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PANDA OR HYDRA?

THE UNTOLD STORIES OF DRIP IRRIGATION

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Introduction of the manuscript as accepted for publication in the Routledge/
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Abstract

The introduction to this book sets out to question why the belief that drip irrigation is a promising technology to save water, modernize agriculture and help the poor remains powerfully intact, despite growing evidence of more contrasted field situations. It pleads for going beyond these narratives to understand the multiple realities of drip irrigation-in-use. This allows showing that drip irrigation is not only a technology but part of broader societal and environmental changes. Unraveling these untold stories raises questions about the accountability and responsibilities over these changes.

Introduction: “... *it works!*”

Irrigated areas in the world are witnessing a transformation from open canal systems to more 'modern' irrigation methods such as drip irrigation that convey water through closed pipe systems. Initially associated with hi-tech irrigated agriculture, drip irrigation is now being used by a wide range of farmers including smallholders in Asia, North Africa and Latin America. Enthused about its potential to save water, improve productivities, and combat poverty, national governments, international development aid organizations, local and global private-sector actors, as well as farmers have enthusiastically embraced drip irrigation. The technology also assumes a prominent place in policy documents and global environmental and development discourses, often figuring as a panacea to help solve contemporary water challenges.

Drip irrigation has left the technosphere in that it no longer is merely a pre-occupation of engineers. It frequently appears in popular media and wide audience publications, where it is referred to as ‘arguably the world's most valued innovation in agriculture’¹. Its attractiveness and popularity rests on several widely circulating ‘success stories’ about the wonders it is capable of bringing about. These include, first of all, its ability to conquer the desert and make it blossom, stories that have their origin in the early days of drip irrigation in Israel and California. Stories of the success of drip irrigation also include those recounting its

importance in helping bring about a water-wise modernization of agriculture. These stories have it that drip irrigation can help improve the efficiency and productivity of large-scale production of fruits and vegetables, while achieving water savings and improvements in water use efficiency (the statement “more crop per drop”, popularized by the former secretary general of the United Nations Kofi Annan, aptly captures this promise). There are, thirdly, also success stories about the capacity of the technology to help turn small-scale farmers into true rural entrepreneurs, who – in the process - work their way out of poverty.

When taken together, drip irrigation can be likened to the “Panda” - the much loved and powerful symbol of the WWF² - in its widespread appeal and popularity. Indeed, the perpetual renewal of the purposes for which the same technology – well not exactly the same, variations on a theme is perhaps a better expression – is proposed is reminiscent of the apparent eternal juvenility and neotenus features of Pandas. Just like the Panda, drip irrigation’s popularity turns it into something that many are keen to be associated with, as this offers a share in the reflections of its glow of goodness, modernity and greenness.

There is nevertheless also a minor strand of literature that engages more critically with drip irrigation, asking (im)pertinent questions about what drip irrigation really does and for whom. Huffaker and Whittlesey (2000) for instance questioned early on the Oregon water conservation programme’s promotion of efficient irrigation methods. They pointed out how the programme narrowly focused on on-farm diversions, while neglecting the return flows at the basin level to conclude that: “*the popular Oregon legislative model may be the least effective in conserving water*”. Others - such as the study of Kulecho and Weatherhead (2005) in Kenya – pointed at the very low adoption rates of drip irrigations systems by smallholders to call into question the success of the technology. Such observations even brought other authors to speak of “*the mostly failed uptake of drip technology in sub-Saharan Africa*” (Garb and Friedlander, 2013).

Do these more critical stories and findings mean that drip irrigation is merely a paper tiger, promoted by an international community looking for yet another silver bullet type but ineffectual solution to the world’s problems, without any connection to field realities? Certainly not. Its rapid spread around the world over the last decades³ shows that drip irrigation is not just a slogan, but is effectively used by millions of farmers in the field. However, it is not sure that farmers adopt drip irrigation for the reasons advocated by the international community or policy makers. Many rather use it to suit their particular conditions and help the multiple problems they face, for example to save labour or time. Moreover, there are many farmers who make a more or less conscious choice not to use drip irrigation, men and women who decided against engaging with it.

The serious questions raised by some about the desirability and effectiveness of very expensive state-sponsored or internationally supported drip irrigation (development) projects have done little to dampen the policy enthusiasm for this technology. We suggest that this may be linked to its plasticity⁴: the fact that it can be mobilized as a “solution” to a range of ever-changing and conjunctural international policy issues including environmental conservation, food security, gender equity, poverty alleviation, agricultural modernization. In this capacity, and to use yet another metaphor, drip irrigation may be likened to a many-

headed Hydra, which grows stronger when one of his heads is slain⁵. Instead of falling out of fashion or being abandoned altogether, the technology continues going strong when confronted with criticisms or problems of adoption. For instance, the serious problems encountered with the promotion of low-cost drip irrigation in Africa (e.g. Garb and Friedlander, 2013) are so far mainly leading to revisions in dissemination strategies or in moving attempts to further spread it to yet another country. The belief that the technology is promising remains powerfully intact, even when ideas about what it is supposed to achieve - helping the poorest, commercializing agriculture, introducing value chain approaches - change. This makes it challenging to have a meaningful conversation about drip irrigation: its context and direction tend to continuously move from water saving to productivity to poverty alleviation. It becomes even more difficult when this hydra - drip irrigation - has become everyone's favourite policy, planning and development tool (why attack a Panda?).

Indeed, the hydra-panda combination that characterizes drip irrigation makes it difficult to talk differently – less positively and more agnostically - about what it is supposed to do (see chapter 2). We experienced this first-hand when telling our preliminary results about what drip irrigation is and does at water and irrigation events: either what we said was politely ignored to move on to the next presentation about the technology's potential and promise, or our stories were dismissed as unfounded attacks on a technology that had “demonstrated” its value. While agreeing that drip irrigation does not always work as designed or hoped, and accepting our evidence about the lack of farmer interest in the technology in West Africa, a representative of one of the largest drip irrigation equipment manufacturing companies worldwide for instance concluded the public debate about drip irrigation at the Stockholm Water Week in 2014 by stating: “*I just want to add one more point: it [drip irrigation] works!*”. The same happened at the first World Irrigation Forum in Mardin, Turkey in 2013: a presentation focusing on the need to study drip irrigation “in context” was followed by a discussion in which a senior Indian researcher stated: “*it is interesting, but in India, it is not like that, drip irrigation works, it saves water*”.

The aim of this book

So what is this book about? Most studies on drip irrigation use plot-level studies to support claims about the technology's potential to save water or improve efficiencies; are grounded in a firm belief in the technology and focus on ways to improve or better realize its potential; and are distinctly managerial in their identification with engineers or policymakers and their use of narrow and rather prescriptive engineering or economic languages. This book, in contrast, looks at drip irrigation-in-use, tracing and making sense of what drip irrigation does in and from the perspectives of the every-day lives of the people who use it. The book stresses that not only farmers “use” drip irrigation; many other actors also invoke the technology in their words and actions, using it for a diversity of reasons and to realize a multiplicity of objectives. These include development workers, national policy makers, international organisations and private companies but also local craftsmen, engineers, extension agents or researchers (like ourselves). Our grounded understanding of drip irrigation reveals that there are much more complex dynamics at play when drip irrigation is used or promoted than the

meta policy-narratives of efficiency, productivity and development that dominate the literature suggest. The book stresses that what drip irrigation is depends on contexts; there are, therefore, many different drip irrigations, just as there are many possible (often untold) stories about how the introduction and use of drip irrigation relates to broader processes of environmental and social change.

This book documents the enthusiasm, spread, and use of drip irrigation in Africa, South Asia, Latin America, and Europe in an attempt to explore and explain under which conditions it works, for whom and with what effects. While anchored in a sound engineering understanding of the design and operating principles of the technology, the book extends its analysis beyond engineering and hydraulics to understand drip irrigation as a socio-technical phenomenon that not just changes the way water is supplied to crops, but also transforms agricultural production systems and even how society is organized - sometimes in unexpected ways.

This book thus aims to unearth some of the untold stories of drip irrigation in use. How farmers and local craftsmen tinkered with drip irrigation to adapt it to different users and uses that were never envisaged at the design stage. How development professionals remained excited about drip irrigation, despite very disappointing adoption rates in the field. Or how peasants felt rejected by the discourse and materiality of drip irrigation, and thus rejected the technology itself.

This introductory chapter first presents the three main discourses and narratives that have come to be closely associated with drip irrigation worldwide, i.e. water savings and efficiency; modernization of agriculture; and poverty alleviation and development. These by-now classic drip tales are at the heart of the current enthusiasm for and popularity of drip irrigation as a “green technology”. The introduction then clarifies how the diverse chapters engage with these classic tales, often challenging the straightforward linear causalities between the technology and its effects that the tales suggest. By telling “the untold stories” of “drip irrigation in use”, the diverse contributions shed a different and often sobering light on drip’s water saving potential, allow deconstructing the standardized vision of what drip irrigation is and can help achieving, or question the often implicit assumptions in drip irrigation promotion strategies about what smallholders are, do, need and aspire to be.

By asking people from very diverse “communities of practice” to contribute to the book, we collected a range of sometimes contrasting viewpoints on and experiences with the dynamics and prospects offered by drip irrigation. Rather than presenting the final truth about drip irrigation, one of the explicit objectives of the book precisely is to provide the reader with a wide range of ideas, framings and perspectives, thereby further underscoring that drip irrigation can and does mean and do different things to different people. The book is meant for a wide audience: irrigation and development professionals, students, scientists, public authorities, donors. While the majority of the book’s case studies have been conducted as part of a coherent research project in which many of the contributors to the book were involved, we have also invited a number of contributions by renowned specialists that were not part of our project.

Some of the book’s chapters critically engage with the question of why the meta-narratives that surround drip remain so powerful in spite of growing evidence of disappointing results.

These analyses remind us of Don Quijote de la Mancha's fight against windmills: the meta-narratives are powerful precisely because they are such wonderful stories – stories that, moreover, resonate remarkably well with powerful desires to believe that it is possible to combine growth with environmental conservation (sometimes referred to as market environmentalism) and with resulting normative ideals about how water responsibilities, rights and powers can best be distributed and arranged. It is far from sure that the untold stories we count here will be as powerful, notably because many of them do clearly not speak from a vantage point of power or dominance. Be that as it may, we nevertheless hope that the book will help diversifying and plurifying the debates about water saving, agricultural development and poverty that drip irrigation has come to be part of, showing how drip irrigation dynamics are part and parcel of broader development and modernization processes that reconfigure relations between the state, civil society and the private sector in ways that are sometimes difficult to predict. In this sense, the book also shows that drip irrigation provides an intriguing entry-point for understanding wider processes of socio-environmental change.

The meta-narratives and classical tales

This book looks at three meta-narratives in particular, i.e. efficiency and water preservation, productivity and agricultural modernization, and poverty and development. These three narratives can unfold independently, but are often mutually constitutive. We understand narratives not only as making sense of (complex) objects, events and processes through storytelling, but also as a mechanism whereby “*sense making by some can affect the sense making and behavior of others*” (Röling and Maarleveld, 1999). In other words, we use the term ‘narrative’ to “*express how perspectives, ‘Leitbilds’, metaphors, stories, images, theories, slogans, and axioms are woven together, become widely shared and dominate behavior*” (*ibid*). We will look at the plot of each narrative, but also at their characters. Character believability is an essential property of narratives because “*the events that occur in the story are motivated by the beliefs, desires and the goals of the characters*” (Riedl and Young, 2004). The heroes (and villains) of each meta-narrative are not exactly the same, even though the same large categories of actors appear in all of them: policy makers, donors, government agents, engineers from private companies, and farmers.

The conservation narrative: drip irrigation saves water due to a high irrigation efficiency

Van der Kooij et al. (2013) unravelled the plot of the conservation narrative that different researchers employ when presenting results of studies to assess and improve drip irrigation efficiency: 1) they use a specific framing of the problem, i.e. the global water crisis; 2) they suggest that drip irrigation is a (contribution) to solving this problem; 3) they refer to other studies highlighting the potential of drip irrigation to improve water efficiencies, 4) they present their case study, 5) they describe the results obtained, showing under which conditions the highest efficiencies can be obtained, 6) they recommend ‘best irrigation practices’ to obtain these. The problem with this story line is first that in almost all cases the results are obtained on experimental fields, with strictly defined and monitored boundary conditions. The assumption is that these are somehow comparable or translatable to what farmers do on theirs,

but this is an assumption that is seldom verified. Second, recommended improvements refer to increases in irrigation efficiency, and thus to a decrease of ‘losses’ or ‘wastage’. However, there is much ambiguity about what can be considered ‘losses’, as water saving at the plot level – the privileged scale of the vast majority of studies – does not necessarily imply any water saving at the river basin level (Seckler, 1996). The authors, therefore, conclude that “*there is no conclusive scientific evidence to support a general belief in drip irrigation as a water saving device or as a tool to help solve the water crisis*” (van der Kooij et al., 2013).

The central actors of this narrative, perhaps surprisingly, are not the farmers but the engineers and irrigation scientists themselves. Farmers rarely make their appearance, although they do figure in the background - as those wasting water with ‘traditional’ irrigation practices, or as those unwilling to adopt modern irrigation technology – to help bring the rightness of the drip irrigation system and the engineer into sharper relief.

The productivity narrative: drip irrigation enables a higher productivity and a modernization of agriculture

This ‘more crop per drop’ narrative is closely interwoven with the water use efficiency narrative, but authors developing this narrative also criticize the narrow technical and plot-level focus of the irrigation efficiency narrative (e.g. Perry, 1999). The water productivity narrative was, perhaps most extensively presented in the International Water Management Institute (IWMI)’s 2003 book on water productivity in agriculture (Kijne et al., 2003). It goes more or less as follows: 1) water and food security are closely related, as water (and not land) is likely to be the most limiting factor in increasing production (this goes back of course to the previous narrative, building on a perceived global water crisis), 2) the solution to food security is thus to be found in improving water management, and more specifically in increasing water productivity, 3) increasing water productivity for agriculture means getting more production, value or benefit “*from each drop of water*”, 4) producing more food with less water will ease water scarcity and leave more water for other uses, including ecosystem services.

Contrary to the previous narrative, in this narrative, farmers assume the centre stage. They are often mentioned in the book and in the associated literature: “*Improvements in crop production can only be made at farm level. They result from the deliberate actions of individual farmers increasing production or the value of output with the same volume of available water or maintaining or increasing productivity using less water.*” (*ibid*; p.9). However, while farmers appear in the plot, their characters remain flat. Sometimes farmers appear as being opposed to irrigation system managers or bureaucrats, who – so the story goes – do not necessarily have the drive to increase water productivity. A distinction is sometimes made between large and small farmers, or between commercial farmers and smallholders. Yet, irrespective of such refinements, farmers’ characters in these narratives remain rather unconvincing and one-dimensional. They tend to be depicted as classical *homo economicus* whose behaviours are mainly guided by financial and economic calculations and rationales. Hence, farmers appear as being primarily interested in producing more crop per drop: “*It can be expected that, when water becomes a real economic good, farmers are more inclined to adopt water saving technologies*” (p. 63). As some chapters of this edited volume show, the

difficulties in transferring best practices from the laboratory to the field provide just one indication that farmers may have other motivations for doing what they do: despite “*impressive successes*” initially (in this case the efficient management of rainwater to improve crop productivity), farmers went back to their “*normal practices*” when researchers went back to check 15 years later (*Ibid*, p. 200).

The poverty and development narrative: drip irrigation support the emergence of a vibrant & entrepreneurial smallholder based agriculture

The third encompassing narrative relates to the poverty alleviation potential of drip irrigation. Articulated first by development practitioners and researchers who were joined later on by global drip irrigation equipment manufacturers looking to further their corporate social responsibility policy, this narrative acquired widespread resonance in the late 1990s/early 2000s. This story starts by announcing that an agricultural revolution supported by drip irrigation (i.e. modernization) is happening, but that smallholders in developing countries are missing out on it (see Hillel, 1988). It continues by referring to the first two narratives; stressing the potential of drip irrigation in terms of improving agricultural productivity and water use efficiency; and then continues by relating the former to increases in income –hence poverty alleviation (through the sales of agricultural products). What the story stresses, then, is the existence of a new spectrum of drip irrigation systems “*that could form the backbone of a second green revolution, this one aimed specifically at poor farmers in Sub-Saharan Africa, Asia, and Latin America*” (Postel et al, 2011, p3).

The narrative has two main characters. The first is an artefact, “the drip kit” which is presented by its promoters as affordable, small size, and infinitely expandable (Polak, 2008). As such the kits provide a ‘solution’ to two major reasons why drip irrigation has, according to the story, eluded smallholders in developing countries for decades: high initial investment costs and complexity of use (the kits come together with a simple user manual). That they are said to be expandable (as for Lego, it is said that kits can be combined to one to another) also signals that farmers using them are not meant to continue to be locked in a “poverty trap”, something that positively distinguishes drip kits from other ‘small-scale’ technical innovations. The second character is the smallholder farmer him- or herself. In the story, smallholders are said to be poor because “they do not earn enough money” (Polak, 2008). On the face of it, this is a statement that seems difficult to challenge. However, it is also a statement that overlooks the structural and political dimensions of development and poverty – which are, as a result, being black boxed and pushed aside. In the story, the smallholder appears as a (potentially) innovative, entrepreneurial and business minded individual, who - if given a simple enough ‘product’ and appropriate support - will work his/her way out of poverty by selling vegetables for the market. What made this story particularly attractive to a range of actors in recent years is the fact that it brought together (1) an image of smallholder modern enough to be supported, (2) and an approach that focused on adopting market-based principles for the promotion of the technology (see Venot, 2016 for a critique).

How to unearth the untold stories of drip irrigation?

The literature that inspired us in our quest for unravelling the untold stories was diverse. The overall framework of the book builds on science and technology studies (STS), envisaging technology as part of co-evolutionary socio-technical networks that weave together heterogeneous materials - artefacts, people, institutions, cultural meanings and knowledge - into working wholes (see chapter 2 for an elaboration). Within this integrative framework, the questions the book addresses include: How is drip irrigation materially and discursively constructed and used in different water and development domains; which and whose goals do such constructions serve; and what are the social and environmental impacts of drip irrigation use? These questions are important inputs for larger reflections about how drip irrigation and the socio-natural transformations that it is part of and contributes to re-configure possibilities for democratically organizing agriculture and water governance.

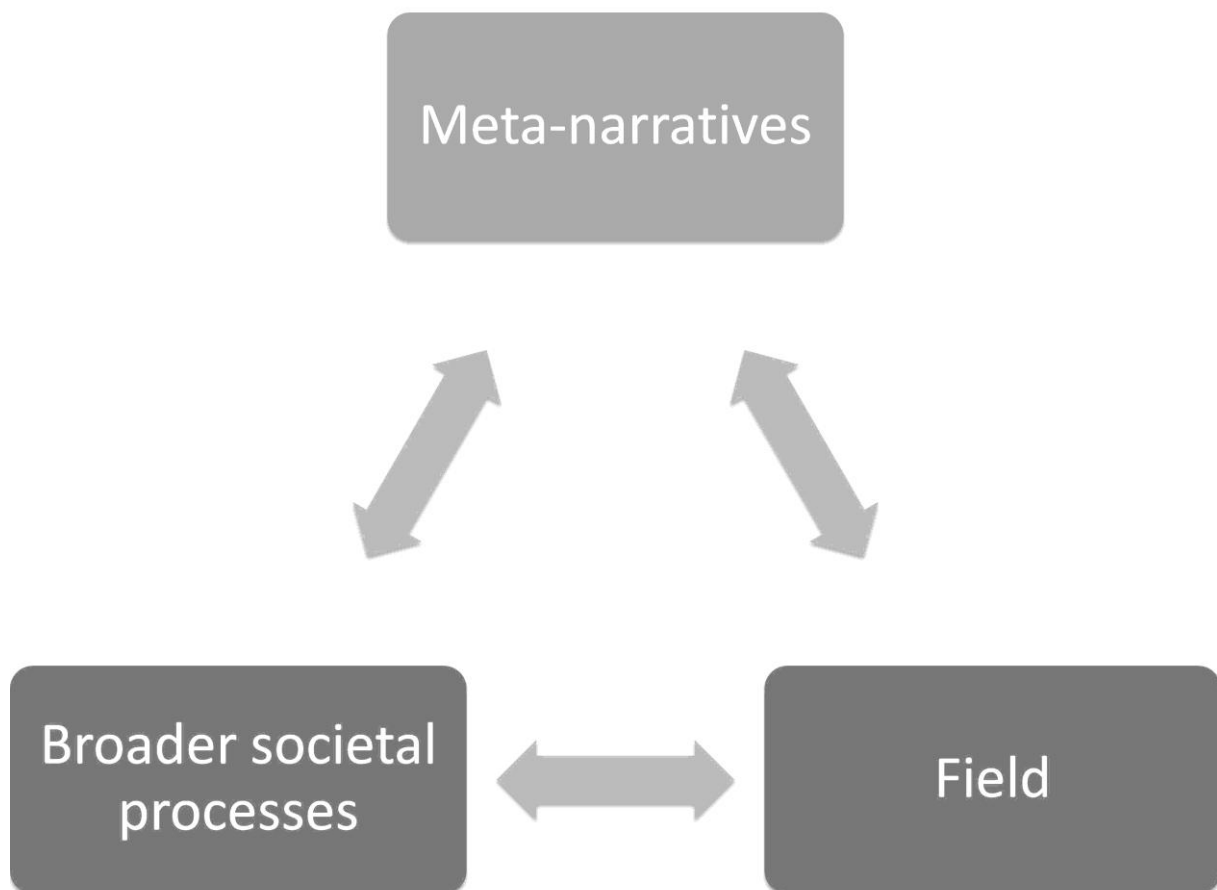
Other sources of inspiration include the water sciences, in particular the irrigation performance debate that has yielded many valuable insights on how to look at irrigation technology in use (e.g. Burt et al., 1997). Another feature of this literature that we build upon is the pragmatic approach to drip irrigation that is apparent in some of the reference works on the topic, showing not only the advantages but also the disadvantages of the technology: “*Microirrigation, as with other irrigation methods, cannot be used for all agricultural crops, land situations, or user objectives*” (Lamm et al., 2006, p. 1). However, this common-sense and practical attitude of some engineers is not often found in more scientific articles that report on drip irrigation, and even disappears further when drip irrigation ‘travels’ to other circles (donors, policy makers, etc.). Finally, we draw from a limited number of studies that confront the theoretical and practical advances on, for example, performance indicators, with farmers’ practices and motivations, instead of just focusing on studies in experimental settings under controlled conditions (e.g. Benouniche et al., 2014).

Recent advances in innovation systems research, in particular those applied to the agriculture sector, also inform many contributions of this book. This literature challenges linear technology transfer models to draw attention to the fact that “*innovation results not just from variation (trying something new), but also from selection (finding things better than what is currently used) and incorporation into long, complex processes*” where different types of knowledge are creatively used by a diversity of actors (Spielman et al., 2009). These insights are helpful to decentre the technology in research, instead moving the attention to the interactions between technology and society, which brings us back to STS studies.

In line with the third meta-narrative of drip irrigation, several contributions of this book also draw from the field of the anthropology of development, and a sub-stream of work that highlights the importance of the interpretation of events over the events themselves (see for instance, Li, 2007; Mosse, 2005). This literature is extremely useful to understand the persistence of a paradox: that of a persistent positive imagery of drip irrigation among development professionals and the near absence of drip irrigation use by smallholders in sub-Saharan Africa. The “will to improve” (Li, 2007) and a widely held belief in technology as a driver of change that still characterizes development interventions are strong enough to see in past failures, reasons to continue promoting a technology that ‘has proved itself’.

Lastly, some chapters in the book were inspired by feminist technoscience studies, in particular their insistence on the methodological importance of starting inquiries from the perspective of those events, phenomena or people that do not fit prevailing categorisations or standards, or those that are not included in the actor-networks studied. What about the peasant farmers in Chile, Peru or Mexico who choose not to irrigate their crops with drip irrigation? And what about the sisters, daughters and wives of the Moroccan men who established their future and modernity by installing drip irrigation on their plots?

Figure 1. The research approach that inspired the contributions in this book



From a more practical standpoint, we took the three meta-narratives as a starting point for structuring the book. We then proceeded in two directions. First, we used field/plot dynamics to find out how the narratives unfolded in different contexts, looking both at the discourses and the materiality of drip irrigation-in-use. For example, a study was undertaken in Morocco to assess whether at all and if so how much water was saved during the implementation of drip irrigation (see chapter 5). Second, we engaged with the meta-narratives by assessing how they had been elaborated, by whom and for what, and by investigating how they are part of broader processes of development and change. For example, a study on the implementation of low-cost drip irrigation in Burkina Faso extended the usual scope of analysis (focusing on (dis)-adoption dynamics) to explain the paradox of the framing of drip irrigation projects as successes even though drip irrigation use remains anecdotal (see chapter 13). Decentralizing

the analysis as such by revealing broader societal processes and field realities allows, in turn, to critically analyse the making of the meta-narratives (see figure 1).

The untold stories: Contrasted views grounded on empirical evidence

As the debate on drip irrigation is dominated by overarching all-encompassing statements, there are many drip irrigation stories that remain untold. These include for instance the story about how millions of smallholders engage in practices of “bricolage” to make hi-tech systems fit their specific circumstances (chapter 15); stories about the fact that drip irrigation rarely travels out of development arenas in sub-Saharan Africa (chapters 12 to 14); or again stories about how farmers adopt drip irrigation because it allows farming to become a white-collar profession rather than because it saves water (chapter 6).

Before telling these stories, based on empirical evidence, the book starts with three overview chapters to provide a general picture of drip irrigation dynamics. Chapter 1 recounts how drip irrigation conquered the world, travelling to different continents, and how – broadly speaking – the meta-narratives unfold around the world. While doing so, the chapter highlights that drip irrigation progressively left the realm of engineers and experts to enter more global water policy and private business arenas. Chapter 2 provides a more theoretical background to the book by specifying how a practice-based understanding of drip irrigation enriches the discussion about the technology’s performances in a range of contexts. Chapter 3 provides an engineering viewpoint showing that drip irrigation is not a standardized technological package, but is re-engineered by farmers, local craftsmen and engineers to fit specific bio-physical and socio-economic requirements.

Once the scene is set, the core of the book is then composed of three different sections, representing the three meta-narratives. The first section is about ‘Efficiency and Water Saving’ with three chapters on North Africa. Chapter 4 shows how the efficiency argument is often used to re-allocate water, which is ‘yet-to-be-saved’, to other uses, ultimately leading to an increase pressure on water resources. Chapter 5 zooms in on the paradox of continued promotion of drip irrigation on the basis of claims of water saving that are rarely backed up with evidence. Illustrated by field evidence, this chapter shows that increased water productivity enhances the pressure on groundwater resources. Chapter 6 is also about groundwater, but looks at how drip irrigation in the Saiss region in Morocco is instrumental in bringing about “enclosures” of water, channelling it to some while making it increasingly difficult to access for others. The chapter thus shows that drip irrigation – at least in this specific context – forms part of and helps bringing about larger transformations in water- and land tenure relations.

The next section is about the water productivity meta-narrative, and more broadly about the modernization and agrarian change that drip irrigation forms part of and helps bring about. This section is composed of four chapters that narrate experiences with drip irrigation in South and Central America (Chile, Mexico, Peru), and North Africa. Chapter 7 shows how the State in Chile promoted drip irrigation for peasants to resolve a water crisis, which was in

part created by promoting intensive export-oriented agriculture. It tells the story of how peasants refuse the technology, as the State (and its subsidy programme) – as they say, does not “*accept our way of life*”. Basically, official government discourses contrasts and compares peasants to the virtual entrepreneurs they are to become according to the new neoliberal doctrine. Chapter 8 shows how drip irrigation enabled large agribusiness companies to conquer the desert and produce luxury goods for export on the desert coast of Peru. The infrastructural works necessary to provide water to these companies were justified with the efficiency as well as the water productivity meta-narrative. The smallholders in the area also benefitted, to some extent, from this project, but the costs and benefits of drip irrigation development are unevenly distributed over the different stakeholders, while promised water savings are not realized. Chapter 9 shows how, in the state of Guanajuato in Mexico, drip irrigation subsidy programmes mainly benefitted large agro-industries, which were in a position to influence the formulation of such programmes. Drip irrigation in this context remains an elite technology, facilitating the accumulation of capital by these industries. Chapter 10 highlights that drip irrigation is the newest of a long suite of technological artefacts that have supported a dual vision of the Moroccan agriculture over the last century. It provides two contrasting examples of technological change and rural development in Morocco. In the first case, the technology was implemented by the state in association with a large sugar-processing industry in a process that ignored the capacities of farmers to innovate and engage with modernization. Farmers were provided with a black-boxed technology and were made to confront the risks associated with the project, ultimately leading to the failure of the project. In the second case, farmers took the initiative themselves, slowing down or accelerating the implementation of drip irrigation whenever required. By this continuous learning process, peasants succeeded to enhance their autonomy and resilience.

The section on ‘Poverty and Development’ is based on various case studies on the introduction of low-cost drip irrigation in Asia (India, Myanmar, and Nepal) and in Sub-Saharan Africa (Burkina Faso, Ethiopia, and Zambia). Chapter 11 discusses the value and limitations of “drip kits”, showing that smallholders in India and Myanmar prefer by far having access to the different components than to be provided with pre-packaged entire kits. The chapter also highlights the importance of significant and long term research and development efforts, and notably the necessary technical and institutional re-design that is needed when introducing a technological artefact in a new context. Chapter 12 takes us inside Zambia’s households, showing how drip irrigation tends to be taken up mostly by the more business-oriented entrepreneurial male farmers. This favours the intra-household bargaining positions of men and works as a mechanism that makes it more difficult for women to derive benefits from low-cost irrigation technologies. Chapter 13 takes place in Burkina Faso, showing the persistent enthusiasm of development actors for drip irrigation - who see and present it as an effective tool to alleviate poverty, improve food security and save water – even in the absence of sustained use of drip kits by farmers. The chapter then provides some explanation for why development actors continue promoting drip kits even when there is little empirical evidence to support the belief that, indeed, they deliver on these promises. Chapter 14 follows and reviews experiences with the donor-supported promotion of low-cost low-pressure drip irrigation kits in sub-Saharan Africa over the past 15 years, noting that no

credible impact assessments of these programs have taken place. It investigates the ‘vested-interests’ hypothesis to explain the continued interest of donors in such technologies, and proposes positive advice to move forward, including the fact that researchers and development practitioners must get away from focusing on testing single technologies and instead should open up to multiple interested parties and a menu of technologies and practices.

After these three sections, closely linked to the three meta-narratives of drip irrigation, the next – and last – section of the book focuses on the alliances and networks in which drip irrigation innovation actually takes place. Chapter 15 looks at the process of ‘bricolage’, understood here as a creative process of learning and adaptation with smallholders co-steering the design process with engineers, thereby changing both the users’ context and the drip irrigation technology itself. The chapter explains that the fact that drip irrigation lends itself to ‘bricolage’ helps explain its success as an innovation. Chapter 16 then focuses on farmer-led innovation of drip irrigation in Algeria’s Sahara. It describes a true ‘innovation factory’ that involved thousands of farmers who gradually improved the technology for different local conditions. The factory produced technical innovations, but also local actors capable of innovating in new situations. Chapter 17 moves away from the farmers and presents the ‘grey’ support sector, providing farmers with equipment, advice and credit. Based on a case study in Morocco, the chapter highlights the fact that these intermediaries not only supply and adapt the technology in close association with farmers, but also help manufacturers to provide technology adapted to local demand. Finally, chapter 18 moves another level away from farmers and deals with the networks and alliances involved in establishing and managing subsidy schemes. It shows how the state of Gujarat (India) set up a business-like semi-autonomous public company to handle subsidy delivery. It highlights that the positive image of drip irrigation in the State is more related to the amount of subsidies distributed and to the surface area equipped with drip irrigation rather than on the actual use of it and on who benefitted from the subsidy programme.

Conclusion: bringing common sense back about drip irrigation?

To conclude, this book is about how to challenge conventional wisdoms about drip irrigation. It is about understanding how drip irrigation has come to be seen as a “Panda”: something that everybody loves and that therefore becomes almost unquestionable. The book does so through an empirically grounded analysis of the multiple realities of drip irrigation-in-use. It first uses case studies and analyses to critically question the likelihood that the introduction of or a conversion to drip irrigation will lead to water savings. Secondly, it discusses the social and environmental desirability of the types of agricultural modernization that drip irrigation forms part of or helps promote, also exploring alternatives. And thirdly, it revisits the attractiveness of low-cost drip irrigation technologies as a tool for alleviating poverty, also using the findings to raise some larger questions about the practices of international development cooperation. Telling the untold stories about the every-day and often messy realities of drip irrigation is also laying bare some larger challenges of water governance, challenges about how to democratically organize and account for water uses and interventions when these

escape public forms of control. It shows how strong political choices favour certain agricultural development models and questions the related increasing influence of global private actors and the impact it has on smallholders.

As a whole, the book underscores that the enthusiasm that surrounds drip irrigation as a technology is primarily based on a theoretical construct, that of its “potential” and “promises”, rather than on what it achieves and does in farmers' fields or river basins. Yet, many public, civil society and private sector actors strategically make use of stories about this potential to negotiate funds, mobilize political support or justify re-allocations of water. This, together, with the difficulty to voice alternative stories, sometimes makes the panda look like a hydra. Those responsible for promoting drip are seldom, if ever, held accountable when the promises of drip irrigation are not met. Instead, the shortcomings of on-going initiatives are used as further justification to increase support for the technology: failures thus become incentives to invest even more in the creation of the necessary conditions needed to make drip irrigation perform well.

Finally, our work suggests that the journey of drip irrigation is not over. The hardware, the discourses and the success stories will continue to travel to other destinations, other users and uses, and other political arenas. We hope that some of the common sense that prevailed when drip irrigation was not yet the global success it is now portrayed to be, can be regained, also to direct much needed attention to the wider processes of environmental and social change that drip forms part of or helps promote.

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Endnotes

¹ E.g. <https://en.wikipedia.org/wiki/Dripirrigation>, accessed on October 19th, 2016.

² Interestingly, there is a direct link between drip irrigation and the WWF panda, as WWF itself also promotes drip irrigation (see <http://wwf.panda.org/wwfnews/?159841/Modern-irrigation-techniques-could-save-Turkeys-water>; accessed on October 31, 2016).

³ According to the International Commission for Irrigation and Drainage, about 11.1 million ha is now under drip irrigation worldwide. This figure is likely to be largely underestimated (see also the FAO Aquastat database, and chapter 1 of this book). While the area under drip irrigation is considerable, and the associated investments substantial (at about 5,000€ per ha, the aggregate investment cost realized to date would amount to 55.5 billion € - not accounting for the necessary maintenance and replacement of the system), this should be compared to the total surface area under irrigation, which is about 300 million ha (Siebert et al., 2010).

⁴ Or perhaps “fluidity”, see De Laet and Mol, 2000 or chapter 2.

⁵ The hydra is a Greek and Roman multi-headed mythological figure guarding one of the entrances to the underworld. It was invulnerable as soon as it retained a head (and several heads grew back each time a head was cut). It was eventually killed by Heràkles.