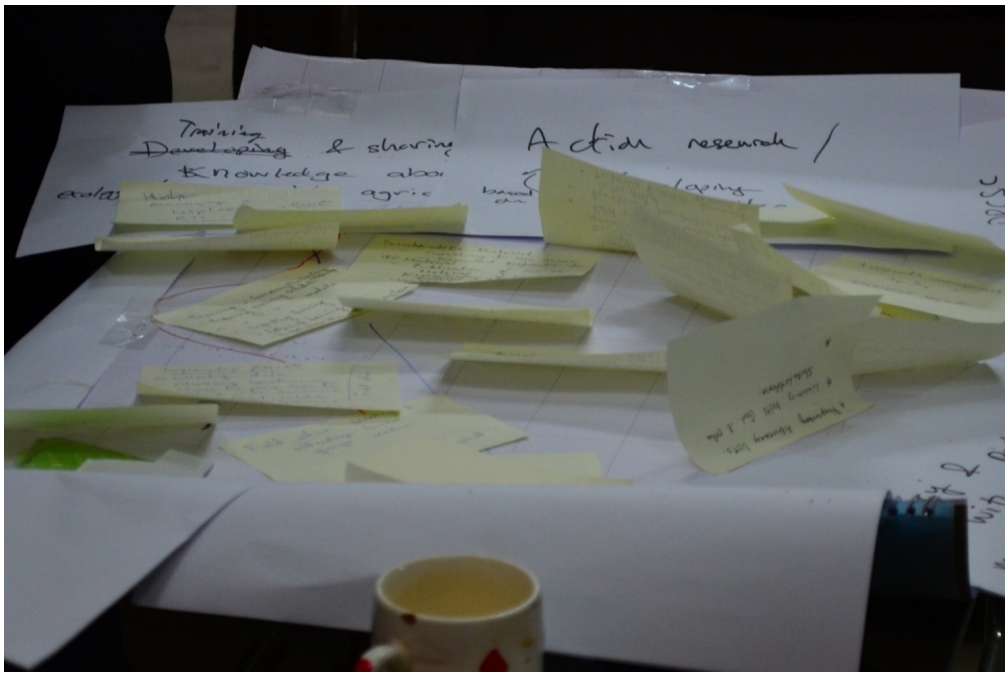


Figure 22. Worksheet used during the follow-up workshop. Picture by author (2017).

The group all thought that it would be worthwhile continuing, and it was discussed how to modify or alter the intervention. One thing that was highlighted was that the text based reports sent over message were both less interesting, harder to follow as well as did not fulfil the purpose of experimenting with new ways of handling reporting. It was decided that the head office group members should post a video or request to the field staff asking them to mostly use video, pictures and audio recording to share their updates in order to create a richer update.

> *Sulekha: "When they write.. actually the original [the "real" or important] issues are not [being sent/coming]. When they are using audio, it is coming, they are taking care to send them."*

Furthermore, the Technologians identified that it was not clear what the field

officers should capture and share in the group. This meant that sometimes there were too many photos shared of the same topic, or there was too little detail in what they had shared. What they record, how much they record and what is shared therefore needed to be adjusted. Accordingly, the Technologians decided to coach the field officers to reduce length, focus on important items and improve the audiovisual quality of items shared.

It was also decided to involve more field staff, so as to cover all the project areas that the head office team members were responsible for. Thus, two more field officers were invited to join the group and introduced to the way it worked. While in the initial planning stage of the project there had been some hesitation about who to involve, as it was felt that it could "expose" lack of activity or possible errors in the work, after this initial period of conducting the reporting the Technologians in the head office seemed more comfortable with the sharing involved in this project.

Finally, I brought up the fact that "reflection and evaluation" formed the final part of an action research project, and that as action researchers they also needed to actively engage with the field staff to reflect upon the way in which this approach to sharing and reporting worked in their project. Some of the Technologians shared that they had already had informal conversations with their field staff about the way in which the approach and the intervention supported them. All agreed that this needed to continue throughout the continuation of the project. It was further decided that another video would be shared in the group, where the head office staff would request feedback on the format of reporting itself. In this way, they could solicit and document some of the feedback from the participating field staff.

Evaluation by the stewards

After the project had been running for about 2 months, the Technologians group sat down to evaluate and review the outcome of the project. This evaluation began with each member of the Technologians reflecting upon the following questions:

- What has worked well so far?
- What benefits have I drawn from this experiment?
- What features of this intervention do I want to maintain in any future?
- Has this intervention changed the way I think about how I communicate with others in the organisation? In what way?

- Has this intervention influenced how I do my job in any way?
- Has it influenced what I consider important information to receive from the field?
- What have I learnt about introducing new ways of using technology so far?

We then proceeded to have a discussion about what reflections they had on the project. This discussion broadly had two focuses. First of all, we were evaluating their intervention and what the impact of the experiment they had undertaken was. Secondly, we focused on the activity itself - that is doing action research and design activities around technology choices within DRCSC. In this section, I will discuss the first half of this - that is, their own evaluation of their action research cycle. In the following section I will evaluate the process of action research itself. The evaluation undertaken with the Technologians was conducted in a mix of Bangla and English, was audio recorded by me and later on transcribed and translated into English (where required).

Motivation

> *Sulekha: "Farmers are also motivated, when taking a photograph of farmers, that they they also talk to Badshaha and ask him what is this for? He would say, this is for all the other people outside to see. In this way motivation comes. Lot of people can see, when they are taking videos in the land"*

One of the things that became clear was that participating in reporting and discussing of activities through WhatsApp was motivating to both field staff and other farmers. The visibility of activities towards other parts of the organisation had an impact on the sense of insular activities that there were within the teams. The audiovisual approach of the WhatsApp group seems to have been especially important in this regards as it was mentioned by farmers, field workers and head office staff that seeing pictures and videos from other locations mattered. As the quote by Sulekha illustrates, several of the field officers involved had spoken to farmers about their participation in the WhatsApp group.

Sharing & Learning

> *Sandeep: "Cross learnings… sharing sheyta hocche [this is happening/what is happening]. Sharing different activities, different good activities."*

One of the challenges identified as early as cycle 0, was sharing of information

between teams. This meant that members of different teams did not know what kind of projects others were involved in, what were good case studies or practices developed in those programmes nor what potential collaborations could be created across geographical areas. This distance and lack of transparency between teams had also resulted in distrust and an unwillingness to share openly. This was mentioned early on in this design activity as a concern, and there was a clear feeling among the Technologians that membership of the group should be limited. However, after three months of running the group both head office and field office staff expressed appreciation for the sharing and learning that could take place on the shared group. Sandeep recognised that this type of platform was especially necessary for the field staff to share and learn from each other and from those in the head office:

> *Sandeep: "What we're doing is creating a platform [for sharing and learning]. Kind of improving my capability also 'that I am doing this well'. I am expert in livestock ok. I know well how to rear chicks, and how to build a business plan on that. That kind of. I am expert on that. And I have successful implementation also, that is the platform where I can put them out and help others to think about that. That I have done this and I have expertise and others can do that. The field workers, the y generally don't get experience to share it. All the management level people, we are at meeting or workshop, sharing that we are doing this and that, this is a good activity. The field workers, they can be motivated that this is implemented. This is a platform where they generally [can share]… What I believe actually, is that all these activities leads to better programme implementation. Better implementation of activities. Which will ultimately lead to these visions [that DRCSC is aspiring to]."*

6.1.4 Evaluate

The main goal of this project was to explore whether organising an active Technology Stewarding programme as a form of action research would support the field officers in innovating using technology. I wanted to especially understand whether they could not only find a new use for a technology, or a new technology to use, but could also identify how to appropriate that technology in a way which would align with the values of the organisation as discussed in the previous cycles.

Innovation

Sudeep: "Using WhatsApp is not new, but the way we are using it, the audio and the video – this is coming as a new thing as an innovation."

Through the intervention, the field officers recognised that they were in fact innovating and coming up with new ways of using a technology they were already familiar with. Before the project started the Technologians had shared with me that they had mostly used WhatsApp for "*faltu*"[28] groups and content which consisted of "good mornings", "hellos" and sharing of pictures and memes. As part of this work they had recognised a way that could let them connect to each other while still feeling that it was getting work done:

Sukumar: "First of all, people use WhatsApp in many ways. But the way we are using this technological practice - like how people are working on their projects what we are doing or not doing we learn – that's why using this practice feels very nice. And the biggest thing of all it is a new thing. The way that WhatsApp networking can be used for work, its a new thing and it feels very good."

It was recognised that their approach would even be something that could be shared with others:

Sandeep: "One another aspect… DRCSC is implementing this kind of technology for better programme implementation, for better monitoring. It can be an example for DRCSC to explain to others. Actually, consider a workshop where DRCSC is there and other NGOs, other organisation is there. DRCSC can explain this is a way how you can implement your programme better. This is a way how cross learning, you can share different project activities in other organisation also. DRCSC can give an example of this technology to other organisation.

Anirban: "[Yes we can share]… this methodology or approach."

The process also allowed the Technologians group to start identifying technical needs that they had. For example, they recognised the potential value of the information shared in the group to the rest of the organisation, whether as case studies, pictures for promotional materials and as general updates to others in the

[28] Idle or useless chatter

organisation. They identified that they would need ways to archive and share such content. This allowed us to start having a conversation about both the technological limitations of WhatsApp, potential integrations with other applications or potential functionalities that they would need to be designed for WhatsApp or being present in a similar tool they could adopt in the future. We could also discuss the choice between using a constrained, but freely available technology, versus having something developed for them. This type of insight could support them in future process of technology evaluation and adoption.

Sustainability

One of the important aims of evaluating this approach to technology design in this context was to ensure the sustainability of the intervention. Importantly, I had not wanted to rely on external funding or technology that the Technologians or the organisation as a whole could not adopt, adapt and manage on their own. This was in part a motivation underlying the choice of WhatsApp.

My role throughout this period of the project changed from being the person leading the intervention - in the previous cycle I was conducting most of the activities of the project - to being first of all an animator for the activities, ensuring that meetings and workshops were held, and ensuring that there were some follow-up with the Technologians group. However, throughout the project all activities were undertaken by the group members themselves. They set-up the technological infrastructure (WhatsApp groups), invited and encourage their team members to participate.

It also allowed the intervention to be replicated even as the experiment was taking place. As one of the members of the Technologians stated at our last meeting:

> *Sandeep: "[I am responsible for …], Murshidabad and Birbum. The person involved [in the Technologians group] is from Birbum. But right now they have created separate groups from different project areas and this kind of [using WhatsApp to share updates of work activities, reporting and learning] activity is going. This is a replication for this"*

Other members of the group also agreed that they would attempt to replicate it in their own teams.

In 2018 work with the Technologies continued - albeit in a somewhat smaller

group as three of the previous members had left the organisation. Together with the remaining three members we discussed the potential for a new experiment following up on the previous one. Highlighting the need for not just continued reporting, but long term access and sharing of material, the group decided that they would like to work on a common repository of information. Across two workshops, we first laid out the challenge - the insular nature of different teams' activities and how there was little interaction or sharing between the teams. Using a similar approach as the initial design experiment we then asked what technology they had access to that could be useful in addressing this challenge.

Transparency & openness

One of the issues that the Technologians had identified as important to address was the connections between teams and transparency between different geographical areas and head offices and field offices. While we can see from their own evaluation of the programme discussed in the previous section, the intervention did manage to do this to some extent. This was especially the case when it came to the relationship between head office and field office, and between different field offices in different geographical areas. However, with a limited number of exceptions the majority of the interaction in the WhatsApp group was updates and stories shared by field staff. Comparatively, the head office staff adopted a monitoring and supervisory role. Furthermore, they admitted in our meetings to not listening or keeping up with the updates shared by the field staff. Even though we calculated that there were not more than about 30 minutes of actual updates recorded on the group per week, on average, the head office staff said that they did not have the time to follow-up and listen to it. They also did not - even though they agreed in the second meeting that they really should - provide their own updates on their activities or shared case studies themselves. So, despite them having recognised that they desired and needed better connection as well as more participation in the kind of activity that the group enabled, they could not manage to engage.

Allowance & permission

During this period, the action learning set became a form of supervisory group to the group of younger team members involved in the design experiments. Two meetings of the action learning set were undertaken, during which the activities of the Technologians and outcomes of their work were discussed. The action learning set provided feedback but also provided the "permission" for the activities undertaken by the Technologians. This allowed the project and their activities to

be anchored as part of the priorities of the organisation. This organisational infrastructure was necessary for the Technologians to be able to operate freely. There were ongoing concerns about adding more people from other parts of the organisation due to the potential information that could be exposed about how their teams worked - or didn't. There was also a formal request from the secretary of the organisation to be added into the WhatsApp group.

6.1.5 Reflect

Choosing WhatsApp was an important initial choice, as the goal was not to generate dependence on introduced technological artefacts that would need external funding and ongoing support. Rather, drawing upon the idea of local self-sufficiency embedded in the organisation's approach to sustainability, we were using a technology that they could themselves incorporate in new ways and maintain. This allowed the work of the intervention to focus specifically on the way that the stewards could configure the technology and how that might relate to their organisation's challenges as well as values. The intention was partially to scaffold the intervention around WhatsApp in order to illustrate how the process of intentional technology design and stewarding could take place, without needing to spend time in technology development or training, but it was also intended to demonstrate the ability of "design" to engage not just with technological development but rather with appropriation and social (re)configuration.

However, there are also critical downsides to this technology choice. One identified at the start of the project was that there were only limited ways in which the technology stewards could modify or alter the technology. While using a commodity technology like WhatsApp did mean that there were no need for direct outside involvement in the maintenance and upkeep of the technology, it also meant that we introduced a dependence on a commercial entity (in this case Facebook, as the owner of WhatsApp) who could easily unilaterally change or modify the way the technology works, or the cost of using it. As such, using commodity technology introduce dependencies of its own.

Unlike Friedman (2008) we made no attempt at a clear technical separation between "the technology" as a unit of analysis (the third part of VSD's methodology) and "the individuals, groups, or larger social systems that configure, use, or are otherwise affected by the technology" considered by Friedman the focus of the empirical second part of their methodology. Rather, the emphasis was on the design of a socio-technical intervention. The technology aspect of and the

social systems at various levels were considered simultaneously as part of this intervention. This involved a combined understanding of how technologies might influence the social system it was introduced in, but also how the choice of technology should be based on the underlying values and structures of DRCSC. For example, the concern for self-sufficiency and resilience meant that we chose commodity technology, that did not need external funding or development time. Building the intervention on generic affordances that could be replicated on other platforms also promoted resilience.

The potential for mutual learning was for me central to the question of with whom I should engage in a Technology Stewarding programme. While, a project involving farmers as potential Technology Stewards may have been a more "interesting" proposition from an ICT4D stand point there were important concerns when taking my own positionality into account. Considering my background, linguistic ability, geographic location, time to dedicate to the research, it was more appropriate to work with the organisation and its field workers. For a researcher from a vastly different class, culture, country of origin and with a limited number of years of field experience, a restricted time frame and less than fluent language skills to attempt a participatory design process based on mutual learning with the organisation's beneficiaries would have been naive at best.

Early in the project one of the organisation's beneficiaries asked: "How much is [the plane ticket] for you to come here?". When he heard the cost, he said "Well, why don't you just give this money to [the local chapter of the organisation] instead?". The money it cost to fly myself to Kolkata was approximately the same as the annual smallholder's profit in the area. The farmer is likely correct in his implied assessment that the greatest direct benefit at the field site would have been through contribution to their fund. One response to this challenge would be to attempt to hide or not disclose such vast differences in affluence as they may serve as impediments to mutual engagement in participatory activities. A perhaps more honest approach is recognising that engaging as equals across such divides required levels of relationship building and long-term engagement outside the scope of, for instance, a PhD project. As a result of this realisation, while I engaged with the farmers throughout the project, I focused the design activities with the organisation's project staff.

This could also lead to greater sustainability. The infrastructure - organisational

and relational - to maintain the socio-technical intervention itself or stewardship activities as a whole would be less likely to be maintainable with the farmers' groups. In the end of this cycle, the project already demonstrated initial sustainability in the form of replication, and there was a strong interest from the group to keep up these types of activities in the future.

When it comes to understanding the ability of the intervention to support the development of stewards who could identify, configure and appropriate technology in ways in which addressed their values and the organisational reality they faced, the initial results are mixed. On the one hand, the approach of conducting an action research oriented development phase for technology stewards enabled them to think critically about technology, as well as in some cases continue stewarding activities in other parts of their work (by for example replicating the WhatsApp intervention). On the other, this level of intervention could not address the fundamental realities and limitations that are placed on the project staff of the organisation by for example outside funders. Even though they considered the WhatsApp intervention to be able to connect them to the "real work" of the organisation, and it improved many aspects of their and the field officers work, it did not satisfy external reporting requirements.

One thing that became clear throughout this period was that conducting a full-time[29] research programme with a time frame of 4-5 years meant that I needed this phase to be - from the perspective of the organisation's team members - relatively intensive. As I had only about six months available for this phase, and I was keen on having some form of socio-technical intervention designed, there was some need to keep the pace up in the work. What I realised was that, while the regular meetings were necessary and useful, the research project could beneficially have been spread out in time. This type of action research may have been more suitably conducted with a planned time frame of 7-8 years, which would have provided the ability for frequent interactions, but spaced over a much longer time frame. It would have allowed the project to engage with the organisation on the basis of their ebb and flow of activities, rather than having to adjust my interactions with them more strictly on the basis of the timeline for my research programme. While the same amount of work need to be conducted whether organised as a part-time or full-time project, the intensity of the

[29] In the United Kingdom, there are both full-time and part-time PhD programmes. A full-time PhD is expected to be completed within 4 years (Sheffield Hallam University, n.d.-a), whereas a part-time PhD is expected to complete within 7 years (Sheffield Hallam University, n.d.-b).

engagement with DRCSC could have been different. The nature of action research as a long-term engagement, makes it difficult to manage within university mandated time frames.

6.2 Cycle 3a: Building research capacity

6.2.1 Plan

The third action cycle began in parallel with the work with the Technologians and involved a different set of people within the organisation. It is divided into two parts, where the first part (cycle 3a) was an initial inquiry or research oriented cycle into one of the organisation's existing programmes and the second part involved an intervention where we designed and implement a weather information service.

One of the challenges that had been identified at an early stage by the action learning set was their ability to collect data and evidence for their programmes in a research oriented way. While the organisation had been involved since its start in various forms of action research, they had felt that they increasingly faced difficulties in getting resources such as time or money to conduct such work. While they still produced training materials and other publications, their previously well managed library had increasingly become a side-activity and was no longer central to the work of the organisation. This was related to their transition from a single funder, that largely funded their general operations, towards specific project funding aimed at achieving specific development goals. These projects would emphasise the achievement of funder-specified objectives, which generally did not include any research oriented ones.

To address this they had formed a capacity building and training team which had - as part of its responsibility - been tasked with conducting action research, gathering evidence for their interventions as well as documenting and publishing such evidence. The capacity building and training team had one staff member who was intended to be full-time devoted to research and they could also self-finance some of their research activity through consulting training work for other organisations.

However, this was still in its early phases and they had as yet struggled to find a role which research could play within the organisation and in relation to the

implementation oriented development projects that external funders were funding. From the start, my work with the organisation had been closely associated with the research & training team as I was involved in conducting research with the organisation that was placed outside of the everyday development oriented activities.

One goal of an action research programme for me is to support the development of research culture within the context that the action research takes place. The formation of the action learning set was part of this, as was the framing of the past cycle as an action research programme. However, I wanted also to support the development of research capacity in other ways. This included - for example - the methodological and ethical approaches they took and partnerships with research agencies and, potentially, funders.

An opportunity to do so presented itself through my association with International Institute of Information Technology (IIIT) in Bangalore. During my initial visit there I presented on my research programme and the questions I was exploring. In relation to this I was approached by one of the professors at the institute who was involved in an international research project called SIRCA (Strengthening Information Society Research Capacity Alliance, 2018) that sought to build research capacity in South Asia. As part of this project, they were looking for a junior research team that could empirically explore questions of social and situated learning in the context of ICTs and open development. After discussing with the action learning set, I started preparing a research proposal for the SIRCA programme together with the training team. This proposal sought funding for a two year research project that involved the production of a case study on one of the organisation's programmes looking at how openness in the project and the social learning it created spaces for, enabled development.

Upon the advice of the action learning set, we selected a programme being implemented in the semi-arid region of West Bengal (see map provided in Appendix E). The programme involved the generation and dissemination of weather forecasts and related agricultural advice. This service was implemented by the organisation as part of a larger programme that sought to support the climate change adaptation of farmers in the region.

As part of our research project into this programme we decided on conducting as a series of interviews and observations to understand the way in which this

programme had become situated in everyday practice of the organisation and its beneficiaries - smallholder farmers. The SIRCA programme funded the cost of the organisation's researcher (in the training team), as well as travel costs and other necessary expenses related to conducting the field work. This allowed the researcher from the training team to work together with me to conduct the research.

Beyond the benefits when it comes to supporting research culture in the organisation, this project enabled me to further explore the knowledge ecosystem of the organisation, as well as the design of knowledge management systems for social and situated learning within their context. The focus of the case study for this programme was specifically on how the practices involved in maintaining the information system influenced the learning, identity and social position (B. Chaudhuri, Dasgupta, Hoysala, Kendall, & Srinivasan, 2017; B. Chaudhuri, Kendall, Srinivasan, Hoysala, & Dasgupta, 2017). The main purpose of the case study, in the context of this thesis, however, lies on the way that it supported two outcomes. One, the expansion of the research capacity of DRCSC, and two, how it could inform further intervention cycles. In later cycles, we drew on the research findings published as a collaboration between myself, DRCSC's researcher and senior researchers from IIIT Bangalore.

The weather system

In this section, I provide a brief overview of the weather information system as it was framed by DRCSC. This programme was one of the largest projects that the organisation had thus far undertaken, involving more than 2.5m USD and spanning a period of 5 years. The project was explicitly placed within the frame of climate change, and was funded through the Adaptation Fund[30]. In the introduction to the project programme, the organisation states (UN Adaptation Fund, 2015):

> *"The multi-hazard events and loss of GDP due to climatic hazards demonstrate that almost the entire state is significantly impacted by at least one hazard and its related vulnerability. Intensification of these instantiations or slow onset disasters like water scarcity, drought, water logging, floods, saline water intrusion and cyclones is one of the predictable impacts of climate change and climate*

[30] The Adaptation fund was formed to support climate change adaptation actions among the parties of United Nations Kyoto protocol within the framework of the UN Framework Convention on Climate Change (UNFCCC) (United Nations Framework Convention on Climate Change, 2021).

instability in future. Lack of availability and access to technological and financial resources coupled with a high dependence on climate sensitive sectors like agriculture, fisheries, forestry, have made West Bengal highly vulnerable to climate change."

The emphasis on climate meant that the programme had several features specifically attuned to this framing. For instance, considerable funds and time was spent in partnership with a leading local university to develop time series GIS-based maps of the watershed, illustrating potential future projections for major water bodies and rivers (Hasra, Roy, & Mitra, 2017). This was combined with gathering "Community Perspective [...via..] collect[ing] and analys[ing] information about their vulnerability through structured PRA[participatory rural appraisal] exercise" (UN Adaptation Fund, 2015). In addition to these, a "climate trend analysis from 50 years historical data" was also to be produced, that was expect to feed into a final analysis of the "vulnerability situation of the farmers". How these three efforts, operating on different levels of detail - one on a large scale of the climate system, one on region scale of the water management system and the other on village scale - and organised by different parties at separate occasions, were to be integrated with one another is unclear from the proposal. While I observed that the village level PRAs were occasionally referred to in the field office, where some of the documentation (in the form of chart paper notes) were stored, I did not observe the results of the GIS survey being applied as it would take until a few years later for the final report to be ready.

The project also includes for the development of two "climate resource centres"(CRCs) at the two field offices. These were intended to gather weather data collected through digital, automated weather stations, transmit it to a meteorologist who would then produce a forecast. The forecast would be sent to agricultural experts who would generate advisories. The advisories along with the forecast would form an "agrometeorological advisory" was then intended to be sent via SMS to affected farmers. The advisory would also be returned to the CRC, from where it could be disseminated through the villages through a network of volunteers. This process is illustrated in Figure 23.

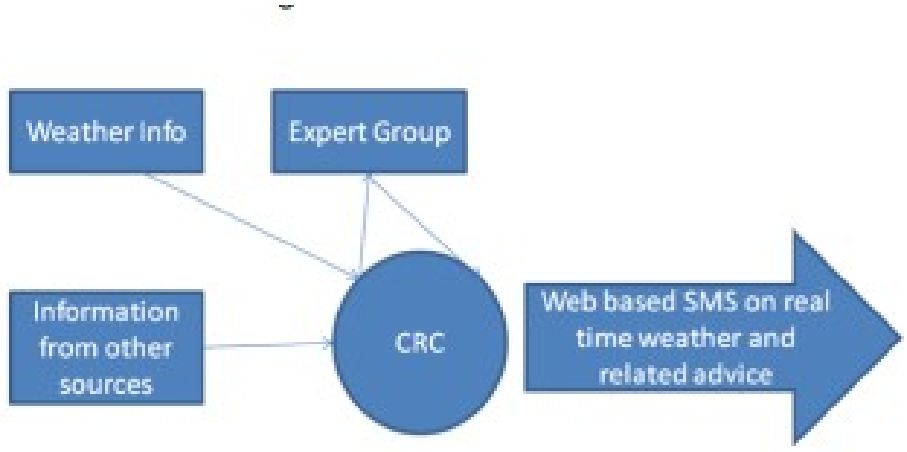


Figure 23. Diagram from DRCSC's proposal to the UN Adaptation Fund illustrating the directional flow of information in the weather system (UN Adaptation Fund, 2015)

6.2.2 Ethics

For this action (i.e. the research project itself) we adopted the approach to risk, informed consent, anonymity and confidentiality that I had laid out together with the action learning set at the start of my research programme. We combined initial group discussion and verbal consent, with ongoing discussions of risks, along with individual - signed or in some cases oral[31] - consent from those whom we followed-up group discussions with. Compared to the farmers I had worked with in Sundarbans, as I have mentioned previously, the farmers in the Dry Zone are a lot more vulnerable as this region has faced multiple droughts along with climate stress related work migration. Taking this vulnerability into account, I had previously opted not to work in the Dry Zone region. However, I considered this acceptable within the frame of this programme for several reasons. First of all, I was not the direct investigator - rather I worked together with the researcher form the organisation to conduct the inquiry. Secondly, like the design oriented intervention in cycle 2 (6.1 Cycle 2: The Technologians), the intervention in this project focused on the organisation's staff - i.e. through my collaboration with the researcher and their team (the training team). Finally, when it comes to the actual research programme it focused on those who were already involved with the organisation in running the programme - that is the field officers and volunteers

[31] Particularly for those who were illiterate or semi-literate.

in the villages that the organisation had recruited. It also was an observational study and did not involve any direct intervention in the programme.

The other ethical question was with regards to the impact that the intervention in itself could have on those involved in the project from the perspective of the organisation. The provision of funding did mean that I now placed myself in a position that I had sought to avoid - that is that of a person who brings funding to the organisation. However, while I would definitely not at this stage have wanted funding to be there for the kind of activities conducted in the design intervention, for the research oriented intervention one of their specific needs was to better understand how they could apply for and get funding for research oriented work. I did not see this as introducing external dependencies in the way that externally funded technology introduction would, as we were in this project, studying an intervention that they had already developed and introduced without my aid. They also did not recruit any new staff members, but rather assigned one of their research and training team staff members to this project and funded him partially to spend time on this project through the research budget. This meant that there was a clear return on his dedicating time to the project in terms of funding for the organisation, but it was also within what would be considered his regular work for DRCSC.

6.2.3 Act

05/2016	Development and submission of proposal
02/06/2016	Virtual presentation to workshop in ICTD at Ann Arbor
24/06/2016-01/07/2016	First field visit in Purulia and Bankura
10/07/2016-12/07/2016`	Workshop in Bangalore with senior research team
25/07/2016-30/07/2016	Second field visit in Purulia
12/2016-03/2017	Collaborative qualitative analysis
01/02/2017-01/05/2017	Writing up of book chapter
20/05/2017-24/05/2017	Workshop and Conference in Indonesia

As part of this cycle two visits were conducted by me and the researcher from the organisation. During these visits, each of which involved spending approximately a week in the field office, we conducted several different activities. Initially, we

used collaboratively created Rich Pictures (Monk & Howard, 1998) to map out the physical infrastructure, the actors, the relationships and the activities of the system (for an example, see Figure 24). We then used these mappings to follow the way in which the system had been introduced and operated throughout the region. We conducted semi-structured interviews with field staff, local volunteers from the villages and farmer beneficiaries. We also attended group meetings of both male farmer and female farmer groups. Apart from the visits I conducted alongside the organisation's researcher, they also travelled to the field office regularly over six months to follow up on the interviews that we had conducted and cover the development of the system over time.

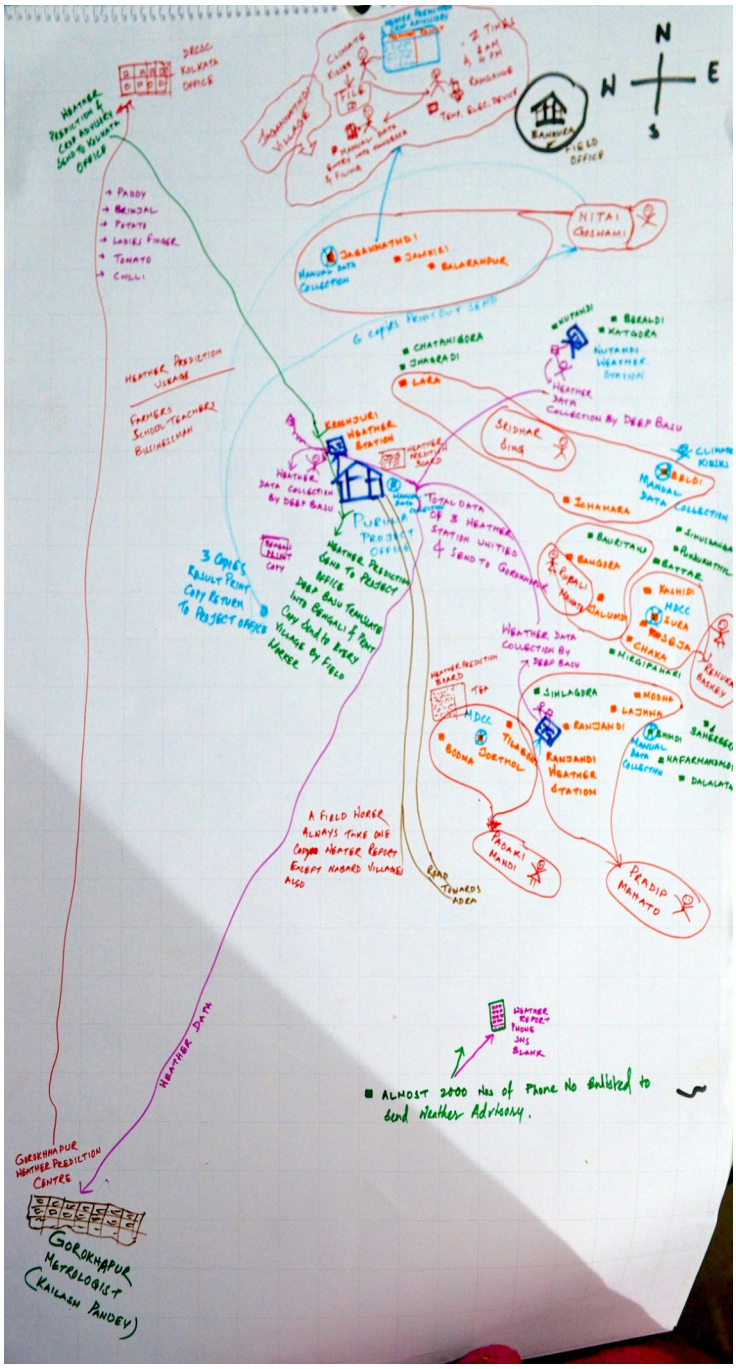


Figure 24. Rich picture drawn during workshop in Purulia (2016).

In addition to the field work activities, we co-wrote a book chapter and a conference paper describing our work in the project. The work was also presented at an international conference, which both myself and the organisation's researcher attended. In this way, additional linkage between the organisation and outside researchers could be facilitated. Furthermore, the continuous dialogue as well as writing taking place between me and the researcher from the organisation allowed us to develop a mutual understanding and interpretation of the system.

We reported our findings through a shared report to the organisation. Therefore, as part of this programme we expanded upon the use of written reports targeted both within the organisation, supporting their own learning as well as reports co-written with members of the organisation targeted to both what they might consider their own "community of researchers" as well as those communities more aligned with my own field. These three levels of writing form an important element of how to develop a written record and publications for this type of project (G. R. Hayes, 2011).

6.2.4 Evaluate

A more detailed account of the impacts of the system has been published in (B. Chaudhuri, Kendall, et al., 2017) and (B. Chaudhuri & Kendall, 2021).

Through the programme we observed and documented several important aspects of the functioning of the weather information system. These insights contributed directly to understanding social and situated learning in knowledge management systems that aligned with the values and aspirations of the organisation. Specifically, it allowed us to gain a clear understanding of how the technical and social aspects around the system interacted to produce the outcomes of it.

First and foremost, the system's provision of the full weather data to the villages meant that it was possible for villages to situate the data in their own everyday practice. They could re-interpret and re-frame it. This was especially as the agricultural recommendations provided by the organisation as part of the system primarily focused on main rainfed crops such as rice and vegetables. Other stakeholders - most prominently women - had drastically different uses. To take women as an example, their primary responsibility was for children, livestock and kitchen gardens. However, the agricultural recommendations provided through the system addressed none of these use cases. The provision of the full weather data in the villages meant that women could apply the information of rainfall,

temperature, humidity and wind to make decisions such as whether they should take livestock out, whether it was safe to let children go to school or not or whether to repair their houses that week. Similarly, villagers doing manual construction labour in nearby towns could understand whether or not to go to their job sites based on the likelihood of rain.

Secondly, the way in which the organisation approached dissemination of the weather information system was important. Their approach to the dissemination of the weather information largely relied on unpaid volunteers and paid field staff disseminating it within the villages through attending meetings, using print-outs and writing the forecast and agroadvisory on blackboards located throughout the villages. This allowed the village volunteers to become both spokes-persons as well as translators of the weather forecasts. As translators, they could interpret and give examples of how different groups within the villages could make use of the data. Their role as spokespersons for the system is perhaps of even greater importance. For some volunteers, this meant they gained a new respect and position within their villages. This was especially clear for the younger volunteers. In the case of a younger, female volunteer, she noted that since becoming a volunteer for this project the village elder now knew who she was and would address her frequently with questions about weather and agriculture. In another case, a young male volunteer noted that the village elders would now turn to him for advice and input, which he could source through his connection to the organisation.

That this system in itself played a prominent part in the programme was largely due to the framing of climate change. It was posited that in light of climate change, ongoing weather data became especially important as there would be greater variability in the weather, and it would be unpredictable as it would not follow traditional, well-known patterns. While this framing would seem to fit well with the mission of the organisation it can lead to consequences that are difficult to align with previously held values in the organisation. Commonly adopted, mainstream, understandings of climate change emphasise a specific type of scientific understanding of weather and climate which, when brought into DRCSC's work, was translated into a notion of need for highly localised weather forecasts and agricultural recommendations (6.2.1 Plan). While this may seem unproblematic at first glance, the difficulty of effectively employing the micro-scale weather forecasts to create agroecological recommendations stemmed not (at least not exclusively) from a lack of understanding of the agricultural system

they worked in - DRCSC certainly did not lack such knowledge.

Rather, what the organisation did not have access to was specific, weather linked advice on the basis of sustainable agriculture. The notion of short-term, reactive recommendations to either problems emerging or potential weather events fits poorly with the long-term, proactive management of the agroecosystem that agroecology envisions (5.1.1 Discursive). This is not to say that the forecasts disseminated in this project were of little use - access to the information was valuable in a variety of ways. However, this meant that the process of generating agrometadvisories became one of translation, where the agricultural experts produced advisories largely based on conventional agricultural practices, and the staff members of the organisation were required to translate the recommendations into practices they considered sustainable (B. Chaudhuri & Kendall, 2021). This often took the form of replacing a specific crop, pest and disease linked recommendation (for instance a particular pesti-, fungi- or viricide) with a more generic organic treatment (often application of "neem oil" or usage of pheromone traps). They found that the emphasis in agroecological practice on broader systemic adjustments to the farm was difficult to combine with the notion of a weekly agroadvisories linked with specific weather patterns. This challenge was interpreted by the staff members in different ways. Some saw it as a deficiency in their knowledge base - they lacked research and data on specific, organic, solutions - whereas others viewed it as a more fundamental different in approaches. In the prior case, the idea of agroadvisories itself did not need to change - i.e. the programme could be kept largely following the same structure as it already had - whereas in the latter, the structure of the programme would need to be more thoroughly rethought to work with agroecological practice.

What is illustrated through the research in this cycle is that the integration between new activities introduced to align their programmes with climate change, along with specific technologies, and their previous agroecological practice, was incomplete. While on the one hand, there is an introduction of technologies that deal with larger-scale scientific modelling (based on GIS watershed management, micro- and meso-scale weather forecast), there is on the other hand a value of systematic, long-term, bottom-up, participatory change to the agricultural system. Thus, there was a disconnect between the stated goals and plans of the project (even though they were linked to an ostensibly matching discursive paradigm of climate change) and the pre-existing discursive notions of sustainability held within the organisation (5.1.1 Discursive). This is the same challenge of "fit

between ICT4D approaches and sustainable agriculture development" that was discussed in cycle 0 (4.1.4 Evaluate) in relationship to IVR.

Insights such as these and other elements of the research produced as part of this project, were discussed within the ALS (which the researcher from the training team was part of). We also produced a specific white paper that summarised our findings as well as our recommendations for the development of the programme. One aspect that was raised by the secretary of the organisation as important was the development of the gender aspects of the system - looking at how it could better serve female farmers and their needs. We also drew on the collaboratively developed findings to further be able to discuss the fit between the organisation's goals and values and specific choices about and approaches to technology.

Following this, we have prepared proposals for four other research grants for the organisation's activities, two of which have been approved. Unfortunately, the researcher I worked with from the organisation left the organisation some time after the conclusion of this project. This meant that some of the work could not be continued or followed-up. As a result, I became responsible for following up on this project within the training and research team along with the head of the same.

6.2.5 Reflect

This research programme provided me with an opportunity to do three things. First of all, gain a better understanding of the knowledge ecosystem of the organisation - both related to the way they applied technology as well as the social organisation and discursive elements of their program. Secondly, it allowed insight into the way that social and situated learning was being applied and could be seen in the organisation's work. This framing of their program, and the understanding of this as a form of knowledge management, was one which I could work together with the organisation's researcher to develop and support the rest of the organisation in understanding. This allowed us - me and members of the ALS - to gain a deeper understanding of their work and their programmes creating both practical recommendations for the development of future, similar programmes, but also new forms of discursive practices around their programmes. Finally, it helped me contribute to the research culture of the organisation. This was both in a purely practical sense, working with a staff member from the organisation to secure a research grant - as opposed to development funding. I could also support a research staff member from the organisation to gain a better

understanding of the methods I have applied in my research, providing for an exchange between his domain knowledge of sustainable agriculture and my knowledge of participatory approaches to research. This cycle illustrates how collaborative inquiries together with those directly in the context forms both a means and an end of research in a pragmatic paradigm.

The way that I was able to link the organisation with other external parties through the research conducted in this cycle further explores how a socially oriented and situated knowledge management can work to strengthen DRCSC's knowledge ecosystem. Considering that I was now part of the knowledge ecosystem of the organisation, I employed my situated understanding of the organisation's work and my "insider-outsider" status to guide the expansion of the ecosystem. This allowed me to better make visible the organisations knowledge and work to other, external, parties. In effect, this process (of me linking the organisation to external entities) forms part of DRCSC's knowledge management system. It is a way by which they communicate and create relationships to other parties, as well as receive new understandings of their work. As a result of this cycle, other researchers are now engaged with DRCSC's work. This is one part of the answer to RQ2 and RQ3 (1 Introduction) as to how to employ social and situated understandings of knowledge management to strengthen a knowledge ecosystem. Initially external, parties (such as myself) can become situated in the knowledge ecosystem (as one social element) and then seek to strengthen it by, for example, creating expanded networks and linkages to others.

The ongoing challenge of the turn over of staff members, did mean that - from the perspective of the organisation - a lot of the impact of this programme was lost as the way of working and mentality I had shared, was embedded with the staff member I had partnered with. This type of tacit knowledge is difficult for organisations to retain as there is turnover of staff members. One way in which it can be sustainably maintained can be through its integration into a community of practice within the organisation (Wenger, McDermott, & Snyder, 2002). This however, is a long-term process that can only happen gradually through - for example - repeated research collaboration (Wenger et al., 2002). In the short run, however, it meant that in his absence, the responsibility for keeping up the results and outcomes of this research project landed on me. This is an unfortunate dependence and does mean that the sustainability of the impact is lower.

6.3 Cycle 3b: Designing a weather system

6.3.1 Plan

The research that we conducted in cycle 3a, formed the basis for a collaboration between IIIT in Bangalore and DRCSC. It also created a set of research insights into a specific project - the weather information system as operating in Purulia and Bankura. In 2018, the opportunity to deploy a small fund arose through UK's Global Challenges Research Fund. In discussing this between me, my advisor, a collaborator at IIIT and DRCSC, we identified that there was an opportunity to attempt to put some of the insights drawn from cycle 3a into an intervention in the Sundarbans field office where I had previously been working (see map given in Appendix E for details about the locations of the activities). The idea was to build a similar system for the dissemination of weather information and agricultural advisory in this region, but re-design it in certain ways based on both the work conducted with the Technologians in cycle 2 as well as the identified research findings from Cycle 3a.

A crucial element that we had identified as important in the Purulia project were the volunteers. This group of individuals, in collaboration with the field staff, helped make the weather information system relevant to the villagers in the region. They could re-interpret and re-frame both the information and the advice provided through the system.

The volunteers helped the system overcome some of the hurdles and built-in exclusions that emanated from its design otherwise. For instance, the exclusion of women's concerns in the original system design, that focused on advisory only for major crops, could be bridged by volunteers helping interpret the data provided on rainfall and temperature (B. Chaudhuri & Kendall, 2019).

The volunteers also saw a great deal of benefit from participating in the system in terms of the impact it had on their social roles in the village, as well as their knowledge of the weather data and forecasts that they received through the system (B. Chaudhuri, Kendall, et al., 2017). Giving the volunteers rain gauges and hygrometers had multiple benefits, it:

- helped them validate the forecasts that the were disseminated through the system,
- provided better data about weather patterns and the accuracy of forecasts that could help improve it
- served to give the volunteers additional understanding of the core elements of the system.

The plan was therefore formulated to introduce the system through volunteers, and to employ mostly manual weather stations (rain gauges and hygrometers) that were managed by the volunteers.

One of the key changes to the original system was that we wanted to rely on as small amount of external funding as possible. This was both necessitated by the small grant amount of the project, but also by the recognition that introducing a large amount of external resources may fit poorly with the approach to the technology that I had taken. It would also create challenges for the sustainability of the project, as we could observe through the interaction we had in the Purulia case. To this end, we chose to use publicly available sources for the weather forecast data rather than generating them through a custom model like in the Purulia case. This meant that we initially wanted to be careful to validate whether or not these forecasts were accurate or not. In addition to the manual weather stations that were operated by the volunteers we decided to finance one automated weather station as well. This automated weather station would provide baseline data in an accurate way allowing us to contrast it with both the forecasts as provided by the Indian Meteorological Department (IMD) as well as the manual weather data collected by the volunteers.

Building on the findings from the Purulia case that the public display boards were important we intended to replicate that in this project as well. However, conscious that the location of the display boards in certain public venues had made them inaccessible to certain groups - most notably women - special care was taken as to locating them in a variety of diverse locations. Initially, this lead to some concern as to whether to place the display board in the location which had the most visibility and the most people passing, or one which would allow for greater diversity in access. There were also issues of accessibility for the volunteers, as the structures of the villages in Patherpratima meant that the ideal location in terms of accessibility for volunteers could be quite interior locations that would not be visible to many other people.

6.3.2 Ethics

One of the ethical challenges of this project involved the question of whether I should be introducing external funding for a project like this into the work. As I have previously discussed, the lack of dependence on external funding had been a benefit in previous programmes. It helped resist the inherent unsustainabilities of

donor funded projects by ensuring that the organisation acted out of their own resources, without introducing either software or hardware that needed to be maintained or required external skill to manage.

Generally, a main principle that we adopted was that any introduced technology as part of the project should be sourced locally (or at the most from Kolkata), and should be possible for DRCSC to manage and maintain themselves. It was also important that any additional costs introduced by the project should be as minimal as possible. This built on some of the findings for the Purulia project, where we had seen that a lot of costly infrastructure was needed to maintain the project - including the human resources in the form of consultants and staff. This was as much a choice of ethics as one of practical concerns for sustainability, as the introduction and later removal of funds could create a situation where benefits introduced that farmers have come to rely on needs to be withdrawn, potentially leaving them in a worse situation than had the technology not been introduced at all.

As we will see, the one major exception (the automated weather station) we made to this principle, as part of this cycle, did cause issues as far as maintainability was concerned.

6.3.3 Act

29/09/2018 - 30/09/2018	Workshop and training with weather volunteers
06/2018-07/2018	First round of installation of display boards, MWS and AWS
03/2019 - 08/2019	Monthly meetings with weather volunteers
28/06/2019	Lead farmer & volunteer workshop
02/07/2019-03/07/2019	Knowledge sharing workshop with external parties
05/11/2019-12/11/2019	Cyclone Bulbul
02/03/2020-04/03/2020	Last pre-pandemic workshop with weather volunteers
23/03/2020	First India-wide lockdown
16/05/2020-17/05/2020	Cyclone Amphan

The project implementation started through the organisation identifying a set of "climate volunteers" who would help maintain and run the project throughout the region. The team leader responsible for the Wet Zone and the head of the field office felt that high school and early college students would be the best as volunteers, as they would find the greatest interest in the activities that climate volunteering would involve.

The goal was set to have 11 volunteers to cover the 11 different villages in one block that the field office did work in. The role of the volunteers was drawn from that of the volunteers in Purulia. They would have two basic roles. First of all, they would receive the weather forecasts and agricultural advice and disseminate them in the villages. Secondly, they would monitor the weather of their village through the simple equipment provided, in order to better understand and monitor the accuracy of the forecasts themselves.

The first step was a workshop where we introduced the project to the volunteers. The agenda for this first workshop is provided in Appendix I and some sample materials that I provided to the volunteers is given in Appendix J. The workshop was partially run by the head of the training and research team (Tapas) and partially by me. In the workshop we spent the first day generally discussing weather and climate and its impact on agriculture. The second day was spent looking at the different pieces of information provided in the weather forecasts we sourced from the IMD. IMD had recently begun providing block level forecasts[32] (PTI, 2019). The importance of block level forecasts is that they cover a much smaller geographical area than the district level forecasts that had previously been available. The need for block level granularity was one of the reasons that the Purulia project had opted for incorporating a custom weather forecasting model.

We also introduced the basic equipment (the hygrometer and the rain gauges, see Figure 25 and Figure 26), how to use them and where to install them in and around their houses. In the following weeks, we conducted follow-up visits to the volunteers to help install the rain gauges and view the results that they gathered.

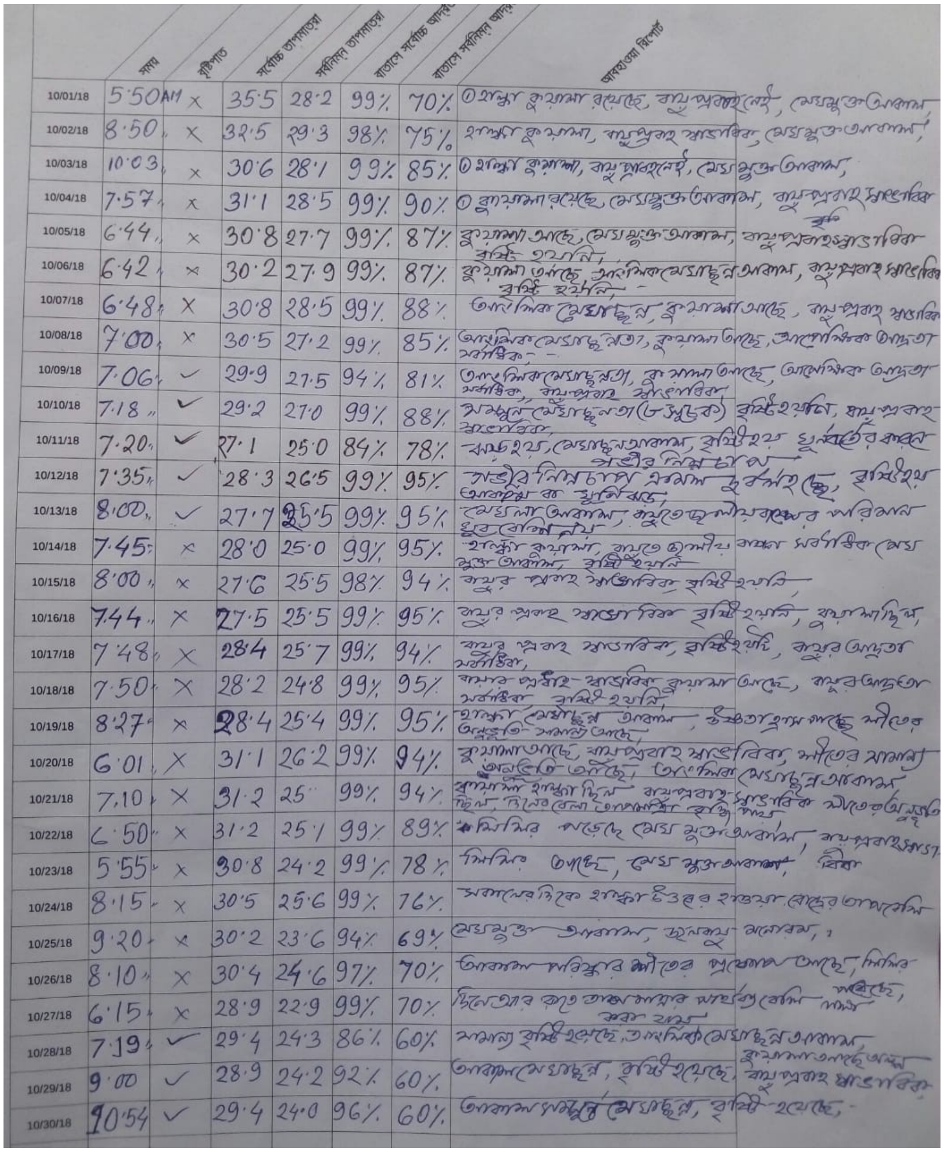
[32] A block is an entity corresponding to a number of villages. Many blocks are aggregated into districts.

Figure 25. Rain gauge provided to the volunteers (2018).

Figure 26. Hygrometer provided to the volunteers (2018).

We also conducted short interviews with each of the volunteers to get some background information. One thing that these interviews revealed were that only a few of the volunteers were actively involved in their family's agricultural work. Rather most of them were in school in order to find jobs outside of agriculture. Many had aspiration to undertake tertiary education, some considering potential for education outside of the area. Others were currently undertaking college courses at the local college. Their level of education, likely corresponded to some degree with the criteria that had been used to select them - they needed to be able to read and write and most were recruited because they were still in either high school or in college.

In the first six months of the project, the main aim was stated as to gather weather data to be able to validate that the freely available forecasts were accurate enough. This validation phase was also helpful for the volunteers to gain additional knowledge and confidence about interpreting the weather data. We conducted a couple of workshops where we asked the volunteers to bring the sheets of data that they had recorded and then compare it in various ways with the forecasts for that period. I have provided a sample filled out workshop in Figure 27. This includes the date, the time information was collected, the maximum and minimum temperature, the maximum and minimum humidity as well as a personal note about what the weather was like that day. Filling these sheets and analysing them collaboratively provided for the dual purpose of allowing the volunteers to actively engage with both the data generated by the forecasts as well as their own data.



	সময়	বৃষ্টিপাত	সর্বোচ্চ তাপমাত্রা	সর্বনিম্ন তাপমাত্রা	বাতাসে সর্বোচ্চ আদ্রতা	বাতাসে সর্বনিম্ন আদ্রতা	আবহাওয়া রিপোর্ট
10/01/18	5:50AM	×	35.5	28.2	99%	70%	[illegible]
10/02/18	8:50	×	32.5	29.3	98%	75%	[illegible]
10/03/18	10:03	×	30.6	28.1	99%	85%	[illegible]
10/04/18	7:57	×	31.1	28.5	99%	90%	[illegible]
10/05/18	6:44	×	30.8	27.7	99%	87%	[illegible]
10/06/18	6:42	×	30.2	27.9	99%	87%	[illegible]
10/07/18	6:48	×	30.8	28.5	99%	88%	[illegible]
10/08/18	7:00	×	30.5	27.2	99%	85%	[illegible]
10/09/18	7:06	✓	29.9	27.5	94%	81%	[illegible]
10/10/18	7:18	✓	29.2	27.0	99%	88%	[illegible]
10/11/18	7:20	✓	27.1	25.0	84%	78%	[illegible]
10/12/18	7:35	✓	28.3	26.5	99%	95%	[illegible]
10/13/18	8:00	✓	27.7	25.5	99%	95%	[illegible]
10/14/18	7:45	×	28.0	25.0	99%	95%	[illegible]
10/15/18	8:00	×	27.6	25.5	98%	94%	[illegible]
10/16/18	7:44	×	27.5	25.5	99%	95%	[illegible]
10/17/18	7:48	×	28.4	25.7	99%	94%	[illegible]
10/18/18	7:50	×	28.2	24.8	99%	95%	[illegible]
10/19/18	8:27	×	28.4	25.4	99%	95%	[illegible]
10/20/18	6:01	×	31.1	26.2	99%	94%	[illegible]
10/21/18	7:10	×	31.2	25	99%	94%	[illegible]
10/22/18	6:50	×	31.2	25.1	99%	89%	[illegible]
10/23/18	5:55	×	30.8	24.2	99%	78%	[illegible]
10/24/18	8:15	×	30.5	25.6	99%	76%	[illegible]
10/25/18	9:20	×	30.2	23.6	94%	69%	[illegible]
10/26/18	8:10	×	30.4	24.6	97%	70%	[illegible]
10/27/18	6:15	×	28.9	22.9	99%	70%	[illegible]
10/28/18	7:19	✓	29.4	24.3	86%	60%	[illegible]
10/29/18	9:00	✓	28.9	24.2	92%	60%	[illegible]
10/30/18	10:54	✓	29.4	24.0	96%	60%	[illegible]

Figure 27. Collected weather data (2018).

We also ended up hiring one of the initial volunteers on a part time basis to manage the project. This volunteer was older than the others and worked as a part time teacher in one of the villages where the project was taking place. His role was to manage and maintain the automated weather station as well as ensure that the weather forecasts were downloaded and disseminated to the other volunteers. At the start of the project, like many of the other volunteers, he had limited experience of using computers though he did have a smartphone.

One of the challenges throughout the project, however, was questions of providing value to the volunteers. As mentioned, several of the volunteers were not actively involved in their family's agricultural activities to a great degree, so did not always relate directly to the information provided. Their main motivation, as well as the main aspirations of their parents, was for them to do better at school and be able to continue with tertiary education. While initially, the idea was that the activities of the project would themselves help the students practice some of what they learnt in school, later on we sought to provide additional value through hosting smaller workshops in the office where the volunteers could get to use the computers available in the office. In addition to this, we also provided a small amount of recharge to their phones monthly so that they could access the weather information. The group of volunteers named themselves "Akash Barta" (weather news/information), which became the name of the system.

The volunteer who was hired for the project, Saptarshi, took main responsibility for managing the volunteers, downloading the forecasts and keeping everyone updated. His role also expanded to include going to farmer groups' meetings and other workshops to explain how the project worked.

One challenge we faced in the beginning of the project was that his activities and the activities of this project in general became entirely separate from the other activities of the field office. Saptarshi would generally communicate with me, and be dependent on me, for anything related to the project - even questions related to finance and disbursement of funds. This led to issues where a poor relationship developed between him and the rest of the field office, and he was unable to draw on the field office's resources to establish the programme within the block. We had to address this several times, with the help of the team leader at the field office as well as Tapas to integrate Saptarshi with the field office's activities.

Getting the automated weather station up and running required multiple visits to the field office and training sessions with Saptarshi. The AWS required configuration on the laptop itself, and the laptop had to be brought to the site where the AWS was installed (see Figure 28). It also used a software that was difficult for somebody without much experience of computers to use. While Saptarshi eventually learned how to download the weather data, he was uncertain how to display and filter it from the software itself. This also led him to not regularly save or e-mail the data as agreed. At one point, the laptop broke down

and was re-installed by a local computer repair shop. The repair shop not being familiar with the software, copied files from the laptop during the reinstall but did not manage to back up the weather data database from the AWS software. This led to the loss of many months of data from the AWS. After this, the integration with the AWS was also broken meaning that Saptarshi could no longer easily download the AWS data.

After the initial phase where manual weather data was collected by volunteers and automated weather data was collected by the weather station, we moved on to adding more information for distribution in the system. The display boards had been designed to accommodate the weather information on half their area, and additional information on the other (see Figure 29). From the Purulia project, we had recognised that being able to create advisories on a weekly basis, directly linked to weather forecasts, but following agroecological practice was a challenge. We also did not want the system to be dependent on outside expertise for the recommendations. Outside expertise would have two limitations. One it would bring additional expense to the project. Second, it would be difficult - as had been demonstrated in our study of the Purulia project - for the expert to have intimate knowledge of the current local situation as well as the practices promoted by the organisation. While an outside expert might bring new knowledge, aligning that with the specific needs of the farmers and the goals of the organisation would require considerable work of translation of any advice provided. This again, had been demonstrated in the case of the Purulia project.

Figure 28. Downloading data from the AWS. Picture by author (2019).

Figure 29. A village display board. Picture by author (2019).

The approach we opted for was to allow Saptarshi and the head of the field office

to manage the information to be added to the display boards. To help them get started we hosted two workshops headed by Tapas where we called lead farmers from across the different villages. In these workshops, Saptarshi explained the weather forecasts and the data they provided, and from this the farmers were involved to generate recommendations on the basis of their own knowledge and practice. Tapas participated to provide feedback and input on the basis of his knowledge of agroecological practice. These workshops helped establish the approach and the questions that needed to be addressed when attempting to develop agricultural advice on the basis of weather forecasts. Using the set of questions developed in these workshops, Saptarshi and the head of the field office could continually work on developing agricultural advice to be disseminated via the display boards. Additionally, we employed this additional space for information dissemination to further embed the project in the field office's other activities. By encouraging the field office staff responsible for other programmes to approach Saptarshi with additional information to be added to the display boards, the collaboration between him and the other's in the field office could be strengthened.

During the project period, two extreme weather events occurred. The first one was cyclone Bulbul in the end of 2019 and the second cyclone Amphan in the beginning of 2020. Several days before the arrival of Bulbul, Saptarshi called me and asked about the large amount of rain that he had noticed in the forecast - atypical for the winter season. He was concerned that the forecast might be incorrect, and he was unsure on how to disseminate the information. On the one hand, if the forecast was correct it was important that the information about the impending rainfall was disseminated, on the other hand, he did not want to spread any unnecessary fear. At this point, no official announcement had yet been given nor official action taken with regards to cyclone in this area. I helped him validate the forecast using other sources, and we identified that the forecast was due to the potential arrival of a cyclone in three days. Together with others from the organisation such as the field office manager and Tapas, we decided that he should disseminate the information that a large amount of rainfall was impending. This made this project the first agency to publicly disseminate information in the area. In the coming days the local government would issue evacuation orders, and three days after Saptarshi had noticed the unusual weather forecast the cyclone hit the area directly. Following this, the next time an even stronger cyclone arrived - cyclone Amphan - he could follow the same pattern and early disseminate information about the cyclone's arrival and the expected amount of rainfall (see Figure 30).

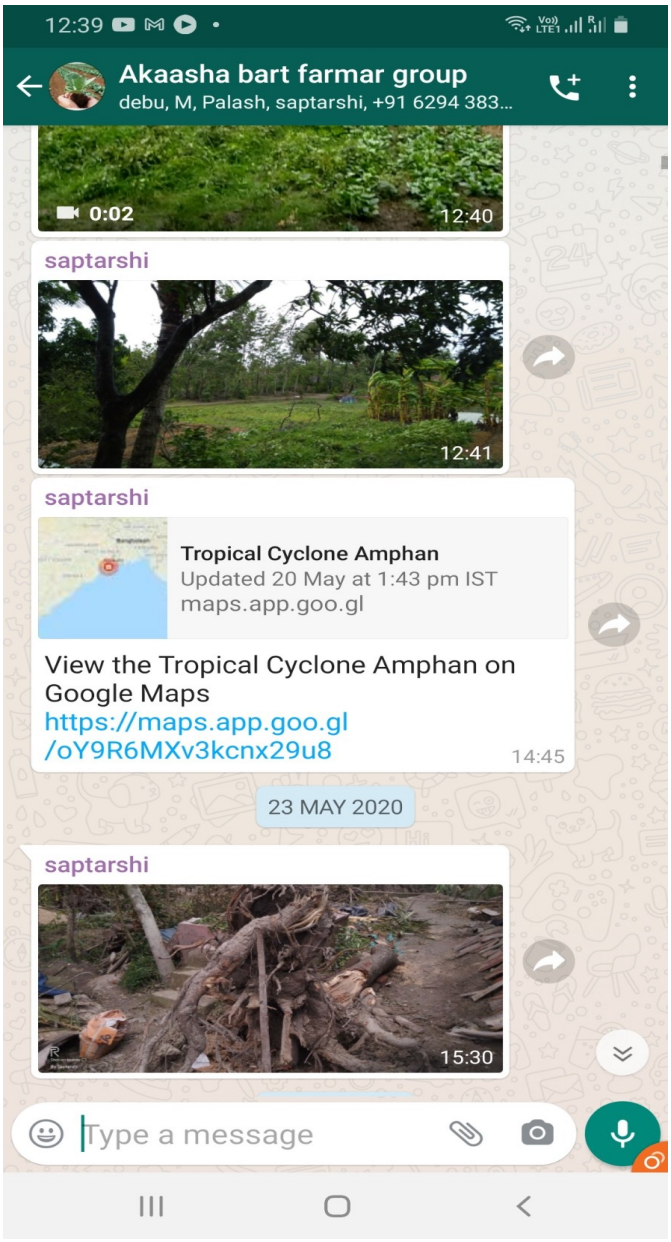


Figure 30. Tracking and sharing information about Cyclone Amphan. Picture by author (2020).

In 2020, when the COVID19 lockdowns started to come into effect, the ability of the field office to operate was greatly affected. However, the information system -

volunteers, the WhatsApp groups they used, the village display boards - could be employed not just for weather information but also for information about COVID19. Initially, this was in the form of general recommendations about the disease and later on for specific advice and resources about usage of sanitiser, masks and so on. The service provided by the volunteers was recognised by the local administration as essential, so despite lockdowns they were allowed to continue to update the display boards with both the weather forecasts as well as other important data.

6.3.4 Evaluate

From the start, the intention was for the volunteers to become stewards for the project. As they were from the local community, the idea was to introduce them to the technology of weather forecasts, weather data gathering (rain gauges and hygrometers), and then let them identify how to go about applying this technology in their everyday lives. Specifically, we did not prescribe exactly how the information should be disseminated. While we did propose the use of display boards, drawing on the Purulia case study, the layout and content of the display boards were worked out gradually in workshops throughout our engagement with the case.

The emphasis on the ability of the stewards to interpret the weather data provided them with capacity development. For instance, Saptarshi commented that he would listen to the radio in the morning and he would find that the forecasts did not match the ones that he had downloaded from IMD a few days in advance. Because we had previously discussed the nature of weather forecasts in detail, he could interpret that this was because forecasts closer to the day on which they were for would be more accurate. In this way, he could combine the 5-day forecasts provided by IMD with the one day forecasts provided via other sources to get a better idea of what the weather might be like. Without this understanding, it would have been difficult for him to trust the 5-day forecasts as well as answer the many questions that he and other volunteers had started getting about the forecasts as they were increasingly being identified with the weather system in their neighbourhoods. This was also demonstrated in the events surrounding cyclone Bulbul, where his understanding of the data led him to ask questions and seek to better understand what was actually going on in the forecast for the next few days.

our presence in the project site. Even though it was not the focus for the project, providing value by sharing computer skills and simply letting stewards have access to computing infrastructure is a way by which we could directly contribute and provide tangible benefits in the settings we we were working in. As other have recognised (Zewge, 2018), the broader research goals of the project may yield benefits to the community much more indirectly and computer literacy is something that can be immediately understood as valuable to the participants (as well as the broader community through, for instance, participants' families).

The emphasis on the development of human, rather than technological, infrastructure ("the social ... substrate on top of which technological infrastructures can be built" (Sambasivan & Smyth, 2010)) as part of this project, allowed for greater sustainability of the project. Not only has it been able to sustain itself, but also expand in reach, throughout the project period but it has also sustained itself through a series of challenging events; both the relatively serious calamities such as cyclones and COVID19, as well as the more mundane, such as ongoing technological issues. The dependence of the project on external input has been continuously reducing.

6.3.5 Reflect

As I mentioned in the discussion of the ethics of this project, the introduction of a funded project into my work with DRCSC was taken with great care. It was important not to change my role to become either a funder of their activities, nor a proponent for introduction of external technologies that could not be managed or maintained locally. I did not want to make DRCSC dependent on my presence in order to continue to run the project.

While the project itself could largely run without my presence or intervention, in the case of the automated weather station, this was not the case. The organisation did depend on my presence to install the station as well as help maintain it. Without that, the station would have fallen into disuse or broken down. This was something that we expected, and therefore the AWS was not made a central element of the intervention nor did the intervention depend on its existence. The limitations of technology that depends on outside expertise to maintain was illustrated when the laptop used by the field officer was re-installed by a local computer repair shop - loosing the AWS's database and a considerable amount of weather data. Had the project critically depended on this information being accessible, this would have been a major threat. It was also not possible for the

field officers to - by themselves - re-activate the data feed to the AWS meaning that they, again, needed support to gain access to it.

In contrast, both the infrastructure of rain gauges and hygrometers, as well as the dissemination infrastructure for the forecasts and accessing forecasts from IMD could be maintained and managed internally in the organisation. Even in the case when IMD changed their website format and access points, it was possible for them to - with minimal support from me - to re-gain access.

7. Implications of the interventions

There were two main interventions presented in this project as part of cycle 2 and cycle 3. Cycle 2 (6.1 Cycle 2: The Technologians) discussed “The Technologians” - a group we formed within the organisation to undertake technology experimentation and innovation. This group, through a series of workshops, initially defined a wide variety of challenges that the organisation was facing, and then developed an idea for how we could employ a technology that they were already familiar with to seek to address these challenges in a way that could fit within their ecosystem.

The second intervention (see 6.2 Cycle 3a: Building research capacity and 6.3 Cycle 3b: Designing a weather system), began with supporting research capacity into one of DRCSC’s existing programmes and then built on this through establishing a programme of action research in one of their field sites. In this intervention, I supported the organisation to conduct research into their own programmes as well as establish a partnership with IIIT in Bangalore. Building on this research we moved on to establishing Akash Barta in Patherpratima, where we employed the technology stewardship model from cycle 2 to replicate some of the elements of the programme studied in Purulia in cycle 3.

While the activities of the interventions, as well as some of their direct impacts have been discussed in chapter 6 Intervening in the organisation's work, I begin this discussion by looking at the broader implications of these interventions in light of the tensions between the managerial and ecological knowledge system discussed in section 5.2 Knowledge systems.

7.1 Reporting and monitoring

With my awareness of the changing knowledge ecosystem in the organisation and the tensions that were already there, I supported a discussion in the very first workshop about what different approaches to reporting and monitoring could be. This discussion emphasised two elements. First of all, what kind of information did we require from the field officers for this reporting and second, what information the technology chosen (WhatsApp) was particularly suited for.

7.1.1 Designing socio-technical practice

The Technologians identified that their regular phone calls was the type of communication that we should experiment with using WhatsApp for. These phone calls covered the day-to-day and week-to-week work that was taking place at the field office, rather than the more structured data required in the ongoing reports to funders. From the discussion of what affordances WhatsApp provided within their particular context, we identified that videos, images and audio were all well supported technically as well as relevant to their situation, as opposed to sharing files such as spreadsheets. There was some discussion about the capacity of field officers to record and share this type of media, but it was agreed that it was possible for the Technologians to facilitate this type of work. Accordingly, we decided to use WhatsApp for sharing of videos, images and other materials of the day to day activities of the field offices that the Technologians were responsible for.

As the technology opted for was already one which had a predominantly social character, it facilitated rather than got in the way of the type of relationships that were important values held within the organisation. In practice, the design intervention that the Technologians carried out was to employ a technology already used, in a slightly modified way. In establishing the WhatsApp groups for reporting and monitoring they added some rules to the interaction that would not have been there in the pre-existing groups devoted to exclusively social sharing of memes, stickers, emoticons and "*faltu*"[33] content like jokes. By establishing these basic rules the groups got a different purpose in supporting the work in a way they had not before. This transition also happened in the way that WhatsApp as a technology was viewed. As Sandeep stated - "before we had not considered that WhatsApp could be used in this way".

While reporting and monitoring in this way, using media and WhatsApp, was a new practice it drew upon a pre-existing practice within the organisation - namely using photos to capture project activities for reports and case studies (discussed in 5.1.3 Technological). However, this new practice changed the way photos could be used. First of all it enabled many more people to participate in the practice and allowed for the sharing of photos to a much wider group. Secondly, they could now find a different use in the field office, where they served to inspire, motivate and connect otherwise disparate groups of field officers with each other - as exemplified by the comments made by Sukumar (6.1.4 Evaluate). Photos could now become important for multiple reasons, including the reporting to funders,

[33] Idle or useless chatter.

but also as a form of accountability - both between field and head office, as well as directly between different field offices.

The daily sharing of videos and pictures from the field sites allowed the project officers in Kolkata to get a sense for what was going on in the field office, but without the entire emphasis being on strict notions of specific work outputs to be reported in a prescribed format. While there is overlap between the formal reports and the WhatsApp reports in terms of the output that they demonstrated - for instance, there might be pictures of a distribution camp in the WhatsApp group - the emphasis in the reports had shifted. As the Technologians noted (6.1.3 Act), this allowed a less filtered perspective on the reports providing them with an "original" picture of what was going on. It was later clarified that by this they referred to actually seeing what's really going on in the field and being able to observe what they considered the important aspects of the work. The transition towards the managerial knowledge system had, in the words of one of the Technologians, obscured "what the real work was" (4.2.3 Act).

The Technologians designed the interventions based on a pre-existing social practice (2.4.3 Social and situated knowledge management), integrating it with their existing practices but also, in the process, changing their practice making it do "more" than it previously had, and in the process addressed several challenges identified as early as Cycle 0 (4.1.4 Evaluate) - such as the sharing of information between teams.

7.1.2 Redefining reporting & monitoring

Recognising the differences between the knowledge systems that were present within the ecosystem discussed in chapter 5 Framing the research we can understand how differently it is possible to interpret "reporting and monitoring". The notion has a fairly clear definition in the managerial knowledge system, one that is primarily driven by external needs such as those of funders (Brigham & Hayes, 2013). In that version, the goal is to track progression towards a specific set of outcomes that have been specified in the project description and subsequent plan. These outcomes are monitored through a set of activities and outputs. For example, this could involve the distribution of clean cook-stoves. Another important element involves the establishment of the beneficiary of the outcome and the validation or verification that there is indeed a specific set of correct beneficiaries that are involved in these activities and outputs. This kind of monitoring regularly involves the compilation of lists of names and detailed

profiles of the beneficiaries involved. In this way, proof can be provided that the right person has received the right benefits. As discussed in section 5.1.3 Technological there is technology that can ostensibly help make this data more accurate - such as GPS tracking. However, this technology was ill-suited to the work of DRCSC and was not adopted after the end of the specific project that mandated it, despite their continued access to the devices (and the presence of staff members trained to use them).

In the case of WhatsApp (and the reporting practice that the Technologians designed around WhatsApp), it actively encouraged reporting on the basis of one set of assumptions about what was important, at the expense of another set. I would argue that the one of these sets of assumptions originated within the managerial knowledge system, and the other was more closely associated to the ecological knowledge system. Another way of putting it is that the affordances that their employment of WhatsApp provided better aligned with the ecological knowledge system.

Early on, the Technologians and the field staff that participated in the experiment noted that this approach to reporting and monitoring lead to “cross learning” between different parts of the organisation - a challenge identified as early as cycle 0 by the action learning set (4.1.3 Act). It also proved motivational to all participants, as well as to several farmers, to share what they were doing in this way - especially when compared to the spreadsheets compiled for reporting and monitoring. In this way, the WhatsApp experiment becomes an illustration of the way in which technology can support specific notions of what “reporting” means. Differences in how the Technologians interacted with the field staff, including the type of media, encouraged different content and focused their attention on different things.

At the same time there was a continuous discussion of how this media could not help with the structured flow of reporting required by management or external funders - the WhatsApp group did not easily afford field staff to aggregate and compile this type of data. There were some ideas about how the information that was shared through WhatsApp could be better organised or re-organised so that it could be of more use for funder oriented reports, but these did not take hold and were not widely adopted. This is notable as the intervention of reporting and monitoring using multimedia content on WhatsApp became ubiquitous within the organisation’s way of working.

A managerial notion of what was important to regularly report on (in particular numerical data about the programme they were conducting) was not supported well by the WhatsApp experiment. Rather, it made it easier for the field officers to maintain the connection with the work as it was conducted, as well as with the field office staff in a social manner rather than a managerial one. As such, unlike other pervasive technologies for reporting and monitoring (for example a spreadsheet in vignette 1 or a GIS tool in vignette 5) it did not contribute to the further development of the managerial knowledge system within DRCSC. Seeing as these two systems were described by members of the organisation as being in contention with each other, I find it reasonable to infer that the intervention helped strengthen one at the expense of the other.

7.2 Knowledge management

The first intervention was termed as focused around "monitoring & reporting" and communication between head office and field office. While this was not in itself positioned within the organisation as a form of knowledge management, it can be understood as such. When it comes to knowledge management, a part of the role of the interventions in cycle 2 and 3 were to create greater awareness of how knowledge management can be viewed differently. This view of knowledge is not exogenous to the organisation, as the case of the seed database (5.1.1 Discursive), perhaps most explicitly illustrates. However, the managerial approach to knowledge management was one which was increasingly dominant in the organisation, and through which many of the problems that the organisation faced was framed (4.1.4 Evaluate). The interventions took place with the backdrop of these tensions in the knowledge ecosystem of DRCSC. Just as the WhatsApp intervention could challenge and re-frame reporting and monitoring, there was potential to influence notions of how knowledge management was conducted.

7.2.1 Situating knowing

The team in the head office employed the WhatsApp intervention to manage their understanding of what was going on in the field office, but also to spot issues that cropped up and create recommendations for how activities could be improved or whether there were potential for exchange of knowledge between field offices - what Sandeep termed as "cross-learning" (6.1.4 Evaluate). Watching videos or photos from other field offices were also recognised by field officers as a way by which they could see how others performed similar activities as they did and how

they might, accordingly, improve their own work. This is an example of how the system supported sharing of knowledge that was otherwise only tacit. The ability to passively keep in touch with the work that was going on in the field office allowed for a very specific kind of knowledge - relational and situated in the work of the field office.

In cycle 3b (6.3 Cycle 3b: Designing a weather system), there were some elements of the project that addressed issues that might be typically understood as knowledge related, the understanding and interpreting of weather forecast data, the operation of manual and automatic weather stations. However, while these were important elements of capacity development for those involved, I would argue that they are of little use if they cannot be situated in local practice. As we saw in the study of the Purulia case, a lot of the impact of the project depended upon the ability to interpret and re-interpret the weather data in ways that made it useful for the local community. Furthermore, the impacts on the participants were often related to their standing within the community and relationships that were created around the system itself. Similarly, we can see that Saptarshi's and the other climate volunteers' roles in Patherpratima meant that they were increasingly recognised as knowledgeable as well as providing access to important and essential services. They would also often be asked by community members about how to interpret or what to do with the information that they disseminated.

The gradual development of capacity for creating advisories based on weather forecasts was something that is continuing to be an important element of the knowledge management system developed in Patherpratima. The emphasis here is not that we should have a system that provides the most "scientifically accurate" or detailed information on basis of forecasts, but rather that a social infrastructure is formed, consisting of farmers, field office workers, experts from DRCSC (such as Tapas) and (potentially) experts from other outside agencies.

7.2.2 Being resilient

An important feature of this social infrastructure is that it is resilient to changes in the environment that is surrounding it - perhaps most importantly, funding arrangements - but also situations such as the pandemic or the cyclone. In the context of the latter, the resilience of the system was demonstrated. The local police and administration recognised that the work done in the system was essential, and they could continue to disseminate information within the local communities. This could be done safely as well, as the volunteers could get access

to information from their homes and also had access to the display boards without being exposed to risk for infection. The ability of the information provided to be adapted by the local organisation was important. Immediately following cyclone Amphan, the local organisation began to disseminate seeds that were saline tolerant. Information about the distribution and usage could now be incorporated in the information disseminated by the volunteers.

The emphasis on the system being designed around social infrastructure for managing knowledge - through the group of volunteers - allowed the group to later on incorporate technology such as WhatsApp to aid them in the distribution of information - both weather data as well as information related to the COVID19 pandemic. This could happen organically and as per their own needs and based on their own capacity as the system evolved. Other components introduced were primarily learning tools to allow the volunteers to better understand the weather forecasts and weather information, that they could then apply continuously. Even the display boards, which were a dissemination technique borrowed from the project in Purulia were only introduced several months after the volunteers had begun both receiving the forecasts, monitoring weather parameters through their manual stations and informally disseminating information to their own families and neighbours. The focus and priority of this kind of knowledge management system is much more on the continuous learning and capacity of those involved, their social relationships and social positions. The tools (technology such as rain gauges, WhatsApp groups, SMS or display boards) are relative to this social infrastructure of secondary importance. Even the content - the weather forecasts - played a smaller role in our version of this system, than it was in the Purulia case. In contrast to the Purulia case, we did not rely on a custom forecasting model driven by a meteorologist, but rather supported the volunteers to use commodity sources for weather information. We did spend time to identify the block level forecast availability from IMD and - together with the volunteers - evaluate how accurate it was, however we did not consider it the only source used. Saptarshi identified that sometimes other sources (such as TV, radio, other Android apps) were more accurate (6.3.3 Act) - especially around weather changes where a forecast that is from the morning of the day it is for is much more accurate. The ability to move beyond just consuming data to be able to evaluate and identify different sources is important for the resilience of the system, but is also a long-lasting (and sustainable) benefit that the system could provide.

Returning to the notions of resilient knowledge management by Pahl-Wostl et. al.

(2008) (2.4.3 Social and situated knowledge management), we can see that the system incorporates many of the features outlined by them:

- Be able to compare data, information and knowledge
- Develop alternative scenarios
- Support online communities of practice
- Help make information and knowledge accessible based on people's social, cultural and educational background (incorporating language translation, social translation and formatting tools)
- Help people present information and knowledge in appropriate and effective ways

However, it is important to recognise that these properties were emergent in the process. For instance, while the Technologians' WhatsApp group was an explicitly designed way to support an online community of practice, the ability of the different participants to compare data, information and knowledge, was an emergent property of the fact that the group was formed from multiple different teams. In the case of the weather information system in Patherpratima, there was no online community of practice to begin with. Rather after the group was formed they employed tools that helped them conduct their work. This involved plenty of offline activities but eventually also online ones such as WhatsApp.

7.2.3 Moving from knowledge to knower

The capacities discussed above, as well as the social infrastructure around the system, are what I consider the long-term knowledge management infrastructure that we introduced through both the weather data intervention, but also the WhatsApp reporting system. These are less about any specific "objects of knowledge" and the technologies used to process, store or transmit them. The affordances that any given technology provides help shape this focus. A technology, such as a spreadsheet, would support certain ideas of knowledge management or reporting and monitoring. In the case of the interventions discussed above, the technologies employed provided affordances that situated knowledge in place and time - i.e. in the continued interactions between people supported by the infrastructure created. The primary way by which this was achieved within this project was by shifting the idea of knowledge management system design from knowledge to knower. The "knower's process of creating and sharing knowledge" (2.4.3 Social and situated knowledge management) was the focus for the interventions. It was around this process that the interventions were

introduced, and they built on existing practices of creating and sharing knowledge but altered them in intentional ways - i.e. through design.

Each intervention involved learning of information *about* various issues - such as technology design (6.1 Cycle 2: The Technologians), research methods (6.2 Cycle 3a: Building research capacity) and weather and climate (6.3 Cycle 3b: Designing a weather system). However, more importantly the interventions sought to encourage participation in a community of practice - the Technologians (6.1 Cycle 2: The Technologians), national and international research (6.2 Cycle 3a: Building research capacity) and the climate volunteers (6.3 Cycle 3b: Designing a weather system). Seen from the perspective of the organisation, both cycle 2 and cycle 3 sought to introduce new social practices that could eventually become a community of practice of its own within the organisation. These practices involved considerations and applications of technology. However, these considerations and applications were not intended to be disconnected information or knowledge sharing activities but rather embedded in the already existing practices. Which practices they were linked to was, as I have outlined in this and previous sections, a choice with important ramifications in relation to how they shaped the ongoing tensions and development of the ecosystem (5.2 Knowledge systems).

The outcome of this project is thus not the specific technologies designed or adopted, but rather the capacity gained through this and the ongoing infrastructure left in place. This means that the premise of the impact is one of sustainability - of creating something that can become part of altered social practice in the ecosystem. As discussed in cycle 2 (6.1.4 Evaluate) and cycle 3b (6.3.4 Evaluate), the interventions introduced illustrated their sustainability in multiple ways. In the first case, while the specific WhatsApp group for the project is no longer in use, the practice has been replicated across the organisation. In the second case, the intervention faced multiple external challenges (two natural disasters and a pandemic) and was able to respond accordingly.

7.3 Summary

In this section I have discussed the interventions that were conducted as part of the second phase of this PhD project and how they acted within this knowledge ecosystem. I relate their impacts to the notions of reporting and monitoring and knowledge management. While these are understood, especially within the organisation, as two separate activities they are in fact interrelated in many ways.

Changing the understanding of the participants of how these activities operate was an important contribution of these projects. It is also a part of the broader contribution of this thesis to illustrate how notions of what designed interventions can look like when incorporating notions of situated knowledge and technology as enacted.

8. Towards Critical Technology Stewardship

Adopting alternate notions of "what" it is that these systems are (whether reporting & monitoring or knowledge management) changes a lot about how you approach designing and implementing them. Cycles of design and evaluation where the design happens outside of the context, fit poorly with the idea of a continuously evolving situated socio-technical design. The framing of the design activities within this project emphasised the creation of a collaborative, social infrastructure where the core activity is capacity development and learning. In this chapter I will argue that there are several key components to this approach as to "how" to do ICT4D project - an approach which I developed together with DRCSC through this project that I call Critical Technology Stewardship.

As detailed in chapters 4 Studying the context and 6 Intervening in the organisation's work, my approach to the intervention drew on Ethnographic Action Research (Tacchi et al., 2003) and Technology Stewardship (Wenger, White, & Smith, 2009). To these approaches, I add two elements:

1. a broader understanding of the ecosystem within which the project exists including the potentially conflicting knowledge systems that exist within the ecosystem
2. adopting and seeking to encourage a critical view of technology and its role within the ecosystem.

8.1 Agency

The capacity for stewardship is a form of capability, one that can be viewed both individually as well as collectively, that at its core relates to the ability to claim agency in relationship to technology.

On an individual level this ability involves understanding potential technology that you can adopt, both its technological affordances as well as how they map to the needs observed in the organisation. This latter part is an important ability stewards bring - as they are embedded in the organisational context they have a clear view of the needs of the organisation.

On a collective level, it is a question of being able to express collective agency in relation to technology. That is, can the group of stewards translate values or ideas into choices about what technologies to adopt and how. While this relies on the actions and capabilities of individual stewards, it cannot be limited to individual action. This becomes a way by which affordances of a technology can be critically understood in relationship to the values collectively held.

The stewardship model emphasises the nurturing of these capacities in an organisational or community context. In practice, this is conducted through a series of "experiments" with technology, where an issue is identified in collaboration with those who are potential stewards within the context. These experiments are action research cycles, where there is a planning phase, an action phase and finally reflection and evaluation phase. The way I have approached this is for the initiator - in this case me - to participate in guiding these phases initially, with the goal that those involved will eventually adopt these practices themselves. The outcome of these cycles are both the actual intervention into work or community practice, but also the experience of the participants in how to conduct such intervention. As Sandeep discussed in reflecting on the stewardship programme, it helped him to see technology in a new way - that something that previously was viewed as a merely social tool could also - with a bit of intentional design - be employed in a different way to help their work. This was recognised as a form of innovation which they could employ in different areas of their work.

The notion of integrating with existing social practice is central to the technology stewardship approach. This has some important differences when compared to models of technology adoption (Venkatesh, Morris, Davis, & Davis, 2003). In particular, we are not looking to encourage or facilitate the acceptance or adoption of an exogenous technology. In a stewardship approach, stewards introduce technology into their daily work and practices in a way that is more organic. There needs to be considerable flexibility in how technology is integrated into practice, and recognition that this can mean stewards reject a technology if it is not needed or suited to their practices. (Wenger et al., 2005). This agency to resist or reject technology is an important element of stewarding.(Wenger et al., 2005). Adding to this, the Critical Technology Stewardship approach that we adopted in this work placed the agency of the stewards within a broader context of power, one that related to the tension between different knowledge systems.

We can see this flexibility at play in Saptarshi's work as a technology steward for the weather information system. Without rigid notions of how the advisory needed to work, nor it being externally imposed as an "expert opinion" to be disseminated, he, together with Debu from the field office and Tapas from the head office, could start creating their own approach. This involved dynamically altering the recommendations given based upon their understanding of the seasonal practices of the farmers in the community. They could rely on their understanding and experience both as people working in the field for some time, but also as members of the community and their own needs.

8.2 Sustainability & Resilience

The goal for this project was to produce some form of sustainable impact. This is not unlike most ICT4D projects, however as I discussed in the introduction to this thesis the ability to create projects that are sustainable has been a real challenge. The term "pilotitis" has been used to describe perpetual pilots being introduced, adopted and then later on unable to be maintained or continued due to lack of interest from the originators and/or funding. Various ways have been thought about how to deal with this challenge, often emphasising some way to "transfer ownership" of the intervention to people who are presumed to be willing to maintain it long-term. In the best case, this is part of an explicit exit strategy or plan formulated before the project even begins. However, the interventions that persist in the long-term are still the exception rather than the norm.

Sustainability can be viewed in multiple ways, from ongoing use, to the ability to meet the financial upkeep requirements to notions that emphasise the sustained increase in users' capacities (Bossen et al., 2010). In chapter 2 Background, I have introduced a notion of sustainability for ICTs as interlinked with a notion of sustainability for the agricultural development ecosystem as a whole. I argue that employing a notion of sustainability that is not grounded in what sustainability in the agroecological context means would be a contradiction. It would inherently mean that an intervention involving ICT would introduce separate, and potentially conflicting, approaches and goals. The notion of Critical Technology Stewardship is premised upon a recursive interaction between the changes in socio-technical practice desired through the intervention and pre-existing social practices. Accordingly, the notion of sustainability that needs to be adopted necessarily needs to align with that of the context within which it takes place. For a project such as e-Choupal, embedded within a commercial supply chain, the notion of

sustainability is one of the ongoing financial returns that the project provides to the participants and its ability to operate at a profit. For projects that seek to be embedded in agroecological practice, the notion of sustainability within the project needs to be aligned with those of that specific external context.

Reliance on external agricultural advice (see 4.1.4 Evaluate and 6.2.4 Evaluate) or advice delivered through digital technologies such as IVR are examples of interventions that may seem beneficial but which fit poorly when viewed from an agroecological perspective of sustainability and resilience. Shifting towards relying on external advice as opposed to locally available sources of knowledge can make farming systems less resilient towards external shocks or changes - for instance if the funding for the new advisory service disappears and the pre-existing information networks have been replaced.

It is important to also note that this means shifting the locus of "what is it that needs to be sustainable" or "what is it that needs to be resilient". At the centre is not an attempt to make a particular innovation sustainable, but rather how that innovation influences the resilience of the ecosystem within which it is designed.

Accordingly, for this context we need to take into account whether the introduced information flows strengthen the community's own resilience or whether they decrease it through replacing existing social infrastructure in the communities. This also leads to an introspective question to the technology project and project implementers - to what degree are they (economically and otherwise) able to and/or willing to ensure that any components introduced by them are resilient? Are they willing to take long-term, or potentially continuous, responsibility for maintaining the resilience of those system components?

A way that these questions can be addressed is a commitment to only introduce new practices or components that either a) do not replace any existing socio-technical infrastructure or b) can be maintained indefinitely by resources endogenous to the community or c) that there is a willingness and truthful ability to maintain any exogenous components introduced.

Adopting these principles would provide a stronger form of sustainability than would a plan or strategy that merely considers how to transfer an intervention after its complete. They demand a critical consideration of whether the project should even be conducted, considering what is known about the motivations and

aspirations of the initiator of the project, the resources available to the community and the socio-technical infrastructure. Adopting these principles also necessitates the kind of long-term non-intervention focused engagement exemplified in this project's first phase (see 4.1 Cycle 0: Starting the project and 4.2 Cycle 1: A collaborative inquiry). They also require that we consider very carefully where and with whom we situate any specific project. As I discussed in the planning of cycle 2 (6.1.2 Ethics) I made an explicit choice not to situate my interventionist oriented work directly with the farmers. This was motivated by me neither considering myself having sufficient understanding to be able to critically assess the impact of activities on the socio-technical infrastructure, nor necessarily the ability to guarantee that I would be able to indefinitely maintain new practices or components deployed in the process.

Other examples of these principles in action concern the very limited application of external funds only towards the very last cycles of this project (see 6.2 Cycle 3a: Building research capacity and 6.3 Cycle 3b: Designing a weather system). A project that begins from the assumed application of external funds may "build in" unsustainability in its very premise.

The challenges with the introduced Automated Weather Stations in Patherpratima (6.3.5 Reflect) provides a small case to illustrate, within the same context, what happens when diverging from these principles. Here was a technology sourced externally, with funds greater than those available in the field sites and which required technical capacities that I might not be able to provide indefinitely. While it was possible to train somebody to install and operate the device - in this case Saptarshi and Debu, they would still depend upon outside support for its long-term function. Once the device would need replacement or repair, there would be considerable question as to whether the funds would be easily available to do so. This is clearly not sustainable.

These notions of sustainability and resilience originated in this project from an engagement with a specific context - agroecological development. However, I argue that they are more generally applicable to ICT4D interventions. They provide an ethical orientation towards how a technology designer or implementer approaches their role and the project.

8.3 Critical understanding

A third element - which is a more challenging aspect - is a critical understanding of the technology introduced. This is an understanding of how to approach technology with an understanding of how it fits with and influences the values of those involved. I have given examples previously throughout this work, and in many ways both the interventions that were undertaken in cycle 2 (6.1 Cycle 2: The Technologians) and cycle 3b (6.3 Cycle 3b: Designing a weather system) were intended to support this kind of critical understanding for technology within the organisation and among the stewards. In the case of WhatsApp, the choice of a social media platform for reporting that emphasises video and images, as opposed to the spreadsheets, e-mails and text-based reports, helped highlight the influence of reporting technology on the way that the work was conducted and the relationships within the organisation. To some degree this was explicitly recognised by some of the stewards, in references to understanding what is "the real work", though I would argue that within the scope of this project this did not move to an explicit understanding of the linkage between technology and values. We can see in the case of Saptarshi, that he was gaining a critical understanding of the way weather forecasts operate and the difficulty of translating them into sustainable agricultural recommendations.

Among the more experienced members of the organisation - Tapas, Ardhendu, Somjita and others from the action learning set - this was more explicitly expressed. Considering their long-term understanding of the values underpinning their work, making the link between specific approaches to technology and the tensions technology may cause was easier for them. It was therefore important to take care to have the project embedded in the organisation at multiple levels - with "management" in this case participating through the action learning set and the stewards being given permission and access to do this project.

Contributing to critical understanding of technology is something that an external partner - in this case myself - can play an important role in. This involves a challenge of understanding what could be important questions to ask and identify potential risks or challenges to the ecosystem of any given technologies. This is a capacity that can be supported among the technology stewards, but is one which also requires a great deal of understanding of both technology and the ecosystem within which it is operating. The experienced members of the organisation could draw on their deep understanding of the ecosystem to draw these parallels. In my

case, I could draw on understanding of potential social implications of technology as well as my own experience of working with technology in similar settings. These are capacities not necessarily available to a steward when they first participate in this process. Rather than assuming that this capacity is a pre-requisite, it should be a goal of the process to cultivate this capacity on both an individual and a collective scale.

8.4 Role of an external agent

Coming then to the final research question asked in the Introduction to this thesis. What does this approach mean for the role of an external agent - such as myself within the knowledge ecosystem of DRCSC?

The first part involves spending time in understanding and - to some degree and unavoidably - becoming a part of the ecosystem. This requires also understanding the type of knowledge systems that exist within it and position oneself ontologically, axiologically and epistemologically in relationship to them. While it is possible to learn about, understand and even adopt a particular position in relationship to a knowledge system, I also hold that it is important that there is some degree of personal alignment between values and commitments held by the researcher, designer or implementer and those held by people already within the ecosystem. Without this personal alignment and commitment, it will be difficult to act as a participant within the ecosystem without - presumably, inadvertently - disrupting it or redirecting its resources towards unsuitable ends.

Secondly, the task of the external agent is to support the development of the capacity for critical technology stewardship. This involves making visible the way that technology affords certain possibilities while restricting others[34] (Volkoff & Strong, 2017). It also involves supporting participants in making the links between the actualisation of specific affordances and the potential impacts that they may have on the broader knowledge ecosystem. The second is a considerably more difficult task, than the first. It does ask of the participants to have a considerable insight into the way in which the knowledge ecosystem operates. There are three ways in which I sought to contribute to this capacity within this project:

1. Having a collaboratively organised inquiry into the organisation: Instead of the initial phase of the project primarily involving me conducting research on

[34] As discussed in the example of the reporting & monitoring system, the technology afforded the possibility of social, narrative reporting of activities and restricted the reporting of detailed numerical data.

the values and practices of DRCSC, I framed it as an inquiry where I was conducting research on behalf of the organisation. This is similar to how ethnography is envisioned within the Ethnographic Action Research approach (Tacchi, 2015). Rather than external researchers being ethnographers describing an (organisational or community) culture from the outside, participants are encouraged to research their own setting. In my case, I was actively involved in the inquiry but made a commitment to make methods of both data gathering and analysis understandable and clear. As I have discussed, this involved setting certain limitations on the complexity of the tools and methods employed.

2. The creation of an action learning set involving both senior and junior members of the organisation, in addition to the technology stewards. This action learning set helped interpret the findings from the inquiry and could make the critical connections between technology and collective values and aspirations. These allowed some issues to be made explicit in a way that less experienced members might not have been able to.

This frames a role for an external agent (whether in research, design or implementation capacity) that encourages attention to be placed not so much on the technology but rather the social system surrounding it. While an understanding of technology is clearly necessary, the actual mode of intervening has more to do with facilitating various types of social interactions discussing and analysing existing technology than it does developing new technological innovations. While this may seem like a limiting perspective, it is a direct outcome of the goals for sustainability and resilience and an ethical standpoint of placing the needs and interests of the participants in the research at the forefront. The commitments that I, as an external agent, am willing to make further informs this question. If I am willing (and able) to commit essentially indefinitely to the management and maintenance of an intervention, then the development and introduction of new technology can be sustainable and resilient. If I cannot honestly make that level of commitment (whether limited by time or funding), then it is important to restrict myself to working with technology that already exists and/or can be sustainably managed by the participants themselves.

This final point indicates a broader point about the role and relationship of external agents to groups of people - whether an organisation, a set of villages or farmers' groups. As I discussed early on this thesis, the question of who do I choose to work with is one that I took great care to think about. The notion of

“mutual learning” drawn from the participatory design literature is helpful. In a space such as ICT4D where the heterogeneity of the actors can be quite extreme, it is necessary to ask yourself (as an external agent intervening): who can I genuinely expect to have a mutual learning process with, that ensures a balanced set of costs and benefits to all parties? In my case, while I interacted with and learned from farmers in the region, I did not frame my project as directly involving them or ask them to actively participate in the intervention. Instead, I focused on the organisation (DRCSC) and my ability to contribute to sustainable agricultural development by supporting DRCSC’s work. In this way, I felt comfortable that the potential benefits that DRCSC could draw from their participation in this project aligned with their cost of participating in time, effort, money or other resources. It could also be made clear to the staff members of DRCSC what benefit I was drawing from the project and how I might use the output of the research - i.e. the achievement of a degree, publications in journals and at conferences.

8.5 Summary

In this chapter, I have discussed the elements of the approach that I, along with various groups within DRCSC, took to making the interventions described in chapter 6 Intervening in the organisation's work. I call the approach critical technology stewardship and it addresses the question of how to do ICT4D interventions as well as the role of a technology researcher or designer. Central to this approach is notions of agency in relationship to technology, critical understandings of the impacts of the technology on the ecosystem and a strong notion of what sustainability means and how it is achieved. Engaging with this approach means adopting a commitment to seeking to understand and adopt an ontological, axiological and epistemological position in relationship to the knowledge ecosystem you are involved with. It means recognising that there can be multiple such positions (i.e. multiple knowledge systems) operating within the ecosystem and alignment towards one or the other requires an explicit choice. This choice can imply “taking sides” and strengthening one knowledge system in relation to another.

It further means setting as your goal not to design a particular technological intervention but rather to support development of the capacity for critical technology stewardship. This capability of being able to critically assess technologies as they become available, to understand the way that they may

influence and affect the values and practices of those within the ecosystem and to accordingly adopt, adapt or reject technologies becomes a key development outcome of an ICT4D project in this vein.

9. Conclusion

This thesis started from a collaboration with a non-profit organisation in West Bengal in India, DRCSC, and the question of how to approach information and communications technologies (ICTs) within their work of sustainable agricultural development for smallholder and marginal farmers. Together with the organisation, I framed an action research project that had as its aim to explore three questions:

1. What are the current practices of communication and knowledge management around sustainable agricultural development in DRCSC's work and how are they structured?
2. How can we apply social and situated understandings of knowledge and learning to design socio-technical interventions that evolve or strengthen these practices?
3. What can the role for technology and technology designers be in these interventions?

9.1 Summary of the interventions

After the idea for the project had been framed together with the organisation, and an action learning set formed consisting of myself and various staff members of the organisation, we began the more active phase of work in the project.

The first part was a phase of collaborative inquiry into DRCSC's work resulting in a description of their ecosystem and a framing of the context for the further work of the project. This inquiry was conducted through participant observation, interviews as well as ongoing reflection and analysis with the action learning set.

Informed by an understanding of development as the expansion of freedoms to achieve what those involved in the development context have reason to value, values and meanings were an important part of this initial inquiry. Particularly, I paid attention to how views and understanding of sustainability informed their work practices. The notions of sustainability that DRCSC employs in their work - and which are more generally present in agroecological views on agriculture - emphasise several important aspects that influenced how we approached technology. I documented how long-term resilience was considered more

important than short-term gains in, for example, agricultural productivity. Events that took place during my PhD research project - such as multiple cyclones and the COVID19 pandemic - illustrated the importance of this thinking. I also observed the holistic nature of their engagement - that they engaged not just with, for instance, finding solutions for specific agricultural issues[35] or crops but also sought to address broader ecological[36] and social[37] issues.

From this phase of inquiry, we moved to an intervention phase. In this phase, we conducted multiple action research cycles that focused on intervening in their work through the conscious act of introducing new socio-technical practices within the organisation. The mode of intervention was through what I have called critical technology stewardship. Within the organisation, the action learning set identified potential technology stewards. Together with the stewards, I employed the findings from the inquiry cycle to critically assess and plan technology interventions. Two interventions were undertaken.

In the first one, we employed WhatsApp as a reporting and monitoring tool between the field workers of the organisation and the head office staff. In this intervention, we drew upon a technology they already used but designed a new way of using it in their everyday work practices. Drawing on the functionalities of WhatsApp - sharing videos, photos and audioclips, we set up a reporting system that allowed rich sharing and discussion about the daily work of the field office. The design in this case was about establishing a socio-technical practice rather than building or developing any new technological tools. The stewards, in collaboration with me, planned, implemented and evaluated the intervention. This way of working with reporting was later replicated throughout the organisation, becoming part of their standard socio-technical work practices. The employment of WhatsApp in this way was grounded in issues identified in the initial phase of the research. One of the observations had been that increasingly metrics-focused projects had led the reporting and monitoring to have become more targeted and

[35] Conventional agricultural extension work typically focuses on one or a few key crops, often those which are primarily intended for market sales rather than subsistence. It centres around providing specific fertilisation for those crops, as well as management of particular pests and diseases of those crops.

[36] This could involve looking at the use of land within the village, the management of watersheds to improve access to water throughout the land and make better use of run-off.

[37] An example would include addressing questions of social networks within the villages, which has important impacts on both the ability to access advice and help from other farmers, or food habits, which influences crop choices and the balance between growing for subsistence and growing for the market. These all influences end-goals of sustainability and resilience both ecological as well as when it comes to food and livelihood security.

reduced to the specific, quantitative, measures[38] that the projects were framed around. The WhatsApp intervention helped re-frame not just how a technology they already had access to could be employed in a different way to support their work, but also how the notion of reporting and monitoring could be viewed differently - i.e. sharing narratives of the work in order to improve the impact of the work rather than emphasising metrics. The stewards recognised that this type of reporting helped them better understand and improve the "real work" - long-term and holistic work that was informed by their values and commitments to sustainability - rather than just benefiting the particular output or outcome goals of a given project or funder.

The second intervention began with a research project into one of DRCSC's largest development projects - a weather forecasting and crop advisory project. Together with an in-house researcher, I studied the way the socio-technical practices that had developed around the project and the way that the project influenced both intended and unintended beneficiaries. This was a way for me to support the development of research capacity in the organisation, as well as support the organisation to critically understand their employment of technology in their work. The findings from this research was again reflected upon, discussed and analysed in collaboration with the action learning set. Following up on this we integrated these findings into replicating elements of the weather information system in a different region. We again employed the critical technology stewardship approach, but this time identifying field officers that could serve as stewards for the new system. In replicating a modified version of the system, we again focused on developing socio-technical practice around the system, as opposed to introducing new technologies. The approach of supporting stewardship, building on existing technologies[39] and emphasising development of socio-technical practice allowed the system to be both sustainable and resilient. Perhaps the strongest evidence of this was during the COVID19 pandemic, when the steward for the system could continue to maintain and expand it, employing communication technology like WhatsApp, to make sure that the system progressed in spite of lockdowns and limited ability to travel. The combination of an inquiry and intervention cycle that this intervention involved mirrored the

[38] Examples include output measures such as the provision of a particular resource (for instance, a cook-stove or seeds) or outcome measures such as the increase in yield or number of livestock held by a farmer.

[39] The rare exception we made to these principles (the installation of an automated weather station) lead to the one component of the system that has not been able to be maintained sustainably without external intervention, further lending evidence to the value of our primary approach.

structure of my research project as a whole, but was designed to be conducted entirely involving the staff of the organisation. This was a way to support not only the interventions initiated by me to influence the way the organisation worked, but also to allow my approach to research and intervention to be incorporated into the organisation's work.

9.2 Contributions

Drawing on the work conducted with DRCSC throughout this action research project, this thesis makes three three main contributions. Firstly, a contribution to practice in the form of the development of DRCSC's work supporting smallholder farmers. Secondly, a methodological and conceptual contribution in the form of the Critical Technology Stewardship approach that I took to socio-technical intervention in their work. Finally, a theoretical contribution in understanding the way that the ontological and epistemological commitments of the knowledge ecosystem of sustainable agricultural development can - and must - be incorporated into ICT interventions in sustainable and resilient agricultural development.

9.2.1 Supporting smallholder farmers

In any action research project, which this project is framed as, the primary contribution is towards positive change within the research context and for the people within it (3 Methodology). What "positive change" means needs to be defined by those with whom the research is conducted. This means that a research project in this vein of action research should place having contribution to practice as a central commitment.

DRCSC frames their work as being socio-economic development - in particular agricultural development. This means that their goal as an organisation is to support positive change for the communities that they work with. Accordingly, I frame the work with ICTs in this thesis as part of ICTs for development (ICT4D). The end goal of supporting DRCSC's application of ICTs is not to just improve their organisational practices, but to - whether directly or indirectly - contribute positively to socio-economic development. This leads to the question of what "positive socio-economic development" means. In this thesis, I have drawn on the Capability Approach in framing what development means (2 Background). This approach defines development as the expansion of beings and doings that people have reason to value. Locally (even individually) held values guide what beings

and doings should be expanded. This aligns closely with my commitments as an action researcher to contribute to positive change to local practice.

When it comes to the contributions of this project, in particular, my goal was primarily the expansion of collective capabilities of DRCSC and the farmers. Particularly, supporting DRCSC to approach technology - particularly technology intended for knowledge management - in ways which strengthened their particular knowledge ecosystem. This includes supporting their ontological and epistemological positions as well as the particular work practices and social relations that emerge from it. Notions of sustainability and resilience were integral to their knowledge ecosystem. For instance, placing the agroecosystem - a complex system that incorporates both ecological and human processes - in the centre leads to a shift away from any attempts at reducing interventions to address specific issues and towards holistic approaches. Prioritising resilience means moving away from growth oriented thinking towards aiming at the capacity to withstand, change and recover in face of shocks.

From the beginning of the project, as well as throughout the research conducted as part of the first (4 Studying the context) phase of the research, we identified both external and internal challenges to the development of their knowledge ecosystem. It was important that the interventions undertaken in this project both contributed to their day to day work, but did so in a way that strengthened the knowledge ecosystem. It was important to not just develop new or existing "being and doings" but to contribute to "*valued* beings and doings".

Through the two interventions that were undertaken as part of the second phase (6 Intervening in the organisation's work), I was able to contribute to DRCSC's valued being and doings by helping to develop their work practices and their use of technology in ways that integrated and supported their knowledge ecosystem. It illustrated that they could conduct reporting and monitoring in ways that supported informal, socially oriented sharing between head and field office (7.1.2 Redefining reporting & monitoring). In their own assessment, this way of reporting helped communicate the "real work" which was obscured by other means of reporting. This intervention also demonstrated how well-known technologies could be effectively appropriated into their work - using an experimental action research approach along with ongoing critical assessment, reflection and evaluation of the intervention. After the conclusion of this action research cycle, this mode of reporting spread throughout the organisation

becoming embedded in their day to day work practices.

The second intervention, too, was built around working with stewards from the organisation to introduce new socio-technical practices. While this intervention did involve the introduction of new technology - automated and manual weather stations and public display boards - the majority of the technology introduced was technology that was sourced locally and could be maintained and managed locally. Important to this project was how to build and steward situated knowledge management practices. The main means by which this was achieved was through the creation of social (rather than technical) infrastructure (7.2.1 Situating knowing) within the programme. The emphasis was laid on the people that would be the "knowers" of the meteorological information disseminated throughout the programme rather than the information itself. As an example, we considered it important that the information gathered and disseminated through the programme could be interpreted and turned into practice - be actionable. The ability to understand how to critically assess a weather forecast is more important in this practice, than whether each and every day's forecast is perfectly accurate. This meant situating the access, interpretation and dissemination of weather data as close as possible to its site of use - in fact, the primary technology steward for the programme was themselves a heavy user of the data.

Both of these interventions have become sustainably adopted within the organisation, being managed and expanded without the need for ongoing input or support from me or other external agencies. For the former intervention this is demonstrated by the ongoing adoption and expansion of the programme within the organisation. For the latter case, it was illustrated particularly well throughout the pandemic where external support and input was not possible due to the lockdowns, but during which period the project continued to operate and even expand to new villages and using new modes of communication (such as online forums).

A final contribution to practice was in terms with the approach to research that I took in the project. Throughout the project I actively sought to share my research practices in various ways. For instance (6.2 Cycle 3a: Building research capacity), I worked with a researcher from the organisation to frame a research programme, apply for funding for it, conduct the research, analyse the findings and publish them both within the organisation and outside of it. The ability for the organisation to conduct research projects is important both in order to gain

credibility and recognition for their work, but also to access new avenues of funding for their programmes. In my work with the action learning set, I sought to make my methods visible and intelligible - whether it came to research ethics (4.2.2 Ethics), data gathering (4.2.1 Plan) or analysis (4.2.4 Evaluate). This did mean that I had to choose both the theoretical approaches employed as well as the methods carefully in order to make them easier to conduct in participation with the organisation.

9.2.2 Developing Critical Technology Stewardship

The second and third research questions of this project addressed the topic of how to intervene - specifically how to design socio-technical interventions that incorporated a situated understanding of the ecological knowledge system that DRCSC operated within, as well as what my role (as an ICT researcher and designer) should be in that process. There were several important requirements for the methodological approach that we sought to adopt. Firstly, it should be built around a participatory approach allowing for active involvement of DRCSC in all parts of the design. Secondly, it should help contribute to sustainable and long-term change within DRCSC (as discussed above in the contribution to practice). Thirdly, it should be mindful of the features of the ecological knowledge system. This last point requires that the approach taken can allow for a critical analysis of the way that any technology introduce may potentially support and / or conflict with the ontological and epistemological positions of that knowledge system.

While agricultural development and ICTs is a heavily studied topic (as discussed in (2.3.2 ICTs in rural development)), agroecology is still relatively under-explored (Grunfeld & Houghton, 2013; Raghavan et al., 2016). This has meant that there is a paucity of approaches detailing how to engage as ICT4D researchers with sustainable and agroecological agricultural development (Grunfeld & Houghton, 2013). As the role of technology in agroecology is contested (Agroecology Europe, 2019; Bellon Maurel & Huyghe, 2017) and at times controversial (Migliorini et al., 2020), it is necessary to develop conscious means by which to approach this intersection (Bellon Maurel & Huyghe, 2017; Carolan, 2017).

To address this, we employed a stewardship approach to technology (Gow et al., 2015; Wenger et al., 2009). The approach we took in this project emerged through the ongoing action research cycles that were part of this project. While I came into the project with a set of ideas for how it could be conducted, the exact format was deliberately kept open in order to allow participation from the organisation in

how the approach developed as well as allow the approach to draw upon the findings of the research as it progressed. This, in particular, allowed situated theories (3.3.4 Theoretical outcomes) of DRCSC's work, developed between myself and the action learning set within the organisation, to inform not just the technology intervention but also the approach taken to the intervention.

An important distinction between our approach to technology stewardship and those previously referred to is that it was explicitly intended to critically assess technology in relationship to what DRCSC as a collective along with its beneficiaries had reason to value. This uncovered the importance of sustainability and resilience not just to their agricultural interventions but also to ICT based ones.

While, I do not argue for a precise methodological approach that can be directly applied to other projects, I contribute some important elements of our approach. The way I consider that these can be employed is that they can be used as a basis for, or integrated with, a locally developed and appropriate approach in another context. This would involve an act of translation - where the particularities of our approach would be adjusted and translated to another situation. In the following sections, I describe some key elements of the approach discussed in this thesis which I have referred to as "critical technology stewardship".

Organisational infrastructure for action research

The most important element of our approach to stewardship involves two separate pieces of organisational and social infrastructure created and maintained throughout the project.

First an action learning set with a combination of senior and junior members of the organisation. This group fulfilled multiple functions. First and foremost, they provided a way to anchor any work within the management of the organisation. In this way, they also served to provide the institutional backing for my activities. They also played a supervisory role, receiving regular reporting from all activities taking place. Additionally, they helped developed situated theories about DRCSC's own setting and its challenges. This involved interpreting research findings that I provided. They also helped prioritise and set the focus and direction of the project.

Secondly, technology stewards. We had two groups of technology stewards involved in the two interventions conducted with the organisation. The first group

(the Technologians) consisted of project officers from the head office and the field officers they worked with. The second group (Akash Barta) were field officers and volunteers at one of the organisation's field sites. From the Akash Barta volunteers, one individual emerged as the primary steward for the intervention. Together with the stewards in both interventions, we used the situated theory developed with the action learning set and translated it into socio-technical interventions.

Restricted introduction of new technological resources

All technological resources come at a cost – whether a direct financial cost for development and maintenance, or a cost such as time for training. In our work with DRCSC we introduced a minimal set of new technologies that were not already in use by the employees of the organisation. Rather we focused on applying existing resources in new ways. This allowed not only the cost for the implementation stage to be minimal, but also the maintenance of any of the systems we introduced. This is particularly important for the long-term sustainability and resilience of the intervention, as they do not depend on continued external funding.

Using technologies that are locally available and have already been locally adopted has many benefits. First of all, the technology is clearly accessible in the context, and secondly those who are intended to use it are already familiar with it. Using pre-existing technology already in use for other purposes reduces costs and increases efficiency. As mentioned previously, most of the technology introduced were using technological resources already available with the community, occasionally facilitating their use by providing small amounts of funding for such things like Internet data plans.

Social rather than technological infrastructure

While it is broadly recognised that the social infrastructure around technology use is of particular importance in a development context, this is not commonly linked with the question of technology choice. We recognised that there was a trade-off in terms of time and money when it came to developing or introducing any technical resource and that this would detract from the more important task of building social infrastructure to critically steward technology.

Following our commitment to the human infrastructure of stewardship, as well as the goal to limit introduction of new technology, it follows that the way that this

project became framed was not as a technology design or implementation project, but rather a project that facilitated innovation in socio-technical practice. I argue that this is a more appropriate framing for projects that seek to have direct contribution to development practice.

Limited external dependencies

Limiting external dependencies is especially important when it comes to management and repair of an intervention. Dependencies on external institutions for these purposes leaves the technology vulnerable as those external partners may become unavailable or unaffordable, leaving the technology unsustainable. The risk of working with external institutions has been highlighted several times in this section already, especially when it involves the introduction of financial resources. These financial resources would rarely be considered permanent, and would at one point or the other end. At that point there's a very real risk that technology will be withdrawn. Limiting external dependencies must also consider the human resources required to run the project. From the start, the emphasis must lie on employing technologies that do not depend on external human resources to function. What the definition of "external" means is not necessarily clear-cut, however, but in view of our work I take external resources to include myself and those external to the organisation itself. If we cannot expect that the human resource will be available on an essentially indefinite timeline, then a dependency on it will lead to unsustainability.

Respecting and building on local knowledge, beliefs and value systems

Technologies are not value neutral, rather, they tend to emphasise and align with particular value sets. It is important to recognise that any introduced technology has the potential to alter existing value systems in ways which are undesirable. Gaining this critical understanding of technology is a challenging, but important, element of a Critical Technology Stewardship approach. However, those operating within the context itself can have access to a direct understanding of the issues that technology can cause. There are several examples of this throughout the thesis. From the Technologians' recognition of the tension between the needs of the funders and the ability to get access to what the "real work" is via the WhatsApp groups, to Tapas' critique of the suitability of IVR systems for agroecological development, or Ardhendu's discussion of how spreadsheets of seed properties did not reflect the realities of highly situated knowledge and provided an, at best, watered-down version of that situated understanding or, at worst, the promotion of an entirely unsuitable ontological paradigm. The involvement of

senior members from the organisation (in the action learning set) was crucial to both check my interpretations, as well as help verbalise what was important to DRCSC, its work and the people involved.

9.2.3 Linking ICTs with sustainable agriculture

The two interventions are examples of are situated systems of managing knowledge that rather than being embedded in notions of documenting and transferring knowledge, builds on a focus on the knower and the social infrastructure of knowing (7.2.3 Moving from knowledge to knower). While I did enter the project with an interest in exploring social and situated knowledge management, what most strongly informed the interventions we ended up taking were the situated theories developed together with DRCSC about their context and situation. For example, the recognition that there were external pressures to organise their work along more managerial terms led to the identification of the ontological and epistemological challenges in combining them with their agroecological approach to development. This in turn, informed the approach to reporting & monitoring and knowledge management that we took. When understood from a perspective of technology being recursively entangled with the social world, we can see that our intervention in turn contributes to strengthening particular elements of the knowledge system.

I argue, however, that the local situated theories contribute to a broader theoretical understanding of the relationship between sustainable agriculture and technology intervention. In particular, it illustrates that it is insufficient to simply seek to adopt an existing technology to support different content or different interventions. For instance, I have discussed the limitations of advisory oriented systems that build upon the ontological notion of the possibility to reduce a crop problem to a specific issue of disease or pest that can be cured by the application of the scientifically identified best solution. Such a system, while it can be adjusted to only include advice judged to be “organic” or “sustainable” does not address the core of what sustainable agriculture means. Likewise, a system can be designed to effectively deliver e-learning on sustainable agriculture but if it does not address the fundamentally different institutional arrangements of an ecological knowledge system - built upon social relationships between farmers within a village, a watershed or a region - it will not contribute effectively to genuinely sustainable agriculture. The impact of such interventions, with only a superficial level of engagement with sustainable agriculture, would have a minimally positive, neutral or even negative impact on sustainable agricultural

development.

In addition to the contributions towards technology stewardship approaches, this thesis thus contributes theoretically to illustrate that agricultural ICT interventions that engage with sustainable agricultural development need to more fundamentally address the ontological and epistemological positions embedded within an ecological knowledge system. In doing so, I add to a limited, but growing body of work that addresses the call (Agroecology Europe, 2019) to identify how technology and agroecology can be combined rather than opposed to each other (Bellon Maurel & Huyghe, 2017; Carolan, 2017; Grunfeld & Houghton, 2013; Migliorini et al., 2020; Raghavan et al., 2016). This body of work, which includes this thesis, engages not only with questions of "which ... technologies are acceptable in agroecology" (Migliorini et al., 2020) but also "what ... socio-technical forms [technologies] engender ... in terms of the thoughts and feelings they enact, the relationships they make possible, the forms of governance they encourage, and the ways of life valued " (Carolan, 2017). As such, the goals of the critical technology stewardship approach discussed here, is "not looking for alternatives to technology but rather [looking for] technologies that engender specific effects" (Carolan, 2017). In discussing and evaluating the interventions (7 Implications of the interventions) I have accordingly placed them in light of the ways of being the encourage (or discourage).

What effects are sought need to be drawn from both the particular context in which the intervention is taking place, but designers and researchers also need to take into account the broader understandings of agriculture that can be gained from literatures such as that of agroecology and accordingly guide their actions.

9.3 Limitations

As I have discussed, this thesis does not present an elaborate model or framework of ICT interventions in development. In part, this is intentional as I consider it an essential part of this work to situate methods, tools and frameworks within the particular context within which the project is taking place. However, in part this is also because this thesis only describes the, albeit long-term, interaction between myself and DRCSC. I have for a variety of reasons (accounted for throughout this thesis) decided to centre the organisational context of DRCSC in my work. From a perspective of development, this leaves the work in this thesis one step removed from the day to day work of improving the lives for farmers. This is indeed a

limitation, but one that I have consciously imposed upon myself due to my position as an external researcher within this context.

This, however, means that I cannot make any broader claims about the transferability of these findings nor whether they apply to contexts elsewhere either geographically or organisationally. The particular interpretation of the ecological knowledge system and its implication for ICT design and development is (even though it builds on a broader set of theoretical positions) situated in DRCSC's work and would need to be re-framed or re-interpreted for other contexts.

9.4 Future work

There are three major strands of future work. The first one involves the continuation of the ongoing action research with DRCSC. Action research is challenging in the sense that there are no clear ending points. There are often practical limitations, however, such as funding (or the completion of a degree) which sets an arbitrary ending point. In this case, I am continuing to work with DRCSC beyond the scope of this thesis and I consider this to be part of my ethical commitment to this form of research. For our future work, I consider the continued integration of the critical stewarding practice and the expansion of the agrometeorological project to be the two main areas of future work. While we have, throughout this project, been able to create sustainable interventions I do not as yet consider the practice of critical technology stewardship itself to be fully integrated into DRCSC's organisational practice.

Secondly, as I mentioned previously in section 9.2 Contributions, taking the findings of this project and using them as a foundation for work in other contexts would help illustrate both what is more broadly applicable and what is highly specific to DRCSC's work, organisational and development context. Going through the process of re-situating these findings would also help contextualise and challenge some of the notions that we have developed throughout the work with DRCSC. This would strengthen both the theoretical and methodological contributions already made through this thesis. If this re-situating could be done in collaboration with DRCSC, it may also strengthen their organisational practice.

Finally, the project of illustrating the ontological and epistemological challenges of working with ICTs in the context of sustainable agriculture is so far explored in a

very limited way in the broader literature, and while this thesis is a starting point, there is clearly a lot of future work to be done in this regard. In this thesis I have limited myself to the particular context of sustainable agriculture, and have not drawn further implications for design and ICT4D. In the future, it should be explored how the ontological and epistemological orientations of sustainable agriculture could help shape broader understandings of how ICT4D can be conducted in a way that contributes to the sustainability and resilience of marginalised communities.

Appendix A: Letters from partners

Appendix A contains two formal letters issued by DRCSC in support of the research described in the thesis and one formal letter issued by IIIT Bangalore. The first one being the formal invitation to work together with DRCSC and the second a description of the impact of the programme.

Invitation letter from DRCSC

The letter below was provided by DRCSC in support of the research programme prior to my application for a PhD.

DEVELOPMENT RESEARCH COMMUNICATION AND SERVICES CENTRE

Contact Address : 58A Dharmotala Road, Bosepukur, Kasba, Kolkata - 700 042
Phone : 91-33-2442 7311, 2441 1646, Fax : 91-33-24427563
Registered Office :18B, Gariahat Road (South), Dhakuria, Kolkata - 700 031
E-mail : drcsc.ind@gmail.com, drcsc@vsnl.com, Visit us at www.drcsc.org
Donations to DRCSC are exempted u/s 80G of Income Tax Act, 1961

DRCSC
ESTD - 1982

To
Admissions
Cultural, Communication & Computing Research Institute
Sheffield-Hallam University

2015-03-20

To whom it may concern

Linus Emil Christopher Kendall has since 01/04/2014 conducted research on the implementation of ICT support tools for climate vulnerable farmers in the Sundarbans. Together with our staff he has developed and tested tools which can be used to help them get better access to information that may be of help to address their problems. This has been a new area of our work which we hope will expand in future through additional funds. Linus has supported us in applying for such funds from possible sources.

Through this letter we would like to recommend him for a PhD position at your university and we think that undertaking research training would be of great benefit to him as well as to us. By developing his abilities to conduct research he would be able to contribute to improving our applications of ICT to the development of climate change resilience among smallholder farmers. This would benefit our work by allowing us to better contribute to farmer food security and livelihood. As these farmers are some of the most vulnerable in the world we believe that his project is both urgent and necessary.

From his previous work with us, we believe that he would be qualified to undertake the research training as well as be an effective researcher in the field during his field work.

We hope that you will consider him for the position.

Best regards,

Somjita Chakraborty
Secretary, DRCSC

Impact statement by DRCSC

This letter was issued after the completion of the PhD research programme to provide a statement on the impact the programme had on DRCSC.

DEVELOPMENT RESEARCH COMMUNICATION AND SERVICES CENTRE

Contact Address : 58A Dharmotala Road, Bosepukur, Kasba, Kolkata - 700 042
Phone : 91-33-2442 7311, 2441 1646, Fax : 91-33-24427563
Registered Office :18B, Gariahat Road (South), Dhakuria, Kolkata - 700 031
E-mail : drcsc.ind@gmail.com, drcsc@vsnl.com, Visit us at www.drcsc.org
Donations to DRCSC are exempted u/s 80G of Income Tax Act, 1961

DRCSC
ESTD - 1982

To
Professor Dearden
Sheffield Hallam University
Sheffield, United Kingdom

29.12.2020

Dear Professor Dearden,

We are writing to express thanks to Sheffield Hallam and you and your colleague Linus Kendall for the work you have done in support of DRCSC in helping people in West Bengal to help them to understand the use of technology in stabilising production and contributing towards food security. We are writing to provide some updates on some of the impacts that the research project has had in our work.

Through the work we have conducted with the team from Sheffield Hallam, we have been supported to making different and better choices about technology especially when it comes to the priorities and values of our organisation. The design activities we have undertaken with Sheffield Hallam ahas been focused on developing our capacity as an organisation and made us more confident about how to develop our technology use.

In practice, this was achieved this through several different people centred design programmes, that each had impacts on our development work in and of themselves:

First of all, hands on support through creating the Technologians group within our organisation. This group of junior members throughout our organisation worked together with Linus to experiment with using different applications like Whats app to help support our work. They created a method for reporting and monitoring of our field work activities, that has now been copied and used around the organisation.

We have also been helped to establish the Akash Bharta volunteers in Ramganga which is providing weather forecasts and agricultural advisories for over 1000 farming families in 11 different villages across the block. This weather information has helped farmers in their everyday work to plan sowing, irrigation, transplanting and other agricultural activities. This has helped farmers improve their agricultural outcomes and their livelihoods. The weather information also helped to inform people early of Cyclone Bulbul which has helped them to save their assets and natural resources.

Finally, we have been helped by Sheffield Hallam University in communicating the problem the marginal farmers are facing during crisis periods such as Cyclone Amphan (in Sundarbans) and during COVID19 and raised some funds to help them in the situation.

The cost of all these projects was very limited making it more financially sustainable. After the engagement with Sheffield Hallam, we can now operate these projects independently making them long-term sustainable from that perspective too.

Best regards,

(Somjita Chakraborty)

Invitation letter from IIIT Bangalore
This letter was issued by IIIT Bangalore in support of the research programme.

International Institute of Information Technology Bangalore
(Formerly Indian Institute of Information Technology)

IIITB/ACADEMICS/SON/2016 **February 3, 2016**

CERTIFICATE OF AFFILIATION

This is to certify that Mr. LINUS KENDALL, Nationality Swedish, at present studying at Sheffield-Hallam University, Sheffield, United Kingdom shall be affiliated as a student/research worker in the Centre for Information Technology and Public Policy of the International Institute of Information Technology Bangalore (IIIT-B) for undertaking research on "Designing ICTs for social and situated learning in sustainable agricultural development".

He will be guided by Prof. Amit Prakash of IIIT-B.

This affiliation does not involve any financial liability on the part of the International Institute of Information Technology Bangalore and is subject to the approval of the above mentioned research project by the Government of India.

(V.S. Prakash)
Registrar

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Appendix B: Ethics Procedures

This section describes the ethics procedures that were formulated for this research hand submitted to the Sheffield Hallam University Research Ethics Committee for approval. In addition to these, the information and consent forms provided in Appendix C were submitted. The approval of these procedures are provided in Appendix D.

Risk Assessment

The following risk assessment assesses the vulnerability of different participants in relation to activities conducted as part of the project. The vulnerability assessment is intended to be part of a continuous process involving ongoing discussions between all project participant groups.

Type of Activity: Risk to:	Activities conducted with external agencies like KVKs	Activities conducted within the DRCSC head office	Field office activities conducted primarily with lead farmers and DRCSC staff	Activities in the villages with the farmers groups
DRCSC	Political repercussions	Organisational issues, especially with regards to relationships between teams. Time taken from other projects (especially those which provide funding)	Loss of trust with the lead farmers Potential loss of trust or issues with regards to field organisation	Loss of trust with farmers groups If any services is used to support agricultural advice - potential need to compensate farmers for losses

Local field staff	-	-	Loss of trust from local farmers Time taken from other projects (especially those which provide funding)	Same as for DRCSC
“Lead Farmers”	-	-	Conflicts related to relationship between lead farmers and the organisation Time taken from their farming activities.	Risks related to the position of the lead farmer in relation to the rest of the village Jealousy and/or bad will emanating from being part of the project Reduced standing in the village if project fails / increased power in village if project succeeds Time taken from their farming activities.

Farmers groups	-	-	-	Potential political risks related to the local village governance board Following recommendations delivered might result in crop losses and livelihood losses

Participant Safeguards

Continuous participatory monitoring and risk assessment:

In discussion with the partner, the most important aspect of managing risks in the project was identified to be a continuous and participatory process of monitoring and assessing risk in the project. This would include discussing potential risks and monitoring already identified risks along with the participant farmers as well as organisation staff throughout the project.

Anonymity & Confidentiality:

At the farmers' groups meetings all contributions will be anonymised and coded, this will include which village it is being collected from. It would be made clear that their names would not be recorded in the written material, but that their contributions would be used by the researcher and DRCSC.

In activities at the field office (whether by DRCSC staff or lead farmers) or the head office participants will be asked whether it would be acceptable to them to be acknowledge for their contribution. If they asked to be anonymous they would be informed that it would be difficult to guarantee complete anonymity as it would be clear to most people whom the research have spoken to and there would generally be participants form the partner organisation present at all meetings. However, the researcher would make it clear that their name and their picture would be kept out of the record of the project if they requested so.

All data collected throughout the research would be stored securely and confidentially (see data management plan for details), but for those participants who accept that their contributions can be acknowledge their name would be acknowledged in discussions and activities as part of the design phase of the research as well as in publications.

Information & Consent Procedures

In the case of the farmers focus would lie on verbally agreed consent. It was raised by the partner organisation that written or signed consent forms would be unsuitable as it would generate distrust and insecurity with the participants as many are wary of signed forms as it might indicate some form of legal or financial commitment.

One potential risk with verbal consent in a group setting is that potentially the dominant individuals within the group will be the ones doing most of the "participating" and in essence consent to everybody's participation. This would be balanced by gathering individual consent when doing interviews or gathering data directly from individual group members.

It would also be of importance to provide the farmers with time to consider their participation in the project. Therefore, therefore at the initial meeting with the farmer's groups the researcher would be introduced and the information sheet handed out. At the next meeting (approximately a week later) the group would be asked to confirm that they want to participate in the project. Likewise, for individuals such as lead farmers time would be given between handing out information sheets and gathering consent.

Verbal consent would be gathered and recorded and would consist of a number of questions asked by the researcher to ensure that the participant was aware of risks, benefits, the information they would be asked for as well as what anonymity could be guaranteed.

	Information sheet	Obtaining Consent
Head office staff	Information sheet #1 (English)	Written consent (English)
Field office staff	Information sheet #2 (Bangla)	Written consent (Bangla)
Lead farmers	Information sheet #3 (Bangla, printed)	Consent verbally agreed during sessions with lead farmers

Farmer group members (engaged with as a group)	Verbal information given in introduction to group session and information sheet #4 handed out to group members.	Consent will be obtained by asking the group on first as well as second visit (after the group has had time to review material handed out) – it will be asked if there are any objections/questions or if they have any concerns being part of the project as a group.
Individual farmers	Verbal information will be given in the introduction of every interview	Consent will be obtained verbally in the beginning of interviews and recorded on tape

The above mentioned consent forms and information sheets are provided in Appendix C.

Governance Procedures

From discussions with the organisation it was highlighted that an ongoing participatory monitoring and governance procedure would be the best way to ensure that:

- The research creates benefit for the organisation and the farmers
- There is no harm or undue risk caused by the project
- Risks are identified ongoing so that they can be handled accordingly.

This governance procedure from the organisation would include:

- One member from the organisation selected to oversee the project and have regular meetings with the researcher where the question of risk, benefit and direction of the research is discussed
- A regular (at least monthly) meeting with the "design group" within the organisation to evaluate progress, discuss any potential issues and problems
- At meetings with the lead farmers and at the field office have the discussion of risk, problems as a recurring agenda item

Additionally, the project is affiliated with an Indian university where a local academic would regularly be briefed on the project and be able to advise on how it fits with Indian research standards and practices.

Debriefing Procedures

The goal of a participatory design process is to ensure that the data collection, coding and analysis happens in a collaborative way between all participants. In this way there is continuous cycles of collaborative data collection – analysis – sharing.

However, as this project is embedded as part of academic practice there will be verbal representations and analysis of the data gathered. These representations would be regularly disclosed to the participants. The aim with this disclosure is to enable the participants in the research to question and clarify statements, representations and analysis made outside of the project context.
Research results will be provided to the organisation for their use, along with any artefacts produced.

Appendix C: Consent Forms

This appendix contains consent forms used both in English and translated to Bangla.

English

Below are versions of the consent forms used for different groups engaged with in the this research (the organisation, the field staff, the lead farmers and the farmers' groups) in English.

Head office staff

Hi,

My name is Linus Kendall and I am currently working with DRCSC to study how we can use information and communication technology to better support learning and generating knowledge about sustainable agriculture.

I am doing this as part of my PhD studies at a university in the United Kingdom called Sheffield-Hallam (www.shu.ac.uk).

The aim of the study is to find both the challenges of knowledge management and learning in DRCSC right as well as improvements that information and communication technology can bring. The goal is that the project can provide benefit to DRCSC through better learning and dissemination of knowledge within the organisation as well as between DRCSC and other stakeholders.

To this end I will work with you and other people in DRCSC and associated with DRCSC (like farmers' groups) to collect information on current practice. More specifically, I will be:

- *Observing and taking notes, photos and videos of your work*
- *Conducting group workshops and interviews with your team and other teams*
- *Conducting individual interviews with you and others in DRCSC*

We will use this material for designing new work approaches for DRCSC. The material will also be put together and analysed to produce papers, reports and finally my thesis in a few years' time. These papers and reports will be published.

Any information I collect during this research project is kept securely stored and accessible only by me and my two supervisors at the university. If you want me to, I can ensure that any information you provide isn't linked with your name and that your name is kept out of any of the written material. You can also at any time ask me to exclude any material such as photos or videos which you are in from the study. I might ask you to have an individual interview at some point, which you can feel free to say no to.

Feel free to contact me in person, at email@email.com.

I agree to participate in this study and acknowledge that:

- *I know what the research is about and how information I provide may be*

used

- *I have understood potential benefits and risks of this research*
- *I can choose not to participate in any of the activities of the study*
- *I can withdraw at any time*
- *I have asked any questions I have right now and know that I can ask anything I want about the project at any point in the future*
- *I consent for photographs depicting me being used as part of the research reports, in presentations or on the Internet*

In any material contributed by me to the research project I would like to:
□ *be acknowledged by name*

OR

□ *have my name hidden*
For any photographs or videos of me used in the research project I would like to:
□ *be acknowledged by name*
OR

□ *have my name hidden*

Name:

Researcher: Linus Kendall (signature)
Date & Location:

Date & Location:

<u>Field staff</u>
Hi,
I am here as a research student from the UK. I am studying the way that DRCSC, Indraprostho[local organisation] and the farmers' groups are learning about and sharing knowledge about sustainable agriculture. I will also be working with DRCSC, Indraprostho and the farmers' groups to find new approaches that can improve the way we share and learn about sustainable agriculture in the Sundarbans.

I will be visiting several times throughout the next few years and participate in the activities of DRCSC and Indraprostho as well as take pictures, videos and record interviews with you and with other members of the local group.
Any material I collect will be used by me for my research purpose and eventually I will write publications using it. We will also use them as part of the project to document and create better ways for DRCSC, Indraprostho and farmers to work together. I will store this material safely on university computers to which only I and the professors working with me have access.
For any material I collect, I can either acknowledge you as a contributor or hide your name in the notes. If you agree, photographs of you as part of the project may be used in publications, on the Internet and in presentations.
You are free to choose not to participate in any of the activities such as interviews and group discussions that are part of the project.
You can ask me any questions you need throughout the project. My phone number is +91xxxxxxxxx.

I agree to participate in this study and acknowledge that:

- *I know what the research is about and how information I provide may be used*
- *I have understood potential benefits and risks of this research*
- *I can choose not to participate in any of the activities of the study*
- *I can withdraw at any time*
- *I have asked any questions I have right now and know that I can ask anything I want about the project at any point in the future*
- *I consent for photographs depicting me being used as part of the research reports, in presentations or on the Internet*

In any material contribute by me to the research project I would like to:
□ be acknowledged by name
OR

□ have my name hidden
For any photographs or videos of you used in the research project I would like to:
□ be acknowledged by name
OR

□ have my name hidden
Name:

Researcher: Linus Kendall (signature)
Date & Location:

Lead farmers

This information sheet will include pictographic aids to further graphically highlight the statements.
Hi,
My name is Linus Kendall.
I am currently working as a researcher for a university in England.
I am interested in how farmers in the Sundarbans learn about and create knowledge about sustainable farming.
I am doing this project as part of attaining a university degree.
By participating in this project you would contribute to researching about your group, your group's needs and the interests of your community.
I will be recording material, taking pictures and eventually writing about the work we are doing here.
If it is OK with you I would like to acknowledge you as a contributor to this project. This means your name and pictures with you in them might be published as part of the work produced. If you would like me to not use your name or pictures of you, let me know at any time.
The information you provide will be used by me and DRCSC in the project as well as to create published materials like reports and articles which will be available to anyone.
You can choose not to participate in the project at any time.
If you have any questions you can ask me at any time.

Farmers' groups

Linus is a researcher from England.
He will be visiting your group as part of a project to learn about how farmers in Sundarban learn about how to do sustainable farming.
He is doing this project as part of him getting a university degree.
He will be attending meetings of your group and have individual interviews with some members from your group. As part of this project you and your group would be providing information about your needs and the needs of your group.
This information will be used by Linus and DRCSC to find ways to support your group. It will also be used to produce reports that will be available to anyone. Your

name or pictures of your face will not be used in any of these materials.
He may be taking pictures and doing sound recordings. These materials will be stored safely where only he and a few others at the university has access to it.
If you have any questions you can ask him any time.

Bangla

This section contains the translated versions of the forms provided in the previous section.

Field staff

নমস্কার,

আমি ইউনাইটেড কিংডাম থেকে রিসার্চ স্টুডেন্ট হিসেবে এখানে এসেছি। ডি আর এস সি সি, ইন্দ্রপ্রস্থ (স্থানীয় সংস্থা) এবং অন্যান্য কৃষি সংগঠনগুলো যেভাবে সাস্টেনেবেল কৃষি পদ্ধতি সম্বন্ধে জানছে ও একে অপরের সাথে সেই তথ্য ভাগ করে নিচ্ছে, সেই বিষয়ে পড়াশুনো করতে এসেছি। একই সাথে যাতে সুন্দরবনে সাস্টেনেবেল কৃষি পদ্ধতির ব্যাপারে জানা ও সেই তথ্য ভাগ করে নেওয়ার নতুন ও উন্নত উপায় খুঁজে বের করা যায় তার উদ্দ্যেশ্যে আমি ডি আর সি এস সি, ইন্দ্রপ্রস্থ এবং অন্যান্য কৃষি সংগঠনগুলোর সঙ্গে একসাথে কাজ করব।

আগামী কয়েক বছর আমি বেশ কয়েকবার এখানে আসব এবং ডি আর এস সি সি ও ইন্দ্রপ্রস্থ দ্বারা আয়োজিত কার্যকলাপে অংশগ্রহন করার সাথে সাথে ছবি তুলব, ভিডিও রেকর্ড করব এবং আপনাদের ও সংগঠনের অন্যান্য মেম্বারদের সাক্ষাৎকার নেব।

আমার দ্বারা সংগ্রহ করা যেকোনো তথ্য আমি আমার রিসার্চের সুবাদে ব্যবহার করব এবং অবশেষে তা নিয়ে লেখালেখি প্রকাশ করব। ডি আর এস সি সি, ইন্দ্রপ্রস্থ ও কৃষকরা যাতে একসাথে মিলে আরও উন্নত পদ্ধতি সৃষ্টি করতে পারে তার জন্য এই তথ্যগুলো প্রমাণ স্বরূপ আমরা প্রোজেক্টের অংশ হিসেবে ব্যবহার করব। আমি যথেষ্ট সাবধানতার সাথে এই তথ্যগুলো ইউনিভার্সিটির কম্পিউটারে জমা করব, যার ফলে শুধুমাত্র আমি এবং আমার সাথে এই কাজে যুক্ত প্রফেসররা ছাড়া অন্য কেউ সেই তথ্য ব্যবহার করতে পারবে না।

আমার দ্বারা সংগ্রহ করা তথ্যগুলোতে আপনার অংশগ্রহণ আমি নথিভুক্ত করতে পারি হয় আপনাকে একজন কন্ট্রিবিউটার হিসেবে চিহ্নিত করে অথবা নোট্‌সে আপনার নাম লুকিয়ে রেখে। আপনার অনুমতি থাকলে, এই প্রোজেক্টের অংশগ্রহণকারী হিসেবে আপনার ছবি ব্যবহৃত হতে পারে ভবিষ্যতের কোনো পাবলিকেশনে, ইন্টারনেটে অথবা প্রেসেন্টেশানে।

এই প্রোজেক্টের অন্তর্গত যেকোনো ইন্টার্ভিউ অথবা গরুপ ডিসকাশানের মতো কর্মকাণ্ডে অংশগ্রহণ করার বিষয়ে আপনার নেওয়া সিদ্ধান্তই সর্বোচ্চ বলে পরিগণিত হবে।

প্রোজেক্ট চলাকালীন প্রোজেক্ট সংক্রান্ত যেকোনো প্রশ্ন জিজ্ঞেস করতে পারেন। আমার ফোন নম্বর হল

আমি এই গবেষণায় অংশগ্রহণ করার সম্মতি দিলাম এবং আমি স্বীকার করি যেঃ

- আমি জানি এই রিসার্চের বিষয়বস্ত কি এবং আমার দ্বারা প্রদত্ত তথ্য ভবিষ্যতে কিরূপে ব্যবহৃত হতে পারে
- আমি এই রিসার্চের সম্ভাব্য উপকারিতা ও ঝুঁকি সম্বন্ধে জ্ঞাত
- আমি এই গবেষণার যেকোনো কর্মকাণ্ডে অংশগ্রহণ না করার সিদ্ধান্ত নিতে পারি
- আমি যেকোনো সময়ে প্রত্যাহার করতে পারি
- আমি এই অবধি আমার সমস্ত জিজ্ঞাস্য প্রশ্নের উত্তর পেয়েছি এবং জানি যে ভবিষ্যতে এই প্রোজেক্ট সংক্রান্ত যেকোনো তথ্য জানার অধিকার আমার আছে
- আমি আমার ছবি এই রিসার্চ রিপোর্টের অংশ হিসেবে, ইন্টার্নেটে অথবা কোন প্রেজেন্টেশানের জন্য ব্যবহার করার অনুমতি দিলাম

এই রিসার্চ প্রোজেক্টের জন্য আমার থেকে সংগ্রহ করা যেকোনো তথ্যের ক্ষেত্রেঃ

☐ নাম দ্বারা পরিচিতি **OR** ☐ নাম অজ্ঞাত

এই রিসার্চ প্রোজেক্টে ব্যবহৃত আপনার যেকোনো ছবি বা ভিডিওতে আমি চাইঃ

☐নাম দ্বারা পরিচিতি **OR** ☐ নাম অজ্ঞাত

নাম: রিসার্চার: Linus Kendall (স্বাক্ষর)
তারিখ ও স্থান: তারিখ ও স্থান:

Lead farmers

নমস্কার,

আমার নাম লিনাস কেন্দাল।

আমি বর্তমানে একজন গবেষণাবিদ হিসেবে ইংল্যান্ডের একটা ইউনিভার্সিটিতে কাজ করছি।

সুন্দরবনে চাষিরা কি করে সাস্টেনেবেল ফারমিং সম্বন্ধে জানতে পারছেন এবং সেই বিষয়ে নতুন তথ্য তৈরি করছেন আমি সে বিষয়ে জানতে আগ্রহী।

আমি একটা ইউনিভার্সিটি ডিগ্রী অর্জন করার অংশ হিসেবে এই প্রোজেক্টে কাজ করছি।

এই প্রোজেক্টে অংশগ্রহণ করার মাধ্যমে আপনি আপনার সংগঠনের ব্যাপারে, আপনার সংগঠনের চাহিদা ও গোষ্ঠীর অধিকার সম্বন্ধে গবেষণায় সাহায্য করবেন।

আমি তথ্য রেকর্ড করব, ছবি তুলব এবং ঘটনাচক্রে, আমরা এখানে যে কাজটা করছি তা নিয়ে লেখালেখি করব।

আপনার সম্মতি থাকলে আমি চাইব আপনাকে এই প্রোজেক্টের একজন অংশদাতা হিসেবে চিহ্নিত করতে। এর অর্থ হল ভবিষ্যতে এই কাজের অংশ হিসেবে আপনার নাম ও আপনার ছবি প্রকাশিত হতে পারে। আপনি যদি চান আমি আপনার ছবি বা নাম ব্যবহার না করি তাহলে যেকোনো সময় নির্দ্বিধায় তা জানাতে পারেন।

আপনার থেকে সংগ্রহ করা তথ্য আমি ও ডি আর সি এস সি এই প্রোজেক্টের জন্য ব্যবহার করব এবং একই সাথে তা থেকে তৈরি রিপোর্ট ও প্রবন্ধ প্রকাশিত হবে জনগণের স্বার্থে।

আপনি যেকোনো মুহূর্তে এই প্রোজেক্ট থেকে আপনার অংশগ্রহন প্রত্যাহার করতে পারেন।

আপনার কোনো প্রশ্ন থাকলে তা আপনি যেকোনো সময়ে আমাকে জিজ্ঞাসা করতে পারেন।

Farmers' groups

লিনাস ইংল্যান্ড থেকে আসা একজন গবেষণাবিদ।

কিভাবে সুন্দরবনের চাষিরা জানতে পারলেন সাস্টেনেবেল ফার্মিং-এর কথা সেই বিষয়ে জানতে, ওনার প্রোজেক্টের অংশ হিসেবে উনি আপনাদের সংগঠনগুলোতে আসবেন।

একটা ইউনিভার্সিটি ডিগ্রী অর্জন করার অংশ হিসেবে উনি এই প্রোজেক্টটিতে কাজ করছেন।

উনি আপনাদের মিটিং-এ উপস্থিত থাকবেন ও সংগঠনের কিছু কিছু সদস্যদের পৃথক সাক্ষাৎকার নেবেন। এই প্রোজেক্টের অংশ হিসেবে আপনি ও আপনার সংগঠন, আপনার ও আপনার সংগঠনের চাহিদা সম্বন্ধে যাবতীয় তথ্য সরবরাহ করবেন।

পরবর্তীকালে, আপনাদের সংগঠনকে কি কি উপায়ে সহায়তা করা যায় তার উদ্দ্যেশ্যে এই তথ্য ব্যবহৃত হবে লিনাস ও ডি আর সি এস সি- এর দ্বারা। এই তথ্য রিপোর্ট তৈরি করার জন্যও ব্যবহৃত হবে যা যে কেউ উপলব্ধ করতে পারে। আপনার নাম বা আপনার ছবি এই কোন কিছুতেই ব্যবহৃত হবে না।

উনি ছবি তুলতে বা শব্দ রেকর্ড করতে পারেন। এই তথ্যগুলো এমন জায়গায় গচ্ছিত থাকবে যেখানে উনি এবং ইউনিভার্সিটির আরও কয়েকজন ছাড়া অন্য কেউ ব্যবহার করতে পারবে না।

আপনার কোনো প্রশ্ন থাকলে আপনি যেকোনো সময়ে ওনাকে জিজ্ঞাসা করতে পারেন।

Appendix D: Approval of Ethics Procedures

Sheffield Hallam University

LINUS KENDALL < **>**

FREC decision re Linus Kendall work in India

Rodrigues, Marcos < **>** 3 March 2016 at 13:30
To: "Dearden, Andrew M" < >, " "
< >
Cc: "Marcos Rodrigues ( )" < >, "Saatchi, Reza"
< >

Hi Andy, Linus,

FREC has fully approved the application. We would only recommend you and Linus, if you have not done so, to check with Finance the new documentation for travel that was introduced last week re. travel insurance since Linus will be working on behalf of SHU. I believe it also includes some version of risk assessment. Good luck with the project,

Kind regards,

Marcos.

Marcos A Rodrigues, BEng, MSc, PhD
Professor of Computer Science
Sheffield Hallam University | GMPR Geometric Modelling and Pattern Recognition Research Group
Communication and Computing Research Centre

Appendix E: Locations of interventions

The following map provides details about the locations of the various activities and interventions described in (4 Studying the context) and (6 Intervening in the organisation's work).

The map is modified version of the provided by Wikimedia Commons (2006).

Appendix F: First stewardship workshop plan

This was the plan and agenda for the first workshop held with the design group (later Technologians). It was translated into the Bengali and provided to different members of the organisation.

Creating new ways of using WhatsApp in DRCSC
In this first phase we would build on the challenges identified during the activities conducted last year. Specifically we would look at the organisational challenges DRCSC is facing as a result of for example a greater focus on project oriented work by funders.
We would start by looking at how we might use technology that DRCSC is already familiar with – WhatsApp – in order to address one or more of those challenges in some way.
This would be the start for building capacity and training people within DRCSC to be "technology stewards" for DRCSC – that is, individuals who are based within DRCSC who also have experience and expertise about how to adapt and make use of technologies for DRCSCs benefit. The long-term goal is that these technology stewards will be able to act in DRCSC interest in any of the programmes to find, design, and implement technologies for DRCSC's use. This programme will serve as a first step to help us learn about the process of supporting technology stewarding, as well as build practical skills for all those involved.

Goals

- Take steps to address (at least) one of the organisational challenges identified last year
- Find creative ways we can use technology in DRCSC
- Build foundation for technology stewarding programme
- Build skills for technology adoption and implementation among participants

Participant Selection
DRCSC (Somjita) helps select 6-9 people who we offer to participate. Their commitment will involve at least attending a full day workshop as well as participating in activities through two weeks following the workshop, after which

a half day workshop will be held. Ideally they should be interested/able to participate in future activities of the programme until September 2017.

Preparation
These steps are briefed individually with each participant who volunteers, while we also go through some basic introduction of me and the project.

- Each participant takes note on how they are using WhatsApp in their work with DRCSC or in relation to other people in DRCSC
- Each participant talks to at least two others within their team about their WhatsApp usage, gathering answers to the following questions:
    - How are you currently using WhatsApp in your work with DRCSC?
    - Who do you communicate with about matters relating to DRCSC?
    - What are the topics that you communicate about?
    - Are there other tools you use as well as WhatsApp for doing and communicating about your work?
    - What do these other tools give you that WhatsApp doesn't provide?
    - What are the things you like about WhatsApp?

Activities

- Initial, individual preparatory discussion (30 minutes, all participants individually)
- Two day design workshop (all teams)
- Two-three week implementation phase where teams meet individually at least twice (with Linus present)
- Half day evaluation workshop (all teams)
- Individual follow-up interviews (30-40 minutes, all participants individually)

Proposed duration & timeline
Total duration approximately a month. First workshop beginning of April with project running throughout April, evaluation at the end of April.

Evaluation

- Participants experience of the process
- Suggestions for next step

Resources required

- Projector

- Flipcharts and markers
- Coloured stickers and post its

Data collection (Linus)

- Record audio from discussions
- Take notes throughout workshop + after workshop
- Gather pictures and video clips from the event
- Individual reflection from participants during workshop
- Individual interviews with participants after activities (end of programme)

Follow-up

Successful WhatsApp initiatives would be brought out as a case study for the organisation and shared internally and externally.

Next step would be to run an additional technology stewarding workshop where we look more broadly at other technologies that could be used for DRCSC. This could include any other technologies such as SMS, mobile voice response, geographic information systems, maps, etc. Together with technology stewards we would identify potential technologies, then train them in the technology they have identified as useful (and provide any development assistance) after which we would again run a promotion/implementation campaign.

Workshop 1 (Full Day, actually two full days?)

Introduction	• Introduce participants, break ice • What is this research project? • What is design and how do we design? • Technology stewardship – what is it? What is the role and what is expected? • What is this workshop? • What can you expect to learn? • Goals and objectives of the day • General principles	Expectations / goals from participants for the day

Critique	• Some challenges DRCSC is facing drawn from previous phase • What are other challenges related to these or that you see in the organization? • Place these challenges on a wall with print outs • Used coloured stickers to pick the ones they feel most urgently about	Curated list of challenges with those felt most urgently by the participants highlighted
Technology Option: WhatsApp	• Go around and share the data they have collected on WhatsApp use • I share data that I have collected on WhatsApp use • What functionalities that whatsapp provide? • What are the benefits of whatsapp? • Why might whatsapp be a suitable technology to start with?	A description of how whatsapp is used, use a powerpoint slide to take public notes on
Vision	• Introduction to brainstorming (principles, ideas)	One or more visionary ideas from each of the groups

	• Split into groups of 2-3 and brainstorm ideas for how we might use whatsapp to address some of the challenges identified in the critique phase
	• Each group gets a flipchart where they can prepare their proposed idea, they should have at least one idea which should contain:
	  • What problem do they seek to address?
	  • In what way do they envision using WhatsApp to address this problem?
	  • Think about utopic solutions and not necessarily those that can be directly addressed
	• They are free to	

	prepare multiple ideas • One or two people switch with another group, with at least one person remaining by the flipchart • The remaining person explains their idea to the newcomers • The newcomers can now build on the previous groups idea – build on what is good about it? How can we make it even better?	
Implementation	• Move back to your starting group, discuss the idea as improved and make final touches to present your idea in front of the group. • Prepare a small presentation of each idea that you have (one or more) on a flipchart • Hang them in the room • Now we will go through the ideas one by one and	A smaller number of ideas selected with one responsible person Action plans, resources required Communication plan Evaluation plan

	decide which are actionable and which ones you would like to work on • We pick 1 or more ideas to work on (can be up to as many ideas as there are participants) • Bring that flipchart down and start making a list of activities with date and time and responsible person • List resources required • Create a plan for how you will promote and run the project • Then discuss how you will evaluate the outcome of the activity – will you talk to people? How will you measure success?	
Wrap-up and next steps	What is the very next step you will take and when? When will you meet as a team?	

Evaluation	First individual reflection on workshop on pieces of paper, then sharing in the group. • How did they enjoy the workshop? Did they learn anything? What? • What was good parts? What worked well? • What did not work well? What could be improved?	

Appendix G: Introduction to follow-up session

The following is an introduction that I wrote and used for the first follow-up workshop:

OK, so now we come to the initial evaluation of these first two/three weeks of this programme or intervention. To start off, I would just like to hear a bit of what are your general impressions so far of this technology intervention?

I'd like to start off with a bit of "meta" reflection – and ask you what kind of questions do we need to ask ourselves in order to evaluate our progress in this program? So in this stage I am just looking for questions that we can ask.
OK, I have also a few specific questions to ask:

- *What do you think about using video/audio as the medium?*
- *In what ways do you find it different from the previous reporting mechanisms?*
- *What do you think works well about this type of reporting?*
- *What do you think works less well?*
- *How could we improve this intervention to make it work better?*
- *Do you believe this could be helpful in addressing some of the organisational challenges we discussed in the previous meeting?*
- *Finally what is your perception of this process so far? What have you learnt?*

Finally, how might we expand this experiment now? Should we share some of the audio clips or video clips with the rest of the organisation? We could create a WhatsApp group that we promote publicly, perhaps through some posters and some information given in the staff meeting later today?
Set our next meeting after two weeks, when I suggest we do a second workshop where we also will look at a broader set of technologies that we might evaluate.

Appendix H: Survey responses after initial evaluation

Below are the answers provided on an informal survey circulated before evaluating the first stewardship programme with the Technologians. These survey answers were used as a basis for further deeper discussion on the outcomes and development of the programme.

What has worked well so far?

Respondent	
1	From this experiment we got to know about the activities, planning & process in all three projects who interacted.
2	Monitoring on regular basis, which is based on evidence.
3	1) Participation is good 2) Respondents hav to plan and execute accordingly. We are having some information.
4	- regular updates from field - involvement of more people for communication
5	Applied "technology" not only for "just" communicating but for "work" also. Colleagues who were involved for reporting/monitoring, accepted & participated well. Updates from different projects helping to replicate good things.

What benefits have I drawn from this experiment?

Respondent	
1	It generated a positive vibe among the field officers as well as among the staff & come to know lot more about each others work.
2	Improved monitoring quality. Both in terms of quantity and quality.
3	# Respondents | those who are sharing the info have to plan and report in a systematic way. They are trying. Daily communication without calling is good.
4	- even if in distant places, information to some extent are exchanged, - helpful in monitoring - corrections

5	Got a day to day updates regarding the planned activities from the field areas.

What features of this intervention do I want to maintain in any future intervention?

Respondent	
1	- Simplicity - Directe towards goal -Manageable - Dynamic - Time bound - Interactive
2	Receiving text plan and picture execution.
3	# Pictures and videos
4	information sharing with field staffs(receiving reqd. information and sending)
5	Posting activities along with photographs/videos in the group.

Has ths intervention changed the way I think about how I communicate with others in the organisation? In what way?

Respondent	
1	Yes, at least to some extent. - Create a platform for formal interactions, - Create a space for informal dialogues as well - Developing positive spirit to look at each other's work
2	Not sure
3	Yes in someways. Actually we usually call the respective person, but through this a visualization and sharing is happening.
4	Communication with WhatsApp is used earlier also with few of the staffs & organisation. But with this intervention, we can share info & communicate with all the staffs of organisation being in a grp.
5	Only few of the organisation ahs been communicated about this except the person involved in it. Though apart from this, it has been [replicated] in both my field areas already.

Has this intervention influenced how I do my job in any way?

Respondent	
1	Yes for example, - how to execute & plan for a short term goals, - The way of monitoring
2	Not sure as in my working area no one is atatched

3	Yes, although it is not new, but I am thinking of forming WhatsAp group to monitor and get info about projects.
4	Yes
5	To some extent.

Has it influenced what I consider important information to receive from the field?

Respondent	
1	Yes, definitely. For example: - Received audio & visual materials from the field - Get to know about diff. or similar works in each others projects
2	Not sure
3	It depends on the respondent. Somehow they will share the important information through this intervention.
4	Yes, but in some cases one has to write & then take a snap and send.
5	Yes, it is a good way.

What have I learnt about introducing new ways of using technology so far?

Respondent	
1	- Gradually take place, - Add things one after another, - Encourage people & create competitve atmosphere through it
2	
3	I have learnt to use the WhatsAp for not only entertainment, but for sharing useful info. But related software should be developed to make a proper system.
4	Helpful new tech for field staffs, all motivating to work hard & perform well as all *members of group) see what is happening. It is a platform for sharing, recognising.
5	If motivated and oriented properly, then it can be successful in proper updates & learning sharing method.

Appendix I: Agenda for climate volunteer training

- General orientation on climate change: why are we doing this project? What is important?

- General orientation on weather and climate system
    - What is weather
    - What is climate
    - Difference between weather and climate

- Links between agriculture and climate and weather
    - How is agriculture affected by climate change?
    - How does weather affect agriculture?
    - How can farmers plan based on knowing about the weather?

- Generating agroadvisory
    - How will we generate the agroadvisory based on forecasts
    - How to disseminate agroadvisory with the forecasts
    - What should be included in the agroadvisory

- Forecasting weather and climate
    - How does forecasting work?
    - What kind of details is provided in the forecasts?
    - What about accuracy of forecasts?

- Monitoring weather and climate
    - How do we monitor weather
    - How do we monitor climate
    - What are the important parameters and what do they mean:
        - Temperature
        - Rainfall
        - Humidity
        - Wind speed
        - Wind direction
    - How will they monitor weather?

- How to use a hygrometer and thermometer
- How to place the rain gauge, measure rain fall
- How to fill out the format for collecting data

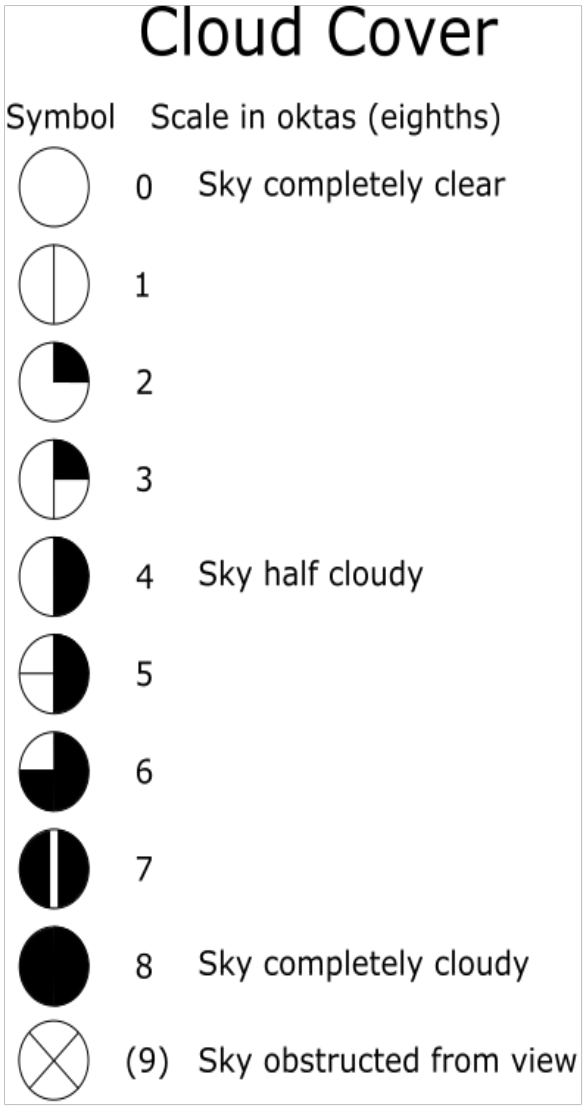
- Disseminating weather and climate
    - How do we make weather forecasts available to farmer?
        - Blackboard
        - Group meeting
    - How do we locate places to keep the blackboards together with the farmers groups?
    - How to gather farmer's feedback on forecasts

Appendix J: Sample training materials provided for weather volunteers

Below are examples of training materials provided to the climate volunteers when learning about weather and climate.

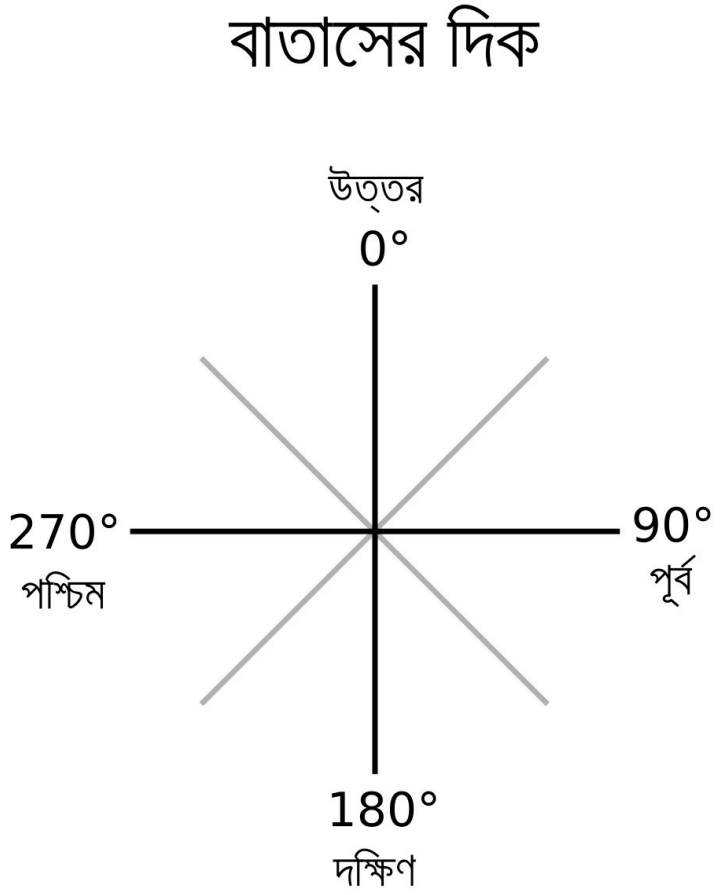
Cloud Cover

Illustrated by author (2018).



Illustrated by author (2018).

Wind Directions



References

Adger, W. N. (2009). Social Capital, Collective Action, and Adaptation to Climate Change. *Economic Geography*, *79*(4), 387–404. https://doi.org/10.1111/j.1944-8287.2003.tb00220.x

Agarwal, S. K., Jain, A., Kumar, A., Nanavati, A. A., & Rajput, N. (2010). The spoken web: A web for the underprivileged. *ACM SIGWEB Newsletter*, (Summer), 1:1-1:9. https://doi.org/10.1145/1796390.1796391

Agroecology Europe. (2019). *Technological innovations in agriculture, including digitalisation, Information and Communication Technologies (ICT) and precision farming*. Retrieved from https://www.agroecology-europe.org/our-approach/vision-of-our-organization/

Aker, J. C. (2008). Does Digital Divide or Provide? The Impact of Cell Phones on Grain Markets in Niger. *Center for Global Development Working Paper*, *154*(February), 64. https://doi.org/10.2139/ssrn.1093374

Aker, J. C. (2011). Dial "A" for agriculture: A review of information and communication technologies for agricultural extension in developing countries. *Agricultural Economics*, *42*(6), 631–647. https://doi.org/10.1111/j.1574-0862.2011.00545.x

Aker, J. C., & Fafchamps, M. (2015). Mobile phone coverage and producer markets: Evidence from West Africa. *The World Bank Economic Review*, *29*(2), 262–292. https://doi.org/10.1093/wber/lhu006

Aker, J. C., Ghosh, I., & Burrell, J. (2016). The promise (and pitfalls) of ICT for agriculture initiatives. *Agricultural Economics*, *47*(S1), 35–48. https://doi.org/10.1111/agec.12301

Aker, J. C., & Ksoll, C. (2016). Can mobile phones improve agricultural outcomes? Evidence from a randomized experiment in Niger. *Food Policy*, *60*, 44–51. https://doi.org/10.1016/j.foodpol.2015.03.006

Ali, J., & Kumar, S. (2011). Information and communication technologies (ICTs) and farmers' decision-making across the agricultural supply chain. *International Journal of Information Management*, *31*(2), 149–159. https://doi.org/10.1016/j.ijinfomgt.2010.07.008

Alkire, S. (2005). Why the Capability Approach? *Journal of Human Development*, *6*(1), 115–135.

https://doi.org/10.1080/146498805200034275

Alkire, S., & Deneulin, S. (2009). The Human Development and Capability Approach. In S. Deneulin & L. Shahani (Eds.), *An Introduction to the Human Developmentand Capability Approach* (pp. 22–48). IDRC. Retrieved from https://www.idrc.ca/sites/default/files/openebooks/470-3/index.html

Altieri, M. A. (2002). Agroecology: The science of natural resource management for poor farmers in marginal environments. *Agriculture, Ecosystems & Environment*, *93*(1–3), 1–24. https://doi.org/10.1016/S0167-8809(02)00085-3

Altieri, M. A., & Nicholls, C. I. (2005). *Agroecology and the Search for a Truly Sustainable Agriculture.* (1st Edition). United Nations Environmental Programme, Environmental Training Network for Latin America and the Caribbean,. Retrieved from http://www.agroeco.org/doc/agroecology-engl-PNUMA.pdf

Anderson, J. R., & Feder, G. (2004). Agricultural Extension: Good Intentions and Hard Realities. *The World Bank Research Observer*, *19*(1), 41–60. https://doi.org/10.1093/wbro/lkh013

Ashley, C., & Carney, D. (1999). *Sustainable livelihoods: Lessons from early experience* (Vol. 7). London: Department for International Development.

Avgerou, C. (2008). Information systems in developing countries: A critical research review. *Journal of Information Technology*, *23*(3), 133–146. https://doi.org/10.1057/palgrave.jit.2000136

Avgerou, C. (2010). Discourses on ICT and Development. *Information Technologies & International Development*, *6*(3), 1–18.

Baines, D., Charlesworth, S., Cunningham, I., & Dassinger, J. (2012). Self-monitoring, self-blaming, self-sacrificing workers: Gendered managerialism in the non-profit sector. *Women's Studies International Forum*, *35*(5), 362–371. https://doi.org/10.1016/j.wsif.2012.07.002

Bardzell, S., Bardzell, J., Forlizzi, J., Zimmerman, J., & Antanitis, J. (2012). Critical design and critical theory: The challenge of designing for provocation. *Proceedings of the Designing Interactive Systems Conference*, 288–297. Newcastle Upon Tyne, United Kingdom: Association for Computing Machinery.

https://doi.org/10.1145/2317956.2318001

Baskerville, R., & Myers, M. D. (2004). Special issue on action research in information systems: Making IS research relevant to practice: Foreword. *MIS Quarterly*, *28*(3), 329–335. https://doi.org/10.2307/25148642

Baskerville, R., & Pries-Heje, J. (1999). Grounded action research: A method for understanding IT in practice. *Accounting, Management and Information Technologies*, *9*(1), 1–23. https://doi.org/10.1016/S0959-8022(98)00017-4

Baskerville, R., & Wood-Harper, A. T. (1996). A critical perspective on action research as a method for information systems research. *Journal of Information Technology*, *11*(3), 235–246. https://doi.org/10.1080/026839696345289

Batool, A., Razaq, S., Javaid, M., Fatima, B., & Toyama, K. (2017). Maternal Complications: Nuances in Mobile Interventions for Maternal Health in Urban Pakistan. *Proceedings of the Ninth International Conference on Information and Communication Technologies and Development*, 1–12. Lahore, Pakistan: Association for Computing Machinery. https://doi.org/10.1145/3136560.3136573

Baumer, E. P. S., & Silberman, M. S. (2011). When the Implication is Not to Design (Technology). *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 2271–2274. Vancouver, BC, Canada: Association for Computing Machinery. https://doi.org/10.1145/1978942.1979275

Baumüller, H. (2015). Assessing the Role of Mobile Phones in Offering Price Information and Market Linkages: The Case of M-Farm in Kenya. *The Electronic Journal of Information Systems in Developing Countries*, *68*(1), 1–16. https://doi.org/10.1002/j.1681-4835.2015.tb00492.x

Baumüller, H. (2018). The Little We Know: An Exploratory Literature Review on the Utility of Mobile Phone-Enabled Services for Smallholder Farmers. *Journal of International Development*, *30*(1), 134–154. https://doi.org/10.1002/jid.3314

Bellon Maurel, V., & Huyghe, C. (2017). Putting agricultural equipment and digital technologies at the cutting edge of agroecology. *OCL*, *24*(3), D307. https://doi.org/10.1051/ocl/2017028

Bidwell, N. J., Winschiers-Theophilus, H., Koch Kapuire, G., & Rehm, M. (2011). Pushing personhood into place: Situating media in rural knowledge in Africa. *International Journal of Human-Computer Studies*, *69*(10), 618–631. https://doi.org/10.1016/j.ijhcs.2011.02.002

Björgvinsson, E., Ehn, P., & Hillgren, P.-A. (2012). Design things and design thinking: Contemporary participatory design challenges. *Design Issues*, *28*(3), 101–116. https://doi.org/10.1162/DESI_a_00165

Bockarie, M., Machingaidze, S., Nyirenda, T., Olesen, O. F., & Makanga, M. (2018). Parasitic and parachute research in global health. *The Lancet Global Health*, *6*(9). https://doi.org/10.1016/s2214-109x(18)30342-5

Bossen, C., Dindler, C., & Iversen, O. S. (2010). User Gains and PD Aims: Assessment from a Participatory Design Project. *Proceedings of the 11th Biennial Participatory Design Conference*, 141–150. Sydney, Australia: Association for Computing Machinery. https://doi.org/10.1145/1900441.1900461

Bowonder, B., Gupta, V., & Singh, A. (2003). *Developing a rural market e-hub: The case study of e-Choupal experience of ITC*. Planning Commission of India. Retrieved from Planning Commission of India website: https://niti.gov.in/planningcommission.gov.in/docs/reports/sereport/ser/stdy_ict/4_e-choupal%20.pdf

Bratteteig, T., & Wagner, I. (2016). Unpacking the Notion of Participation in Participatory Design. *Computer Supported Cooperative Work (CSCW)*, *25*(6), 425–475. https://doi.org/10.1007/s10606-016-9259-4

Brigham, M., & Hayes, N. (2013). Hybridity, consulting and e-development in the making: Inscribing new practices of impact assessment and value management. *Information Technology for Development*, *19*(2), 112–132. https://doi.org/10.1080/02681102.2012.690171

Brown, V. A. (2010). Multiple knowledges, multiple languages: Are the limits of my language the limits of my world? *Knowledge Management for Development Journal*, *6*(2), 120–131. https://doi.org/10.1080/19474199.2010.532148

Burrell, J., & Toyama, K. (2009). What Constitutes Good ICTD Research? *Information Technologies & International Development*, *5*(3), 82–94.

Camacho, A., & Conover, E. (2011). The Impact of Receiving Price and Climate Information in the Agricultural

Sector. *IDB Working Paper*, *IDB-WP-220*(May). https://doi.org/10.2139/ssrn.1858036

Camara, S., & Abdelnour-Nocera, J. (2013). Revealing the Socio-Technical Context of Design Settings: Toward Participatory IS Design. *International Journal of Human-Computer Interaction*, *29*(4), 289–307. https://doi.org/10.1080/10447318.2013.765767

Carolan, M. (2017). Publicising food: Big data, precision agriculture, and co-experimental techniques of addition. *Sociologia Ruralis*, *57*(2), 135–154.

Cecchini, S., & Raina, M. (2002). Warana: The Case of an Indian Rural Community Adopting ICT. *Information Technology in Developing Countries Working Paper*. https://doi.org/10.2139/ssrn.568181

Census of India. (2011). *West Bengal Profile*. Retrieved from https://censusindia.gov.in/2011census/censusinfodashboard/stock/profiles/en/IND019_West%20Bengal.pdf

Chahal, S. S., Sidhu, M. S., & Kaur, P. (2012). Impact Assessment of Reuters Market Light (RML) in Agricultural Information Dissemination in Punjab. *Agricultural Economics Research Review*, *25*(347-2016–17051), 373–378.

Chambers, R. (1997). *Whose Reality Counts?* (2nd Edition). London: ITDG Publishing.

Chambers, R. (2008). PRA, PLA and Pluralism: Practice and theory. In *The SAGE Handbook of Action Research* (2nd Revised edition, pp. 297–318). London: SAGE Publications Ltd.

Chambers, R., & Conway, G. R. (1991). Sustainable rural livelihoods: Practical concepts for the 21st Century. *IDS Discussion Paper*, *296*. Retrieved from https://opendocs.ids.ac.uk/opendocs/handle/20.500.12413/775

Chaudhuri, A. (2012). ICT for Development: Solutions seeking problems? *Journal of Information Technology*, *27*(4), 326–338. https://doi.org/10.1057/jit.2012.19

Chaudhuri, B., Dasgupta, P., Hoysala, O., Kendall, L., & Srinivasan, J. (2017). Actor-networks and “practices” of development: Impact of a weather information system in West Bengal. *Information and Communication Technologies for Development. ICT4D 2017*, *504*. Springer, Cham. https://doi.org/10.1007/978-3-319-

59111-7_66

Chaudhuri, B., & Kendall, L. (2019). The Ins and Outs of Participation in a Weather Information System. In P. Nielsen & H. C. Kimaro (Eds.), *Information and Communication Technologies for Development. Strengthening Southern-Driven Cooperation as a Catalyst for ICT4D* (pp. 3–14). Springer Cham. https://doi.org/10.1007/978-3-030-18400-1_1

Chaudhuri, B., & Kendall, L. (2021). Collaboration without consensus: Building resilience in sustainable agriculture through ICTs. *The Information Society*, *37*(1), 1–19. https://doi.org/10.1080/01972243.2020.1844828

Chaudhuri, B., Kendall, L., Srinivasan, J., Hoysala, O., & Dasgupta, P. (2017). Understanding capabilities through everyday practice. *Proceedings of the Ninth International Conference on Information and Communication Technologies and Development*, 1–10. Lahore, Pakistan: Association for Computing Machinery. https://doi.org/10.1145/3136560.3136578

Checkland, P. B. (1988). Information systems and systems thinking: Time to unite? *International Journal of Information Management*, *8*(4), 239–248. https://doi.org/10.1016/0268-4012(88)90031-X

Cole, S. A., & Fernando, A. N. (2012). The Value of Advice: Evidence from Mobile Phone-Based Agricultural Extension. *Harvard Business School Finance Working Paper*, *No. 13-047*(November). Retrieved from http://nrs.harvard.edu/urn-3:HUL.InstRepos:10007889

Cooke, B., & Kothari, U. (2001). *Participation: The New Tyranny?* London: Zed Books.

Crewe, E., & Harrison, E. (2002). *Whose development? An ethnography of aid*. London: Zed Books.

Cross, A., Gupta, N., Liu, B., Nair, V., Kumar, A., Kuttan, R., … Thies, W. (2019). 99DOTS : A Low-Cost Approach to Monitoring and Improving Medication Adherence. *Proceedings of the Tenth International Conference on Information and Communication Technologies and Development*. Presented at the ICTD '19, Ahmedabad, India. https://doi.org/10.1145/3287098.3287102

Cuendet, S., Medhi, I., Bali, K., & Cutrell, E. (2013). VideoKheti: Making Video Content Accessible to Low-Literate and Novice Users. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 2833–

2842. Paris: Association for Computing Machinery. https://doi.org/10.1145/2470654.2481392

Daly, H. E. (1990). Toward some operational principles of sustainable development. *Ecological Economics*, *2*(1), 1–6. https://doi.org/10.1016/0921-8009(90)90010-R

Das, A., Basu, D., & Goswami, R. (2012). Accessing Agricultural Information through Mobile Phone: Lessons of IKSL Services in West Bengal. *Indian Research Journal of External Education*, *12*(3), 102–107.

Davison, R. M., & Díaz Andrade, A. (2018). Promoting indigenous theory. *Information Systems Journal*, *28*(5), 759–764. https://doi.org/10.1111/isj.12203

Dearden, A. (2012). See No Evil? Ethics in an Interventionist ICTD. *Proceedings of the Fifth International Conference on Information and Communication Technologies and Development*, 46–55. Atlanta, Georgia, USA: Association for Computing Machinery. https://doi.org/10.1145/2160673.2160680

Dearden, A., Matthews, P., & Rizvi, H. (2011). Kheti: Mobile multimedia in an agricultural co-operative. *Personal and Ubiquitous Computing*, *15*(6), 597–607. https://doi.org/10.1007/s00779-010-0335-3

Dearden, A., & Rizvi, H. (2008). Participatory IT design and participatory development: A comparative review. *Proceedings of the Tenth Anniversary Conference on Participatory Design 2008*, 81–91. Bloomington, Indiana: Indiana University. https://doi.org/10.5555/1795234.1795246

Dearden, A., & Rizvi, H. (2015). ICT4D and Participatory Design. In *The Wiley Blackwell-ICA International Encyclopedias of Communication*: *Vol. 1*. *The International Encyclopedia of Digital Communication and Society*. Wiley Blackwell. Retrieved from https://doi.org/10.1002/9781118767771.wbiedcs131

Dearden, A., & Tucker, W. D. (2015). The ethical limits of bungee research in ICTD. *2015 IEEE International Symposium on Technology and Society (ISTAS)*, 1–6. Dublin, Ireland: IEEE. https://doi.org/10.1109/ISTAS.2015.7439430

deeptrivia. (2006). *West Bengal Districts*. Retrieved from https://commons.wikimedia.org/wiki/File:WestBengalDistricts_numbered.svg

Deneulin, S. (2006). *The Capability Approach and the Praxis of Development*. New York: Palgrave Macmillan.

Retrieved from https://doi.org/10.1057/9780230627253

Dick, B., Stringer, E., & Huxham, C. (2009). Theory in action research. *Action Research*, *7*(1), 5–12. https://doi.org/10.1177/1476750308099594

DiSalvo, C., Nourbakhsh, I., Holstius, D., Akin, A., & Louw, M. (2008). The Neighborhood Networks Project: A Case Study of Critical Engagement and Creative Expression through Participatory Design. *Proceedings of the Tenth Anniversary Conference on Participatory Design 2008*, 41–50. Bloomington, Indiana: Indiana University. https://doi.org/10.5555/1795234.1795241

Dodson, L., Sterling, S. R., & Bennett, J. K. (2012). Considering Failure: Eight Years of ITID Research. *Proceedings of the Fifth International Conference on Information and Communication Technologies and Development*, 56–64. Atlanta, Georgia, USA: Association for Computing Machinery. https://doi.org/10.1145/2160673.2160681

Dolejšová, M., van Gaalen, S., Wilde, D., Raven, P. G., Heitlinger, S., & Light, A. (2020). Designing with More-than-Human Food Practices for Climate-Resilience. *Companion Publication of the 2020 ACM Designing Interactive Systems Conference*, 381–384. Eindhoven Netherlands: Association for Computing Machinery. https://doi.org/10.1145/3393914.3395909

Dourish, P. (2006). Implications for design. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 541–550. Montreal QC, Canada. https://doi.org/10.1145/1124772.1124855

DRCSC. (2016a). About Us. Retrieved November 8, 2020, from http://www.drcsc.org/aboutus.html

DRCSC. (2016b). Database Search. Retrieved January 4, 2021, from https://www.drcsc.org/db-search.html

Duflo, E., & Banerjee, A. V. (2011). *Poor economics*. United States: PublicAffairs.

Eagleton-Pierce, M. (2020). The rise of managerialism in international NGOs. *Review of International Political Economy*, *27*(4), 970–994. https://doi.org/10.1080/09692290.2019.1657478

Eagleton-Pierce, M., & Knafo, S. (2020). Introduction: The political economy of managerialism. *Review of International Political Economy*, *27*(4), 763–779. https://doi.org/10.1080/09692290.2020.1735478

Escobar, A. (2011). *Encountering development: The making and unmaking of the Third World*. Princeton, N.J: Princeton University Press.

Escobar, A. (2017). Response: Design for/by [and from] the 'global South.' *Design Philosophy Papers*, *15*(1), 39–49. https://doi.org/10.1080/14487136.2017.1301016

Evans, P. (2002). Collective capabilities, culture, and Amartya Sen's Development as Freedom. *Studies in Comparative International Development*, *37*(2), 54–60. https://doi.org/10.1007/BF02686261

Evenson, R. E., & Gollin, D. (2003). Assessing the impact of the green revolution, 1960 to 2000. *Science*, *300*(5620), 758–762. https://doi.org/10.1126/science.1078710

Fafchamps, M., & Minten, B. (2012). Impact of SMS-Based Agricultural Information on Indian Farmers. *The World Bank Economic Review*, *26*(3), 383–414. https://doi.org/10.1093/wber/lhr056

Fallman, D., & Stolterman, E. (2010). Establishing criteria of rigour and relevance in interaction design research. *Digital Creativity*, *21*(4), 265–272. https://doi.org/10.1080/14626268.2010.548869

Fazey, I., Schäpke, N., Caniglia, G., Hodgson, A., Kendrick, I., Lyon, C., … Young, H. R. (2020). Transforming knowledge systems for life on Earth: Visions of future systems and how to get there. *Energy Research & Social Science*, *70*, 101724. https://doi.org/10.1016/j.erss.2020.101724

Feder, G., Willett, A., & Zijp, W. (1999). Agricultural Extension: Generic Challenges and Some Ingredients for Solutions. *World Bank Policy Research Working Papers*. https://doi.org/10.1596/1813-9450-2129

Folke, C. (2016). Resilience (Republished). *Ecology and Society*, *21*(4). JSTOR. https://doi.org/10.5751/ES-09088-210444

Folke, C., Carpenter, S., Elmqvist, T., Gunderson, L., Holling, C. S., & Walker, B. (2002). Resilience and Sustainable Development: Building Adaptive Capacity in a World of Uncertainty. *Ambio*, *31*(5), 437–440. https://doi.org/10.1579/0044-7447-31.5.437

Folke, C., Hahn, T., Olsson, P., & Norberg, J. (2005). Adaptive Governance of Social-Ecological Systems. *Annual Review of Environment and Resources*, *30*(1), 441–473.

https://doi.org/10.1146/annurev.energy.30.050504.144511

Foth, M., & Axup, J. (2006). Participatory design and action research: Identical twins or synergetic pair. *Expanding Boundaries in Design: Proceedings Ninth Participatory Design Conference 2006*, *2*, 93–96. Trento, Italy.

Francis, C., Lieblein, G., Gliessman, S., Breland, T. A., Creamer, N., Harwood, R., … Poincelot, R. (2003). Agroecology: The Ecology of Food Systems. *Journal of Sustainable Agriculture*, *22*(13535), 99–118. https://doi.org/10.1300/J064v22n03_10

Frankel Pratt, S. (2016). Pragmatism as Ontology, Not (Just) Epistemology: Exploring the Full Horizon of Pragmatism as an Approach to IR Theory. *International Studies Review*, *18*(3), 508–527. https://doi.org/10.1093/isr/viv003

Frauenberger, C., Good, J., Fitzpatrick, G., & Iversen, O. S. (2015). In pursuit of rigour and accountability in participatory design. *International Journal of Human-Computer Studies*, *74*, 93–106. https://doi.org/10.1016/j.ijhcs.2014.09.004

Friedman, B., Kahn, P. H., & Borning, A. (2008). Value Sensitive Design and Information Systems. In *The Handbook of Information and Computer Ethics* (pp. 69–101). Wiley. Retrieved from https://doi.org/10.1002/9780470281819.ch4

Friedman, V. J., & Rogers, T. (2008). Action science: Linking causal theory and meaning making in action research. In *The SAGE Handbook of Action Research* (2nd Revised edition, pp. 252–265). London: SAGE Publications Ltd.

Fu, X., & Akter, S. (2016). The Impact of Mobile Phone Technology on Agricultural Extension Services Delivery: Evidence from India. *The Journal of Development Studies*, *52*(11), 1–16. https://doi.org/10.1080/00220388.2016.1146700

Gaillard, J. C. (2010). Vulnerability, capacity and resilience: Perspectives for climate and development policy. *Journal of International Development*, *22*(2), 218–232. https://doi.org/10.1002/jid.1675

Gakuru, M., Winters, K., & Stepman, F. (2009). *Inventory of Innovative Farmer Advisory Services using ICTs*. The

Forum for Agricultural Research in Africa.

Gandhi, R., Veeraraghavan, R., Toyama, K., & Ramprasad, V. (2007). Digital green: Participatory video for agricultural extension. *2007 International Conference on Information and Communication Technologies and Development*. Presented at the International Conference on Information and Communication Technologies and Development (ICTD), Bangalore, India. https://doi.org/10.1109/ICTD.2007.4937388

Garnham, N. (1997). Amartya Sen's capabilities approach to the evaluation of welfare: Its application to communications. *Javnost - The Public*, *4*(4), 113–124. https://doi.org/10.1080/13183222.1997.11008658

Gaver, W. (2012). What should we expect from research through design? *Proceedings of the 2012 ACM Annual Conference on Human Factors in Computing Systems*, 937. Austin, Texas, USA: ACM Press. https://doi.org/10.1145/2207676.2208538

Genat, B. (2009). Building emergent situated knowledges in participatory action research. *Action Research*, *7*(1), 101–115. https://doi.org/10.1177/1476750308099600

Glendenning, C. J., Babu, S., & Asenso-Okyere, K. (2010). Review of Agricultural Extension in India: Are Farmers' Information Needs Being Met. *FPRI Discussion Paper*, *010408*. Retrieved from https://www.ifpri.org/publication/review-agricultural-extension-india

Gliessman, S. R. (2006). The Agroecosystem Concept. In *Agroecology: The Ecology of Sustainable Food Systems* (Second Edition, pp. 23–32). CRC Press.

Goldkuhl, G. (2008). What kind of pragmatism in information systems research. *Proceedings of the Inaugural Meeting of AIS SIGPrag*. Presented at the AIS SIGPrag, Paris.

Goldkuhl, G. (2012). Pragmatism vs interpretivism in qualitative information systems research. *European Journal of Information Systems*, *21*(2), 135–146. https://doi.org/10.1057/ejis.2011.54

Government of West Bengal. (2010). *West Bengal State Action Plan on Climate Change* (p. 191).

Gow, G. A., Waidayanatha, N., Jayathilake, C., Hambly, H., Barlott, T., & Anwar, M. (2015). Fostering Inclusive Innovation for Agriculture Knowledge Mobilization in Sri Lanka: A Community-University Partnership

Development Project. *Proceedings of the Work-In-Progress Track of the 7th International Conference on Communities and Technologies*, *12*, 5–14.

Gregor, S., & Hevner, A. R. (2013). Positioning and presenting design science research for maximum impact. *MIS Quarterly*, *37*(2), 337–355.

Grunfeld, H., Hak, S., & Pin, T. (2011). Understanding benefits realisation of iREACH from a capability approach perspective. *Ethics and Information Technology*, *13*(2), 151–172. https://doi.org/10.1007/s10676-011-9268-4

Grunfeld, H., & Houghton, J. (2013). Using ICT for climate change adaptation and mitigation through agro-ecology in the developing world. *On Information and Communication Technologies*, 128.

Guba, E. G., & Lincoln, Y. S. (1994). Competing paradigms in qualitative research. In *Handbook of qualitative research* (Vol. 2, pp. 105–117). California: SAGE Publications Ltd.

Guijt, I., & Shah, M. Kaul. (1998). *The myth of community: Gender issues in participatory development*. ITDG Publishing. Retrieved from https://vtechworks.lib.vt.edu/handle/10919/70065

Halskov, K., & Hansen, N. B. (2015). The diversity of participatory design research practice. *International Journal of Human-Computer Studies*, *74*, 81–92. https://doi.org/10.1016/j.ijhcs.2014.09.003

Hammersley, M. (2012). Troubling theory in case study research. *Higher Education Research & Development*, *31*(3), 393–405. https://doi.org/10.1080/07294360.2011.631517

Hansen, J. R., & Ferlie, E. (2016). Applying Strategic Management Theories in Public Sector Organizations: Developing a typology. *Public Management Review*, *18*(1), 1–19. https://doi.org/10.1080/14719037.2014.957339

Harris, R. W. (2016). How ICT4D Research Fails the Poor. *Information Technology for Development*, *22*(1), 177–192. https://doi.org/10.1080/02681102.2015.1018115

Harvey, D. (2010). *A brief history of neoliberalism* (Illustrated Edition). USA: Oxford University Press,.

Hasra, S., Roy, S., & Mitra, S. (2017). *Enhancing Adaptive Capacity and Increasing Resilience of Small and Marginal*

Farmers of Purulia and Bankura Districts, West Bengal to Climate Change. Kolkata: School of Oceanographic Studies Jadavpur University\.

Hayes, G. R. (2011). The relationship of action research to human-computer interaction. *ACM Transactions on Computer-Human Interaction*, *18*(3), 1–20. https://doi.org/10.1145/1993060.1993065

Hayes, G. R. (2014). Knowing by doing: Action research as an approach to HCI. In *Ways of Knowing in HCI* (pp. 49–68). New York: Springer. Retrieved from https://www.springer.com/gp/book/9781493903771

Hayes, N., & Westrup, C. (2014). Consultants as intermediaries and mediators in the construction of information and communication technologies for development. *Information Technologies & International Development*, *10*(2), 19–32.

Hearn, G., & Foth, M. (2005). Action research in the design of new media and ICT systems. In *Topical issues in communications and media research* (pp. 79–94). UK: Nova Science Pub Inc. Retrieved from http://eprints.qut.edu.au/1910/

Hearn, G., & Foth, M. (2007). Communicative Ecologies: Editorial Preface. *Electronic Journal of Communication*, *17*(1–2), 2–6.

Heath, J. (2020). Methodological Individualism. In E. N. Zalta (Ed.), *The Stanford Encyclopedia of Philosophy* (Summer 2020). Metaphysics Research Lab, Stanford University. Retrieved from https://plato.stanford.edu/archives/sum2020/entries/methodological-individualism/

Heeks, R. (2010). Editorial: Do information and communication technologies contribute to development? *Journal of International Development*, *22*(5), 625–640. https://doi.org/10.1002/jid

Heeks, R., & Wall, P. J. (2018). Critical realism and ICT4D research. *The Electronic Journal of Information Systems in Developing Countries*, *84*(6). https://doi.org/10.1002/isd2.12051

Hersberger-Langloh, S. E., Stühlinger, S., & Schnurbein, G. von. (2020). Institutional isomorphism and nonprofit managerialism: For better or worse? *Nonprofit Management and Leadership*. https://doi.org/10.1002/nml.21441

Hevner, A., March, S., Park, J., & Ram, S. (2004). Design Science Research in Information Systems. *MIS Quarterly*, *28*(1), 75–105. https://doi.org/10.2307/25148625

Holt-Giménez, E., & Altieri, M. A. (2012). Agroecology, Food Sovereignty and the New Green Revolution. *Agroecology and Sustainable Food Systems*, *37*(1), 90–102. https://doi.org/10.1080/10440046.2012.716388

Hvenmark, J. (2016). Ideology, Practice, and Process? A Review of the Concept of Managerialism in Civil Society Studies. *VOLUNTAS: International Journal of Voluntary and Nonprofit Organizations*, *27*(6), 2833–2859. https://doi.org/10.1007/s11266-015-9605-z

Ibrahim, S. S. (2006). From Individual to Collective Capabilities: The Capability Approach as a Conceptual Framework for Self-help. *Journal of Human Development*, *7*(3), 397–416. https://doi.org/10.1080/14649880600815982

Iivari, J. (2015). Distinguishing and contrasting two strategies for design science research. *European Journal of Information Systems*, *24*(1), 107–115. https://doi.org/10.1057/ejis.2013.35

Iivari, J., & Venable, J. (2009). Action Research and Design Science Research—Seemingly similar but decisively dissimilar. *ECIS 2009 Proceedings*, *Paper 73*, 1–13.

Irungu, K. R. G., Mbugua, D., & Muia, J. (2015). Information and Communication Technologies (ICTs) Attract Youth into Profitable Agriculture in Kenya. *East African Agricultural and Forestry Journal*, *81*(1), 24–33. https://doi.org/10.1080/00128325.2015.1040645

ITC. (n.d.). ITC e-Choupal—Rural India's largest Internet-based intervention. Retrieved May 17, 2020, from https://www.itcportal.com/businesses/agri-business/e-choupal.aspx

Järvinen, P. (2007). Action research is similar to design science. *Quality & Quantity*, *41*(1), 37–54. https://doi.org/10.1007/s11135-005-5427-1

Johnstone, J. (2007). Technology as empowerment: A capability approach to computer ethics. *Ethics and Information Technology*, *9*(1), 73–87. https://doi.org/10.1007/s10676-006-9127-x

Jones, D., & Gregor, S. (2007). The Anatomy of a Design Theory. *Journal of the Association for Information Systems*, *8*(5). https://doi.org/10.17705/1jais.00129

Jones, G. E., & Garforth, C. (1997). The history, development, and future of agricultural extension. In *Improving agricultural extension. A reference manual*. Rome: Food and Agriculture Organization of the United Nations. Retrieved from http://www.fao.org/3/w5830e/w5830e03.htm

Kam, M., Ramachandran, D., Raghavan, A., Chiu, J., Sahni, U., & Canny, J. (2006). Practical considerations for participatory design with rural school children in underdeveloped regions. *Proceedings of the 2006 Conference on Interaction Design and Children*, 25–32. Tampere, Finland: Association for Computing Machinery. https://doi.org/10.1145/1139073.1139085

Kaptelinin, V., & Nardi, B. (2012). Affordances in HCI: toward a mediated action perspective. *Proceedings of the 2012 ACM Annual Conference …*, 967–976. Austin, Texas, USA: Association for Computing Machinery. https://doi.org/10.1145/2207676.2208541

Keen, P. G. (1991). Relevance and rigor in information systems research: Improving quality, confidence, cohesion and impact. *Information Systems Research: Contemporary Approaches and Emergent Traditions*, *27*, 49.

Kendall, L. (2015). *Opportunities, constraints and challenges to the introduction of ICT services for sustainable agricultural development in West Bengal, India* (Master Degree Thesis, KTH, School of Computer Science and Communication (CSC)). KTH, School of Computer Science and Communication (CSC), Stockholm, Sweden. Retrieved from http://www.diva-portal.org/smash/record.jsf?pid=diva2%3A825034

Kendall, L., & Dearden, A. (2018a). Disentangling Participatory ICT Design in Socioeconomic Development. *Proceedings of the 15th Participatory Design Conference: Full Papers*, *1*, 1–12. Hasselt and Genk, Belgium: Association for Computing Machinery. https://doi.org/10.1145/3210586.3210596

Kendall, L., & Dearden, A. (2018b). Towards alternate theories of change for M4ARD. In *Digital technologies for agricultural and rural development in the global south* (pp. 92–103). United Kingdom: CABI Publishing. Retrieved from https://doi.org/10.1079/9781786393364.0092

Kendall, L., & Dearden, A. (2020). The politics of co-design in ICT for sustainable development. *CoDesign*, *16*(1), 81–95. https://doi.org/10.1080/15710882.2020.1722176

Kleine, D. (2009). The ideology behind the technology – Chilean microentrepreneurs and public ICT policies. *Geoforum*, *40*(2), 171–183. https://doi.org/10.1016/j.geoforum.2008.02.006

Kleine, D. (2010). ICT4WHAT? - Using the choice framework to operationalise the capability approach to development. *Journal of International Development*, *22*(5), 674–592. https://doi.org/10.1002/jid.1719

Kleine, D. (2013). *Technologies of Choice?: ICTs, Development, and the Capabilities Approach*. London: MIT Press.

Klikauer, T. (2015). What Is Managerialism? *Critical Sociology*, *41*(7–8), 1103–1119. https://doi.org/10.1177/0896920513501351

Lane, J.-E. (2000). *New public management*. London: Routledge.

Le Dantec, C. A., & DiSalvo, C. (2013). Infrastructuring and the formation of publics in participatory design. *Social Studies of Science*, *43*(2), 241–264. https://doi.org/10.1177/0306312712471581

Lin, C. I. C., Kuo, F.-Y., & Myers, M. D. (2015). Extending ICT4D Studies: The Value of Critical Research. *MIS Quarterly*, *39*(3), 697–712. https://doi.org/10.2753/MTP1069-6679160205

Lincoln, Y. S., & Guba, E. G. (1986). But is it rigorous? Trustworthiness and authenticity in naturalistic evaluation. *New Directions for Program Evaluation*, *1986*(30), 73–84. https://doi.org/10.1002/ev.1427

Lokanathan, S., De Silva, H., & Fernando, I. (2011). Price transparency in agricultural produce markets: Sri Lanka. In *Strengthening Rural Livelihoods: The Impact of Information and Communication Technologies in Asia* (pp. 15–32). Rugby, United Kingdom: Practical Action Publishing. Retrieved from http://hdl.handle.net/10625/45947

Lyle, P., Korsgaard, H., & Bødker, S. (2020). What's in an Ecology? A Review of Artifact, Communicative, Device and Information Ecologies. *Proceedings of the 11th Nordic Conference on Human-Computer Interaction: Shaping Experiences, Shaping Society*, 1–14. Association for Computing Machinery. https://doi.org/10.1145/3419249.3420185

Madon, S. (2004). Evaluating the developmental impact of e-governance initiatives: An explanatory framework. *The Electronic Journal on Information Systems in Developing Countries*, *20*(1), 1–13. https://doi.org/10.1002/j.1681-4835.2004.tb00132.x

Mahla, A., Martin, D., Ahuja, I., Niyaz, Q., & Seth, A. (2012). Motivation and design of a content distribution architecture for rural areas. *Proceedings of the 2nd ACM Symposium on Computing for Development*, 1–10. Atlanta, Georgia: Association for Computing Machinery. https://doi.org/10.1145/2160601.2160610

Malhotra, Y. (2002). Information Ecology and Knowledge Management: Toward Knowledge Ecology for Hypertubulent Organizational Environments. In *Encyclopedia of Life Support Systems* (p. 25). Oxford, UK: UNESCO/Eolss Publishers. Retrieved from https://surface.syr.edu/mgt/3

Marais, M. A. (2011). An analysis of the factors affecting the sustainability of ICT4D initiatives. *5th IDIA Conference: ICT for Development: People, Policy and Practice*, 100–120. Lima, Peru. Retrieved from http://www.developmentinformatics.org/conferences/2011/papers/marais.html

Marais, M. A. (2015). ICT4D and Sustainability. In P. H. Ang & R. Mansell (Eds.), *The International Encyclopedia of Digital Communication and Society* (1st ed.). Wiley. https://doi.org/10.1002/9781118767771

Mckay, J., & Marshall, P. (2001). The dual imperatives of action research. *Information Technology & People*, *14*(1), 46–59. https://doi.org/10.1108/09593840110384771

McKernan, J. (2007). *Curriculum and Imagination: Process Theory, Pedagogy and Action Research* (1st ed.). London: Routledge. https://doi.org/10.4324/9780203946930

McLennan, S. J. (2016). Techno-optimism or Information Imperialism: Paradoxes in Online Networking, Social Media and Development. *Information Technology for Development*, *22*(3), 380–399. https://doi.org/10.1080/02681102.2015.1044490

Medhi, I., Patnaik, S., Brunskill, E., Gautama, S. N. N., Thies, W., & Toyama, K. (2011). Designing mobile interfaces for novice and low-literacy users. *ACM Transactions on Computer-Human Interaction*, *18*(1), 1–28. https://doi.org/10.1145/1959022.1959024

Migliorini, P., Bàrberi, P., Bellon, S., Gaifami, T., Gkisakis, V. D., Peeters, A., & Wezel, A. (2020). Controversial topics in agroecology: A European perspective. *International Journal of Agriculture and Natural Resources*, *47*(3), 159–173.

Ministry of Home Affairs. (2010). *Introduction to FCRA, 2010*. Ministry of Home Affairs. Retrieved from Ministry of Home Affairs website: https://fcraonline.nic.in/home/PDF_Doc/fc_faq_07062019.pdf

Ministry of Law and Justice. *THE FOREIGN CONTRIBUTION (REGULATION) AMENDMENT ACT*. , (2020).

Mitchell, G. E. (2018). Modalities of Managerialism: The "Double Bind" of Normative and Instrumental Nonprofit Management Imperatives. *Administration & Society*, *50*(7), 1037–1068. https://doi.org/10.1177/0095399716664832

Monk, A., & Howard, S. (1998). Methods & tools: The rich picture: A tool for reasoning about work context. *Interactions*, *5*(2), 21–30. https://doi.org/10.1145/274430.274434

Morgan, D. L. (2014). Pragmatism as a Paradigm for Social Research. *Qualitative Inquiry*, *20*(8), 1045–1053. https://doi.org/10.1177/1077800413513733

Mpogole, H., Usanga, H., & Tedre, M. (2008). Mobile Phones and Poverty Alleviation: A Survey Study in Rural Tanzania. *Proceedings of The 1st International Conference on M4D Mobile Communication Technology for Development*, 62–72. Karlstad. Retrieved from https://www.diva-portal.org/smash/record.jsf?pid=diva2%3A201367&dswid=6915

Mudliar, P., Donner, J., & Thies, W. (2013). Emergent Practices Around CGNet Swara: A Voice Forum for Citizen Journalism in Rural India. *Information Technologies & International Development*, *9*(2), 65–79.

Muller, M. J., & Kuhn, S. (1993). Participatory design. *Communications of the ACM*, *36*(6), 24–28.

Nakasone, E., Torero, M., & Minten, B. (2014). The Power of Information: The ICT Revolution in Agricultural Development. *Annual Review of Resource Economics*, *6*(1), 533–550. https://doi.org/10.1146/annurev-resource-100913-012714

Nardi, B., & O'Day, V. (1999). Information Ecologies. In *Information Ecologies: Using Technology with Heart* (p.

246). Cambridge, Massachusetts: MIT Press. Retrieved from https://firstmonday.org/ojs/index.php/fm/article/download/672/582?inline=1

Niall Hayes, C. W. (2011). Context and the process of ICT for development. *Information and Organization*.

Nielsen, J. (2012, January 3). Usability 101: Introduction to Usability. Retrieved November 26, 2020, from Nielsen Norman Group website: https://www.nngroup.com/articles/usability-101-introduction-to-usability/

Nirvik12. (2015). বাংলা: সুন্দরবনের মানচিত্র।. Wikimedia Commons. Retrieved from https://commons.wikimedia.org/wiki/File:%E0%A6%B8%E0%A7%81%E0%A6%A8%E0%A7%8D%E0%A6%A6%E0%A6%B0%E0%A6%AC%E0%A6%A8%E0%A7%87%E0%A6%B0_%E0%A6%AE%E0%A6%BE%E0%A6%A8%E0%A6%9A%E0%A6%BF%E0%A6%A4%E0%A7%8D%E0%A6%B0.svg

NordNordWest. (2010). *India West Bengal location map.svg*. Retrieved from https://commons.wikimedia.org/wiki/File:India_West_Bengal_location_map.svg

Nussbaum, M. C. (2001). *Women and Human Development: The Capabilities Approach*. Cambridge University Press.

Olson, J. S., & Kellogg, W. (Eds.). (2014). *Ways of knowing in HCI*. New York: Springer.

Oreglia, E. (2013). When Technology Doesn't Fit: Information Sharing Practices among Farmers in Rural China. *Proceedings of the Sixth International Conference on Information and Communication Technologies and Development: Full Papers*, *1*, 165–176. Cape Town, South Africa: Association for Computing Machinery. https://doi.org/10.1145/2516604.2516610

Orlikowski, W. J. (1999). Technologies-in-practice: An enacted lens for studying technology in organizations. *Working Paper (Sloan School of Management)*, *WP 4056-99*. Retrieved from http://hdl.handle.net/1721.1/2742

Orlikowski, W. J. (2007). Sociomaterial Practices: Exploring Technology at Work. *Organization Studies*, *28*(9), 1435–1448. https://doi.org/10.1177/0170840607081138

Orlikowski, W. J., & Baroudi, J. J. (1991). Studying Information Technology in Organizations: Research Approaches

and Assumptions. *Information Systems Research*, *2*(1), 1–28. https://doi.org/10.1287/isre.2.1.1

Orlikowski, W. J., & Iacono, C. S. (2000). The truth is not out there: An enacted view of the digital economy. In E. Brynjolfsson & B. Kahin (Eds.), *Understanding the digital economy: Data, tools, and research* (pp. 352–380). Cambridge, Massachusetts: MIT Press.

Orlikowski, W. J., & Yates, J. (1994). Genre repertoire: Examining the structuring of communications practices in organizations. *Administrative Science Quarterly*, *39*(4), 541–574. https://doi.org/10.2307/2393771

Ospina, A. V., & Heeks, R. (2010). *Linking ICTs and Climate Change Adaptation: A conceptual Framework for e-Resilience and e-Adaptation* (p. 41). IDRC. Retrieved from IDRC website: http://hdl.handle.net/10625/44416

Pahl-Wostl, C. (2006). The Importance of Social Learning in Restoring the Multifunctionality of Rivers and Floodplains. *Ecology and Society*, *11*(1), 10.

Pahl-Wostl, C., Craps, M., Dewulf, A., Mostert, E., Tabara, D., & Taillieu, T. (2007). Social learning and water resources management. *Ecology and Society*, *12*(2), 5.

Pahl-Wostl, C., Mostert, E., & Tàbara, D. (2008). The growing importance of social learning in water resources management and sustainability science. *Ecology and Society*, *13*(1), 24.

Parayil, G. (1992). The Green Revolution in India: A Case Study of Technological Change. *Technology and Culture*, *33*(4), 737–756. https://doi.org/10.2307/3106588

Patel, N., Agarwal, S., Rajput, N., Nanavati, A., Dave, P., & Parikh, T. S. (2009). A Comparative Study of Speech and Dialed Input Voice Interfaces in Rural India. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 51–54. Boston, MA, USA: Association for Computing Machinery. https://doi.org/10.1145/1518701.1518709

Patel, N., Chittamuru, D., Jain, A., Dave, P., & Parikh, T. S. (2010). Avaaj Otalo: A field study of an interactive voice forum for small farmers in rural India. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 733–742. Atlanta, Georgia, USA: Association for Computing Machinery.

https://doi.org/10.1145/1753326.1753434

Patel, N., Shah, K., Savani, K., Klemmer, S. R., Dave, P., & Parikh, T. S. (2012). Power to the peers: Authority of source effects for a voice-based agricultural information service in rural India. *Proceedings of the Fifth International Conference on Information and Communication Technologies and Development*, *9*(2), 169–178. Atlanta, Georgia, USA: Association for Computing Machinery. https://doi.org/10.1145/2160673.2160696

Pelenc, J., Bazile, D., & Ceruti, C. (2015). Collective capability and collective agency for sustainability: A case study. *Ecological Economics*, *118*, 226–239. https://doi.org/10.1016/j.ecolecon.2015.07.001

Pingali, P. L. (2012). Green Revolution: Impacts, limits, and the path ahead. *Proceedings of the National Academy of Sciences*, *109*(31), 12302–12308. https://doi.org/10.1073/pnas.0912953109

Potter, R. B., Binns, T., Elliott, J. B., & Smith, D. (2004). *Geographies of development* (Second Edition). Harlow, England: Pearson Education.

Prakash, S., & Velu, C. (2010). Reuters Market Light: Business Model Innovation for Growth. *Effective Executive*. Retrieved from https://www.jbs.cam.ac.uk/wp-content/uploads/2020/08/prakash-reuters.pdf

Pretty, J. N. (1995). Participatory learning for sustainable agriculture. *World Development*, *23*(8), 1247–1263. https://doi.org/10.1016/0305-750X(95)00046-F

Pretty, J. N. (2008). Agricultural sustainability: Concepts, principles and evidence. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *363*(1491), 447–465. https://doi.org/10.1098/rstb.2007.2163

Pretty, J. N., Noble, A. D., Bossio, D., Dixon, J., Hine, R. E., De Vries, F. W. T. P., & Morison, J. I. L. (2006). Resource-conserving agriculture increases yields in developing countries. *Environmental Science and Technology*, *40*(4), 1114–1119. https://doi.org/10.1021/es051670d

Pretty, J. N., & Ward, H. (2001). Social capital and the environment. *World Development*, *29*(2), 209–227. https://doi.org/10.1016/S0305-750X(00)00098-X

Principles for Digital Development. (n.d.). Understand the Existing Ecosystem. Retrieved October 27, 2020, from

https://digitalprinciples.org/principle/understand-the-existing-ecosystem/

PTI. (2019, April 23). IMD to issue block-level weather forecast from next year. *The Hindu BusinessLine*. Retrieved from https://www.thehindubusinessline.com/economy/agri-business/imd-to-issue-block-level-weather-forecast-from-next-year/article26919180.ece

Puri, S. K., Byrne, E., Nhampossa, J. L., & Quraishi, Z. B. (2004). Contextuality of participation in IS design: A developing country perspective. *Proceedings of the Eighth Conference on Participatory Design: Artful Integration: Interweaving Media, Materials and Practices*, *1*, 42–52. Toronto, Ontario, Canada: Association for Computing Machinery. https://doi.org/10.1145/1011870.1011876

Qiang, C. Z., Kuek, S. C., Dymond, A., & Esselaar, S. (2012). Mobile Applications for Agriculture and Rural Development. In *World Bank*. Washington, DC: World Bank. Retrieved from World Bank website: http://hdl.handle.net/10986/21892

Qureshi, S. (2005). How does information technology effect development? Integrating theory and practice into a process model. *AMCIS 2005 Proceedings*, *261*, 500–509. Retrieved from http://aisel.aisnet.org/amcis2005/261/

Qureshi, S. (2015). Are we making a Better World with Information and Communication Technology for Development (ICT4D) Research? Findings from the Field and Theory Building. *Information Technology for Development*, *21*(4), 511–522. https://doi.org/10.1080/02681102.2015.1080428

Raghavan, B., Nardi, B., Lovell, S. T., Norton, J., Tomlinson, B., & Patterson, D. J. (2016). Computational Agroecology: Sustainable Food Ecosystem Design. *Proceedings of the 2016 CHI Conference Extended Abstracts on Human Factors in Computing Systems*, 423–435. New York, New York, USA: ACM Press. https://doi.org/10.1145/2851581.2892577

Ramos, R. R., & Hayes, N. (2015). The formalising regime and its formalising technology: The case of informal trade in Recife, Brazil. *Proceedings of the 13th International Conference on Social Implications of Computers in Developing Countries (IFIP 9.4)*, 643–653. Negombo, Sri Lanka: Department of Informatics, University of

Olso. Retrieved from https://eprints.lancs.ac.uk/id/eprint/76683

Raworth, K. (2017). *Doughnut Economics: Seven Ways to Think Like a 21st-Century Economist*. Vermont, United States: Chelsea Green Publishing.

Ray, D. K., Ramankutty, N., Mueller, N. D., West, P. C., & Foley, J. A. (2012). Recent patterns of crop yield growth and stagnation. *Nature Communications*, *3*(1293). https://doi.org/10.1038/ncomms2296

Redclift, M. R. (2005). Sustainable development (1987–2005): An oxymoron comes of age. *Sustainable Development*, *13*(4), 65–84. https://doi.org/10.1002/sd.281

Rizvi, H. (2011). LifeLines: Livelihood solutions through mobile technology in India. In *Strengthening Rural Livelihoods: The Impact of Information and Communication Technologies in Asia* (pp. 53–70). Rugby, United Kingdom: Practical Action Publishing. Retrieved from http://hdl.handle.net/10625/45947

Roberts, S. M., Jones, J. P., & Fröhling, O. (2005). NGOs and the globalization of managerialism: A research framework. *World Development*, *33*(11), 1845–1864. https://doi.org/10.1016/j.worlddev.2005.07.004

Robeyns, I. (2005). The Capability Approach: A theoretical survey. *Journal of Human Development*, *6*(1), 93–117. https://doi.org/10.1080/146498805200034266

Robeyns, I. (2006). The Capability Approach in Practice. *Journal of Political Philosophy*, *14*(3), 351–376. https://doi.org/10.1111/j.1467-9760.2006.00263.x

Rockstrom, J., Steffen, W., Noone, K., Persson, A., Chapin, F. S. I., Lambin, E., … Foley, J. (2009). Planetary Boundaries: Exploring the Safe Operating Space for Humanity. *Ecology And Society*, *14*(2), 32.

Röling, N. G., & Jiggins, J. (1998). The ecological knowledge system. In *Facilitating sustainable agriculture: Participatory learning and adaptive management in times of environmental uncertainty* (pp. 281–311). Cambridge: Cambridge University Press.

Ryan, G. W., & Bernard, H. R. (2003). Techniques to Identify Themes. *Field Methods*, *15*(1), 85–109. https://doi.org/10.1177/1525822X02239569

Sajesh, V. K., & Suresh, A. (2016). Public-Sector Agricultural Extension in India: A Note. *Review of Agrarian Studies*,

6(1). Retrieved from http://ras.org.in/public_sector_agricultural_extension_in_india

Sambasivan, N., & Smyth, T. (2010). The Human Infrastructure of ICTD. *Proceedings of the 4th ACM/IEEE International Conference on Information and Communication Technologies and Development*. Presented at the ICTD '10, London, United Kingdom. https://doi.org/10.1145/2369220.2369258

Sampath, G. (2016, December 27). Time to repeal the FCRA. *The Hindu*. Retrieved from https://www.thehindu.com/opinion/lead/Time-to-repeal-the-FCRA/article16946222.ece

Saravanan, R., & Bhattacharjee, S. (2014). Mobile Phone Applications for Agricultural Extension in India. In *Mobile Phones for Agricultural Extension: Worldwide mAgri Innovations and Promise for Future* (pp. 1–75). New Delhi: New India Publishing Agency.

Schech, S. (2002). Wired for change: The links between ICTs and development discourses. *Journal of International Development*, *14*(1), 13–23. https://doi.org/10.1002/jid.870

Schutter, O. D. (2010). *Report submitted by the Special Rapporteur on the right to food* (No. Agenda Item 3: Promotion and Protection of All Human Rights, Civil, Political, Economic, Social and Cultural Rights, Including the Right to Develop). New York: United Nations General Assembly.

Schutter, O. D., & Vanloqueren, G. (2011). The New Green Revolution: How Twenty-First-Century Science Can Feed the World. *The Solutions Journal*, *2*(4), 33–44.

Sein, M. K. (2005). Paradigms of ICT in development. *Proceeedings of the Eight International Working Conference of IFIP WG 9.4*, 148. Abuja, Nigeria.

Sein, M. K., Henfridsson, O., Purao, S., Rossi, M., & Lindgren, R. (2011). Action Design Research. *MIS Quarterly*, *35*(1), 37–56. https://doi.org/10.2307/23043488

Sein, M. K., Thapa, D., Hatakka, M., & Sæbø, Ø. (2019). A holistic perspective on the theoretical foundations for ICT4D research. *Information Technology for Development*, *25*(1), 7–25. https://doi.org/10.1080/02681102.2018.1503589

Sen, A. (1983). *Poverty and famines: An essay on entitlement and deprivation*. Oxford: Oxford University Press.

Sen, A. (2001). *Development as freedom*. Oxford University Press.

Sheffield Hallam University. (n.d.-a). PHD Computing and Informatics Full-time 2021. Retrieved December 13, 2020, from https://www.shu.ac.uk/courses/computing/phd-computing-and-informatics/full-time/2021

Sheffield Hallam University. (n.d.-b). PHD Computing and Informatics Part-time 2021. Retrieved December 13, 2020, from https://www.shu.ac.uk/courses/computing/phd-computing-and-informatics/part-time

Singh, R. B. (2000). Environmental consequences of agricultural development: A case study from the green revolution state of Haryana, India. *Agriculture, Ecosystems and Environment*, *82*(1–3), 97–103. https://doi.org/10.1016/S0167-8809(00)00219-X

Singh, V. (2020, September 13). The Hindu Explains | What is Foreign Contribution (Regulation) Act, and how does it control donations? *The Hindu*. Retrieved from https://www.thehindu.com/news/national/the-hindu-explains-what-is-foreign-contribution-regulation-act-and-how-does-it-control-donations/article32590504.ece

Slater, D. (2013). *New Media, Development & Globalization*. Cambridge: Polity.

Slater, J., & Masih, N. (2020, March 28). India coronavirus: Migrant workers stranded by lockdown walk hundreds of miles home. *The Washington Post*. Retrieved from https://www.washingtonpost.com/world/asia_pacific/india-coronavirus-lockdown-migrant-workers/2020/03/27/a62df166-6f7d-11ea-a156-0048b62cdb51_story.html

Smith, J. B., Klein, R. J. T., & Huq, S. (Eds.). (2003). *Climate Change, Adaptive Capacity and Development*. London: Imperial College Press.

Smith, M. L. (2006). Overcoming theory-practice inconsistencies: Critical realism and information systems research. *Information and Organization*, *16*(3), 191–211. https://doi.org/10.1016/j.infoandorg.2005.10.003

Spinuzzi, C. (2005). The Methodology of Participatory Design. *Technical Communication*, *52*(2), 163–174.

Srinivasan, J., & Burrell, J. (2015). On the Importance of Price Information to Fishers and to Economists: Revisiting Mobile Phone Use Among Fishers in Kerala. *Information Technologies & International Development*, *11*(1),

57–70.

Sterling, S. R., & Rangaswamy, N. (2010). Constructing Informed Consent in ICT4D Research. *Proceedings of the 4th ACM/IEEE International Conference on Information and Communication Technologies and Development*, 46. London, United Kingdom: Association for Computing Machinery. https://doi.org/10.1145/2369220.2369264

Strengthening Information Society Research Capacity Alliance. (2018). About SIRCA III. Retrieved December 13, 2020, from http://arulchib.com/sirca/programs/about-sirca-iii/index.html

Suchman, L., Trigg, R., & Blomberg, J. (2002). Working artefacts: Ethnomethods of the prototype. *The British Journal of Sociology*, *53*(2), 163–179. https://doi.org/10.1080/00071310220133287

Tacchi, J. (2015). Ethnographic Action Research: Media, information and communicative ecologies for development initiatives. In *The SAGE Handbook of Action Research* (Third Edition, pp. 220–229). London: SAGE Publications Ltd.

Tacchi, J., Slater, D., & Hearn, G. (2003). Ethnographic Action Research. In *UNESCO*. New Delhi: UNESCO. Retrieved from http://books.google.com/books?hl=en&lr=&id=Eo2HMtTjz0gC&oi=fnd&pg=PA300&dq=Ethnographic+Action+Research&ots=rdM6JghtgO&sig=pHDKr74VYMG4u95kplN26Xb4qgY

Thakur, D., Chander, M., & Sinha, S. (2017). Whatsapp for farmers: Enhancing the scope and coverage of traditional agricultural extension. *International Journal of Science Environment and Technology*, *6*(4), 2190–2201.

Thapa, D., & Hatakka, M. (2017). Understanding ICT in ICT4D: An Affordance Perspective. *Proceedings of the 50th Hawaii International Conference on System Sciences (2017)*, 2618–2626. Hawaii. https://doi.org/10.24251/hicss.2017.316

Thapa, D., & Sæbø, Ø. (2014). Exploring the Link between ICT and Development in the Context of Developing Countries: A Literature Review. *The Electronic Journal of Information Systems in Developing Countries*, *64*(1), 1–15. https://doi.org/10.1002/j.1681-4835.2014.tb00454.x

Thapa, D., Sein, M. K., & Sæbø, Ø. (2012). Building collective capabilities through ICT in a mountain region of Nepal: Where social capital leads to collective action. *Information Technology for Development*, *18*(1), 5–22. https://doi.org/10.1080/02681102.2011.643205

The Lancet Global Health. (2018). Closing the door on parachutes and parasites. *The Lancet Global Health*, *6*(6), e593. https://doi.org/10.1016/s2214-109x(18)30239-0

Thies, I. M. (2015). *User Interface Design for Low-literate and Novice Users: Past, Present and Future* (Vol. 8). Foundations and Trends® in Human–Computer Interaction. Retrieved from https://doi.org/10.1561/1100000047

Toyama, K. (2011). Technology as Amplifier in International Development. *Proceedings of the 2011 IConference*, 75–82. Seattle, Washington, USA. https://doi.org/10.1145/1940761.1940772

UN Adaptation Fund. (2015). Enhancing Adaptive Capacity and Increasing Resilience of Small and Marginal Farmers in Purulia and Bankura Districts of West Bengal—Adaptation Fund. Retrieved November 30, 2017, from https://www.adaptation-fund.org/project/enhancing-adaptive-capacity-and-increasing-resilience-of-small-and-marginal-farmers-in-purulia-and-bankura-districts-of-west-bengal/

UNDP. (1990). *Human Development Report 1990: Concept and Measurement of Human Development*. New York. Retrieved from http://www.hdr.undp.org/en/reports/global/hdr1990."

United Nations. (2015). *Global Sustainable Development Report*. United Nations Department of Economic and Social Affairs. Retrieved from United Nations Department of Economic and Social Affairs website: https://www.un.org/en/development/desa/publications/global-sustainable-development-report-2015-edition.html

United Nations Framework Convention on Climate Change. (2021). Adaptation Fund | UNFCCC. Retrieved December 13, 2020, from https://unfccc.int/Adaptation-Fund

Valkokari, K. (2015). Business, innovation, and knowledge ecosystems: How they differ and how to survive and thrive within them. *Technology Innovation Management Review*, *5*(8), 17–24.

https://doi.org/10.22215/timreview/919

Van Der Velden, M. (2002). Knowledge facts, knowledge fiction: The role of ICTs in knowledge management for development. *Journal of International Development*, *14*(1), 25–37. https://doi.org/10.1002/jid.862

Vashistha, A., Cutrell, E., Borriello, G., & Thies, W. (2015). Sangeet Swara: A Community-Moderated Voice Forum in Rural India. *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems*, 417–426. Seoul: Association for Computing Machinery. https://doi.org/10.1145/2702123.2702191

Veeraraghavan, R., Yasodhar, N., & Toyama, K. (2009). Warana Unwired: Replacing PCs with mobile phones in a rural sugarcane cooperative. *2007 International Conference on Information and Communication Technologies and Development*, *5*, 81–95. Bangalore, India: IEEE. https://doi.org/10.1109/ICTD.2007.4937395

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User Acceptance of Information Technology: Toward a Unified View. *MIS Quarterly*, *27*(3), 425–478. https://doi.org/10.2307/30036540

Volkoff, O., & Strong, D. M. (2017). Affordance theory and how to use it in IS research. In R. D. Galliers & M.-K. Stein (Eds.), *The Routledge Companion to Management Information Systems* (1st ed., pp. 232–245). Abingdon, Oxon ; New York, NY : Routledge, 2017.: Routledge. https://doi.org/10.4324/9781315619361-18

Walsham, G. (2013). Development Informatics in a Changing World: Reflections from ICTD2010 / 2012. *Information Technologies & International Development*, *9*(1), 49–54.

Walsham, G. (2017). ICT4D research: Reflections on history and future agenda. *Information Technology for Development*, *23*(1), 18–41. https://doi.org/10.1080/02681102.2016.1246406

Walsham, G., & Sahay, S. (2006). Research on information systems in developing countries: Current landscape and future prospects. *Information Technology for Development*, *12*(1), 7–24. https://doi.org/10.1002/itdj.20020

Warner, K. D. (2008). Agroecology as Participatory Science: Emerging Alternatives to Technology Transfer

Extension Practice. *Science, Technology & Human Values*, *33*(6), 754–777. https://doi.org/10.1177/0162243907309851

Wenger, E. (1998). *Communities of practice: Learning, meaning, and identity*. Cambridge: Cambridge University Press.

Wenger, E., McDermott, R., & Snyder, W. M. (2002). *Cultivating Communities of Practice: A Guide to Managing Knowledge*. Harvard, Boston: Harvard Business Review Press.

Wenger, E., White, N., & Smith, J. D. (2009). *Digital Habitats; Stewarding Technology for Communities*. Portland, Oregon, USA: CPsquare.

Wenger, E., White, N., Smith, J. D., & Rowe, K. (2005). Technology for Communities. In L. Langelier (Ed.), *Working, Learning and Collaborating in a Network: Guide to the Implementation and Leadership of Intentional Communities of Practice* (pp. 71–94). Quebec City: CEFIRO.

World Bank. (2017). *ICT in Agriculture (Updated Edition): Connecting Smallholders to Knowledge, Networks, and Institutions*. Washington, DC: World Bank. Retrieved from World Bank website: http://hdl.handle.net/10986/27526

World Commission on Environment and Development. (1987). *Our Common Future*. New York: Oxford University Press. Retrieved from https://archive.org/details/ourcommonfuture00worl/

Wyche, S., & Steinfield, C. (2016). Why Don't Farmers Use Cell Phones to Access Market Prices? Technology Affordances and Barriers to Market Information Services Adoption in Rural Kenya. *Information Technology for Development*, *22*(2), 320–333. https://doi.org/10.1080/02681102.2015.1048184

Zapico, J. L. (2013). *Hacking for Sustainability* (Doctoral thesis, monograph, KTH Royal Institute of Technology). KTH Royal Institute of Technology, Stockholm. Retrieved from http://kth.diva-portal.org/smash/record.jsf?pid=diva2%3A678371

Zewge, A. (2018). *Community-based Participatory Design of Technological Alternative for a Development Context: (The Case Study of ICT appropriation for Ethiopian Rural Communities)* (IT-Universitetet i København). IT-

Universitetet i København, ITU-DS, no. 150. Retrieved from https://pure.itu.dk/portal/en/publications/communitybased-participatory-design-of-technological-alternative-for-a-development-context-the-case-study-of-ict-appropriation-for-ethiopian-rural-communities(1323a419-1770-4a32-a078-586f0337c245).html

Zheng, Y. (2007). Exploring the Value of the Capability Approach for e-Development. *Proceedings of the 9th International Conference on Social Implications of Computers in Developing Countries*, 14. São Paulo, Brazil.

Zheng, Y. (2009). Different spaces for e-development: What can we learn from the capability approach? *Information Technology for Development*, *15*(2), 66–82. https://doi.org/10.1002/itdj.20115

Zheng, Y., Hatakka, M., Sahay, S., & Andersson, A. (2018). Conceptualizing development in information and communication technology for development (ICT4D). *Information Technology for Development*, *24*(1), 1–14. https://doi.org/10.1080/02681102.2017.1396020

Zheng, Y., & Walsham, G. (2008). Inequality of what? Social exclusion in the e-society as capability deprivation. *Information Technology & People*, *21*(3), 222–243. https://doi.org/10.1108/09593840810896000

Zimmerman, J., Forlizzi, J., & Evenson, S. (2007). Research through Design as a Method for Interaction Design Research in HCI. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 493–502. San Jose, California, USA: Association for Computing Machinery. https://doi.org/10.1145/1240624.1240704

फ़िलप्रो. (2016). हिन्दी: भारत में पश्चिम बंगाल का स्थान।. Wikimedia Commons. Retrieved from https://commons.wikimedia.org/w/index.php?curid=50825723