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ICTs for Agroecology

Shifting agricultural ICT4D from "I" to "C"

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Abstract. The urgent need for inclusive and sustainable agriculture has seen transition towards holistic, situated and participatory approaches to agricultural development such as agroecology. In this paper we use observations drawn from an action research project to examine the implications of such approaches on ICT design and implementation strategy. We suggest that ICTs designed for sustainable agriculture need to shift their emphasis from packaging and transmitting information toward facilitating communication and sharing of practice, adopting diverse collective, social and situated forms of knowing and learning.

Keywords: ICT4D · Agroecology · Social learning · Sustainable agriculture · Knowledge Management · ICT for sustainability

Responding to the fact that a large number of the world's poor reside in rural areas and draw their livelihoods from agricultural activities there has been a wide variety of ICT interventions designed and implemented to support rural and agricultural development. These interventions have provided information services, advisory, education and training through various modalities such as text message (SMS), interactive voice response (IVR), smartphone applications and video.

Agricultural "ICTs for development" (ICT4D) regularly take as their starting point the challenges of extension services to adequately reach out to and support farmers. As Patel et. al. [1] 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*". In their paper on Digital Green, Gandhi et al. [2] begins 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*" and suggests participatory video as one way of supporting extension officers. In a recent review, Aker et al. [3] suggests ICTs as a way to "*increase the scale and sustainability of extension services*" while also enabling greater accountability.

This starting point is one which addresses logistical and practical challenges of government extension programmes. However, increasing concerns for sustainable agricultural development have called extension programmes themselves into question. In response to this, we set out in this paper to elaborate some of the implications of sustainable agricultural approaches for technology strategy within ICT4D.

1 What is "sustainable agricultural development"?

The second half of the 20th century saw great increases in agricultural productivity through, most prominently, the Green Revolution (GR). The GR programme focused on crop genetic improvement–development of high yielding varieties (HYV)–as well as ensuring the availability to farmers of modern inputs such as 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 [4]. 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 [5].

Despite its success in intensifying agriculture, the outcomes of the GR programme have increasingly been critiqued from the perspective of sustainability. There is evidence that the improvements in crop yields–especially for wheat and rice–have stagnated and in some cases collapsed [6]. Furthermore, the adoption and intensive usage of inputs such as pesticides and fertilisers have caused negative ecological impacts, degrading both soil and water resources [4]. 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 increases in fresh-water scarcity and soil salinity [7].

Evidence suggests that the "modernisation of agriculture" achieved through GR and post-GR agricultural development have not benefitted the most marginal farmers and in many cases been directly harmful to their food security and livelihoods [8, 9]. In part this is because GR practices and HYVs were never designed to be used in marginal agricultural areas, but were still promoted and spread widely through government subsidies, extension programmes and commercial interests [4].

A response to these challenges are approaches such as natural resource management (NRM) and agroecology [10]. Agroecology emphasise sustainable use of natural resources through locally situated agricultural practices developed in participatory ways with farmers [9]. 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" [10]. Evidence for this can be found in a survey of 286 projects in 57 countries [11] 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 [9, 12]. Röling & Jiggins [13] suggests that sustainable agricultural development requires transition to a new "ecological knowledge system" built upon participatory, social and action based learning.

2 How can ICTs support sustainable agriculture?

As was highlighted in the introduction of this paper, ICT4D interventions in agricultural development often take as their starting point the current practice of extension

and how to bridge the gaps caused by insufficient capacity to reach farmers. Many, if not most, of these interventions have been concerned with information and knowledge dissemination, training or education in one form or another. If sustainable agriculture requires a shift in the way extension and, more broadly, the agricultural knowledge system is organised, it follows that changes to strategies for ICT design and implementation will also be needed.

One way to view this change can be drawn from the field of knowledge management (KM) where there has been a longstanding debate of how to incorporate social and situated theories of learning [14, 15]. ICT designs, it is argued, need to transition away from a view of knowledge as an object which can be packaged, stored and transferred [16]. The alternative is a "knower-centered" approach, building on 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 [17]. Oreglia [18] highlights that when viewing farmers as a community of practice [15], it is clear that approaches which privileges disconnected information-sharing are inappropriate. In contrast, "knower-centered" view of agricultural knowledge is one which recognises that it is embedded in and transferred through participation in shared community practice.

In other words, while access to information may allow for learning *about* sustainable agriculture, in order to learn how *to be* a sustainable farmer more than information is required [19]. Consequently, overcoming obstacles to information access is a necessary but not sufficient condition for improved performance. To acquire "know how", participation in a community of practice is needed. We suggest this argument separates access to *information* from opportunity to *communicate*, the latter a concept encompassing not only access to necessary media but importantly also social relationships, shared language and iterative dialogue. This aligns with calls for an "ecological knowledge system" [13], suggesting an alternate approach to ICTs for agroecology.

In order to better explore these approaches and what they might mean in practice for the development of ICT4D interventions, we are working together with an NGO in an action research project. The NGO, Development Research Communication and Services Centre (DRCSC), is based in West Bengal in Eastern India and has worked for several decades supporting small-scale and marginal farmers in adopting agricultural practices which are "environment friendly, economically appropriate, socially just and developed by mutual cooperation" [20].

3 Methodology

The methodology we have adopted is action research [21]. Action research (AR) involves a specific set of epistemological, ontological and methodological choices which we perceive as being well aligned with working in the intersection of development, sustainability and technology [12, 21, 22]. As an AR programme, the project is organised around cycles of reflection, planning, action and observation, where action is intended to involve interventions into the knowledge system of the organisation and its stakeholders. In this paper, we report on the initial cycles of this work. For these we have decided to draw on Ethnographic Action Research (EAR) [23] a form of

Participatory Action Research (PAR) that combines PAR with ethnography. Accordingly, our initial focus has been supporting the establishment of a technology research culture, along with conducting ongoing ethnographic inquiry into work practices, values and challenges facing the organisation.

AR in general, and PAR approaches such as EAR in particular, demand engagement *with* those affected by research, adopting methods aimed at enabling participation. This project aims for active participation of the organisation in the planning and execution of the research program, achieved primarily through the engagement of an action learning set consisting of staff from the organisation. The action learning set was formed at the start of the project and meets regularly to discuss the progress and findings of the project, set goals and plan future activities.

The initial cycle was conducted between March and August of 2016 and consisted of an in-depth ethnographic study of the current knowledge system and work context of the organisation. Ten weeks were spent with the head office staff in Kolkata and six weeks spread between two field offices. A pragmatic, multi-method approach was taken involving participant observation, semi-structured and informal interviewing, and small workshops. Data was collected in the form of field journals kept by the researcher as well as photographs and audio-recordings of interviews. Interviews were later transcribed and translated. In-depth interviews lasting a minimum of an hour were conducted with eight staff members who hold roles of varying seniority in the head office as well as six staff members in the field offices. In addition to these longer interviews, shorter, informal interviews were held with both farmers as well as other staff from field and head offices. The collected data was analysed thematically using themes sourced from prior theory, literature and from the data itself.

Acknowledging that the training as well as, importantly, the time and funding to lead such work was primarily available to the researcher (first author), this work was mainly conducted by the researcher on behalf of the action learning set. The analytic approach taken placed ongoing findings and observations in the context of the work and mission of the organisation and involved continuous reporting back to, reflection upon and discussion of data and analytical notes with the action learning set. Ongoing engagement with the organisation in planning, conducting and analysing the research meant that it was not possible for the researcher to operate purely as a detached observer. Rather, we recognise a dual role for the researcher as observer and participant. In the role as an observer or "friendly outsider" [24], the researcher provides an external perspective of the organisation and its work context, facilitating discussions and analysis. Long-term embedding in the organisation enables this role through relationships, background knowledge and trust, but also results in a second role as an active participant in the research context. In order to retain the ability to provide an external perspective on the data under these conditions, we have employed external advisors as well as a process of continuously relating findings back to the broader literature.

This dual role requires an approach to research ethics adapted for interventionist research to ensure that trust and along with it informed consent is maintained between different actors in the research project. In this respect, we adopted an ongoing, mediated process of consent, risk and benefits analysis [25]. This process involved repeat-

ed explanations of and negotiations about research in general and the research project itself. This was combined with continuous inquiry into perceived risks and benefits.

4 Findings

From the initial research phase, several aspects and challenges of the work and context of the organisation that might impact technology strategy were identified. Below we review these through the lens of their relationship to the organisation's value of and commitment to sustainability.

4.1 Content for sustainability

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 practices. Greater integration with agricultural supply chains have meant 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 [4]. Reduced crop variety and dependence on market forms a challenge to sustainability and resilience of these agricultural communities especially as they experience greater climactic variability as a result of climate change. It is not only through the preference for newly available products that food habits impact the sustainability of farms in the area. The staple of 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 along with a package of practice including irrigation, pesticides and fertilisers have been introduced 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 choose the HYV rice crop.

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 sociocultural preferences. The organisation found these types of intertwining socioagricultural concerns difficult to document and represent; speaking about the case studies they create from their programmes and for funders a staff member, A., shared:

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 a ecological diversity also. [For example: Previously] there was not so much diversity but now there is a 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."

The inappropriateness of reductionist approaches suggested by the examples above was made explicit by T., one of the most senior trainers in the organisation. In discussing an attempt at providing advice over an IVR system, where most of the questions had been about pest problems, he highlights the incompatibility of the implicit reductionism in the questions asked with sustainable approaches to agriculture:

T: "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 far[….] 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."

4.2 Work practices for sustainability

One of the observations made of the field workers of the organisation was that their work was entirely dependent upon their social and community relationships. They lived in or near their work areas and 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.

As one of the field worker's 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. In describing their attempts at engaging new groups of farmers, one of the trainers related that it was not so much about teaching new technical practices as about building relationships and trusts.

In another instance, it was 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. When questioned about this D., the trainer, responded: "*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 knowledge. The researcher 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.

Another example relates to the way field workers interact with each other. In looking at the technological tools they use, several instances of using WhatsApp were observed. Their uses of WhatsApp often moved beyond the basic functionality of keeping in touch with each other. Taking a few examples, one involved sharing images of documents and hardcopy materials between geographically dispersed staff. Another connecting with others within and outside of the organisation working on similar projects or programmes in order to share experiences, pictures and materials. A third involved using it for financial reporting by "scanning" bills and receipts and sharing them with the project manager. In a fourth case, they used it for scheduling events and meetings such as trainings. Several of these uses may appear inefficient. Taking a print-out of 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.

4.3 Management for sustainability

Early on, a team leader, C., suggested that the main sustainability challenge for the organisation was how to manage projects more efficiently & effectively and that a system should be designed to help them: "*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: "*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 explained: "*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 any changes toward sustainable agricultural practices took many years to establish and involved continuous engagement. The type of transition they were advocating for therefore fit poorly with the 3-5 year timeframes 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."

This greater emphasis on projects, oriented towards specific targets was described as being implicated in multiple changes within the organisation. One of the founders of the organisation highlighted that it had re-oriented their recruitment towards people from educational backgrounds such as social work, who intended to do a career in the development field. Another senior staff member shared how he and others of the 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. Taking on new staff members as a result of external projects furthermore 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."

As these quotes illustrate, contributing to greater project management efficacy would not adequately address sustainable development. As such alternatives to a project management system were sought. A staff member, R., suggested that what was really needed was a system that enabled greater sharing 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:

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..."

5 Discussion: Towards collective learning

As has been argued in the introduction to this paper, sustainable agroecological development and management of natural resources requires forms of learning which are social and collective in nature. Integral to these is the combination of multiple perspectives and engagement with multiple knowledges [26, 27].

In order to unpack these in our case we will adopt the five cultures or paradigms of knowledge, inquiry and content defined by Brown [27], namely: individual lived experience; local shared experience of people and places; specialised disciplinary knowledge; organisational and managerial knowledge and holistic understandings of value generated through aesthetic practices. Brown highlights how the prevailing power-hierarchy between these knowledge types can undermine our collective learning towards sustainable living. As in the case described by her, the organisation we

studied have seen an increasing weight given to the "organisational knowledge culture", and technical/specialised knowledge forms. The strengthening of this culture has resulted in the decline of practices sourced from and embedded in other knowledge cultures, such as film screenings or extended individual experiences of field sites. This is most clearly seen in the head office, whereas in the field offices "community" and relational communication practices are still dominant. We can see this evidenced by the field officers work being a primarily "social activity" based in dialogue and shared experiences between themselves and the farmers they work with. This difference in dominant knowledge paradigms and interests between head and field offices can be identified as one source of conflict and communication gaps.

As described by multiple members of the organisation, the organisational knowledge culture is one which has accompanied a transition towards external funders along with a change in the type of staff members recruited. As is evidenced through the interviews reported above, this knowledge culture has evolved in response to both external pressures as well as internal enactment of what has been termed an increasingly prevalent "formalising, development work regime" [28, 29].

The dominance of this knowledge culture is detrimental to practicing sustainability, as is shown through both the ethnographic work described in this paper as well as through Brown's work [27]. While the language of the organisational knowledge culture needs to be one voice in a collective learning process, its reductionist approach and emphasis on accounting as a lens for understanding is insufficient to support the way sustainability is turned into practice by the organisation and their farmers.

Choices of technology for knowledge management can easily serve to strengthen the dominance of the organisational and specialist knowledge cultures, as exemplified by the impact assessment tools and spreadsheets described by Ramos & Hayes and Hayes & Westrup [28, 29]. The adoption of spreadsheets to monitor NGO work supports the creation of new definitions of what "really happens" and orients the working practices of NGOs towards "calculative practice" [29].

Likewise, agricultural information systems can orient both farmers and NGO workers towards certain paradigms of agricultural development, such as those amenable to "off the shelf" solutions delivered through questions & answers. As T. highlights above, this model is built on the modernist premise and the "specialist knowledge paradigm". In this paradigm the problem solving approach is to apply an increasingly specific solution to problems as they emerge. It is a model for knowledge management easily supported by ICT interventions and therefore readily adopted. However, we argue that in order to better support sustainable agricultural development, ICT strategies for sustainable agriculture need to move towards strengthening the voices of other knowledge cultures.

Another way in which agricultural advice systems strengthen organisational and specialist knowledge cultures concerns individual vs collective approaches to agricultural decision making. Designing information systems where advice is provided in interactions by individual farmers through SMS or IVR strengthens a shift away from the collective, social spaces that field workers of the organisation emphasise as critical, towards farmers as individuals and individual managers of their farms. As one ICTD evaluation states: "*Farmers offered the service turn less often to other farmers*

and input sellers for agricultural advice" [30]. While this was perceived as a benefit of the ICT intervention, when seen through the lens of collaborative learning, we might take a different stance. Reduced reliance on local, social relationships is potentially detrimental to the resilience and long-term sustainability of the farming system. As Oreglia [18] recognises, ICTs designed around individual farmer use and decision making fit poorly in the context of community learning patterns among Chinese farmers. We suggest that this also applies to the context of sustainable agricultural development detailed here.

Our empirical findings reveal practices and concerns that move well beyond "information provision" suggesting need for a technology strategy built upon community relations and multiple forms of inquiry and knowledge. Returning to the difference between access to *information* and opportunity to *communicate*, it is clear that a system built on an information access paradigm will be unable to meet these demands. This implies a strategy whereby we seek to privilege supporting communication practices as opposed to disseminating information. This requires recognising that ICTs cannot, do not, and should not be approached as a neutral transmission channel that allows for efficient and (ideally) lossless communication. The "social life of information", i.e. the communicative practices in which information is embedded, is not "noise" to be filtered, but rather what our interventions should place their focus on. Critically, this includes engaging with knowledge cultures different from the organisational, institutional and specialist. We argue that this is a necessary step if ICTs are to be able to contribute to sustainable and agroecological agricultural development.

6 Conclusion: Shifting agricultural ICT4D from I to C

The ability of ICTs to allow for dissemination of advice and practices across wide social, spatial and temporal distances, for which they are commonly lauded, is key to the separation of knowledge from knower [17]. Reliance on such attributes diminishes the tacit and situated knowledges deemed critical to sustainable, agroecological development. It builds on universalist assumptions "obscuring the role of the knower and of the knower's social system" [17]. It is premised on the "myth of information" as separated from the human practice within which it is embedded [19]. Systems built on these attributes commonly conceptualise "knowledge" as an object to be stored, indexed and transferred, designed to separate the outcomes of knowing from the context in which it is experienced or produced. In this view, learning is the successful access to and understanding of such knowledge objects. This form of learning and view of knowledge may not only be unsuitable to sustainable and resilient agricultural systems but may also serve to marginalise and perpetuate inequalities between different actors in the development system [16].

In this paper, we have argued that ICTD for sustainable agricultural development requires approaches that engage with multiple knowledges and collective learning. This entails placing the knowers and the knowers' context in focus, defining learning as part of, and facilitated through, engagement in communities of practice. When it comes to attributes of ICTs, the focus therefore should be on the ways in which they

facilitate shared practice, communication and interaction within and between communities of practice. It also requires ICT strategies to engage with languages and forms of inquiry other than those of specialists or organisational managers, such as individual reflection, storytelling or aesthetic forms.

This holds implications for what we perceive as the purpose of and strategies employed for ICTs for agricultural development. For an organisation, such as the one discussed in this paper, rather than using ICTs as way to transmit knowledge this could translate into systems enabling field workers to better facilitate sharing through scheduling social spaces and face to face encounters. It could also mean, as suggested by one staff member, ICTs which allow the organisation to be better at promulgating values and motivating staff. For agricultural ICT4D interventions in general the broader implication, we argue, is a need to shift our focus from practices and designs related to "Information" towards those emphasising "Communication".

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